



Government of **Western Australia**
Department of **Mines, Industry Regulation
and Safety**



Guidelines for the Safe management of high voltage electrical installations



April 2023

Preface

These guidelines for the safe management of high voltage electrical installations are issued under Section 33AA of the *Electricity Act 1945 (WA)* by the Director of Energy Safety and are endorsed by WorkSafe.

The risks and potential consequences of an electrical incident involving high voltage are significantly higher than low voltage due to the much higher quantities of energy involved. This justifies stringent safety designs and operating procedures to prevent injury to persons and major damage to electrical installations and buildings.

I strongly recommend compliance with the practices and procedures set out in these guidelines. Should you have any suggestions and comments on these guidelines, please send them to me in writing and I will be pleased to consider them.



Saj Abdoolakhan
Director of Energy Safety

Endorsed:



Darren Kavanagh
WorkSafe Commissioner

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Summary

Persons conducting a business or undertaking at premises with high voltage (HV) electrical installations are required to comply with all relevant technical and safety requirements for the duration of the operating life of the electrical plant, including:

- design and construction;
- maintenance;
- operation; and
- de-commissioning.

These guidelines complement, and should be read together with, other related documents including (but not limited to):

- Electricity (Licensing) Regulations 1991 (ELR).
- The Western Australian Electrical Requirements (WAER).
- Network operators' technical rules.
- Relevant electrical technical standards, including:
 - ▶ AS/NZS 3000 *Electrical installations* (known as the Australian/New Zealand Wiring Rules).
 - ▶ AS 2067 *Substations and high voltage installations exceeding 1kV a.c.*
 - ▶ AS/NZS 7000 *Overhead line design*.
 - ▶ *Work Health and Safety Act 2020* (WHS Act) and Regulations.
 - ▶ *Western Australia Service and Installation Requirements* (WASIR) as published by Western Power and Horizon Power.

Technical requirements for design purposes are covered by legislation and technical standards and are not repeated in these guidelines.

Under Section 7 of the WAER, design proposals for all installations connected to a network at voltages greater than 1kV are required to be submitted to the relevant network operator for assessment ("Design submission" (formerly "HV Submission")).

A comprehensive electrical safety management plan and safe working procedures must be developed and maintained for all HV installations.

1. Introduction

1.1 Duty of care

PCBUs at a workplace (see definition of “PCBU” below) are responsible for the safety of people and property in relation to the management and conduct of undertakings at those premises.

The WHS Act and WHS Regulations apply to workplaces, and establish duties upon a number of persons.

1.2 Electrical risks

The most common risks of death or injury caused directly or indirectly by electricity are:

- electric shock;
- arcing, explosion or fire; and
- ingestion of toxic materials released by burning and arcing associated with electrical equipment.

Electric shocks from faulty electrical equipment may also lead to related injuries, including falls from ladders, scaffolds or other elevated work platforms. Other injuries or illnesses may include muscle spasms, palpitations, nausea, vomiting, collapse and unconsciousness.

The electrical risks and consequences of an electrical incident involving high voltage may be significantly higher than for low voltage. Under fault conditions, the higher voltages and fault current levels can release massive quantities of energy. The inherent risks are therefore potentially very high and must be effectively managed.

Under work health and safety legislation, the PCBU has the primary duty to ensure, so far as is reasonably practicable, that workers and other persons at the workplace are not exposed to electrical risks. This duty requires eliminating or minimising and managing these risks.

These responsibilities include, but are not limited to, ensuring compliance with all relevant technical and safety requirements for the duration of the operating life of the electrical plant, including:

- design and construction;
- maintenance;
- operation; and
- de-commissioning.

These guidelines complement, and should be read together with, other related documents including (but not limited to):

- Electricity (Licensing) Regulations 1991 (ELR).
- Western Australia Electrical Requirements 2021 (WAER).
- Network operators’ technical rules.
- Relevant electrical technical standards, including:
 - ▶ AS/NZS 3000 *Electrical installations* (known as the Australian/New Zealand Wiring Rules).
 - ▶ AS 2067 *Substations and high voltage installations exceeding 1kV a.c.*
 - ▶ AS/NZS 7000 *Overhead line design*.
 - ▶ *Work Health and Safety Act 2020* (WHS Act) and Regulations.
 - ▶ *Western Australia Service and Installation Requirements* as published by Western Power and Horizon Power.¹

The fundamental requirements specified in regulation 49 of the Electricity (Licensing) Regulations 1991 must be observed to ensure that HV installations:

- are safe to use, maintain and operate, recognising that higher voltages and related fault levels are especially dangerous, demanding rigorous safety practices to manage the risks to an acceptable level; and are suitable for connection to an electricity supply network, where this is intended.

