

Australian/New Zealand Standard™

**Safe working on or near low-voltage
electrical installations and equipment**



AS/NZS 4836:2011

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-044, Safe Working on Low-voltage Electrical Installations. It was approved on behalf of the Council of Standards Australia on 22 March 2011 and on behalf of the Council of Standards New Zealand on 1 April 2011. This Standard was published on 4 May 2011.

The following are represented on Committee EL-044:

Australasian Railway Association
Australian Council of Trade Unions
Australian Industry Group
Communications Electrical and Plumbing Union
Department of Building and Housing (New Zealand)
Department of Industry and Investment New South Wales
Department of Justice and Attorney General, Queensland
Electrical Contractors Association of New Zealand
Electrical Institute (New Zealand)
Electrical Safety Organisation (New Zealand)
Electricity Association of New South Wales
Electricity Standards & Safety (Tasmania)
Energy Safe Victoria
Energy Safety WA
Hunter Industry Safety Network
National Electrical and Communications Association
NSW Office of Fair Trading Department of Commerce
Telstra Corporation
WorkCover NSW

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.saiglobal.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR 10021.

Australian/New Zealand Standard™

Safe working on or near low-voltage electrical installations and equipment

First published as AS/NZS 4836:2001.
Second edition 2011.

COPYRIGHT

© Standards Australia Limited/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Australia) or the Copyright Act 1994 (New Zealand).

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, Private Bag 2439, Wellington 6140.

ISBN 978 0 7337 9832 0

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-044, Safe Working on Low-voltage Electrical Installations to supersede AS/NZS 4836:2001, *Safe working on low-voltage electrical installations*.

The objective of this Standard is to provide workers on low-voltage electrical installations and equipment with—

- (a) the principles of safe working practices; and
- (b) recommended procedures for safe working practices.

This edition of AS/NZS 4836 contains additional information on the following:

- (i) Principles of risk management, assessment of risk and risk treatment.
- (ii) Working with asbestos and PCBs.
- (iii) Working below ground level.
- (iv) Cutting cables and wiring enclosures.
- (v) Selection and use of test equipment.
- (vi) Selection and use of personal protective equipment (Table 9.2).
- (vii) Preservation of an incident scene.

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.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	5
1.2 APPLICATION	5
1.3 ACTS AND REGULATIONS	5
1.4 ADDITIONAL REQUIREMENTS	5
1.5 REFERENCED DOCUMENTS	5
1.6 DEFINITIONS	8
SECTION 2 PRINCIPLES OF RISK MANAGEMENT AND ASSESSMENT OF RISK	
2.1 GENERAL	11
2.2 PRINCIPLES	11
2.3 IDENTIFY THE HAZARDS	11
2.4 ASSESSING AND PRIORITIZING THE RISKS	14
SECTION 3 RISK TREATMENT	
3.1 APPLYING CONTROL MEASURES	16
3.2 ISOLATION	19
3.3 FAULT FINDING OR TESTING	24
3.4 TESTING PLUG-IN ELECTRICAL EQUIPMENT	25
3.5 WORK ON EXPOSED ENERGIZED CONDUCTORS OR LIVE CONDUCTIVE PARTS	25
3.6 CUTTING CABLES OR WIRING ENCLOSURES	27
3.7 REMOVING OUT-OF-SERVICE ELECTRICAL EQUIPMENT AND CABLES....	27
3.8 CONTROL MEASURES WHEN LEAVING WORK UNFINISHED	27
3.9 RISK CONTROL FOR SPECIAL SITUATIONS	28
SECTION 4 RE-ENERGIZATION OF ELECTRICAL INSTALLATIONS AND EQUIPMENT	
	33
SECTION 5 SAFETY EQUIPMENT AND TOOLS	
5.1 GENERAL	34
5.2 INSULATED TOOLS AND EQUIPMENT	34
5.3 PORTABLE ELECTRIC TOOLS	34
5.4 LADDERS AND STEP LADDERS	35
5.5 ELEVATING WORK PLATFORMS AND SCAFFOLDING	36
5.6 USE OF INDUSTRIAL FALL-ARREST SYSTEMS AND DEVICES	36
5.7 INSULATING BARRIERS, COVERS AND MATS	36
SECTION 6 SAFETY OBSERVERS	
6.1 GENERAL	37
6.2 GENERAL PRINCIPLES	37
SECTION 7 TEST EQUIPMENT	
7.1 GENERAL	38
7.2 SUITABILITY OF EQUIPMENT	38
7.3 TEST EQUIPMENT VERIFICATION	39

	<i>Page</i>
SECTION 8 TRAINING, QUALIFICATIONS AND COMPETENCE	
8.1 GENERAL	40
8.2 SUPERVISION	40
SECTION 9 PERSONAL PROTECTIVE EQUIPMENT.....	41
SECTION 10 ELECTRICAL INCIDENTS	
10.1 MEDICAL ATTENTION.....	43
10.2 PRESERVATION OF INCIDENT SCENE.....	43
10.3 REPORTING.....	43
APPENDICES	
A TYPICAL RISK ASSESSMENT FORM.....	44
B CASE STUDIES OF ELECTRICAL INCIDENTS.....	47
C ACTS AND REGULATIONS	50

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard

Safe working on or near low-voltage electrical installations and equipment

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard outlines principles and procedures of safe work, organization and performance on or near low-voltage electrical installations and equipment. It provides a minimum set of procedures, safety requirements and recommendations to manage the hazards associated with electricity, specifically arc blast, arc flash, electric shock and electrocution. Adopting these will provide a safe working environment for work on or near low-voltage electrical installations (see Clause 1.6.9) and equipment (see Clause 1.6.8).

1.2 APPLICATION

This Standard applies to all persons carrying out work on or near low-voltage electrical installations and equipment.

It is the responsibility of all persons to ensure that the work they are doing does not present a risk to themselves and others at the work site or at a remote location.

1.3 ACTS AND REGULATIONS

All employers and persons involved in the electrical industry have legal responsibilities under various Acts of parliament, associated regulations called up by an Act, or documents called up by an Act or regulation (collectively known as statutory requirements).

Details of some of these statutory requirements and the government agencies responsible for their administration are set out in Appendix C. It is the responsibility of employers to ensure that the latest versions of these documents and any other relevant occupational health and safety requirements are applied at all work sites.

1.4 ADDITIONAL REQUIREMENTS

Some work sites may be subject to additional requirements imposed either by company policy or by contractual arrangement.

1.5 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
1270	Acoustics—Hearing protectors
1319	Safety signs for the occupational environment
1892	Portable ladders
1892.2	Part 2: Timber
2225	Insulating gloves for electrical purposes
2550	Cranes—Safe use
2550.10	Part 10: Elevating work platforms

AS	
2676	Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings
2676.1	Part 1: Vented cells
2676.2	Part 2: Sealed cells
2865	Safe working in a confined space
3190	Approval and test specification—Residual current devices (current-operated earth-leakage devices)
3527	Hand-operated screwdrivers and screwdriver bits
3527.2	Part 2: Insulated screwdrivers
4024	Safeguarding of machinery
4024.1	Part 1: General principles
4202	Insulating covers for electrical purposes
4741	Testing of connections to low voltage electricity networks
60529	Degrees of protection provided by enclosures (IP Code)
61010.1	Safety requirements for electrical equipment for measurement, control and laboratory use—General requirements (IEC 61010-1:2001, MOD)
AS/NZS	
1336	Recommended practices for eye protection in the industrial environment
1337	Eye protectors for industrial applications
1715	Selection, use and maintenance of respiratory protective equipment
1716	Respiratory protective devices
1768	Lightning protection
1801	Occupational protective helmets
1891	Industrial fall-arrest systems and devices
1891.1	Part 1: Harness and ancillary equipment
1891.4	Part 4: Selection, use and maintenance
1892	Portable ladders
1892.1	Part 1: Metal
1892.3	Part 3: Reinforced plastic
1892.5	Part 5: Selection, safe use and care
2161	Occupational protective gloves
2161.4	Part 4: Protection against thermal risks (heat and fire)
2210	Safety, protective and occupational footwear
2210.1	Part 1: Guide to selection, care and use
2210.2	Part 2: Test methods (ISO 20344:2004, MOD)
2381	Electrical equipment for explosive atmospheres—Selection, installation and maintenance
2381.1	Part 1: General requirements
2978	Insulating mats for electrical purposes
3000	Electrical installations (known as the Australian/New Zealand wiring rules)
3012	Electrical installations—Construction and demolition sites
3017	Electrical installations—Testing guidelines

AS/NZS

- 3760 In-service safety inspection and testing of electrical equipment
- 3800 Electrical equipment for explosive atmospheres—Repair and overhaul
- 3832 Electrical installations—Cold-cathode illumination systems
- 4576 Guidelines for scaffolding
- 4804 Occupational health and safety management systems—General guidelines on principles, systems and supporting techniques
- 60079* Explosive atmospheres
- 60079.14* Electrical installations design, selection and erection
- 60079.17* Electrical installations inspection and maintenance
- 61008 Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)—
- 61008.1 Part 1: General rules
- 61009 Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
- 61009.1 Part 1: General rules
- 61241* Electrical apparatus for use in the presence of combustible dust
- 61241.14* Part 14: Selection and installation
- 61558 Safety of power transformers, power supply units and similar (all parts)

* AS/NZS 60079.14 and AS/NZS 60079.17 are running in parallel with AS/NZS 61241.14 and the AS/NZS 2381 series for two years from September 2009.

AS/NZS ISO

- 31000 Risk management—Principles and guidelines
- IEC
- 60900 Live working—Hand tools for use up to 1000 V a.c. and 1500 V d.c.
- 61111 Live working—Electrical insulating matting
- 61112 Live working—Electrical insulating blankets
- 61229 Rigid protective covers for live working on a.c. installations
- 61479 Live working—Flexible conductor covers (line hoses) of insulating material
- BS EN
- 60900 Live working. Hand tools for use up to 1000 V a.c. and 1500 V d.c
- ASTM
- D178 Standard specification for rubber insulating matting
- D1048 Standard specification for rubber insulating blankets
- D1049 Standard specification for rubber insulating covers

OTHER DOCUMENTS

- Electricity Engineers Association of New Zealand, *Safety manual—Electricity industry*
- Electricity Engineers Association of New Zealand, *Guide to livening of service connections to premises*
- Australian Department of the Environment, Water, Heritage and the Arts, *Identification of PCB-Containing capacitors*

1.6 DEFINITIONS

For the purpose of this Standard, the definitions in AS/NZS 3000 and those below apply.

1.6.1 Appropriate

Being suitable and proper for the duty concerned.

1.6.2 Approved

Having a relevant organization's endorsement for a specified function.

1.6.3 Competent person

A person, who has acquired, through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly.

1.6.4 De-energized

Separated from all sources of supply, but not necessarily isolated, earthed or out of commission.

1.6.5 Discharge

The removal of an electric charge by the application of a suitable discharge device.

1.6.6 Disconnected

Physically separated from any source of electrical energy, and where necessary insulated or secured in a position clear of any electrical equipment that is capable of being energized.

1.6.7 Earthed

Connected to the general mass of earth in accordance with the appropriate requirements of AS/NZS 3000.

1.6.8 Electrical installation

Electrical equipment installed for the purposes of conveyance, control, measurement or use of electricity, where electricity is or is to be supplied for consumption. It includes electrical equipment supplied from a distributor's system or a private generating system.

NOTE: An electrical installation usually commences at the point of supply and finishes at a point (in wiring), but does not include portable or stationary electrical equipment connected by plug and socket-outlet (other than where a socket-outlet is used to connect sections of the fixed installation).

1.6.9 Electrical work

The actual physical work of installing, maintaining, repairing, altering, removing or adding to an electrical installation or the supervising of that work.

1.6.10 Electrical worker

A person carrying out electrical work.

1.6.11 Energized

Connected to a source of electrical supply or subject to hazardous induced or capacitive voltages.

1.6.12 Equipment (electrical)

Wiring systems, switchgear, control gear, accessories, appliances, luminaires and fittings used for such purposes as generation, conversion, storage, transmission, distribution or utilization of electrical energy.

1.6.13 Exposed conductive part

A conductive part of electrical equipment that—

- (a) can be touched with the standard test finger as specified in AS/NZS 3100; and
- (b) is not a live part but can become live if basic insulation fails.

Exception: The term ‘exposed conductive part’ does not apply to the following:

- (i) Conductive parts within an enclosure where the parts cannot be touched unless a key or a tool is required to remove the covers of the enclosure.
- (ii) Conductive parts within electrical equipment where the parts cannot be touched in normal use and movement of the electrical equipment, because of its configuration and size.
- (iii) Conductive parts that are effectively and permanently separated from live parts by—
 - (A) double insulation; or
 - (B) other conductive parts that are earthed.
- (iv) Conductive parts that are in the form of nameplates, screw heads, covers and similar attachments that cannot become live in the event of failure of insulation of live parts because of the manner in which they are supported and fixed.
- (v) A removable or hinged conductive panel fitted to a switchboard or other enclosure containing conductors that are so located and/or restrained that, in the event of any conductor becoming detached from a terminal or mounting, the conductor is incapable of making contact with the panel.

