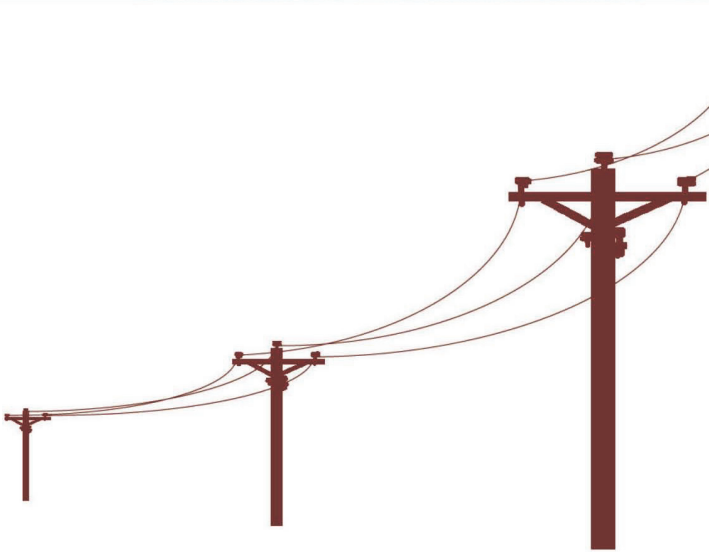




# High Voltage Live Work Manual



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For the current version of this document, see:

- Depot Pack (see *Depot Pack Instructions* (DM# 9001578))
- the Western Power website:  
[http://www.westernpower.com.au/documents/High\\_Voltage\\_Live\\_Work\\_Manual.pdf?](http://www.westernpower.com.au/documents/High_Voltage_Live_Work_Manual.pdf?)
- the Western Power intranet site, *busbar* <http://busbar/work-practices.html>
- Enterprise Connect (DM# 6127457)

**Note:**

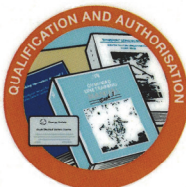
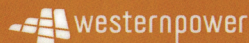
Any updates to this manual will be communicated to the Network Total Workforce (NTW) and the electronic version updated on Depot Pack, the Western Power website and *busbar*.

This document has been prepared by Work Practice Development and Training.  
[work.practice.development@westernpower.com.au](mailto:work.practice.development@westernpower.com.au)

# Safety LifeSavers



*Safety LifeSavers are essential safe work practices designed to protect you and others from serious injury or death.*



To safely perform the work including operating equipment, you must have the necessary qualifications, certificates, competencies and training.



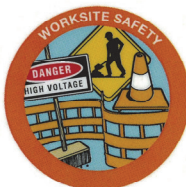
Before you start, make sure you plan the job and all members of the work team understand their roles and responsibilities. A Job Risk Assessment must be completed for all operational jobs.



Always wear the appropriate personal protective equipment and clothing at the work site and for the job.



Comply with all the requirements of working at heights when using equipment such as a ladder, harness, lanyard or scaffold.



Provide adequate control to manage site hazards, excavations, traffic and public safety.



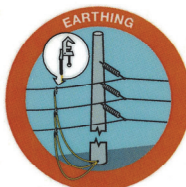
Test before you touch. Treat all conductors as live until YOU prove they are de-energised and made dead. Confirm your work and follow the correct work instructions.



The relevant permits or programs must be issued before work starts. Make sure the correct isolations are made and the proper tags are used for the job.



Use the approved insulating mats and covers to prevent accidental contact.



Apply appropriate earthing where required. Use visible earths in the work area.



Always drive safely, obey traffic laws, secure loads and conduct regular safety checks.

## Think Safe Work Safe Live Safe

Breach of Safety LifeSavers or concealing breaches can result in disciplinary action and may lead to termination of employment.





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10.0	Transmission insulated stick method	6	07/2016
10.1	Blank – ‘Applying a bolted fitting – transmission insulated stick method’ has been replaced by ‘TIS-02 Insulator and conductor disconnection/reconnection’.	4	12/2015
10.2	Blank – ‘Rigging conductor support equipment – transmission insulated stick method’ has been replaced by ‘TIS-05 Wire tong support pole saddle method’.	5	12/2015

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10.3	Blank – 'Displacing conductors using crane and lifting beam – transmission insulated stick method' has been replaced by 'TIS-04 Displacing conductors using crane and lifting beam'	5	12/2015
10.4	Blank – 'Crane-mounted conductor support equipment – transmission insulated stick method' has been replaced by 'TIS-03 3-pole construction (cricket wicket) pole change'.	4	12/2015
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## Introduction

### Work practices

This manual has been produced to ensure standardisation of work practices and procedures for qualified and authorised high voltage (HV) live workers undertaking HV live work on the Western Power Network. They ensure that HV live workers are aware of their roles and responsibilities in creating and maintaining a safe working environment that meets state and national legislation, standards and work practices. The main reference document for this manual is *AS 5804 High-voltage live working*.

These work practices, which set the minimum requirements, must be issued to all relevant staff and must be followed at all times.

### Review process

The manual is constantly being reviewed, updated and developed to meet new legislation, newly developed techniques and technological advancements in equipment and network design for accessing and working on the Western Power Network.

The following groups meet regularly to discuss HV live line work, and oversee all major changes to this manual.

- Senior Management High Voltage Live Line Work Committee
- High Voltage Live Line Work Group
- Local High Voltage Live Line Work Groups

### Version control

- It is the **user's responsibility** to update and maintain their own copy of the manual.
- It is the **formal leader's responsibility** to ensure that employees are using the current version of this manual.

#### Note:

Use the electronic version wherever possible. It is available on Depot Pack, the Western Power website and *busbar*. This will help to ensure that the most up to date version is being used.

Depot Pack

Depot Pack is an electronic resource that was designed to be used by workers in the field where a data connection may not be available. It does not require a network or internet connection to be used (although one is required to update the Depot Pack files).

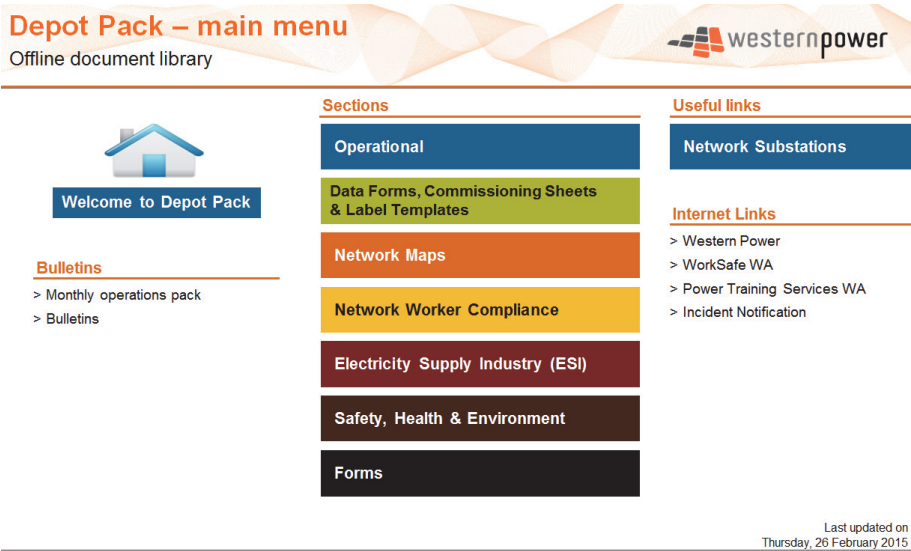


Figure 1: Depot Pack main menu

Depot Pack is available to the entire NTW and is in use by all Western Power staff and many of our contractors.