¹ Guidelines produced by Western Power and Horizon Power for connection to their distribution networks

1.3 Definitions

For the purposes of these guidelines:

High Voltage (HV) means an operating voltage exceeding 1kV (AC) or 1.5 kV (DC).

Network operator has the meaning given in the Electricity (Network Safety) Regulations 2015.

Person conducting a business or undertaking (PCBU) is an umbrella concept which intends to capture all types of working arrangements or structures. A PCBU includes a company, unincorporated body or association, sole trader or self-employed person. Individuals who are in a partnership that is conducting a business will individually and collectively be a PCBU (meaning given in the WHS Act and Regulations).

Professionally qualified engineer has the meaning given in the WAER.

1.4 Application

These guidelines do not apply to network operators' HV installations which are covered by the Electricity (Network Safety) Regulations 2015.

2. Design and construction

2.1 General

HV electrical installations (and subsequent major augmentations) must be designed and constructed to a standard consistent with good industry practice, with careful consideration of the ongoing safety of workers and members of the public, integrity of equipment and risks to property.

When procuring equipment for private HV installations, whether it is from suppliers, directly from manufacturers or from network operators, it is important to verify that the equipment complies with the relevant standards. Some equipment is only suitable for use by major network operators and is not to be used on private networks without compliance verification and certification.

2.2. Technical requirements

The technical requirements for design purposes are adequately covered by various existing legislation and technical standards and are not repeated in this guideline.

The relevant documents include, but are not limited to:

- WAER (regulations 49(1) and 49A of the ELR).
- Network operator technical rules (published by network operators).
- Relevant electrical technical standards, including AS 2067, AS/NZS 3000 and AS/NZS 7000.
- WASIR.
- Other network operator connection requirements.

The WHS Act and Regulations outline additional requirements, including statutory positions where there is a high voltage installation on a mine site².

2.3 Submission of HV design proposal

For all proposed new HV installations and subsequent material augmentations, the WAER requires an HV installation design proposal to be developed and certified by a professionally qualified engineer as complying with all relevant technical requirements.

Under the WAER, where connection to a network is required, the design submission should be referred to the relevant network operator for review before finalising specifications and calling for tenders. It must be submitted in reasonable time for assessment prior to the connection proceeding.

² In the case of mine sites, submission is also required to the Mines Safety Division of the Department of Mines, Industry Regulation and Safety, in accordance with r. 675UK of the Work Health and Safety (Mines) Regulations.

2.4 HV submission outline

The HV submission will typically include detailed design and performance information on the following:

- site plan;
- single line diagram;
- electrical load;
- control of incoming supplies and metering arrangements;
- earthing system design;
- primary plant – generators, motors, power transformers, switches, current and voltage transformers;
- protection scheme;
- applicable technical standards;
- operating procedures;
- recommended equipment maintenance schedules; and
- timeframe for initial commissioning supply and permanent connection.

Further detailed requirements for HV submissions are provided in the WAER and the network operator's technical rules and connection requirements (including the WASIR). Network operators may also have additional requirements for specific connection locations.

2.5 Commissioning tests

Notwithstanding the submission of the HV design proposal to the relevant network operator or technical safety regulator, final commissioning tests are also required to verify the performance of the installation design. These tests shall be performed by a competent testing organisation acceptable to the approving party. All testing and results are to be retained and provided when requested under regulation 52(2D) of the ELR.

In the case of network connections, satisfactory test results of all HV electrical equipment between the point of supply and the main switch shall be recorded and submitted to the network operator prior to permanent supply being made available.

Final certification is required by a professionally qualified engineer that the 'as commissioned' installation complies with the design and all relevant technical requirements. A copy of the final certification shall be given to the network operator (where connected to a network).

3. Maintenance

PCBUs at a workplace with an electricity supply at high voltage shall ensure that their installation:

- safely performs the functions for which it is designed and intended;
- operates in accordance with the manufacturers' requirements;
- is maintained in good order; and
- in the event of a fault or malfunction does not create a hazard or cause interference to the network operator's distribution network.

The PCBU shall implement an effective written maintenance plan for the HV installation, including the main incoming circuit breaker and protection system.

The protection and control systems associated with the installation shall be tested for correct operation in accordance with the manufacturer's specifications. The PCBU shall keep records of maintenance tests, and make them available to the network operator upon request.

Maintenance programs, frequencies and operations for particular item(s) of plant should be planned in consultation with the relevant manufacturers and the network operator.