1.6.14 Fault finding

The process of taking measurements or carrying out tests on electrical installations and equipment to locate faults or prove operability. It may also include the process of applying testing instruments or devices to various parts of the electrical installation and equipment to determine how the electrical installation and equipment is operating.

1.6.15 Hazardous area

An area in which an explosive atmosphere is present or may be expected to be present, in quantities that require special precautions, when working on electrical installations and equipment or using test equipment.

1.6.16 Insulated

Separated from adjacent conducting material by a non-conducting substance or airspace permanently providing resistance to the passage of current, or to disruptive discharges through or over the surface of the substance or space, to obviate danger of shock or injurious leakage of current.

1.6.17 Isolated (electrically)

Separated from all possible sources of electrical energy and rendered incapable of being energized unintentionally.

1.6.18 Isolator

A device which for reasons of safety, provides in the open position, breaks appropriate to the voltage and the insulating medium.

1.6.19 May

Indicates the existence of an option.

1.6.20 Personal protective equipment (PPE)

Clothing, equipment and/or substances, which when worn or correctly used, protect parts or all of the body from foreseeable risk of injury or disease at work or in the workplace.

1.6.21 Ripple-free d.c.

For sinusoidal ripple voltage, a ripple content not exceeding 10% r.m.s.

NOTE: The maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system.

1.6.22 Risk

The likelihood and consequence of injury or harm occurring.

1.6.23 On or near

A situation where an electrical worker is working on or near exposed energized conductors or live conductive parts and there is a reasonable possibility that the electrical worker's body, or any conducting medium the electrical worker may be carrying or touching during the course of the work, may come closer to the exposed energized conductors or live conductive parts than 500 mm. The term 'on or near exposed energized conductors or live conductive parts' does not apply if the uninsulated and energised part is safely and securely shielded by design, or segregated and protected with barricades or insulated shrouding or insulating material to prevent inadvertent or direct contact.

1.6.24 Safety observer

A person who has been specifically assigned the responsibility of observing and warning against the unsafe approach to electrical equipment, exposed energized conductors or live conductive parts and other potential risks

1.6.25 Shall

Indicates that a statement is mandatory.

1.6.26 Should

Indicates a recommendation.

1.6.27 Testing

The use of test instruments or test equipment by a competent person.

1.6.28 Voltage

Differences of potential normally existing between conductors or between conductors and earth as follows:

- (a) *Extra-low voltage* Not exceeding 50 V a.c. or 120 V ripple-free d.c.
- (b) *Low voltage* Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.
- (c) *High voltage* Exceeding low voltage.

1.6.29 Zero energy state

The isolator position in which the energy source has been deemed to have been dissipated and controlled.

SECTION 2 PRINCIPLES OF RISK MANAGEMENT AND ASSESSMENT OF RISK

2.1 GENERAL

To work on or near any electrical installations and equipment, it is first necessary to determine whether it is safe to do so. This can be done before starting work by applying a risk management system at each and every work site.

The first aim shall be to eliminate the risk.

If risk assessment indicates that risks cannot be sufficiently controlled to enable the work to be done safely, then the work shall not proceed.

Risk control principles and procedures for electrical work are covered in Section 3.

NOTES:

- 1 AS/NZS 31000 provides guidance on the establishment and implementation of the risk management process.
- 2 AS/NZS 4804 provides guidance on the development and implementation of occupational health and safety management systems.
- 3 Regulatory authorities in Australian states and territories and in New Zealand may have requirements for work in these areas (see Appendix C)

2.2 PRINCIPLES

The principles of risk management comprise—

- (a) identifying the hazards;
- (b) assessing and prioritizing the risks; and
- (c) applying control measures to the identified risks.

2.3 IDENTIFY THE HAZARDS

2.3.1 General

Identify all the hazards and environmental considerations (e.g. position of exposed energized conductors or live conductive parts, cramped conditions, moving equipment such as cranes or transfer cars, hot or wet conditions and hazardous areas).

Do not operate switches under load unless they are designed for the purpose.

NOTE: All other non-electrical sources of energy (e.g. counterweights on machines and stored hydraulic and pneumatic energy) should be considered. AS 4024.1 provides guidance on the safeguarding of machinery.



WARNING: ALL ELECTRICAL CONDUCTORS AND PARTS, INCLUDING NEUTRAL AND EARTHING CONDUCTORS, SHALL BE TREATED AS ENERGIZED UNTIL PROVEN DE-ENERGIZED.

* TEST BEFORE YOU TOUCH *

2.3.2 Electric shock

There are many sources of electric shock. Some of these are as follows:

- (a) Voltages between phases, and between phases and neutral.
- (b) Voltages between phases and earth (including metalwork, damp situations, other conductive surfaces and persons nearby).
- (c) Voltages across open switch contacts.
- (d) Voltages across undischarged capacitors, e.g EMI filters.
- (e) Voltages on disconnected conductors (particularly neutrals).
- (f) Voltages caused by static electricity.
- (g) In multiple earthed neutral (MEN) electrical installations or systems, the rise in the earth potential in an electrical installation due to a high resistance return path to the supply neutral.
- (h) Induced voltages.
- (i) Voltages across secondary terminals of transformers, including current transformers.
- (j) Voltages between different earthing systems.
- (k) Incorrect wiring connections.
- (l) Faulty electrical equipment or wiring, which may result in the frame of the electrical equipment being energized.
- (m) Voltages from other sources of supply, e.g. illegal connections, uninterruptible power supplies, motor generators, inverters, solar panels and wind generators.
- (n) Lightning.
- (o) Breaking of the continuity of the incoming water supply.
- (p) Voltages triggered inadvertently through the operation of float switches, thermostats, time switches and photo-electric cells, etc.
- (q) Penetration with tools or fixings of structures containing concealed conductors.

2.3.3 Arc, blast and flash injuries

Persons working on or near energized conductors of electrical equipment should be aware that fault currents of up to 20 times the rated current of the supply transformer can flow for short times during arc fault conditions.



WARNING: ARCS THAT ARE PRODUCED UNDER THESE CONDITIONS HAVE THE ENERGY TO CAUSE AN EXPLOSION, MELT METALLIC SWITCHBOARD CUBICLES AND EQUIPMENT, CAUSE SEVERE BURNS AND FLASH BURNS TO THE FACE, EYES AND BODY AND INJURY THROUGH IMPACT FROM FLYING DEBRIS OR DISLODGED COMPONENTS. CIRCUIT PROTECTION DEVICES MIGHT NOT OPERATE TO SAFEGUARD THE WORKER IN SUCH CIRCUMSTANCES.

2.3.4 Hazardous areas

Many gases, vapours and dusts are combustible and potentially explosive. Risk of injury from explosion and fire and associated equipment damage exists in these areas. Potential sources of ignition include:

- (a) Clothing made from wool, wool blends, nylons (unless treated with an antistatic process) and polyvinyl materials (especially those with a nylon base). It is possible for these materials to generate an electrical spark sufficient to ignite a flammable gas or vapour mixture.
- (b) Personal effects, e.g. jewellery, watches, cigarette lighters, matches, battery-operated items such as hearing aids, mobile telephones, pagers, electronic car keys, key ring torches and transistor radios.
- (c) Electric tools, test equipment and instruments, e.g. mains and battery-powered appliances such as inspection hand lamps, drills and torches.
- (d) Actions such as—
 - (i) any form of hot work including welding or brazing;
 - (ii) use of a hacksaw;
 - (iii) drilling or grinding of any type;
 - (iv) impact of a hammer or chisel onto concrete or metal;
 - (v) rubbing or movement of plastics; or
 - (vi) use of test equipment.

The items listed in Items (a), (b) and (c) above should not be taken or worn into a hazardous area, and the actions listed in (d) should not be undertaken unless—

- (A) the items listed in Items (a), (b) and (c) are certified and authorised for use in the areas into which they are to be taken; or
- (B) the area has been determined to be safe by a competent person (i.e. an explosive atmosphere does not exist).

NOTE: AS/NZS 2381.1, AS/NZS 61241.14, AS/NZS 60079.14 and AS/NZS 60079.17 specify requirements for the selection, installation and maintenance of electrical equipment in hazardous areas. The AS/NZS 3800 series specifies requirements for the repair of electrical equipment to be used in explosive atmospheres.

2.3.5 Other factors

Risks can be increased by—

- (a) Cramped working conditions.
- (b) Confined spaces.
- (c) Multiple sources of supply.
- (d) Damp situations.
- (e) Environmental factors, e.g. heat, cold, vibration and noise.
- (f) Height (working at heights and danger of falling objects).
- (g) Operational pressures to carry out work or to restore electricity supply.
- (h) Unstable work area.
- (i) Conductors, cables or equipment under tension or likely to fall.
- (j) Proximity of other work functions and other mobile plant and equipment.
- (k) Working below ground.

- (l) Corrosive and toxic materials.
- (m) Radiation, e.g. microwave antennas, radio towers, mobile phone antennas, radar.
- (n) Material containing asbestos.
- (o) Hazardous substances (e.g. PCBs; see Clause 3.9.10).
- (p) Other energy sources (e.g. stored, mechanical, pneumatic, hydraulic and gravitational).
- (q) Accumulation of conductive dust.
- (r) Inappropriate practices and procedures.
- (s) Working in isolation from others.

2.4 ASSESSING AND PRIORITIZING THE RISKS

All work shall be planned and organized to minimize the risks associated with the work.

An assessment shall be carried out at the work site before starting work to assess all risks that might have the potential to cause harm or damage.

If any person is required to work within 3 m of energized exposed conductors or parts, a competent person shall identify appropriate risk treatments (see Figure 2.1).

Safety shall not be compromised because of operational pressures to carry out the work.

NOTES:

- 1 In some cases the identification and possibility of encroaching within 3 m of low-voltage energized exposed conductors or parts will be obvious, e.g. overhead lines and cables and crane collector rails. In other cases it will not be immediately obvious, e.g. power tools drilling into structures (see Clause 5.3). Work equipment can extend into the 3 m distance, e.g. ladders (see Clause 5.4), elevating work platforms and scaffolding (see Clause 5.5).
- 2 Appendix A provides a typical form for use in the assessment of risk.

Where hazards exist, the risks shall be prioritized and appropriate control measures implemented in accordance with Clause 3.1.



WARNING: ALL WORKERS SHALL BE MADE AWARE OF THE HAZARDS OF THE TASKS AND THE CONTROL MEASURES REQUIRED TO MITIGATE THEM.

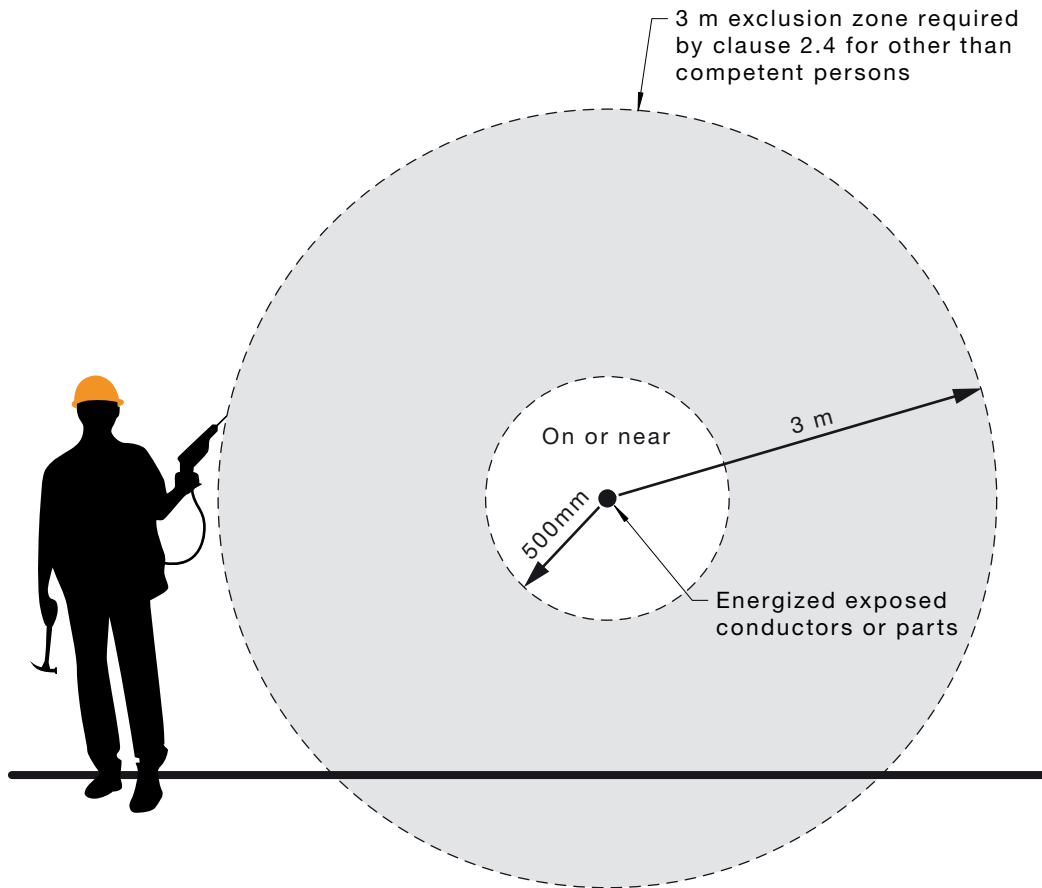


FIGURE 2.1 ILLUSTRATION OF 3 M EXCLUSION ZONE AND 'ON OR NEAR'

SECTION 3 RISK TREATMENT

3.1 APPLYING CONTROL MEASURES

3.1.1 General risk control measures

The application of control measures is the process of considering each hazard in turn and following the 'risk control procedures' described in Figure 3.1. The following details the hierarchy of controls:

- (a) Eliminate the hazard, which is always the first priority, e.g. by switching off and isolating. This may require rescheduling the work to a time when it can be done de-energized.
- (b) Substitution, e.g. use of battery-powered tools instead of mains powered. This is not always an option but should be considered whenever possible.
- (c) Separate the person from the hazard, e.g. by distance or by barriers.
- (d) Minimise risk through engineering, e.g. design, automation, provision of local isolation, containment or limitation (RCDs).
- (e) Minimise risk by administration, e.g. policy, procedures, safe work practices, signage and training.
- (f) Minimise risk with PPEs. This shall not be used as the first line of defence (except possibly in an emergency) but is always useful as a precautionary measure.