Depot Pack is:

- the one stop shop for all Western Power work practice information
- easier to use and more reliable than printed paper documents. It's regularly updated, so you know the information is current, unlike a printed document that may have changed since your copy was printed.
- a controlled source of information, which is crucial when it comes to safe and efficient work practices

For information on installing and updating Depot Pack, see *Depot Pack Instructions* (DM# 9001578).

### Western Power website

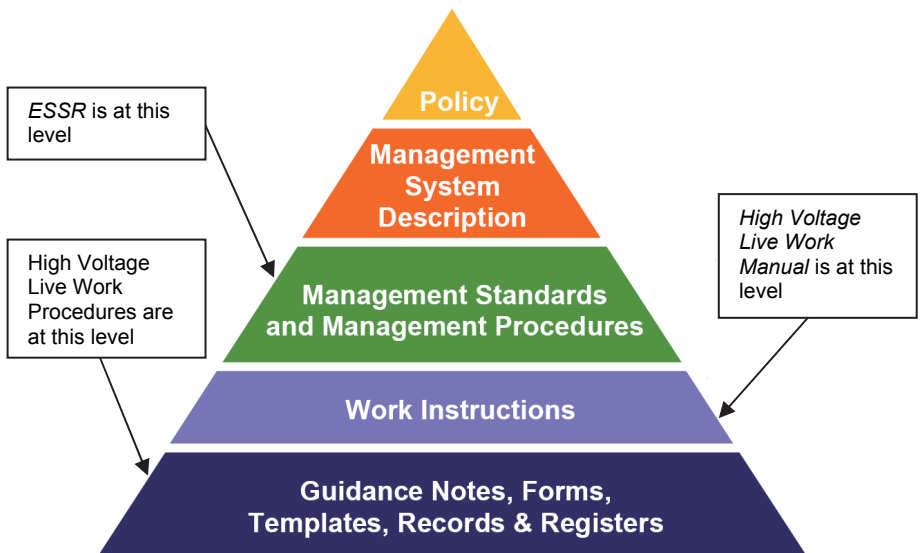
The *High Voltage Live Work Manual* is available on the Western Power website in the *Network contractors* section:

[http://www.westernpower.com.au/documents/High\\_Voltage\\_Live\\_Work\\_Manual.pdf?](http://www.westernpower.com.au/documents/High_Voltage_Live_Work_Manual.pdf?)

### Hierarchy of documentation

Government legislation and regulations set the requirements for company-level policy. Within Western Power, documentation is governed by the hierarchy shown in Figure 2, below. If there is ever a difference between documentation, the higher level documentation always overrides documentation at a lower level.

- The *Electrical System Safety Rules* (ESSR) overrides the *High Voltage Live Work Manual*.
- The *High Voltage Live Work Manual* overrides High Voltage Live Work Procedures etc.



**Figure 2: Western Power's Safety, Health and Environment Management System Document Framework**

### Feedback

The Work Practice Development team strives for continual improvement of systems, procedures, processes and instructions. We value feedback and encourage suggestions and recommendations for changes, alterations or inclusions.

Feedback must be submitted to a formal leader for review, who can then forward it on to:

- the Work Practice Development team at [work.practice.development@westernpower.com.au](mailto:work.practice.development@westernpower.com.au)
- if the item is related to HV live line work, it can be forwarded to a representative of a High Voltage Live Line Work Committee or Group

### References

- Depot Pack Instructions
- Work Practice Manual



### Definitions

#### Apparatus

Any item of electrical machinery or equipment (including primary and secondary) in which conductors are used, or supported, or of which they form a part.

#### Approved

Having appropriate Western Power endorsement in writing for a specific function.

#### Approved work technique

A documented technique which meets the requirements of this manual and which has been approved by Western Power.

#### Authorised person

A competent person with the delegated authority to perform the duty concerned on behalf of Western Power.

#### Auto-reclose

A device designed to automatically reclose the circuit after it has been broken due to a fault operation.

#### Brush contact

Momentary accidental or inadvertent contact.

#### Circuit

A set of conductors and associated hardware and insulation, which together form a single electrical connection, and which, when faulted, are normally switched automatically from the system as a single entity.

#### Constant leakage monitoring

Monitoring continually or at intervals of leakage (in micro amps) of current across the insulated section of the boom during high voltage work – 1 uA/kV allowable.

#### Contact area

The area within one metre of the nearest energised high voltage apparatus.

#### De-energised

- The electrical supply to electrical apparatus has been switched off.
- The electrical supply has been de-energised but not necessarily isolated, tested and earthed.

#### Drop zone

The area below the immediate work where objects could fall, or be directed into, if they strike other structures or objects after the fall.

#### Earthed

Electrically connected to earth in an approved manner by approved earthing conductors or switches.

### **Equipment management system**

A secure documentation system used to accurately record specific details about equipment used for high voltage live work.

### **Ergonomic distance**

The distance calculated to take into account inadvertent movement and errors in judgement of distances while performing work. The ergonomic distance applies to personnel and plant and can be influenced by personal and environmental factors.

### **Fully insulated EWP**

An approved, tested and insulated EWP that has constant leakage monitoring facilities to ensure continued insulation for higher voltage work, 66 kV and above.

### **Glove and barrier method**

A method of performing live line work on circuits up to, and including, 33,000 volts. The HV live worker is fully insulated from earth and phases using approved insulating gloves and sleeves, insulating platform and/or insulated EWP and insulating barriers.

### **High voltage (HV)**

A voltage of 1,000 volts AC or 1,500 volts DC or greater.

### **HV live worker**

A person who, by way of training and demonstration of competency, performs live high voltage work.

### **Insulated EWP**

- An approved and tested insulated EWP fitted with an approved and tested insulating liner to the inside of the basket – used with the glove and barrier method.
- An approved and tested insulated EWP without a liner – used with the insulated stick method.

### **Insulated stick (also called live line stick or hot stick)**

A stick of insulating material specifically designed, approved and tested for use in physically bridging the distance between the HV live worker and energised apparatus, between the energised apparatus and earth, between adjacent phases, and to enable physical loads to be taken or tools to be applied to the stick.