Additionally, when conducting inspections of HV equipment, the condition of the following typically should be considered:

- external insulation;
- internal insulation, including oil and gas where appropriate;
- contacts, interrupting devices and connections;
- earthing system and connections;
- operating mechanisms and their lubrication;
- weather seals and gaskets;
- protective finishes and signs of corrosion;
- legibility of labels and signage;
- substations and switchboard rooms not used for general storage, with adequate spaces around each HV installation;
- emergency lighting in substations and switchboard rooms; and
- fire extinguishers with correct fire suppressants by each door of switch rooms.

Due consideration should be given to site conditions and protection of equipment against external influences.

Periodic inspections of switch rooms and switchgear enclosures are required to ensure:

- emergency exits are not obstructed and panic release mechanisms are operational;
- safety signs are present and legible;
- integrity of security systems against unauthorised access;
- equipment labelling and operational diagrams are correct and legible;
- no ingress of moisture, water or contaminants;
- no intrusion by rodents, birds or insects; and
- any ventilation or fire suppression system is fully operational.

The results of periodic inspections and examinations, including thermographic tests, may give guidance on the intervals that should be allowed to elapse between future inspections, examinations and overhaul operations with reference to particular operating conditions.

The latest versions of the following Standards are relevant and useful guides:

- AS 2067 *Substations and high voltage installations exceeding 1kV a.c.*
- AS 1319 'Safety signs for the occupational environment'.
- AS 1940 *The storage and handling of flammable and combustible liquids.*
- AS 60422 *Mineral insulating oils in electrical equipment – Supervision and maintenance guidance.*
- AS 1767 *Insulating liquids (series).*
- AS/NZS 7000 *Overhead line design.*
- IEC 61230 *Live Working – Portable equipment for earthing or earthing and short-circuiting.*

4. Operation

4.1 HV operating procedures and safety management plan

PCBUs shall have:

- a set of operational procedures for HV installations incorporated into:
 - ▶ their site safety management plan; or
 - ▶ a specific high voltage installation safety management plan.

The procedures and plan shall ensure compliance with the requirements of the relevant legislation, codes, guides and Australian Standards including, but not limited to, the following matters:

- isolation procedures, including work permits, locking, testing and tagging;
- personnel competencies and electrical access authorisations;
- barriers for electrical, mechanical and personal protection;
- access to rotating machines and discharging of deactivated apparatus;
- earthing and short circuit requirements;
- provision and use of personal protective clothing and equipment;
- training, education and worksite safety briefings;
- internal and external communications including emergency personnel and network operator contact details; and
- emergency and evacuation procedures.

The procedures and plan shall be updated following any plant upgrades.

The PCBU shall, on request, provide a copy of the procedures and plan to the network operator.

4.2 High voltage switching operators

The PCBU shall ensure that HV switches are operated only by workers selected, trained and authorised by the PCBU and, where required, by the network operator.

The PCBU shall ensure that its switching operator(s) are conversant with the operational procedures, safety management plan and the network operator's requirements.

Switching operators shall be trained and regularly assessed³ as competent, by a registered training organisation (RTO), to perform the roles for which they are responsible including, but not limited to, the use of:

- personal protective equipment;
- HV testing equipment;
- HV earthing apparatus designed to facilitate the earthing of all types of HV equipment within the installation; and
- insulating mats, screens and other similar equipment necessary for the safe operation of the HV installation.

The switching operators shall coordinate their activities with the network operator and, where required, be responsible for the issuing of access permits authorising persons to work on isolated and earthed sections of the installation.

The PCBU shall establish (before commissioning) and maintain a register of all authorised persons with details of switching competencies and any restrictions.

If the contact details of the PCBU change, the network operator must be notified promptly.

4.3 Switching agreement

The PCBU must establish a switching agreement with the relevant network operator, prior to connection. The basic functions of a switching agreement are:

- assignment of accountabilities and obligations;
- exchange of contact details between the owner and the network operator; and
- to establish switching procedures for both routine and emergency operations.

³ HV switching operators are required to be assessed as being competent, and maintain currency, in units of switching contained in industry training packages delivered by an RTO approved to deliver nationally recognised training within the Australian Qualifications Framework.