It is normal to use a combination of control measures to reduce the risks associated with a serious hazard to a tolerable level. It should be noted that the nature and duration of a given task might be cause to amend the specific controls from job to job and location to location on a project, e.g. in relation to fatigue or exposure.

As the selection of the control measures moves down the above list, the level of risk mitigation decreases.

Risk control procedures shall be developed in accordance with Figure 3.1 and reviewed before work commences in accordance with Figure 3.2.

3.1.2 Means of reducing risk

Electrical safety depends upon:

- (a) Appropriate job planning.
- (b) Correct testing and isolation procedures and techniques (see Clause 3.2).
- (c) The use of safety equipment and tools, test instruments and PPE that are fit for purpose (see Sections 5, 6 and 7).
- (d) The work being carried out by competent persons (see Sections 6 and 8).



WARNING: ALL ELECTRICAL CONDUCTORS AND PARTS, INCLUDING NEUTRAL AND EARTHING CONDUCTORS, SHALL BE TREATED AS ENERGIZED UNTIL PROVEN DE-ENERGIZED.

* TEST BEFORE YOU TOUCH *

Work should be planned in advance, particularly where other services are likely to be present or affected, e.g. gas, telephone, data communications, water pipes, other electrical circuits, other energy sources and where other trades are likely to be working.

Work should be planned to avoid jeopardizing the operation of lighting and electrical equipment essential for safety or for the preservation of life, e.g. emergency lighting and dialysis machines.

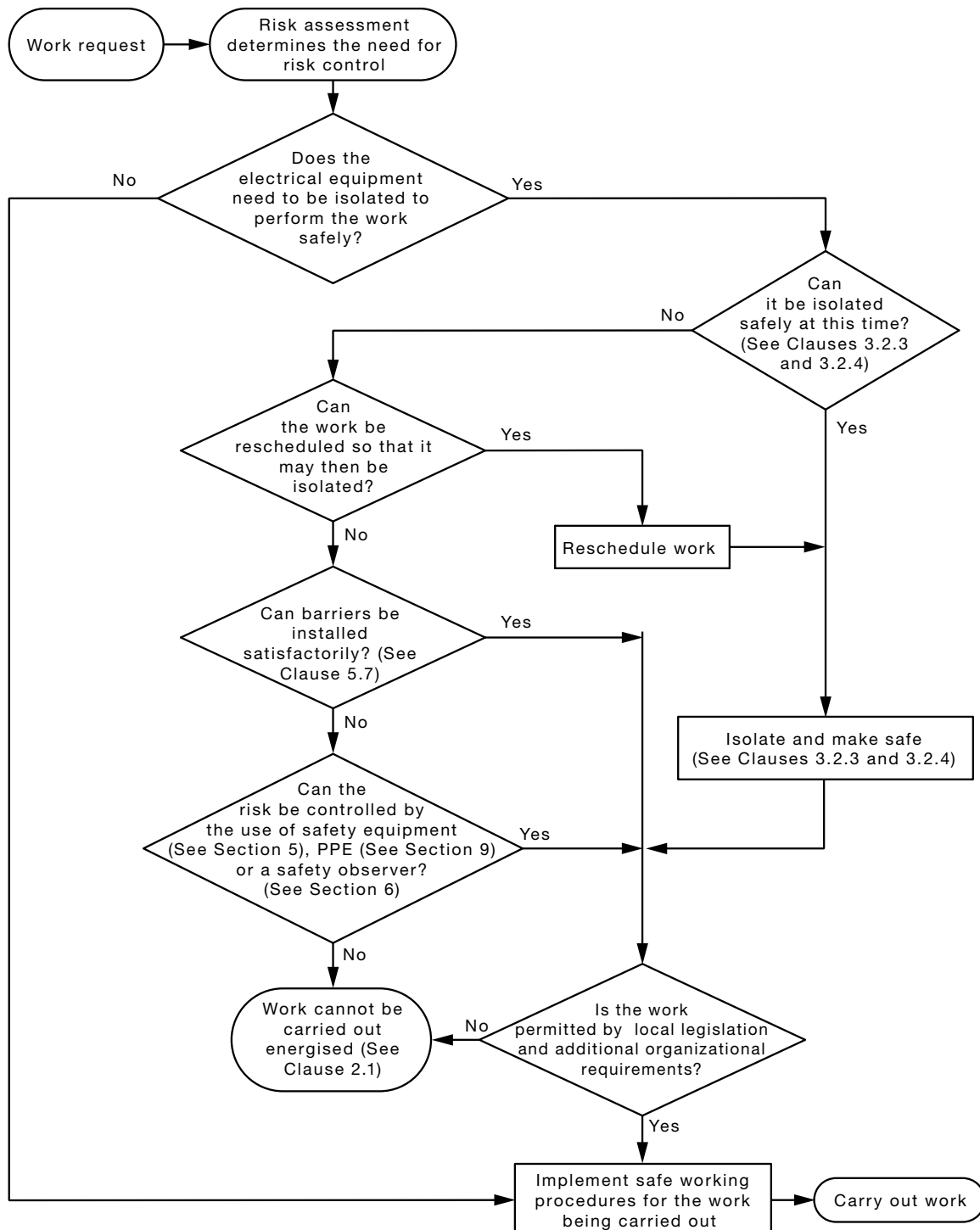


FIGURE 3.1 RISK CONTROL PROCEDURES

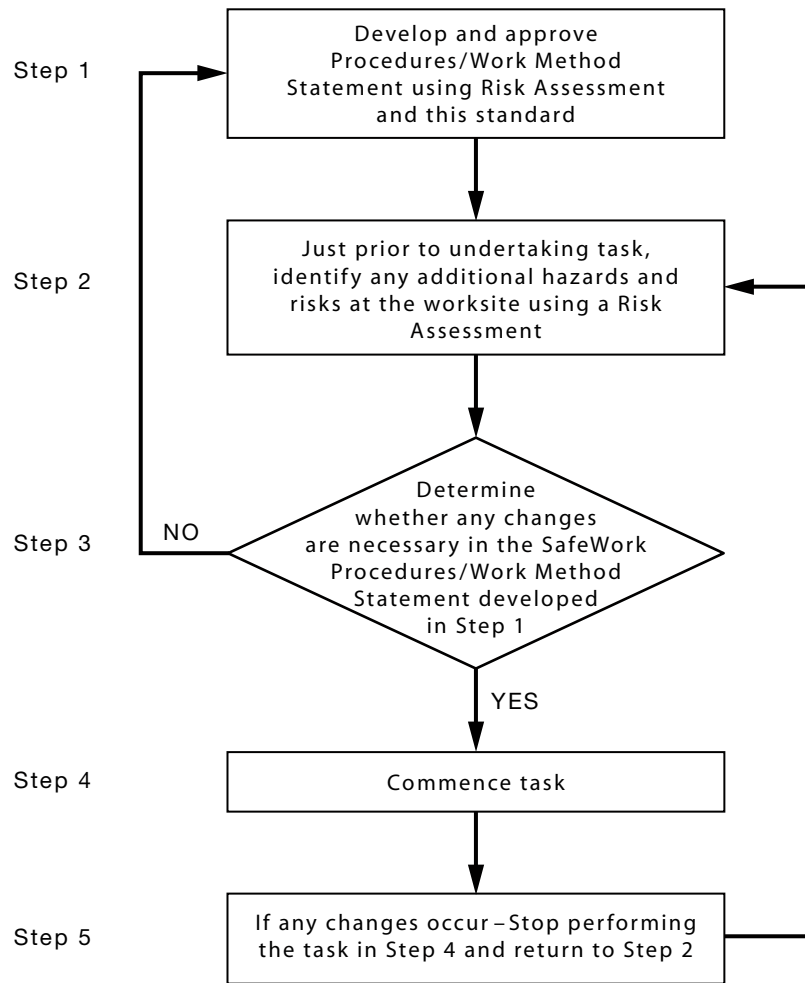


FIGURE 3.2 WORK PROCEDURES

3.1.3 Awareness

All persons, including electrical workers, supervisors, safety observers and those assisting electrical workers working on or near electrical installations or equipment, shall understand the scope of the work and the potential hazards involved in working on or near electrical installations or equipment. They should be capable of always maintaining an adequate physical and mental ability when working on or near electrical installations and equipment. If personnel are temporarily or permanently physically or mentally impaired, e.g. under the influence of alcohol, drugs, fatigue or are injured to a level that adversely affects their work performance, they shall not participate in the work.

3.1.4 Identification of isolation procedures

The switching, isolation or disconnection procedures and other necessary precautions appropriate to the work being carried out shall be identified and verified by a competent person. If the electrical installation is of a complex nature, the isolation procedures should be verified by another competent person.

3.1.5 Areas of reduced mobility

Care should be taken when working in areas of reduced mobility because of restriction of movement and the inability to readily escape from the area. Examples of areas of reduced mobility can be as follows:

- (a) Restricted areas in and around switchboards.
- (b) Ceiling and roof spaces.

- (c) Spaces under floors.
- (d) Ladders, scaffolds or elevated work platforms.
- (e) Trenches.
- (f) Pits or tunnels.
- (g) Confined spaces.

NOTE: AS 2865 identifies the hazards to persons entering and working in confined spaces and sets out the precautions to be taken to prevent occupational injuries and fatalities associated with such work environments.

3.1.6 Trafficable areas

Persons working near traffic areas, including vehicular and pedestrian, should employ approved traffic management procedures, install suitable screens, barriers, signage and, if necessary, lighting for personnel safety and protection. Caution should be exercised and appropriate preventive action taken when working in a passageway or narrow access area, e.g. where a door might be inadvertently opened or closed and propel persons into an energized electrical source, it should be restrained while work is being undertaken.

3.1.7 Illumination

Work areas shall be provided with lighting that is both adequate and suitable for the work and emergency evacuation. Lamps should be protected against breakage.

3.1.8 Work permit system

Some electrical installations may have a work permit system to control access to any work being performed on or near electrical installations or equipment where potential hazards of injury to personnel or equipment damage exist. The work permit system should set out relevant conditions of accessing electrical equipment, electrical or mechanical isolation of equipment, use of safety observers, use of safety equipment, conditions of restoring operational status and other relevant matters.

NOTE: Work permit systems may require practices additional to the requirements set out in this Standard.

3.1.9 Use of tools, electrical equipment or plant with exposed conductive parts

Conductive items such as tape measures, rules, reinforced tapes, ladders, elevating work platforms, scaffolding and guards on portable lamps, shall not be used on or near exposed energized conductors or live conductive parts.

NOTE: AS/NZS 1892 specifies requirements for ladders.

3.2 ISOLATION

3.2.1 Isolation principles



WARNING: ALL ELECTRICAL CONDUCTORS AND PARTS, INCLUDING NEUTRAL AND EARTHING CONDUCTORS, SHALL BE TREATED AS ENERGIZED UNTIL PROVEN DE-ENERGIZED.