### **Insulated stick method (also called live work stick method)**

A method of performing live line work using tools and equipment attached to insulated sticks with the HV live worker maintaining the MAD from energised apparatus

### **Insulating barrier**

A barrier of rigid or flexible insulating material specifically designed, approved and tested for use as an insulated cover.

### **Insulating gloves**

Gloves that are especially designed, approved and tested to a rated voltage for working on, or near, live electrical apparatus.

### **Insulating pole platform**

A platform of insulating material specially designed, approved and tested for use with the HV live work glove and barrier method.

### **Insulating sleeves**

Insulating sleeves are specially designed, approved and tested to a rated voltage for working on or near live electrical apparatus.

### **Insulation testing**

Insulation resistance testing using an insulation tester to measure resistance and indicate the condition of insulation.

### **Live**

Energised or subject to hazardous induced or capacitive voltages.

### **Live work equipment**

All approved live line tools, rope, insulating equipment and other gear used for live line work.

### **Live work**

All work performed on components of electrical apparatus that are not isolated or proved de-energised, short-circuited or earthed.

### **Minimum approach distance (MAD)**

The minimum separation distance that must be maintained by a person, mobile plant (including its load) or any object (other than insulated objects designed for contact with live conductors) from electrical apparatus for that apparatus' nominal voltage and the person's skill level (authorised person or ordinary person).

### **Minimum tool insulating distance**

The distance that the insulating material (stick or rope) is subjected to while touching energised conductors. This distance must be measured between the metal end fitting at the conductor end of the insulating material and the metal end fitting or hand mark, where provided, at the opposite end of the insulating material. When insulated sticks consist of sections joined with metal couplings, the insulating distance must be the total of each of the lengths of insulating material which have not been bridged out by the metal couplings.

### **Other cable systems**

Telecommunications cables, pay television cables, control cables, aerial earthed cables, electrolysis drainage cables.

### **Periodic inspection**

A type of inspection made regularly on tools and equipment.

### **Primary point of contact**

The main electrical apparatus being worked on.

### **Rated voltage**

The manufacturer's recommended maximum voltage to be applied to their specified equipment.

### **Safety observer**

A person fully trained and authorised in the work method being used and specifically assigned the duty of observing and warning against unsafe approach to electrical apparatus, or other unsafe conditions. .

The safety observer must remain outside the MAD.

### **Safe working load (SWL)**

The maximum working load or force that can be applied, as defined by the manufacturer. Also referred to as working load limit (WLL).

### **Secondary point of contact**

All electrical apparatus or earth structures within reach and operating at different potentials to the primary point of contact under live work.

### **Step potential**

A shock hazard that occurs when a person is close to, or steps towards, an energised contact site. The voltage that passes through the body is calculated by the difference in voltage of the energised soil between their feet.

### **Tested**

Apparatus that has been tested in accordance with the relevant standard.

### **Test voltage**

The voltage that must be applied to the specified equipment for the purpose of periodic electrical testing.

### **Touch potential**

A shock hazard that occurs when a person touches an energised object while standing on a zone that is at a different potential. The voltage that passes through the body is calculated by the difference between the voltage of the energised object and the voltage of the zone where the feet are placed.

### **Work area**

The area within normal body reach of the working position.

### **Working load limit (WLL)**

The maximum working load or force that can be applied as defined by the manufacturer. Also referred to as safe working load (SWL).

### 1.0 Introduction to HV live work

#### Purpose

The purpose of this work practice is to provide a basic description of high voltage (HV) live work and related requirements.

#### HV live work

- HV live work is a process by which personnel can safely perform work on energised (live) HV electrical apparatus.
  - The work practices contained in this manual have been written around work on overhead lines.
  - In order to perform HV live work on the Western Power Network, personnel must have the appropriate qualifications and authorisations. For more on this, see section 3 (Training, competency and auditing requirements) in this manual.
  - The methods permitted for use on the Western Power Network are:
    - glove and barrier method. For more on this, see the following in this manual:
      - work practice 1.2 (Glove and barrier method – voltages up to 33 kV)
      - section 8 (Glove and barrier method).
    - insulated stick method. For more on this, see the following in this manual:
      - work practice 1.1 (Insulated stick method – voltages up to 132 kV)
      - section 9 (Distribution insulated stick method)
      - section 10 (Transmission insulated stick method).
- or**
- a combination of both. For more on this, see work practice 1.3 (Combining the insulated stick method with the glove and barrier method – voltages up to 33 kV) in this manual.

#### Important

No HV live work must be undertaken without an applicable and approved HV live work procedure.

If no applicable HV live work procedure is available, a draft procedure must be produced by the work team intending to do the work. The draft procedure must be submitted to, and approved by, Work Practice Development before it can be used.

### Restrictions

#### Older style cast iron cable termination boxes

HV live work must not be carried out in the same bay or on structures with older style cast iron cable termination boxes as shown in Figure 1, below. These cable termination boxes have been known to fail after being:

- re-energised
- exposed to movement of attached conductors
- exposed to live line insulator spray washing.



**Figure 1: Older style cast iron cable termination box**

#### Reclosers with internal potential transformers

HV live work must not be carried out on reclosers with internal potential transformers (IVTs). Reclosers with IVTs, once removed, must not be reinstalled. Arrangements must be made to return them back to the manufacturer (for assistance with this, ask your formal leader).

##### **Note:**

Reclosers with IVTs can be identified by three name plates and/or warning stickers, as shown in Figure 2, below.





3 name plates

Warning sticker

**Figure 2: Name plates on internal potential transformers**

### HV spreaders

HV live work involving displacing or changing the tension on conductors must not be carried out in bays fitted with HV spreaders as shown in Figure 3, below. HV live work methods must not be used to install or remove HV spreaders.



**Figure 3: HV spreader**

### Important

- HV live work must be performed in accordance with the work practices in this manual and Western Power HV live work procedures.
- HV live workers must only work on one potential at any given time and manage the potential of secondary points of contact and minimum approach distances (MADs).

## Safety requirements

### Safety observer

- The safety observer for HV live work must be fully trained and authorised in the work methods being used.
- An HV live worker under supervision cannot be a safety observer unless under the direct supervision of a fully authorised HV live worker.

### Risk assessment

All hazards must be identified, risks assessed and control measures put in place during:

- pre-job planning
- onsite risk assessment.

Hazards must be continually reviewed, monitored, recorded and controlled for the duration of the task. For more on this, see:

- *High Voltage Live Work Manual*, work practices:
  - 2.1 (Onsite risk assessment)
  - 2.9 (Job briefing process).
- *Work Practice Manual*, work practices:
  - 2.27 (Construction site hazard management forms)
  - 2.28 (Job briefing process).