The switching agreement shall:

- specify the PCBU's obligations and responsibilities when undertaking switching activities;
- include provisions to ensure that the PCBU:
 - ▶ only performs switching operations on customer-owned equipment as listed in the agreement;
 - ▶ is not permitted to operate network operator-owned equipment unless expressly mentioned in the special conditions of the agreement or as directed by the network operator;
 - ▶ provides 24 hour, seven day availability of a switching operator to undertake switching operations of the HV assets as required by the network operator for the purposes of inspection of HV metering, load shedding, routine maintenance or emergency repair of the incoming HV supply equipment; and
- include, where applicable, provisions to enable the network operator to operate customer-owned equipment as nominated by the PCBU.

4.4 Basic safety requirements

4.4.1 Access to electrical equipment

The HV operator must provide, in accordance with the PCBU's safety plan, "access permits" to:

- manage the movement and monitoring of all persons accessing de-energised sections of the electrical installation;
- perform work; and
- ensure all such persons are clear prior to re-energising the relevant section of the installation.

The HV operator must use appropriately coloured tape barriers and stands to display access permits clearly identifying proven de-energised and earthed sections of the HV installation on which work can be performed safely and maintain, at all times, a minimum of two levels of personnel safety protection against inadvertent contact with live parts.

4.4.2 Operating equipment

Appropriately rated and tested HV safety apparatus and personal protective equipment shall be made readily available on site by the PCBU for use by its HV operator(s) and, where required, the network operator's workers, in accordance with the PCBU's HV operating procedures and applicable legislation.

Safety apparatus shall include, but not be limited to:

- HV operating sticks;
- testing equipment to prove that HV apparatus has been de-energised;
- portable earthing equipment;
- HV gloves;
- insulating mats; and
- signage, barriers and tags.

The PCBU shall provide labelled storage facilities, as close as practicable to the point of use, for the apparatus. All operating equipment shall be maintained by the PCBU in a secure, fit-for-purpose condition for use at any time.

4.4.3 Operational diagram

A single-line schematic diagram of the complete installation, showing all aspects of the HV installation (including normally open points), shall be provided in a suitable prominent and permanently displayed enclosure adjacent to all control and isolating switches within the electrical installation.

Where items of switchgear or equipment are remote from the main installation, the operating diagram shall also be permanently displayed at such locations.

4.4.4 Safety signs

Appropriate warning and safety signage shall be installed in accordance with the requirements of this guideline, AS 2067, AS/NZS 3000 and AS 1319.

In each location where HV equipment is present within an installation, a durable safety poster shall be displayed in a prominent and permanent position which outlines emergency resuscitation methods and provides instruction for the release of persons from contact with live parts.

4.4.5 Applicable guidelines

Safety guidelines published by the Energy Networks Association relevant to this matter, include:

- ENA Doc 001-2019 *National electricity network safety code*.
- ENA NENS 03-2006 *National guidelines for safe access to electrical and mechanical apparatus*.
- ENA NENS 04-2006 *National guidelines for safe approach distances to electrical and mechanical apparatus*.
- ENA NENS 09-2014 *National guidelines for the selection, use and maintenance of personal protective equipment for electrical arc hazards*.

5. Audits

For HV installations, PCBUs should (as part of an effective safety management plan) conduct periodic audits as appropriate to ensure:

- site safety management plans or specific HV installation safety management plans are relevant, up-to-date and being applied in practice;
- HV installation maintenance plans are being followed and maintenance records are being maintained;
- any HV installation augmentation has been appropriately integrated; and
- compliance with switching agreements.

Audits should be conducted by an appropriately qualified and experienced electrical engineer or electrician.

A copy of the audit report shall be provided to the network operator (where the installation is connected to a network).

6. Additional work health and safety considerations

PCBUs at a workplace with an HV installation should consider whether the work (including construction, maintenance and operation) complies with the WHS legislation, including requirements of the following:

- Safe work method statements where the work is considered high risk construction work.
- Overhead and underground electric lines.
- Duties for plant at the workplace.
- Incident notification.
- HV requirements on mines, such as statutory positions and high voltage vicinity permits.

Government of Western Australia

**Department of Mines, Industry Regulation
and Safety**

Building and Energy

1300 489 099

8.30am – 4.30pm

Level 1 Mason Bird Building

303 Sevenoaks Street

(entrance Grose Avenue)

Cannington Western Australia 6107

Online

Website: www.dmirs.wa.gov.au/building-and-energy

Email: be.info@dmirs.wa.gov.au

Mailing address

Locked Bag 100

East Perth WA 6892

Regional offices

Goldfields/Esperance	(08) 9021 9494
Great Southern	(08) 9842 8366
Kimberley	(08) 9191 8400
Mid-West	(08) 9920 9800
North-West	(08) 9185 0900
South-West	(08) 9722 2888

National Relay Service: 13 36 77

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