*** TEST BEFORE YOU TOUCH ***

Work shall not be carried out on or near de-energized exposed conductors and parts until an electrical worker has:

- (a) Positively identified the relevant electrical equipment and conductors, all of their energy sources and the isolation points. (See Clause 3.2.2.)
- (b) Isolated electrical equipment and conductors from all energy sources. (See Clause 3.2.3.)
- (c) Secured the isolation. (See Clause 3.2.4.)
- (d) Discharged, where necessary, any stored energy. e.g. capacitors. (See Clause 3.9.2.)
- (e) Proved the de-energization of all relevant electrical equipment and conductors. (See Clause 3.2.5.)
- (f) Identified the limits of the safe area of work. (See Clause 3.2.7.)

3.2.2 Identification of electrical equipment and isolation points

The electrical equipment to be worked on, and the appropriate points of isolation and all of its energy sources shall be positively identified.

3.2.3 Isolation of electrical equipment

The electrical equipment to be worked on shall be isolated from all sources of electrical supply either by opening switches, removing fuses or links, opening circuit breakers or removal of circuit connections.

Procedures shall be adopted to identify alternative power supplies connected to the electrical installation. Isolation procedures should include steps to ensure isolation of all alternative supplies.

NOTE: Alternative sources of supply may include inverter/UPS systems, standby generators, solar cells, neutral backfeed from intermixed circuits, ring main systems, main power with separate auxiliary power supplies for control, transformation up (backfeed from ELV controls), multiple control supplies and luminaires supplied from emergency sources of supply.

Control circuits or control systems (PLCs, emergency stops, control selector switches, etc.) shall not be used as a means of isolation, e.g. by operation of a stop button.

All other non-electrical sources of energy (e.g. counterweights on machines and stored hydraulic and pneumatic energy) shall be isolated, controlled or secured to prevent the release of energy.

Consideration shall be given to the possibility of circuit wiring of electrical equipment or conductors becoming energized due to any operation of automatic control devices, e.g. thermostats, switches, PLCs and other interface devices.

NOTES:

- 1 AS/NZS 2381.1 specifies requirements for the isolation of electrical equipment in hazardous areas.
- 2 It is recommended that active conductors be disconnected first, followed by neutral conductors. Earth conductors should be disconnected last.

3.2.4 Secure the isolation

3.2.4.1 Isolation securing devices

Isolating devices shall be secured in the open position or zero energy state in such a manner as to prevent inadvertent operation of the isolator. It may be necessary to apply some form of third-party adaptor to the isolator to facilitate the attachment of the isolation-securing device or devices. No person shall operate an isolator (e.g. switches, valves, protective devices, etc) or knowingly use equipment to which an isolation-securing device is attached.

Where a facility exists to lock an isolation switch, it shall be used.

The securing device need not be an integral part of the switch, but shall require a deliberate action to engage or disengage it and may be—

- (a) an additional component, such as a clip, screw, bolt, pin or padlock that will prevent the switch from being operated; or
- (b) a personal danger tag, lock-out or permit system; or
- (c) some other approved system that provides an equivalent level of safety.

3.2.4.2 *Securing and identification*

3.2.4.2.1 *Padlocks—General*

The padlocks should be red in colour and should be uniquely keyed to prevent inadvertent removal by others. Each personal lock shall indelibly identify the person's name, company and contact details, and if required, the date of application. The identification may be achieved by either engraving on the padlock or an additional personal identification tag. The use of a multi-lock device shall be employed where more than one person is required to attach a personal lock to an isolator.

Figure 3.3(a) shows a typical lock and multi-lock device. Figure 3.3(b) shows a typical personal identification tag.



FIGURE 3.3(a) TYPICAL PERSONAL RED LOCK AND MULTI-LOCK DEVICE

PERSONAL LOCK ID TAG	
Name:	<input type="checkbox"/> ..□□□□□□□□.
Company:	..□□ .□□ .□□□.
Contact Phone No:	□□ .□□□□□□ ...

FIGURE 3.3(b) TYPICAL PERSONAL IDENTIFICATION TAG



FIGURE 3.3(c) TYPICAL TAGS

3.2.4.2.2 Tags—General

Each electrical worker shall affix a tag with string or a lock. PVC tape shall not be used to secure a tag. Entries on the tag shall be legible, permanent, dated and signed by the electrical worker. If a formal permit system is used, the designated sign-on and tagging procedure shall be used.

Figure 3.3(c) shows typical tags.

NOTE: AS 1319 specifies requirements for the design and use of safety signs.

3.2.4.2.3 Danger tags

Appropriate danger tags shall be placed at all points of switching, isolation or disconnection, except where a padlock is utilized in accordance with Clause 3.2.4.2.1.

3.2.4.2.4 Warning tags

If used, warning tags shall be affixed as a warning that the device or electrical equipment is not to be operated, except as indicated on the tag.

3.2.4.2.5 Removal of tags

A tag shall only be removed with the permission of the signatory or in accordance with other approved procedures.

3.2.5 Proving de-energization

All electrical equipment and conductors shall be treated as energized, unless proven to be de-energized. Any voltage tests used to prove de-energization shall be conducted in the following sequence:

- (a) Test the voltage tester on a known voltage source for correct operation.
- (b) Test between all conductors and a known earth.
- (c) Test between all conductors.
- (d) Retest the voltage tester on a known voltage source for correct operation.



WARNING: WHEN VOLTAGE TESTERS ARE USED TO PROVE DE-ENERGIZATION, THEY SHALL BE TESTED FOR CORRECT OPERATION IMMEDIATELY BEFORE USE, AND AGAIN IMMEDIATELY AFTER USE, PARTICULARLY IF THE TEST RESULT INDICATES ZERO VOLTAGE, TO CONFIRM THAT THE INSTRUMENT IS STILL WORKING CORRECTLY.

Only competent persons shall perform the tests.



WARNING: THE USE OF TESTERS THAT DETECT AN ELECTRIC FIELD SURROUNDING AN ENERGIZED CONDUCTOR ARE NOT SUITABLE FOR CABLES THAT ARE SURROUNDED BY A METALLIC SCREEN, CABLES CARRYING DIRECT CURRENT AND IN SIMILAR CIRCUMSTANCES.

3.2.6 Bonding of conductors

Differences may develop in the voltages of local earths with respect to the general mass of earth due to the presence of earth fault currents, particularly when earth faults occur on high voltage conductors or equipment, driving high fault currents through earthing electrodes at substations.

Such differences in earth voltages may cause harm from electric shock to any person exposed to them. Therefore, where such voltages may be transmitted along conductors from a remote position, the conductors and equipment to be worked on should be bonded to a local earth before work commences. This ensures that should any earth voltage difference between the remote point and the work site occur during the work, the person in contact with the conductors or equipment will not be exposed to that difference.

Where the work risk assessment identifies the need for bonding, the conductors shall be bonded together and connected to the general mass of earth at the work site. Bonding to earth may be effected by connecting conductors to the earthing system with conductors that are adequate to carry the potential short circuit currents to the electrical installation earthing system. The cross-section area of the conductor shall not be less than 4 mm².

Temporary bonding conductors shall always be connected together and attached to the general mass of earth before any attempt is made to attach them to any de-energized component of the electrical installation.

Suitable PPE should be used when attaching or removing temporary bonding conductors.

3.2.7 Identify the safe area of work

The safe area of work should be identified by erecting barriers or warning signs or by other approved means if necessary. All personnel who are to work in the safe area shall be advised of its limits and the location of any adjacent exposed energized conductors or live conductive parts.

3.2.8 Work on de energized electrical equipment

Work on de-energized electrical equipment shall only proceed if the electrical equipment is isolated and any other exposed conductors or conductive parts in the work area are either—

- (a) de-energized and isolated; or
- (b) separated by barriers or an appropriate distance based on a risk assessment. Clause 2.4 specifies minimum distance.

Figure 3.4 illustrates the requirements of this Clause.

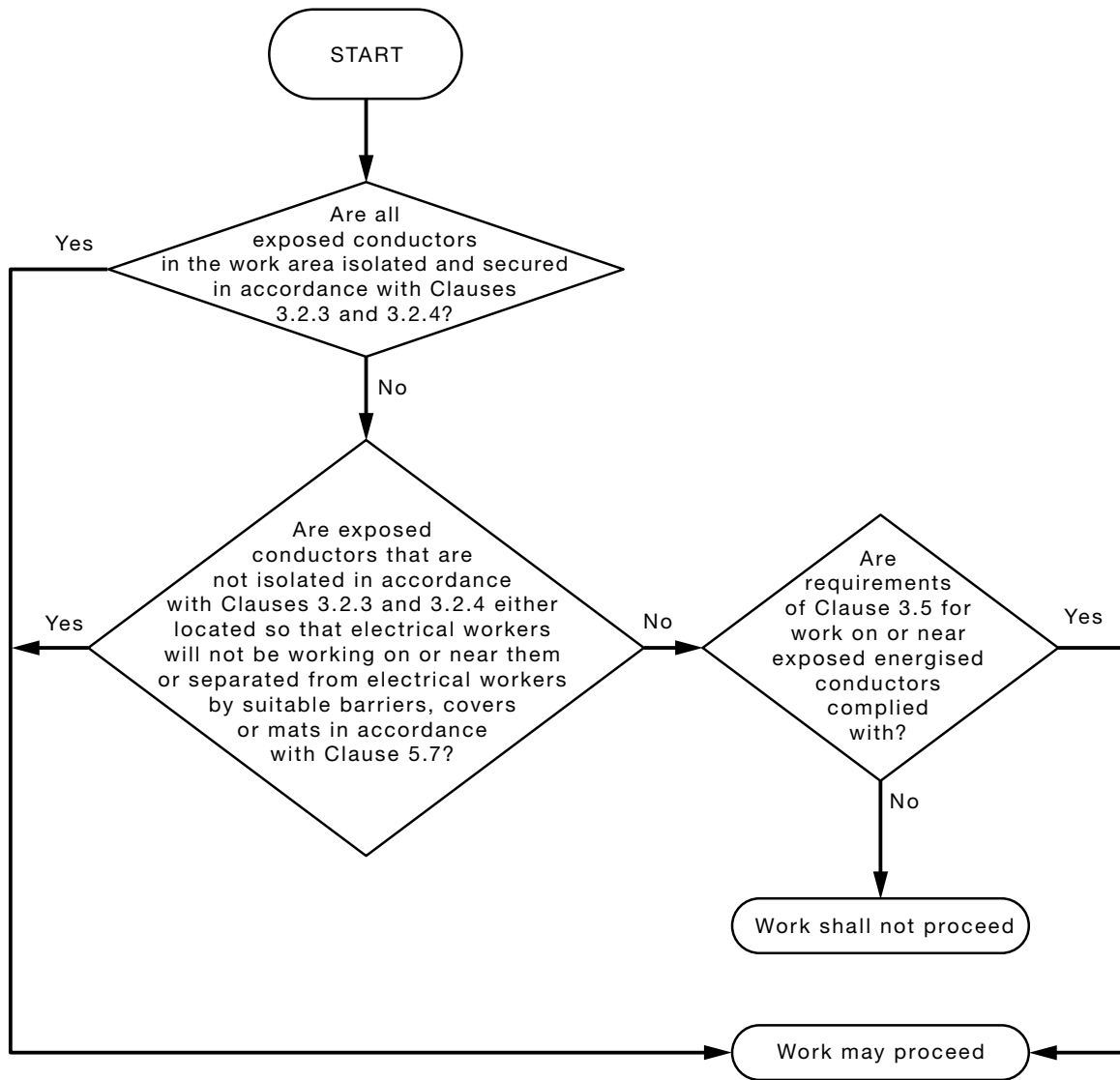


FIGURE 3.4 WORK ON DE-ENERGIZED ELECTRICAL EQUIPMENT

3.3 FAULT FINDING OR TESTING

The risk of electric shock, electrocution, arc, blast and flash burn injuries exists when performing fault-finding or testing on or near exposed energized conductors or live conductive parts. To manage this risk the following precautions shall be taken:

- (a) Before commencing any fault-finding work on or near exposed energized conductors or live conductive parts, an assessment of the associated risks shall be made. The risk assessment shall include, but not be limited to, the determination as to whether isolation, the use of suitable barriers or a safety observer is required.

NOTE: Regulatory authorities and legislation in some jurisdictions may have requirements for the use of a safety observer during fault-finding work.

- (b) Any persons undertaking fault-finding work on or near exposed energized conductors or live conductive parts shall be competent in the work to be carried out.
- (c) When fault-finding work is to be carried out on or near exposed energized conductors or live conductive parts, precautions shall be taken or procedures put into place to prevent the possibility of simultaneous contact with conductors at different voltages or to earth.