### Night work

Most HV live work will be carried out during daylight hours. However, if HV live work is undertaken at night, the following lighting requirements apply.

- Lighting must illuminate all objects in the work area, such as:
  - second points of contact
  - conductors

- pole
- hardware.
- All HV live workers and safety observers must be able to identify all objects in the work area.
- Work is restricted to the area of illumination.

### Important

If the HV live workers or the safety observer cannot clearly see all objects and second points of contact within the work area, the task must not proceed.

### Permits and network protective devices

Before performing any HV live work on the Western Power Network:

- a Vicinity Authority (VA) must be issued. A VA is the Western Power permit that authorises work in close proximity to:
  - live electrical apparatus
  - apparatus that may become live.
- auto-reclose devices immediately upstream of the worksite must be disabled
- network protective devices must be operational in the circuit being worked on. These devices must be capable of detecting and clearing faults at the worksite. For more on this, see work practice 2.3 (Permits, network protective devices and communication) in this manual.

#### Note:

The only exception is devices that contain sensitive earth fault (SEF) protection (e.g. recloser, circuit breaker). These devices must be disabled to avoid causing them to trip when temporary bypass jumpers are applied to the circuit.

### Approved PPE

All personal protective equipment (PPE) used for HV live work must be approved and appropriately rated. PPE must be worn in accordance with:

- the work practices relevant to the task
- the risk assessment on the day.

For more on this, see work practice 2.10 (Personal protective equipment (PPE) requirements) in this manual.

### Approved tools, equipment and plant

All tools, equipment and plant used for HV live work must be:

- approved and appropriately rated for HV live work
- within test date
- used in accordance with manufacturer's guidelines.

For more on this, see the following sections in this manual:

- 4 (Use of plant and machinery)
- 5 (Care and maintenance of equipment)
- 6 (Tools and equipment).

### Accessories, hair and body jewellery

- Metallic objects such as tool belts, watches, bracelets, neck chains, mobile phones and other body jewellery, must not be worn while carrying out HV live work.
- Long hair, including facial hair, must be constrained to prevent inadvertent contact with energised conductors or electrical apparatus.
- The lanyard of body harnesses, straps or ropes must be restrained from infringing MADs.

**Table 1: MADs\* to be maintained by HV live workers with auto-reclose off**

System voltage (kV)	Insulated stick (mm)		Glove and barrier
	Phase-to-earth	Phase-to-phase	
6.6	450	550	<p>There are no MADs that apply to glove and barrier work as approved insulated gloves and sleeves are used to contact energised electrical apparatus directly. However, the glove and barrier worker must maintain:</p> <ul style="list-style-type: none"><li>• a minimum air gap of 150mm between any uninsulated part of the body and the energised electrical apparatus (potential) being worked on</li><li>• a minimum air gap of 250mm between the elevated work platform (EWP) basket and any uninsulated second point of contact. If the second point of contact is fitted with one level of insulated barriers rated to the highest working voltage on the structure, this clearance can be reduced to accidental contact.</li></ul>
11	450	550	
22	450	550	
33	450	550	
<p><b>All secondary points of contact within normal reach of the work area must be identified and, for voltages up to 33kV, have rated insulated barriers applied.</b></p>			
66	820	1000	<b>Glove and barrier method not permitted</b>
132	1200	1300	

\* MADs are determined by adding the electrical voltage surge gap to an ergonomic distance of 300mm (allowed for inadvertent movement).

## Procedures

Procedures have been provided on how to perform HV live work using glove and barrier and insulated stick methods. For detailed procedures using these methods, see:

- High Voltage Live Work Procedures – Distribution Insulated Stick*

- *High Voltage Live Work Procedures – Glove and Barrier*
- *High Voltage Live Work Procedures – Transmission Insulated Stick*

A combination of glove and barrier and insulated stick procedures can be used to complete a task.

### References

- *High Voltage Live Work Manual:*
  - work practice 1.1 (Insulated stick method – voltages up to 132 kV)
  - work practice 1.2 (Glove and barrier method – voltages up to 33 kV)
  - work practice 1.3 (Combining the insulated stick method with the glove and barrier method – voltages up to 33 kV)
  - work practice 2.1 (Onsite risk assessment)
  - work practice 2.3 (Permits, network protective devices and communication)
  - work practice 2.9 (Job briefing process)
  - work practice 2.10 (Personal protective equipment (PPE) requirements)
  - section 3 (Training, competency and auditing requirements)
  - section 4 (Mobile plant and related equipment for HV live work)
  - section 5 (Care and maintenance of equipment)
  - section 6 (Tools and equipment)
  - section 8 (Glove and barrier method)
  - section 9 (Distribution insulated stick method)
  - section 10 (Transmission insulated stick method).
- *High Voltage Live Work Procedures – Distribution Insulated Stick.*
- *High Voltage Live Work Procedures – Glove and Barrier.*
- *High Voltage Live Work Procedures – Transmission Insulated Stick.*
- *Work Practice Manual:*
  - work practice 2.27 (Construction site hazard management forms)
  - work practice 2.28 (Job briefing process).



### 1.1 Insulated stick method – voltages up to 132kV

#### Purpose

The purpose of this work practice is to provide an overview of high voltage (HV) live work using insulated sticks.

#### Background

Insulated stick work is a method of performing HV live work based on the principle that the HV live worker always maintains a minimum approach distance (MAD) from any energised HV line or apparatus while performing work using tools and equipment fitted to insulated sticks.

#### Note:

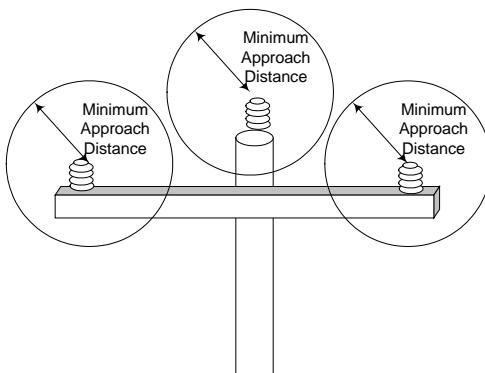
For MADs, see the following work practices in this manual:

- 1.0 (Introduction to HV live work).
- 9.0 (Distribution insulated stick method), Table 1: MADs to be maintained by HV live workers for the distribution insulated stick method.
- 10.0 (Transmission insulated stick method), Table 1: MADs for the transmission insulated stick method.

The stick method can be used when working:

- from a work platform or ladder attached to a pole or structure
- from an elevated work platform (EWP).

The stick method can be used on all types of pole structures (e.g. wood, concrete, steel, composite).