- (d) Personal protective equipment (PPE) that is appropriate and suitable for the task shall be worn. PPE shall be of correct fit and in good condition. (See Section 9.)
- (e) All fault-finding work on exposed energized conductors or live conductive parts shall be done from a stable work position.
- (f) Before commencing work, confirm suitability and check for correct operation of test equipment.
- (g) Use approved test equipment for the application and ensure that the appropriate operating range is selected. Refer to HB 187, *Guide to selecting a safe multimeter*.
- (h) Consider the effects at the work site and remotely of—
 - (i) bridging out of safety and control circuit interlocks;
 - (ii) inadvertent initiation of equipment operation;
 - (iii) inadvertent energization of electrical equipment;
 - (iv) bridging of terminals;
 - (v) forcing of contactors and interlocks; and
 - (vi) forcing of software interlocks, e.g. programmable logic controllers.
- (i) Extreme caution is required not to open circuit the secondary winding of a current transformer (CT) because high voltages may be generated.
- (j) Caution must be taken when inserting fuses or closing links carrying full load current or under a suspected fault condition.
- (k) When work is left unfinished, the requirements of Clauses 3.2.4.2 and 3.8, in particular the requirement to leave the workplace in a safe state for access by others, shall be satisfied.
- (l) Ensure the electrical equipment is returned to service in its original state or that changes made have been approved.

After electrical testing of cables, a considerable build up of capacitive charge can occur and remain on the cable. Care must be taken to ensure that such cables are properly discharged to earth for a reasonable period of time to ensure all the capacitive charge is removed before persons handle the cables.

NOTE: In New Zealand a set of voluntary rules, *Safety manual—Electricity industry* is in use in the electricity supply industry.

3.4 TESTING PLUG-IN ELECTRICAL EQUIPMENT

When performing energized fault finding or testing on electrical equipment that plugs into a 3-pin flat-pin socket outlet rated at up to and including 20 A, a residual current device (RCD) or an isolating transformer shall be used. RCDs shall be Type II (30 mA) or Type I (10 mA) complying with AS 3190 or shall comply with AS/NZS 61008 or AS/NZS 61009. Isolating transformers shall comply with AS/NZS 61558.

3.5 WORK ON EXPOSED ENERGIZED CONDUCTORS OR LIVE CONDUCTIVE PARTS

Working on or near exposed energized conductors or live conductive parts, shall be considered only when an adequate risk assessment indicates—

- (a) the work is necessary in the interests of safety and the risk of harm would be greater than working de-energized;
- (b) the work complies with local legislative requirements that allows work on energised electrical installations and equipment under mandatory risk controls; and

(c) the preparations specified in this Clause have been carried out.

Electrical safety is primarily dependent upon job planning, safe working practices, and appropriate training in live work techniques and test procedures.

The first aim shall be to eliminate the risk. If this is not reasonably practicable then the risk shall be controlled. Usually, the simplest way to eliminate the risk is to ensure the electricity supply is isolated.

Electrical equipment should not be assumed to have been de-energized after isolation until it has been proved de-energized.

Workers must be appropriately trained and competent in live working test procedures and in the use of testing equipment.

NOTE: Appendix B provides case studies of electrical incidents.

The risk of electric shock, electrocution, arc, blast and flash burn injuries exists when performing work on or near exposed energized conductors or live conductive parts.



WARNING: GENERALLY, WORKING ON ENERGIZED CIRCUITS AND EQUIPMENT CANNOT BE JUSTIFIED AS BEING AS SAFE AS WORKING DE-ENERGIZED.

To manage this risk, the following precautions shall be taken:

- (i) Before commencing any work on or near exposed energized conductors or live conductive parts an assessment of the associated risks shall be made and documented.
- (ii) Where a risk assessment procedure determines that isolation or the use of suitable barriers is impracticable, a safety observer shall be used as a precaution against potential injury or damage unless a generic or site-specific assessment determines that the use of an observer is unnecessary (see Section 6).

NOTE: Regulatory authorities and legislation in some jurisdictions may have requirements for the use of a safety observer for energised (live) electrical work.

- (iii) Any persons undertaking work on or near exposed energized conductors or live conductive parts shall be competent in the work to be carried out.
- (iv) When work is to be carried out on or near exposed energized conductors or live conductive parts, precautions shall be taken or procedures put into place to prevent the possibility of simultaneous contact with conductors at different voltages.
- (v) Personal protective equipment (PPE) that is appropriate and suitable for the task shall be worn. PPE shall be of correct fit and in good condition. (See Section 9.)
- (vi) All work on exposed energized conductors or live conductive parts shall be done from a stable work position.
- (vii) When working on energized electrical equipment that has earthed metal, precautions shall be taken to ensure earthing continuity is always maintained to any component of the electrical equipment at all times, or work shall be carried out to an approved procedure. Temporary protective earthing conductors may be required to be installed when removing electrical equipment from earthed metal, e.g. an electrical component separated from its normal earthing medium. Temporary protective earthing conductors shall be rated to withstand the prospective short-circuit current of the primary protection without failing.

- (viii) Particular care should be taken when removing neutral connections because tests may have indicated a de-energized situation. However, when these connections are removed, a voltage may be present between conductors or between conductors and earth.
- (ix) Only conductors at the same voltage should be worked on at any one time. Insulating barriers, covers or mats shall be used in the work area between conductors of different phases or voltage, or work shall be carried out to an approved procedure. The conductive path between electrical workers and conductors and between electrical workers and earth (including building materials such as concrete and steel that may be earthed), or between electrical workers should be broken by one or more of the following methods:
 - (A) Insulating barriers, covers or mats.
 - (B) Insulating tools.
 - (C) Insulating gloves.
- (xi) When work is left unfinished, the requirements of Clause 3.8, in particular the requirement to leave the workplace in a safe state for access by others, shall be satisfied.
- (xii) Ensure the electrical equipment is returned to service in its original state or that changes made have been approved.

NOTE: In New Zealand a set of voluntary rules, *Safety manual—Electricity industry* is in use in the electricity supply industry.

3.6 CUTTING CABLES OR WIRING ENCLOSURES

When carrying out work that involves cutting cables or wiring enclosures, the cables or cables within a wiring enclosure shall be treated as energised and the procedures for working on energised electrical equipment adhered to, until positive tests can be made at the point where the cable is to be cut that prove the cable is de-energized.



WARNING: THE USE OF TESTERS THAT DETECT AN ELECTRIC FIELD SURROUNDING AN ENERGIZED CONDUCTOR MAY NOT BE SUITABLE FOR CABLES THAT ARE SURROUNDED BY A METALLIC SCREEN, CABLES CARRYING DIRECT CURRENT AND IN SIMILAR CIRCUMSTANCES.

3.7 REMOVING OUT-OF-SERVICE ELECTRICAL EQUIPMENT AND CABLES

Before removal of out-of-service or decommissioned electrical equipment, the electrical equipment and cables shall be isolated from all sources of supply and appropriate tests made to ensure the electrical equipment and cables are de-energized in accordance with Clause 3.2.

3.8 CONTROL MEASURES WHEN LEAVING WORK UNFINISHED

The work site shall be left in a safe state for access by others.

Means of making the work site safe should include the following:

- (a) Terminating exposed conductors in a manner that provides a degree of protection of IP 2X in accordance with AS 60529 and, where necessary, providing appropriate mechanical protection or restraint.
- (b) Affixing of safety or information tags as required.

- (c) Installation of barriers or barrier tape or other means necessary to keep unauthorised persons out of the work site.
- (d) Where appropriate, informing relevant parties that the work is not complete and advising of potential hazards.
- (e) Taking any necessary precaution to ensure that electrical installations and equipment cannot become energized.
- (f) Ensuring that switchboards and equipment are clearly and correctly labelled in relation to their status.
- (g) Providing sufficient information for workers to allow them to safely continue the work.

3.9 RISK CONTROL FOR SPECIAL SITUATIONS

3.9.1 General



WARNING: IF RISK ASSESSMENT INDICATES THAT RISKS CANNOT BE SUFFICIENTLY CONTROLLED TO ENABLE THE WORK TO BE DONE SAFELY, THEN THE WORK SHALL NOT PROCEED.

3.9.2 Capacitors

When working on electrical installations or equipment that includes capacitors, electrical workers should be made aware that substantial energy can be present even when de-energized and therefore voltages could be produced that might cause electrocution, arcs, flash burns or electric shock to workers or ignite gases or solid material.

Capacitors and associated circuitry shall be proved to be de-energized and fully discharged before commencing work on them and their associated circuit wiring. This may be achieved by using and maintaining, for the duration of the work, approved safe discharging devices or by following the manufacturer's instructions. A voltage tester shall be used to prove that these units are discharged, immediately before performing work, because capacitors that do not have discharge devices attached might reinstate the full line voltage. The voltage tests shall be on an appropriate d.c. scale of the tester.

NOTE: If a capacitor is not discharged then the requirements of Clause 3.5 for work on or near exposed energized conductors or live conductive parts apply.

Care should be taken against the harmful effects of arcing when applying discharging devices. Short-circuiting or earthing of capacitor terminals with metal objects such as spanners or screwdrivers can result in electrocution, arcs, flash burns or electric shock and should not be attempted. Use only suitable devices.

3.9.3 Hazardous areas

Work on or near electrical installations or equipment within hazardous areas, e.g. petrochemical installations, grain storage, flour mills, spray booths and fine particle process areas, shall only be performed using approved procedures.

NOTES:

- 1 AS/NZS 2381.1 specifies requirements for the selection, installation and maintenance of electrical equipment in hazardous areas. AS/NZS 3800 specifies requirements for the repair of electrical equipment to be used in explosive atmospheres.
- 2 Regulatory authorities have requirements regarding the competency of electrical workers working in hazardous areas.

3.9.4 Batteries and d.c. supplies

Accidental short-circuiting of d.c. supply terminals or battery connections might create substantial arcs that can cause personal injuries or ignite hazardous gases or material. Appropriate precautions shall be taken, including the use of insulated tools and PPE, when working on or near batteries and d.c. supplies or electrical equipment that contains them. (See Sections 7 and 9).

NOTE: AS 2676.1 and AS 2676.2 provide guidance on safe practices during battery installation and maintenance.

3.9.5 Electrical equipment producing high voltages

Electrical equipment producing high voltages including cold cathode systems of illumination, outline lighting systems, X-ray equipment and open circuited secondary terminals of current transformers may have open circuit voltages up to 15000 V.

NOTE: AS/NZS 3832 contains requirements for cold-cathode lighting systems.

3.9.6 Elevated electrical equipment, poles structures and overhead conductors

3.9.6.1 General

A minimum safe distance from overhead conductors and lines shall be maintained to avoid contact, shock or injury. An appropriate safe distance shall be determined before work commences.

Extra caution should be exercised when working on or near exposed energized overhead conductors or other energized electrical equipment in elevated positions. In elevated positions, even a slight shock can result in a fall that could prove fatal. Approved fall-arrest devices and other necessary safety equipment and PPE shall be used where appropriate. If a safety observer is deemed necessary (see Section 3), the safety observer shall be competent in relevant rescue procedures (see Clause 6.2).

Poles and structures shall be tested and inspected to approved procedures to establish, as far as practicable, whether they are structurally sound for the work to be carried out without special precautions. The testing and inspection shall be performed before climbing the poles or structures or before accessing them by means of elevating work platforms. Elevating work platforms should be used whenever practicable. Section 5 covers requirements and guidance on tools and equipment for this work.

NOTE: AS 2550.10 contains requirements for elevating work platforms. AS/NZS 4576 provides guidelines for the use of scaffolding.

3.9.6.2 Precautions before working on poles or structures

Persons shall not climb a pole or structure unless they have:

- (a) Authorization, training and competence to carry out the work;
- (b) Satisfied themselves that it is safe to climb and there is no danger of collapse during the course of the work;

NOTE: Particular care should be taken with poles whose loading conditions are to be significantly changed during the course of the work, e.g. made freestanding or have the tensions in any direction increased or decreased.

- (c) Ensured they can maintain minimum safe approach distances to other live circuits that are on or near the pole, or that action has been taken so that other circuits are de-energized.
- (d) Obtained and use the appropriate safety equipment, including approved fall-arrest, pole top rescue kits and a safety observer competent to carry out pole top rescues.

3.9.6.3 *Work on conductive poles or structures*

Extreme care should be exercised when earth situations caused by telecommunications installations and catenary wires, earth wires, conductive fittings and brackets, concrete or metal poles and structures are encountered near live electrical equipment.

Except as mentioned below, when working on isolated low voltage lines supported by conductive poles or structures, the lines shall be (temporarily) electrically connected to each pole or structure, if anyone is in contact with the line.

NOTE: This also applies to wood poles with exposed earth downloads or other exposed earth bonding conductors (except low voltage neutrals).

The only exceptions to the requirements of the Clause are:

- (a) If the line is treated as live and live working procedures are adopted: or
- (b) If work is carried out from an appropriately insulated elevating work platform positioned so that simultaneous contact with the pole and any conductor is avoided.
- (c) If the exposed conductive equipment, such as earth downloads, can be effectively covered with insulating covers to prevent inadvertent contact between different potentials.

3.9.6.4 *Erection of electrical equipment or conducting materials*

Precautions shall be taken to prevent any electrical equipment or conducting material (including building material) being erected from coming within the minimum safe approach distances to live exposed electrical conductors. If adequate precautions cannot be taken, the exposed electrical conductors shall be de-energized in accordance with approved procedures.

3.9.7 **Asbestos**

Asbestos may be present in electrical equipment or in building materials. In the bonded condition asbestos cement products do not represent a significant health risk. A risk can exist when the product is handled in such a way that removes the cement bond, thus releasing asbestos fibres that may be of a respirable size. The use of high-speed drills, saws and grinding will cause a release of asbestos fibres from the bonded material.

NOTE: Regulatory authorities may have requirements for the handling of asbestos and the training of personnel.

No removal, drilling or cutting shall be undertaken unless the work is carried out in accordance with regulatory authority requirements. In addition, a risk assessment and safe working procedures that enable capture of released asbestos particles shall be used.

Additional precautions should be taken into account when an electrical switchboard or electrical equipment containing asbestos is found to be damaged.

3.9.8 **Working below ground on cables or services**

3.9.8.1 *Excavation of and near to cables and services*

When excavating cables or working in areas known to contain cables or other services, persons should always treat the cables as energized until proven otherwise and:

- (a) *Carry out a services search* A services search can be carried out using:
 - (i) In Australia dial before you dig: Telephone 1100 for services in public areas. In New Zealand consult the local telephone directory for the appropriate number for service in the local area before you dig.
 - (ii) Cable location records for the property concerned.
 - (iii) Cable search instruments or services, e.g. cable locators, or commercially available services.

- (b) *Excavate with extreme caution* Cables may not be enclosed in a wiring enclosure and older cables may not be provided with a warning tape. Excavation of cables that may be energised shall be carried out with extreme caution following a site assessment and in accordance with the following:
- (i) A safety observer shall be used with the sole task of continually guiding the excavator to ensure it keeps clear of, and does not make contact with or damage any cables.
 - (ii) Jackhammers or crowbars shall not be used to excavate cables due to the risk of their penetrating the cable.
 - (iii) Mechanical excavation shall be only with a toothless bucket, down to the wiring enclosure or warning tape.
 - (iv) The final excavation to expose a cable shall be with non-invasive excavation methods, i.e. hand tools or hydro/vacuum excavation only.

3.9.8.2 *Identify the cable*

Before commencing work on a cable, the cable shall be positively identified at the work site by a suitable method.

The cable shall be identified either by—

- (i) visual tracing from the point of isolation; or
- (ii) a suitable method of identification.

Before work commences on the cable, tests shall be carried out to prove the cable is de-energized. If for some reason it is impossible to identify a cable using electrical or physical methods, or to prove it de-energized by testing, it shall be spiked and the spiking equipment used shall be remotely operated.

3.9.8.3 *Cable identification methods*

There are several cable identification methods.

- (a) Electrical methods are as follows:
 - (i) Audio frequency signal generator.
 - (ii) Current injection.
 - (iii) Pulse injection.
 - (iv) Interrupted earth.
 - (v) Use of fault location equipment.
- (b) Non-electrical methods are as follows:
 - (i) Visual tracing from a proven isolation point.
 - (ii) Rodding of wiring enclosures.
 - (iii) Cable plans. (Use of this method shall not be used as the sole means of identification).

3.9.8.4 *Other site risk factors*

Other risk factors shall be considered in the site risk assessment, including:

- (a) Excavation and pit hazards including—
 - (i) depth (shoring may be required);
 - (ii) hollows, pits and sumps, e.g. collection of toxic fumes and gases (air monitoring and confined space entry may be required).

- (b) Traffic hazards.
- (c) Lack of ventilation or elevated temperatures.
- (d) Induced voltages and transferred earth potential (work site equipotential bonding or complete insulation methods may be required).

3.9.9 Cutting cables or wiring enclosures

Cables or wiring enclosures shall be positively identified before the commencement of cutting.

3.9.10 Identification of PCB-containing electrical equipment

Polychlorinated biphenyl (PCB) belongs to a group of synthetic chlorinated organic compounds. They are odourless and range in appearance from colourless or yellowy oily liquids to increasingly darker or brown/black viscous liquids or resins. PCBs do not readily break down or burn, and have good electrical insulation properties. Up till about 1980 they used as coolants and lubricants in transformers, capacitors and other electrical equipment.

PCB-filled capacitors were typically used for motor starters and power factor correction on fluorescent lighting, ceiling fans, dishwashers, air conditioners, small washing machines and clothes dryers.

With time, the sealed containers can corrode and leak, and if released into the environment, PCBs can accumulate in fatty tissue of animals and humans. They can enter the body by ingestion, absorption through the skin or inhaled as the vapours of the heated product.

Repeated and prolonged exposure (e.g. skin contact) is a risk to health and it is appropriate that any equipment found in the field be removed and disposed of safely. There is the possibility that PCB may cause cancers.

When removing sealed product, take precautions to protect against spill and skin contact, and do not dispose of with normal waste. Remove PCBs from the skin with soap and water.

PCB-containing electrical equipment within fluorescent light fittings is likely to have one or more of the following characteristics:

- (a) A capacitor that is cylindrical or rectangular, encased in an aluminium container with a weld running all the way around the top edge and with two with quick-connect terminal tags.
- (b) A date mark from the 1950s, 1960s or 1970s.
- (c) A capacitor encased in a rectangular tin container with soldered seams.
- (d) Slightly heavier than similar types of capacitors manufactured after the 1970s (which do not contain PCBs).

NOTE: Further information can be obtained from *Identification of PCB-containing capacitors*, an information booklet available from the Federal Department of Environment and Water Resources.

3.9.11 Lighting

Lightning may present a risk to persons when working on electrical installations or equipment. When working outdoors, there may be a risk from the direct or indirect effects of a lightning strike. When working indoors, persons may be at risk indirectly as a consequence of lightning currents being conducted into the building.

AS/NZS 1768 sets out guidelines for the protection of persons and property from risks arising from exposure to lightning. This includes avoiding contact with metallic structures and objects, or electrical installations and equipment while local thunderstorms are present.

SECTION 4 RE-ENERGIZATION OF ELECTRICAL INSTALLATIONS AND EQUIPMENT

Precautions against the inadvertent operation of other electrical equipment shall be carefully considered before supply is restored.

For re-energization the following steps shall be carried out. They should be done in the order listed below:

- (a) All relevant persons shall be notified that testing is about to commence or supply is about to be restored.
- (b) A visual inspection shall be conducted to ensure that all tools, surplus material and wastes have been removed and the work site has been reinstated.
- (c) Visual inspection and tests required by AS/NZS 3000 shall be carried out.
- (d) Applicable work permits shall be cancelled.
- (e) Applicable personal tags and locks shall be removed.
- (f) Re-energization as appropriate is carried out.
- (g) Functional testing as required, e.g. phase rotation, are carried out
- (h) Confirmation that all guards and covers are reinstated is obtained.

NOTES:

- 1 AS/NZS 3017 provides guidance on testing of low voltage electrical installations.
- 2 It is recommended that the earth be connected first followed by the neutral and the actives.
- 3 See AS 4741 and the Electricity Engineers Association of New Zealand, *Livening of service connections to premises*, for reconnecting electrical installations.

SECTION 5 SAFETY EQUIPMENT AND TOOLS

5.1 GENERAL

All safety equipment and tools shall be regularly maintained and tested where required. They shall be visually inspected before every use. If found defective, they shall not be used and shall be tagged as defective.

5.2 INSULATED TOOLS AND EQUIPMENT

Insulated tools and equipment shall be of an approved type and shall be in good order, regularly maintained and tested where required. Tools and equipment shall not be used if any doubt exists that their insulation might not be adequate.

NOTE: AS 3527.2, IEC 60900 and BS EN 60900 contain specific requirements for insulated hand tools.

5.3 PORTABLE ELECTRIC TOOLS

5.3.1 General

Standards applicable for the use of portable electric tools include—

- (a) AS/NZS 3760, which specifies procedures for the in-service safety inspection and testing of electrical equipment; and
- (b) AS/NZS 3012, which specifies requirements for the use of portable electric tools used on construction and demolition sites.

Regulatory authorities may have additional requirements.

Consideration should be given to the use of battery-powered tools because they reduce the risk of electric shock.

5.3.2 Protection

Personnel protection should be provided by supplying all portable electrical tools, appliances and equipment through a residual current device (RCD) or through an isolating transformer. RCDs shall be Type II (30 mA) or Type I (10 mA) complying with AS 3190 or shall comply with AS/NZS 61008 or AS/NZS 61009.1. Isolating transformers shall comply with AS/NZS 61558. The secondary winding shall not be connected to the primary winding or earthed.

When used, portable RCDs or isolating transformers should be as close as practicable to the point of supply, e.g. at the supply end of an extension lead and not at the appliance end.

RCDs do not provide protection—

- (a) if there is no current path to earth or if the portable electric tool comes in contact with an alternative source of electricity (e.g. a drill bit contacting an embedded electrical conductor in a wall, floor or ceiling);
- (b) against electric shock or electrocution from between the electrode and return leads when welding;
- (c) where the current leakage path is from active to neutral or phase to phase; or
- (d) for a portable electric tool supplied from an isolating transformer or isolated winding generator.

NOTES:

- 1 RCDs do not prevent electric shock but are designed to reduce the likelihood of electrocution by disconnecting the supply rapidly to safeguard the user.
- 2 RCDs do not provide protection on all types of supply. Whether or not an RCD performs satisfactorily on a given supply depends on the type of RCD.

Isolating transformers do not provide protection—

- (i) if the secondary winding is earthed;
- (ii) if the portable electric tool comes in contact with an alternative source of electricity (e.g. a drill bit contacting an embedded electrical conductor in a wall, floor or ceiling);
- (iii) against electric shock from between the electrode and return leads when welding; or
- (iv) where the current leakage path is between live conductors.

5.3.3 Risk of exposed conductive parts becoming energized

Caution shall be exercised when using portable electric tools or equipment having exposed conductive parts where there is a risk of exposed conductive parts contacting exposed energized conductors or live conductive parts, e.g. by drilling or cutting into conductors concealed in the building structure.

NOTE: Chuck keys tied on portable drills are a risk if they can come into contact with exposed energized conductors or live conductive parts.

5.4 LADDERS AND STEP LADDERS

5.4.1 General

Portable ladders and stepladders shall comply with either AS 1892.2 or AS 1892.3 or equivalent and be used according to the manufacturer's instructions and in accordance with AS 1892.5.

A ladder shall have all of the following attributes:

- (a) Be rated for industrial use.
- (b) Have a load rating of at least 120 kg.
- (c) Be of correct size and length for the work.
- (d) Be provided with anti-slip feet where practicable.

A person using a ladder shall cover all the following requirements:

- (i) Ensure the ladder has a stable footing.
- (ii) Ensure they have three points of contact at all times.
- (iii) Climb no higher than three rungs from the top.
- (iv) Ensure that only one person works from the ladder at any one time.
- (v) Not over-reach when using the ladder.

Occupational health and safety legislation specifies the requirements for the use of ladders.

5.4.2 Use of electrically conductive ladders

Metallic, wire-reinforced or otherwise conductive ladders shall not be used on or near electrical equipment if an electrical risk might result from their use. Preference should be given to the use of non-conductive ladders in all circumstances.

NOTES:

- 1 Ladders that are damp or dirty might become conductive and create a potential risk.
- 2 AS/NZS 1892 specifies requirements for ladders.

5.4.3 Positioning and securing

Ladders shall be located and positioned to provide a safe and secure working medium. Ladders, except self-supporting ladders, should be secured at the bottom and top, e.g. an assistant may be used to foot the ladder or alternative measures may be employed to prevent the base of the ladder from moving.

5.5 ELEVATING WORK PLATFORMS AND SCAFFOLDING

5.5.1 General

All persons using elevating work platforms and scaffolding shall be competent. Persons working from elevating work platforms or scaffolding should not over-reach.

NOTE: Elevating work platforms include scissor lifts, boom lifts and cherry pickers.

5.5.2 Use of electrically conductive equipment

The clearance requirements from exposed energized conductors or live conductive parts specified by legislation and work site requirements for work platforms shall be observed. Elevating work platforms that are damp or dirty might become conductive and create a risk.

NOTES:

- 1 AS 2550.10 specifies requirements for the safe use of elevating work platforms.
- 2 AS/NZS 4576 provides guidance on the safe erection and use of scaffolding.
- 3 Regulatory authorities might have requirements for work platforms and scaffolding.

5.6 USE OF INDUSTRIAL FALL-ARREST SYSTEMS AND DEVICES

Persons using ladders, working in elevated positions or near trenches should, or where deemed necessary by a risk assessment, be constrained by an appropriate industrial fall-arrest system or device.

NOTES:

- 1 AS/NZS 1891.1 and AS/NZS 1891.4 specify requirements for fall-arrest systems and devices.
- 2 Regulatory authorities in Australian states and territories and in New Zealand may have requirements for work in these areas.