**Figure 1: Minimum approach distances for HV live work**

### Minimum requirements for stick work

Insulated stick work is a single, insulated process. The key requirements for this work are listed below:

- Approved insulated sticks must have:
  - insulation suitable for the voltage being worked on and the environment in which the work is being carried out
  - the structural capacity to safely manipulate or support the electrical apparatus they are attached to.
- The HV live worker must maintain:
  - a minimum length of rated insulated stick between themselves and the energised equipment
  - the MAD between themselves and sources of electrical potential.
- Insulated barriers must be used on second points of contact within normal reach of the work area. This is particularly important when manipulating conductors.

### Using insulated sticks

Insulated sticks are used to manipulate, support or take conductor tension. This provides electrical insulation between live electrical apparatus and the HV live worker and other sources of electrical potential.

Insulated sticks generally fall into two categories:

- Hand insulated sticks used by HV live workers to manipulate or operate electrical apparatus.
- Supporting sticks, either individual or in rigs, to support energised electrical apparatus.

#### Note:

All load bearing supporting sticks must have the safe working load (SWL) or working load limit (WLL) clearly marked on the device. For more on this, see work practice 6.0 ((Tools and equipment) in this manual.

### Hand guards for insulated sticks

Hand guards must be installed on all insulated sticks to indicate the MAD for the voltage being worked on and the task being performed. It is important that hand guards must be firmly secured to the insulated sticks to prevent movement during work, cleaning, inspection and transport.

### References

- High Voltage Live Work Manual:
  - work practice 1.0 (Introduction to HV live work)
  - section 6.0 (Tools and equipment)
  - work practice 9.0 (Distribution insulated stick method)
  - work practice 10.0 (Transmission insulated stick method)

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### 1.2 Glove and barrier method – voltages up to 33kV

#### Purpose

The purpose of this work practice is to provide an overview of high voltage (HV) live work using the glove and barrier method.

#### Background

The HV live work glove and barrier method is based on the principle that the HV live worker always maintains a minimum of two independent levels of insulation to prevent phase-to-earth or phase-to-phase contact. The HV live worker operates at varying potentials between the electrical apparatus they are working on and other line and earth potentials. This is achieved by:

- wearing appropriately rated and tested insulating gloves and sleeves
  - always maintaining an air insulation gap of 150mm between uninsulated parts of the HV live worker's body and the energised electrical apparatus being worked on
  - using insulated barriers
  - always working from:
    - an insulated and tested elevated work platform (EWP) fitted with an insulated and tested basket liner
- or
- an insulated, rated and tested pole platform.

#### Important

The glove and barrier method **must never** be used:

- directly from a ladder, pole or non-insulated platform or structure
- on the transmission network (i.e. voltages over 33kV). Work on apparatus at transmission voltages must be done using the method described in section 10 (Transmission insulated stick method) in this manual.

Additional protection for HV live workers is provided by maintaining clearances or applying additional levels of insulation to all second points of contact in the working area.

For more on this, see work practice 8.0 (Glove and barrier method) in this manual.

## Contact area

The contact area is the area within one metre of the nearest energised HV apparatus. Any part or extension of the body (i.e. tools in outstretched hand) which encroaches into this area is considered to be within the contact area.

HV live workers using the glove and barrier method must:

- wear insulated HV gloves and sleeves prior to entering the contact area and at all times while in the contact area
- not remove their gloves and sleeves until they have moved outside the contact area.

### Important

The fitting or removal of gloves and sleeves must be confirmed with the safety observer prior to entering or after leaving the contact area.

## Minimum approach distances

There are no minimum approach distances (MADs) that apply to glove and barrier work as the gloved hands are in contact with the energised electrical apparatus being worked on. However, the following air insulation gaps and clearances must be maintained:

- An air insulation gap of 150mm must be maintained at all times between the uninsulated parts of the HV live worker's body and the energised electrical apparatus being worked on.
- A minimum air gap of 250mm between the EWP basket and any uninsulated second point of contact. If the second point of contact is fitted with one level of insulated barriers rated to the highest working voltage on the structure then this clearance can be reduced to accidental contact.

For more on this, see work practice 8.0 (Glove and barrier method) in this manual.

## Using insulated sticks

Insulated sticks are sometimes used as part of the glove and barrier method. This should not be confused with combining the glove and barrier method with the insulated stick method.

## Using insulated sticks with the glove and barrier method

HV live workers may use insulated sticks while using the glove and barrier method. However, the HV live worker must still wear their gloves and sleeves at all times.

Although insulated stick MADs do not apply to the glove and barrier method, HV live workers should always maintain a minimum safe clearance of 450mm when operating fuses, touch-testing surge diverters or other tasks where there is a risk of arc flash.

**Note:**

Hand guards or MAD markers are not required on insulated sticks when being used with the glove and barrier method.

### Combining the insulated stick method with the glove and barrier method

The glove and barrier method is not intended to eliminate the use of insulated sticks. It is simply another work method that can be used by HV live workers to complete a specific work task. Some tasks may be completed more efficiently by using both the insulated stick method and the glove and barrier method.

For more on using both methods together, see work practice 1.3 (Combining the insulated stick method with the glove and barrier method – voltages up to 33 kV) in this manual.

**Note:**

For convenience, HV live workers authorised in both the glove and barrier and insulated stick methods may choose to remain in their gloves and sleeves during short periods of work while using the insulated stick method.

### References

- High Voltage Live Work Manual:
  - work practice 1.0 (Introduction to HV live work)
  - work practice 1.3 (Combining the insulated stick method with the glove and barrier method – voltages up to 33 kV)
  - work practice 8.0 (Glove and barrier method)
  - section 10 (Transmission insulated stick method)

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### 1.3 Combining the insulated stick method with the glove and barrier method – voltages up to 33 kV

#### Purpose

The purpose of this work practice is to provide an overview of the requirements when combining the insulated stick method and the glove and barrier method to perform high voltage (HV) live work.

#### Background

##### Important

While the methods may be combined when performing a task, the key requirements are that:

- the methods must each be used separately, i.e. the two methods must not be used at the same time by:
  - the same HV live worker
  - HV live workers on the same insulated support structure, i.e. EWP or pole platform
- safety observers are notified when changing methods
- they must not be combined when working on the transmission network (i.e. voltages over 33 kV). Work on apparatus at transmission voltages must only be done using the method described in section 10 (Transmission insulated stick method) in this manual.

For more on the individual methods, see the following work practices in this manual:

- 1.1 (Insulated stick method – voltages up to 132 kV)
- 1.2 (Glove and barrier method – voltages up to 33 kV)

#### Instructions

The following requirements apply when combining the insulated stick method with the glove and barrier method.

- Methods may only be combined on voltages up to 33 kV.
- If the two methods will be combined, this must be considered during the job briefing process and onsite risk assessment. For more on this, see the following work practices in this manual:
  - 2.1 (Onsite risk assessment)

- 2.9 (Job briefing process)
- An HV live worker must:
  - be authorised and competent in the method they are using
  - only use one method at any one time. If authorised in both methods, they must change methods as outlined in the *HV live workers authorised in both methods* section, below.
- HV live workers must use the same method when performing work from the same insulated support structure, i.e. EWP or pole platforms.
- HV live workers may use different methods during the same task, but only if:
  - working from separate insulated support structures, i.e. EWPs or pole platforms
  - there is a separate safety observer for each method
  - A minimum distance between EWP's of at least 2 m is maintained.
- All secondary points of contact must have insulating barriers applied.