5.7 INSULATING BARRIERS, COVERS AND MATS

5.7.1 Barriers

Barriers shall be of suitable material to effectively separate electrical workers from adjacent energized electrical equipment. They shall be visually inspected for possible defects before and after each use. Defective items shall be tagged accordingly.

5.7.2 Insulating covers and mats

Insulating mats for use with electrical equipment rated at voltages less than 650 V shall comply with and be tested according to the requirements of AS/NZS 2978. Insulating covers for use with electrical equipment rated at voltages less than 650 V shall comply with and be tested according to the requirements of AS 4202.

They shall be visually inspected for possible defects before and after each use. Defective items shall be tagged accordingly.

NOTE: The following standards provide requirements for insulating covers and mats for voltages above 650 V: IEC 61112, ASTM D1048, IEC 61111, ASTM D178, IEC 61229, IEC 61479, ASTM D1049.

SECTION 6 SAFETY OBSERVERS

6.1 GENERAL

Where the risk assessment procedures or legislative requirements determine that a safety observer is necessary for any work on or near exposed energized conductors or live conductive parts, then work shall not be undertaken without the presence of a safety observer.

6.2 GENERAL PRINCIPLES

The safety observer's role is to be clearly communicated and understood. Their role is to be risk aware and to continually observe that safety procedures are carried out by the electrical workers performing the work and warn the workers of danger, including inadvertent contact with energised electrical circuits and equipment.

If a safety observer is used as part of a safe system of work, the following shall apply:

- (a) The safety observer shall be able to warn and, if necessary, stop the work before the risks become too high.
- (b) The safety observer shall not carry out any other work or function that compromises their role as a safety observer, i.e. the safety observer shall not observe more than one task at a time.
- (c) The safety observer shall be able to communicate quickly and effectively with the electrical workers performing the work.
- (d) The safety observer shall be capable of providing assistance in the case of emergency as well as being competent to perform electrical rescue and cardiopulmonary resuscitation, as required. On an energised electrical installation, the safety observer shall be competent to perform their task and shall also be competent in electrical rescue and cardiopulmonary resuscitation (CPR).
- (e) The safety observer shall be suitably attired in personal protective equipment appropriate to the situation.
- (f) The safety observer shall not have any known temporary or permanent disabilities that would adversely affect their role and performance.
- (g) The presence of a safety observer is one of the risk control measures to ensure electrical safety when electrical work on energized circuits and electrical equipment is being carried out.

SECTION 7 TEST EQUIPMENT

7.1 GENERAL

Only suitable testing equipment appropriate for the tests being performed shall be used for testing and shall be used in accordance with its operating instructions.

To ensure electrical safety, the combination of leads and instrument used should be capable of withstanding the highest voltages and fault current levels that could be experienced at the test location. Table 7.1 lists the categories and their typical use.

TABLE 7.1
CATEGORIES AND TYPICAL USE

Category	Circuit energy level	Prospective fault current kA	Applications
II	Low	≤ 5	Home + office power outlets + lighting circuits
III	Medium	≤ 25	Motor control centres, distribution boards, main switchboards, up to (1 MVA transformer LV terminals)
IV	High	> 25	Between main switchboards and transformers (> 1 MVA)

Particular care shall be taken with the transport and storage of test equipment, including leads.

7.2 SUITABILITY OF EQUIPMENT

Test equipment shall be such as to minimise the risk of electric shock, electrocution or injury, e.g. burns to personnel or damage to the electrical equipment during testing. Test equipment shall comply with the following:

- Test equipment used in hazardous areas shall be clearly marked as being suitable for use in such locations.
- Test probes, leads and other equipment shall be selected so that they cannot inadvertently short circuit between energized conductors or live conductive parts, and energized conductors or live conductive parts and earth.
- The terminals of test equipment should be shrouded and all other test sockets on measuring instruments should be designed to prevent inadvertent contact with any energized test socket, conductor or both when the equipment is in use.
- Where appropriate, test leads and testing equipment should be provided with suitable overcurrent protection.

NOTES:

- AS/NZS 2381.1, AS/NZS 61241.14, AS/NZS 60079.14 and AS/NZS 60079.17 specify requirements for the selection, installation and maintenance of electrical equipment in hazardous areas.
- Clause 3.2.5 of this Standard provides requirements for proving de-energization.
- AS 61010.1 provides a classification for instruments on the basis of their immunity to overvoltages liable to be experienced in different parts of an electrical installation. Devices should be rated as Category III or IV to enable their use on all parts of the electrical installation.
- Refer to HB 187, *Guide to selecting a safe multimeter*, for guidance on selecting multimeters.

7.3 TEST EQUIPMENT VERIFICATION

Test equipment shall be checked before each use to ensure—

- (a) it is in good condition, clean, has no cracked or broken components;
- (b) the insulation on leads, probes and clips of test equipment are in good condition; and
- (c) it operates correctly.

SECTION 8 TRAINING, QUALIFICATIONS AND COMPETENCE

8.1 GENERAL

Personnel working on or near exposed energized conductors or live conductive parts or electrical equipment shall be competent, familiar with the equipment and be aware of all risks. In some situations, specific training and authorization might be required or necessary before proceeding with the work.

8.2 SUPERVISION

Regulatory authorities have requirements for licensing and supervision of personnel.

Where an electrical worker is required to be supervised, the supervisor shall—

- (a) consider the type of work being undertaken, in particular evaluating whether exposed energized conductors or live conductive parts are being worked on or are near the work area;
- (b) have regard to the level of competence of the person to be supervised; and
- (c) be aware of additional requirements of regulatory authorities for the supervision of apprentices or trainees.

SECTION 9 PERSONAL PROTECTIVE EQUIPMENT

Protective clothing worn by electrical workers working on or near exposed energized conductors or live conductive parts shall be appropriate for the purpose, fit correctly, cover the full body (including the arms and legs) and be in good condition while the work is being performed.

All personal protective equipment (PPE) shall be selected in accordance with the risk assessment and with the type of work being performed.

Table 9.1 lists the requirements for PPE and Table 9.2 provides guidance on the selection of PPE.

Bracelets, rings, neck chains, exposed metal zips, watches and other conductive items shall not be worn while working on or near exposed energized conductors or live conductive parts. If worn, earplugs or earmuffs shall not be conductive.

**TABLE 9.1
PERSONAL PROTECTIVE EQUIPMENT**

Personal protective equipment	Requirements
Eye protection	Eye protection without metal frames and complying with AS/NZS 1337 and selected in accordance with AS/NZS 1336.
Face shield	Face shield certified as rated at 10 cal/cm ² protection.
Arc flash suit and hood	Arc flash suit and hood rated at a minimum of 40 cal/cm ² protection.
Footwear	Shoes or boots complying with AS/NZS 2210.2 and selected and maintained in accordance with AS/NZS 2210.1.
Insulating gloves	Gloves complying with AS 2225 or an equivalent Standard and insulated to the highest potential voltage expected for the work being undertaken, and air tested each time prior to use.
Flame-resistant gloves	Gloves complying with AS/NZS 2161.4, e.g. gloves made from leather or other non-melting heat-resistant material.
Hearing protection	Ear plugs or muffs complying with AS 1270.
Protective clothing	Flame-retardant clothing covering the full body (including arms and legs) and not made from conductive material or containing metal threads.
Industrial fall-arrest systems and devices	Industrial fall-arrest systems and devices complying with AS/NZS 1891.4 and that have been checked and inspected each time before use with particular attention being paid to buckles, rings, hooks, clips and webbing.
Safety helmets	Headwear complying with AS/NZS 1801.
Respiratory protection	Respiratory protection complying with AS/NZS 1715 and AS/NZS 1716.

NOTES:

- 1 Regulatory authorities may have additional requirements for personal protective equipment.
- 2 Where insulated and flame-resistant gloves are worn together, they are to be matched in accordance with the insulated glove manufacturer's instructions.

TABLE 9.2
GUIDE TO THE SELECTION OF PERSONAL PROTECTIVE EQUIPMENT

TASK	CURRENTS UP TO AND INCLUDING 100 A	CURRENT EXCEEDING 100 A AND UP TO AND INCLUDING 400 A	CURRENTS EXCEEDING 400 A
Work (isolated and verified)	Footwear Protective clothing (if required) Eye protection (if required) Gloves (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)	Footwear Protective clothing (if required) Eye protection (if required) Gloves (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)	Footwear Protective clothing (if required) Eye protection (if required) Gloves (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)
Switching, isolating, removing fuses or links	Footwear Protective clothing Eye protection Gloves (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)	Footwear Protective clothing Eye protection Gloves Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)	Footwear Protective clothing Eye protection Gloves Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)
Isolation verification, testing or fault finding	Footwear Protective clothing Eye protection Gloves Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)	Footwear Protective clothing* Eye protection Gloves Arc flash suit and hood (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required) Face shield (if required)	Footwear Protective clothing* Eye protection Gloves Face shield Arc flash suit and hood (if required) Hearing protection (if required) Safety helmet (if required) Respiratory protection (if required)
Live electrical work	Footwear Protective clothing* Eye protection Insulating gloves Arc flash suit and hood (if required) Flame-resistant gloves (if required) Face shield (if required) Safety helmet (if required) Hearing protection (if required) Respiratory protection (if required)	Footwear Protective clothing * Eye protection Safety helmet Insulating gloves Arc flash suit and hood (if required) Flame-resistant gloves (if required) Face shield (if required) Hearing protection (if required) Respiratory protection (if required)	Footwear Protective clothing * Eye protection Insulating gloves Flame-resistant gloves Arc flash suit and hood Hearing protection Respiratory protection (if required)

‘(if required)’: Determined by the risk assessment.

* Collar up, top buttons done up and sleeves down.

Bracelets, rings, neck chains, exposed metal zips, watches, and other conductive items shall not be worn while working on or near exposed energized conductors or live conductive parts.

SECTION 10 ELECTRICAL INCIDENTS

10.1 MEDICAL ATTENTION

Any person receiving an electric shock or involved in an electrical incident contributing to an injury should seek medical attention immediately. Care shall be taken to ensure that other personnel are not exposed to potential hazards.

NOTE: The full effects of an electric shock or an electrical incident might not be immediately obvious but symptoms may materialize later.

10.2 PRESERVATION OF INCIDENT SCENE

Legislation may require that the incident scene be preserved and not unnecessarily altered to permit any relevant authorities to undertake an investigation.

10.3 REPORTING

All electrical incidents and electric shocks shall be immediately reported to a responsible person and to any organizations as required by legislation.

NOTE: The purpose of reporting an incident is to ensure proper investigation takes place, and ultimately to prevent future occurrences of similar incidents. Employers should actively encourage personnel to report electrical incidents, even where no electric shock occurred, in order to institute appropriate procedures or safety measures.

APPENDIX A
TYPICAL RISK ASSESSMENT FORM
(Informative)

WORK RISK ASSESSMENT FORM

No: Date:/...../.....

OBJECTIVE: At the end of this assessment, you must be able to answer YES to these questions:

1. Does the work site appear safe? 2. Is it likely to remain safe?

Job site:.....

Work description:

SITE SUPERVISOR

	Qualified	Unqualified trainee	Other		Qualified	Unqualified trainee	Other
Name:				Name:			
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

See prompt sheet A1.

STEP-BY-STEP WORK ACTIVITY	POTENTIAL RISK What are the potential risks that could cause a safety incident or injury?	CONTROL MEASURES
PREPARATION		

Is a permit required?	Permit No:	Issued by:
Does the work site appear safe?	Is it likely to remain safe?	← If you can't answer YES to both questions more controls are required.

Sign on: I have participated in this pre work risk assessment and agree to implement the required precautions to control the identified risks.

Site supervisor: Date:...../...../.....

PROMPT SHEET A1

The items listed below are intended as a guidance and are not all inclusive.