### HV live workers authorised in both methods

When changing method, HV live workers authorised in both methods must:

1. notify the safety observer that they are changing method
2. move outside of the MAD or contact area (whichever is higher)
3. change equipment (e.g. replace gloves and sleeves with insulated stick). They may fit or remove their gloves and sleeves without returning to the ground or EWP basket rest.
4. notify the safety observer that they are recommencing work and confirm the method they are now about to use

#### Note:

For convenience, HV live workers authorised in both the glove and barrier and insulated stick methods may choose to remain in their gloves and sleeves during short periods of work while using the insulated stick method, as long as:

- the MADs are maintained at all times during the insulated stick work
- the gloves do not affect the HV live worker's ability to safely operate the insulated stick

### References

High Voltage Live Work Manual:

- work practice 1.1 (Insulated stick method – voltages up to 132 kV)

## High Voltage Live Work Manual

- work practice 1.2 (Glove and barrier method – voltages up to 33 kV)
- work practice 2.1 (Onsite risk assessment)
- work practice 2.9 (Job briefing process)
- section 10 (Transmission insulated stick method)

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### 2.0 Safe working principles

#### Purpose

This section provides information and guidance for safe working common to all high voltage (HV) live work methods. Safe working principles covers:

- onsite risk assessment
- permits, network protective devices and communication
- use of plant and equipment
- managing risks associated with weather conditions
- incident reporting
- job briefing process
- personal protective equipment (PPE) requirements
- electromagnetic fields (EMFs)
- ferroresonance
- rescue and emergencies
- step and touch potential
- temperature of conductors and electrical apparatus

The section is not intended as a comprehensive guide to all aspects of safety. For more on general safety, see section 2 (Safety) in the *Work Practice Manual*.

#### Instructions

For specific safe working principles, see the following sections in this manual:

- 2 (Safe working principles)
- 8 (Glove and barrier method)
- 9 (Distribution insulated stick method)
- 10 (Transmission insulated stick method)

#### Safety observer

- The safety observer for HV live work must be fully trained and authorised in the work methods being used.
- A HV live worker under supervision cannot be a safety observer unless under the direct supervision of a fully authorised HV live worker.

### Risk assessment

All hazards must be identified, risks assessed and control measures put in place and reviewed throughout the pre-job planning and duration of the task. For more on this, see the following work practices in this manual:

- 2.1 (Onsite risk assessment)
- 2.9 (Job briefing process)

#### Important

- HV live work must be performed in accordance with the work practices in this manual.
- HV live workers must manage the potential of secondary points of contact and minimum approach distances (MADs).

### References

- High Voltage Live Work Manual:
  - work practice 2.1 (Onsite risk assessment)
  - work practice 2.9 (Job briefing process)
  - section 8 (Glove and barrier method)
  - section 9 (Distribution insulated stick method)
  - section 10 (Transmission insulated stick method)
- Work Practice Manual, section 2 (Safety)

### 2.1 Onsite risk assessment

#### Purpose

This work practice outlines the minimum requirements for onsite risk assessments for high voltage (HV) live work.

#### Hazard Identification, risk assessment and control

Onsite hazards must be identified, risks assessed and control measures put in place and reviewed according to the hazard and risk control assessment in the risk assessment document (e.g. Workplace Risk Assessment Plan (WRAP)). Where necessary, the risk assessment may need to be updated during the task. For more on this, see work practice 2.27 (Construction site hazard management forms) in the *Work Practice Manual*.

##### Note:

The live work option must be rejected onsite if the team believes that the work cannot be completed safely.

#### Assessment process

All onsite hazard identification, risk assessment and controls must be documented in the risk assessment. All personnel onsite must be involved in the process and record their name and signature on the associated documents.

##### Note:

An onsite risk assessment must be carried out as part of the job briefing process. For more on this, see work practice 2.9 (Job briefing) in this manual.

Before any work commences, the team must conduct an onsite risk assessment to address, as a minimum, the following:

- What is the task that is to be performed and what are the work procedures and permits that are to be utilised?
- Voltage to be worked on and suitability of equipment.
- Is there other work being conducted in the vicinity?
- Who is conducting the task? Consider authorisation, experience, competency and supervision levels for the site coordinator, safety observer and workers aloft.
- Access and egress to the worksite.
- Positioning of plant and equipment.

- Conductor condition, weights and loading changes applied to structures been assessed or calculated? For more on this, see section 7 (Conductors and insulators) in this manual.

### Important

Copper conductors smaller than 7/0.080 (7/14) must not be worked on using HV live work methods. This does not apply to removing or replacing bridges that are connected to the non-tensioned conductor tails.

- Electrical loading of the circuit being worked on and the temperature of conductors and joints. For more on this, see the following work practices in this manual:
  - 2.15 (Temperature of conductors and electrical apparatus).
  - 8.4 (Energising/de-energising and bypassing of conductors and apparatus – glove and barrier method).
  - 9.3 (Energising/de-energising and bypassing of conductors and apparatus – distribution insulated stick method).
- The integrity of:
  - the structure on which work is to be carried out
  - the adjacent structures and spans
  - insulation in the immediate work area, including the risk of earth leakage current from damaged insulators.

### Note:

Structures must be fully inspected, including from above using a pole-top camera or elevated work platform (EWP).

For more on this, see work practice 6.2 (Poles – assessment and support before climbing or changing loads) in the *Work Practice Manual*.

- Management of potential secondary points of contact and minimum approach distances (MADs), including the need for barriers, where applicable.
- Clearances to structures and potential mid-span hazards, particularly where conductors are to be displaced or removed during the work.
- Management of ground approach distances (GADs) and step and touch potential risks. For more on this, see:
  - work practice 2.14 (Step and touch potential) in this manual
  - work practice 2.6 (Mobile elevated work platform (EWP) safety) in the *Work Practice Manual*



- Electrical potential and clearance issues associated with running earth.
- Drop zone. For more on this, see work practice 2.3 (Height safety) in the *Work Practice Manual*.
- The positioning of workers in relation to possible body movement, reach and ergonomic allowances.
- Communication, which must be clear, concise and confirmed.
- Presence of temporary inline isolators – HV live work must not be performed in any bay where these items are installed (other than their installation or removal).
- Noise management.
- Site terrain conditions (e.g. stability of equipment and security of footings).
- Livestock management (interference with the work).
- Traffic and pedestrian management.
- Public safety.
- Potential weather conditions during the work.
- Environmental issues.
- Fire risk.
- Any other factors covered in section 2 (Safe working principles) in this manual.
- Any other factors that may affect the safety of the crew or general public.

The risk assessment must be reviewed after completion of the work, in accordance with work practice 2.27 (Construction site hazard management forms) in the *Work Practice Manual*.

## Control measures

The hierarchy of control shown in Table 1, below, must be used when determining control measures. For Western Power personnel, this is contained in the WRAP.

**Table 1: Hierarchy of control (apply in numerical order, from 1 to 5)**

Control		Examples
1	<b>Elimination</b>	Working de-energised, earthed and permitted.
2	<b>Substitution</b>	Use a less hazardous product or process.
3	<b>Engineering</b>	Guards and barriers.
4	<b>Administrative</b>	Additional safety observer. Schedule to avoid traffic.
5	<b>PPE</b>	Safety glasses, gloves, helmet, sunscreen.

Control measures must be reassessed if:

- the control measure is not effective in controlling the risk
- there is going to be a change at the construction site which may introduce a new or different hazard
- the result of further discussion indicates that a review is necessary.

## References

- High Voltage Live Work Manual:
  - section 2 (Safe working principles)
  - section 7 (Conductors and insulators)
  - work practice 8.4 (Energising/de-energising and bypassing of conductors and apparatus – glove and barrier method)
  - work practice 9.3 (Energising/de-energising and bypassing of conductors and apparatus – distribution stick method).
- Work Practice Manual, work practices:
  - 2.3 (Height safety)
  - 2.6 (Mobile elevated work platform (EWP) safety)
  - 2.27 (Construction site hazard management forms)
  - 6.2 (Poles – assessment and support before climbing or changing loads).

### **2.2 This work practice has intentionally been left blank**

Details on site hazards have been moved and can now be found in the following work practices in this manual:

- 1.0 (Introduction to HV live work)
- 2.1 (Onsite risk assessment)

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### 2.3 Permits, network protective devices and communication

#### Purpose

The purpose of this work practice is to provide high voltage (HV) live workers with an understanding of the key requirements relating to the use of permits, network protective devices and communication techniques and protocols.

#### Permits

The procedure for the issuing of a Vicinity Authority (VA) must ensure the following.

- Auto-reclose devices immediately upstream of the worksite must be disabled. This may involve auto-reclosers at a substation or pole-top reclosers.
- Manual reclose, in the event of tripping, must not be done without first ensuring that the work team is:
  - safe and clear of the apparatus to be re-energised
  - aware that the apparatus is about to be re-energised
- The VA must be cancelled on completion of the work.
- Where more than one work team is working on the same circuit but at different locations, auto-reclose functions must not be enabled until all the teams have cancelled their VA.

#### Note:

Further information on VAs can be found in the *Electrical System Safety Rules (ESSR) section 7 (Safety rules for work on high voltage (HV) networks)*

#### Important

All auto-reclosing features on the electrical apparatus must be made inoperative and tagged appropriately when performing HV live work on the Western Power Network.

#### Network protective devices

- Network protective devices must be operational in the circuit being worked on. These devices must be capable of detecting and clearing faults at the worksite.
- Auto-reclose function of equipment which controls the circuit being worked on must be disabled for the duration of the task in accordance with the switching program controlled by Network Operations Control (NOC).

- In the event that a manual reclose or other planned switching of a circuit is required, the work teams must be informed and move clear of the circuit prior to the reclose being attempted.
- Operation of an auto-recloser on an HV live worksite is a reportable incident and all HV live work must cease. For more on this, see work practice 2.8 (Incident reporting) in this manual.

### Communication

Clear and reliable communications are essential in HV live work and communication must be included as an item in all job briefings.

Each work team member must establish clear and reliable communications with the site coordinator and other team members throughout the duration of the work. All HV live work team members need to keep other team members aware of their intended actions so that safety is not compromised.

The safety observer must maintain particularly close communication with the HV live work team performing the task. For more on this, see work practice 2.9 (Job briefing process) in this manual.

NOC must be advised of any HV live work:

- before the work commences
- when the HV live work team moves location
- when the work is complete

During the course of HV live work, effective communications must be maintained between the HV live work team and NOC. It is important that NOC knows exactly where all of the teams are located on the feeder in case the system configuration requires altering, e.g. transferring loads.

If the circuit on which HV live work is being carried out becomes de-energised due to the operation of feeder protection equipment, the circuit must not be re-energised until all HV live work teams on the affected feeder are confirmed clear of any live apparatus.

It is imperative that NOC maintains the ability to communicate with the work team and keep them fully briefed on any feeder trip or other system switching requirements.

#### **Note:**

For more on communication, see *ESSR, section 4 (Communication)*.

### References

- High Voltage Live Work Manual, work practices:
  - 2.8 (Incident reporting)
  - 2.9 (Job briefing process)
- Electrical System Safety Rules:
  - section 4 (Communication)
  - section 7 (Safety rules for work on high voltage (HV) networks)
  - Appendix 6 (Vicinity Authority (VA) work permit)

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### **2.4 This work practice has intentionally been left blank**

Details on tools and techniques have been moved and can now be found in work practice 6.0 (Tools and equipment) in this manual.

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### 2.5 Use of plant and equipment

#### Purpose

This work practice provides high voltage (HV) live workers with basic information and guidance on the use of plant and equipment.

#### Background

This work practice is not intended as a comprehensive guide to the use of plant and equipment. More detailed instructions are available in:

- *Work Practice Manual*, work practices:
  - 2.6 (Mobile elevated work platform (EWP) safety)
  - 2.19 (Crane use in substations and near powerlines)
  - 2.20 (Dogger – construction site)
  - 2.21 (Traffic management)
- *High Voltage Live Work Manual*, work practices:
  - 4.0 (Mobile plant and related equipment for HV live work)
  - 4.1 (Mobile elevated work platforms (EWPs))
  - 4.2 (EWP and crane-mounted conductor support equipment)
  - 5.2 (Maintenance of EWPs and fitted hydraulic tools)

#### Instructions

- Before starting work, crane operators must be instructed on the procedure and safe working distances to be used. The crane operator and the dogger must be under the supervision of a nominated member of the HV live work team who is authorised in the live work method being performed. The designated safety observer or a person aloft assigned as the safety observer can perform the supervision. For more on the role of the safety observer, see work practice 2.9 (Job briefing process) in this manual.
- Where an insulated EWP with a telescopic boom is used, the boom must be extended to ensure that the insulating requirement (as specified on the HV certification of the equipment) relevant to the voltage being worked on is obtained.
- Uninsulated parts must not be introduced into the work area that could create a hazard for HV live workers. Conductor support equipment that utilises a conductive mounting bracket on the insulated upper boom of an EWP must be removed after use.