<p>ELECTRICAL HAZARDS</p> <ul style="list-style-type: none"> • Electric shock or burns • Arc blast and flash • Working on energized electrical equipment • Inadvertent contact with energized conductors or parts • Unidentified stored electrical energy • Contact with energized conductors or parts by tooling or swarf when modifying switchboards • High energy sources • Inadequately verified or secured isolations • Inappropriate or inadequately rated test equipment • Inappropriate use of test equipment • Unplanned movement of equipment • Unauthorized work • Manual forcing of power devices such as motor contactors • Non-compliant electrical installation • Identification of emergency isolation points • Alternative supplies • Undischarged capacitors • Neutral conductors • Lightning • Static • Induced voltages • Incorrect, non-compliant, deteriorated and/or illegal wiring 	<p>HAZARDOUS SUBSTANCES AND ENVIRONMENTAL HAZARDS</p> <ul style="list-style-type: none"> • Biological • Flammable • Toxic • Carcinogens • PCBs • Chemicals • Particulate matter/dust (e.g. asbestos, etc) • Damp or wet conditions • Lightning or strong winds • Restricted or confined spaces • Working at heights • Persons working above or below • Excavation collapse • Venomous spiders, snakes, stinging insects and other dangerous animals
<p>PEOPLE HAZARDS</p> <ul style="list-style-type: none"> • Incompetent workers • Lack of appropriate supervision • Fatigued workers • Unauthorized persons • Unrealistic job expectations or demands • Fitness for work (e.g. drugs, alcohol, etc) 	<p>MANUAL HANDLING HAZARDS</p> <ul style="list-style-type: none"> • Excessive effort • Heavy lifting • Awkward lifting • Repetitive task • Over-reaching • Ergonomics • Twisting
<p>MECHANICAL HAZARDS</p> <ul style="list-style-type: none"> • Rotating equipment • Entanglement or entrapment • Cutting or stabbing • Burns • Falling objects • Unplanned movement of equipment • Vehicles and/or traffic • Hot work • Other energy sources (e.g. steam, compressed air, high pressure fluids, laser, radiation, etc) 	
<p>OTHER</p> <p>Other hazards not yet considered.</p> <p>Non-compliance with legislative or local procedural requirements</p>	

Accessed by POLYTECHNIC WEST on 12 Sep 2014 (Document currency not guaranteed when printed)

APPENDIX B
CASE STUDIES OF ELECTRICAL INCIDENTS
(Informative)

B1 SCOPE

This Appendix provides case studies of electrical incidents to illustrate the need for the principles and procedures set out in this Standard.

B2 CASE 1

B2.1 Incident

An electrical worker had replaced the fuses in a switch fuse unit and had difficulty in turning the switch on. He opened the cover of the switch and found that the fuse carriage had jammed. As he was trying to free the switch carriage with a pair of pliers, the pliers slipped off, shorting the live incoming terminals. He received burns to his face and arm.

B2.2 Contributing factors and relevant clauses

Failure to isolate—Clause 3.2.

Failure to wear appropriate PPE—Section 9.

B3 CASE 2

B3.1 Incident

An electrical worker was replacing a triple-pole MCB in an existing switchboard. The MCBs were arranged vertically in two columns.

Power was fed to the MCBs from a set of busbars mounted vertically with interconnecting copper busbars running horizontally to the two columns of MCBs. The vertical section of busbars was covered with plastic insulation. The horizontal busbars were uninsulated.

As he was attempting to fit the MCB, his screwdriver slipped from his fingers and fell onto the exposed busbars. An ensuing arc and flames erupted causing him to receive burns to both hands and his left arm.

The 100 A isolating switch on the switchboard did not handle the short-circuit current and disintegrated under the load. The panel cover housing on the main switch was burnt, and metal had melted in the region of the switch operating lever. The panel wiring was smoke damaged but still useable. Protection for the switchboard was from 400 A fuses, two of which ruptured during the short circuit.

The electrical worker was using an uninsulated screwdriver at the time of the incident. The switchboard had an isolating switch rated at 100 A; this failed under fault conditions. A 400 A fuse switch unit protected the switchboard. This did not offer protection for the 100 A isolating switch downstream. The electrical worker was wearing overalls containing a synthetic material that caught fire during the flashover, possibly adding to the burn injuries on his arm.

See Figure B1 for an example of the effects of the arcing fault.

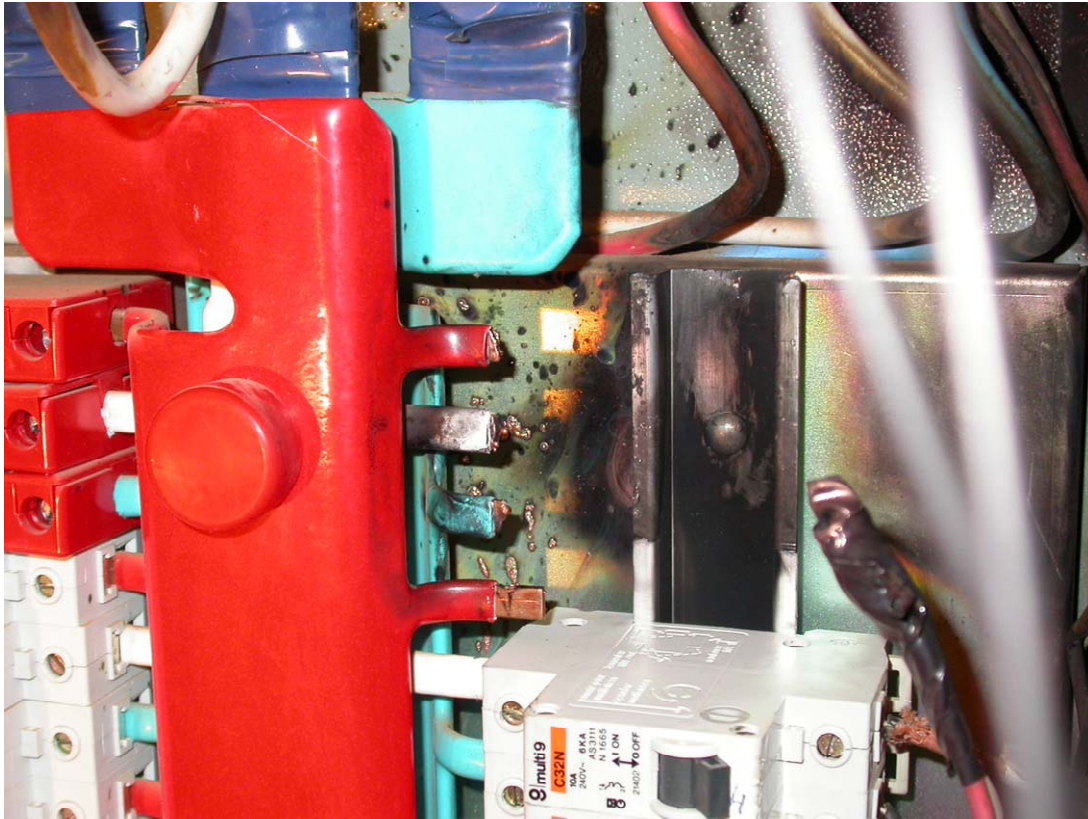


FIGURE B1 EFFECTS OF AN ARCING FAULT

B3.2 Contributing factors and relevant clauses

Failure to do a risk assessment—Section 3

Failure to isolate—or failure to use insulating barriers, covers or mats—Clause 3.2, Clause 3.2.7, Clause 3.5(i) and Clause 5.7.

Failure to follow appropriate isolation procedure—Clause 3.2

Failure to use insulated tools—Clause 3.3(i) and Clause 5.2.

Failure to wear flame-retardant clothing—Section 9.

Failure to wear flame resistant gloves—Section 9.

B4 CASE 3

B4.1 Incident

Two electrical workers were installing cables in a section of a switchboard isolated and proved de-energized. While one electrical worker was working on busbars in one cubicle, the other was working in an adjacent cubicle, using a two-piece metal hole punch to make a 37 mm penetration through to a cable access zone. During this task, the rear section of the hole punch was caught around a neutral conductor that was obscured from view and consequently the conductor was severed in the hole cutting process. This neutral conductor was supplying a control panel neutral link. The actives for the control circuits associated with the link were supplied from a separate energized portion of the switchboard.

The severing of this neutral created a backfeed on the red phase that the other electrical worker was touching at the time, resulting in a shock, which was measured as approximately 180 V shortly afterwards. The electrical worker receiving the shock was unable to break contact and was dragged clear from the switchboard (without the use of any insulated aids) by his working companion. He was taken to hospital with burns to both hands.

B4.2 Contributing factors and relevant clauses

Failure to do a risk assessment—Section 3.

Failure to follow appropriate isolation procedure—Clause 3.2.

Failure to wear insulating gloves—Section 9.

Failure to have suitable rescue techniques and equipment in place—Clause 6.2.

APPENDIX C
ACTS AND REGULATIONS
(Informative)

Region	Act or regulation	Responsible department or agency
Australian Capital Territory	Electricity Supply Act 1997	ACT Building Electrical and Plumbing
	Occupational Health and Safety Act 1989	WorkCover
	Occupational Health and Safety Act Regulations	
New South Wales	Occupational Health and Safety Act 2000	WorkCover NSW
	Occupational Health and Safety Regulation 2001	
	Coal Mine Health and Safety Act 2002	Department of Industry and Investment
	Coal Mine Health and Safety Regulation 2006	
	Mine Health and Safety Act 2004	
	Mines Health and Safety Regulation 2007	Office of Fair Trading
	Electricity Supply Act 1995	
	Electricity Supply (General) Regulation 2001	
	Electricity Supply (Safety and Network Management) Regulation 2008	
	Electricity (Consumer Safety) Act 2004	
	Electricity (Consumer Safety) Regulation 2006	
	Home Building Act 1989	
	Home Building Regulation 2004	
Northern Territory	Electricity Act 1996	Power and Water Authority
	Work Health Act 1998	Work Health Authority
	Work Health (Occupational Health and Safety) Regulations 1996	
	Mining Act 1998	Department of Mines and Energy
	Mining Regulations 1996	
Queensland	Electricity Act—1994	Department of Mines and Energy
	Electricity Regulation 2006	
	Coal Mining Safety & Health Act 1999	
	Coal Mining Safety & Health Regulation 2001	
	Mining & Quarrying Safety & Health Act 1999	
	Mining & Quarrying Safety & Health Regulation 2001	
	Petroleum and Gas (Production and Safety) Act 2004	
	Petroleum and Gas (Production and Safety) Regulation 2004	
	Electrical Safety Act 2002 (Electrical Safety Office)	Department of Justice and Attorney General
	Electrical Safety Regulation 2002 (Electrical Safety Office)	

Region	Act or regulation	Responsible department or agency
	Code of Practice—Electrical Work (Electrical Safety Office)	
	Code of Practice—Working near exposed live parts (Electrical Safety Office)	
	Code of Practice—Electrical Equipment—Rural Industry Relations (Electrical Safety Office)	
	Code of Practice—Works (Electrical Safety Office)	
	Workplace Health & Safety Act 1995 (Workplace Health and Safety Queensland)	
	Workplace Health & Safety Regulation 2008 (Workplace Health and Safety Queensland)	
	Electrical Safety Code of Practice—Risk Management (Electrical Safety Office)	
South Australia	Electricity Act 1996	Department of Transport Energy and Infrastructure Office of the Technical Regulator
	Electricity (General) Regulations 1997	
	Occupational Safety, Health and Welfare Act 1986	Safework South Australia
	Occupational Health, Safety and Welfare Regulations 1995	
	Mines and Works Inspection Act 1920	Department of Primary Industries and Resources
Tasmania	Electricity Industry Safety and Administration Act 1997	Electricity Standards and Safety, Department of Justice
	Electricity Industry Safety and Administration Regulations 1999	
	Occupational Licensing Act 2005	
	Occupational Licensing (Electrical Work) Regulations 2008	
	Workplace Health and Safety Act 1995	Workplace Standards Tasmania
	Workplace Health and Safety Regulations 1998	
Victoria	Electricity Safety Act 1998 Electricity Safety (Installations) Regulations 2009	Energy Safe Victoria
	Occupational Health and Safety Act 2004	WorkCover Authority
	Occupational Health and Safety (General Amendment) Regulations 2007	
	Mines Act 1958	
Western Australia	Electricity Act 1945	Department of Consumer and employment Protection—Energy Safety Division
	Electricity Act Regulations 1947	
	Electricity (Licensing) Regulations 1991	
	Mines Safety and Inspection Act 1994	Department of Consumer and employment Protection—Resource Safety Division
	Mines Safety and Inspection Regulations 1995	
	Occupational Safety and Health Regulations Act 1984	Department of Consumer and employment Protection—Worksafe Division
	Occupational Safety and Health Regulations 1996	

Region	Act or regulation	Responsible department or agency
New Zealand	Electricity Act 1992	Ministry of Economic Development New Zealand
	Electricity Amendment Act 1993	
	Electricity Amendment Act 1997	
	Electricity Amendment Act 2006	
	Electricity Amendment Regulations 1999	
	Electricity (Safety) Regulations 2010	
New Zealand	Health and Safety in Employment Act 1992	Department of Labour (Occupational Health & Safety)
	Health and Safety in Employment Regulations 1995	

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

Visit our web sites

www.standards.org.au

www.standards.co.nz

www.standards.com.au



GPO Box 476 Sydney NSW 2001
Phone (02) 9237 6000
Fax (02) 9237 6010
Email mail@standards.org.au
Internet www.standards.org.au
SAI Global Customer Service
Phone 13 12 42
Fax 1300 65 49 49
Email sales@saiglobal.com



Level 10 Radio New Zealand House
155 The Terrace Wellington 6011
(Private Bag 2439 Wellington 6140)
Phone (04) 498 5990
Fax (04) 498 5994
Customer Services (04) 498 5991
Information Service (04) 498 5992
Email snz@standards.co.nz
Internet www.standards.co.nz

This page has been left intentionally blank.