- All conductive attachments must be removed from the boom prior to HV live work using the glove and barrier method.
- Cranes and EWPs may be used to support conductors and equipment for HV live work when set up in accordance with the requirements in this manual.
- When supporting energised components, appropriate insulation (rated to meet the electrical and mechanical loads) must be fitted between energised components and the crane or EWP.
- Uninsulated parts of the crane or EWP must be monitored to ensure they do not encroach within the minimum approach distances (MADs) for mobile plant. For more on this, see:
  - work practice 4.0 (Mobile plant and related equipment for HV live work) in this manual
  - work practice 2.8 (Minimum approach distances (MADs)) in the *Work Practice Manual*
- When using plant to move conductors, an HV live worker must advise the crane operator if any risks have been identified with:
  - condition of the conductor
  - movement of the conductor
  - conductor temperature
  - environmental conditions, e.g. wind
  - mechanical loads being placed on conductors
  - structural integrity of adjacent structures
  - clearances from ground and other conductors

For more on this, see work practice 7.0 (Conductors and insulators) in this manual.

- Crane and EWP chassis' must be earthed. For more on this, see work practice 4.0 (Mobile plant and related equipment for HV live work) in this manual.
- When moving plant, ensure that:
  - vehicle extensions and protrusions (e.g. stabilisers, gin pole assemblies, masts) are stowed in a safe position where they will not create a hazard
  - equipment that extends the height of the vehicle (e.g. conductor support apparatus) is removed prior to travelling on roadways. These extensions may be left attached when travelling limited distances in paddocks, but only after risks such as clearances under powerlines and vegetation have been assessed.

- Vehicles are restricted to a maximum height of 4.3 metres when travelling on roadways. The minimum height of overhead powerlines is 4.5 metres.

### References

- High Voltage Live Work Manual, work practices:
  - 2.9 (Job briefing process)
  - 4.0 (Mobile plant and related equipment for HV live work)
  - 4.1 (Mobile elevated work platforms (EWPs))
  - 4.2 (EWP and crane-mounted conductor support equipment)
  - 5.2 (Maintenance of EWPs and fitted hydraulic tools)
  - 7.0 (Conductors and insulators)
- Work Practice Manual, work practices:
  - 2.6 (Mobile elevated work platform (EWP) safety)
  - 2.8 (Minimum approach distances (MADs))
  - 2.19 (Crane use in substations and near powerlines)
  - 2.20 (Dogger – construction site)
  - 2.21 (Traffic management)

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### **2.6 This work practice has intentionally been left blank**

Details on night work have been moved and can now be found in work practice 1.0 (Introduction to HV live work) in this manual.

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### 2.7 Managing risks associated with weather conditions

#### Purpose

To provide high voltage (HV) live workers with clear guidelines on managing the risks associated with weather events.

#### Background

Wet weather, electrical storms, high winds, inadequate lighting and temperature extremes are all potential hazards to the HV live worker. Wet weather can reduce the insulating effectiveness of the insulated equipment being used. Electrical storms may cause overvoltage on electrical conductors and apparatus. High winds and extremes in temperature may cause structural or clearance problems. Humidity can reduce the insulating effectiveness of gloves and sleeves. Controlling these risks is essential to the safety of the HV live worker.

#### Instructions

##### Pre-planning

Wherever possible, adverse weather conditions should be determined prior to the job. Forecasts of adverse weather are available from:

- Bureau of Meteorology
- Network Operations Control (NOC)
- general media outlets

##### Onsite risk assessment

The onsite risk assessment must include any adverse weather conditions that are present or are expected (e.g. based on the weather forecast). The relevant hazards and controls must be included in the risk assessment. For more on this, see work practice 2.1 (Onsite risk assessment) in this manual.

#### Important

If adverse weather conditions arise, the HV live work team must assess the risks of the live work to determine whether to:

- continue work

or

- suspend work temporarily and safely secure the worksite

For more on this, see the *Suspending work* section, below.

### High temperatures and humidity

- When employees are exposed to heat stress, conduct a risk assessment on whether it is safe to work. In making such decisions, consider provision of personal protective equipment (PPE), fluid availability, rest breaks and task rotation.
- Consideration should also be given to humidity as well as temperatures, as high temperatures combined with high humidity can lead to dehydration and heat illness. High humidity may also cause excessive sweating and moisture build-up underneath gloves and sleeves and may pose a hazard to the HV live worker. For more on this, see Appendix 1 (Apparent temperature index) in this manual.
- The signs and symptoms of heat illness include:
  - lack of concentration
  - feeling sick and nauseous
  - dizziness, weakness or clumsiness
  - collapsing or convulsions in severe cases
- To avoid dehydration and heat illness, personnel should drink a cup of water approximately every 20 minutes.

### Suspending work

If the risk assessment determines that the work is to be suspended, the actions below must be taken.

- The HV live work team must temporarily and safely secure the work site.
- If the HV live work team is to leave the site, the circuit must be left in a safe condition and NOC informed.
- Prior to recommencing temporarily suspended work, review and update the risk assessment. Any HV live work insulating equipment that is left on, or attached to, live apparatus must be wiped with a silicone cloth attached to a universal tool.
- Avoid leaving HV live work insulating equipment on, or attached to, live apparatus for extended periods of time (e.g. overnight). Should it be necessary to do so, the equipment must not be depended on to provide any form of insulation. They must be removed, cleaned and visually inspected before reuse and, if suspect, submitted for electrical testing.

### Electrical storms

If you can see lightning or hear thunder:

1. suspend work and seek shelter in a building or enclosed vehicle that is in a safe location and is away from powerlines as lightning strike can induce very high voltages
2. wait until 30 minutes after the last time you see lightning or hear thunder before recommencing work

#### Important

During a storm, if you cannot seek shelter in a building or enclosed vehicle, avoid using fixed line phones and avoid the following locations as they have a higher risk of lightning strike.

- Tall objects (e.g. poles, trees). The lightning could jump to you (i.e. side flash) or result in a voltage gradient in the ground, creating a step potential.
- High elevation compared to the surroundings (e.g. on top of a hill or building).
- Electrical apparatus connected to the network. Lightning strike on, or near, the network can result in explosive damage to plant.

#### Note:

For more information on electrical storms, see work practice 2.12 (Electrical storms) in the *Work Practice Manual*.

### Wet weather

Suspend work:

- if there is any significant rain beyond intermittent spotting, mist, fog, snow, sleet or dew, unless using methods and live work equipment specifically designed and tested as being able to operate during wet conditions (e.g. leakage meter for stick work)
- if, when using insulating rope, there is any threat of rain, mist, fog, snow, sleet or dew
- if rain is significant enough to pool, form an unbroken surface or run along the surface of insulated equipment rather than beading. Streams allow tracking or electrical leakage to occur. As the leakage increases so does the risk.

### Windy weather

- Suspend work if there are excessive wind velocities, as this may cause a reduction in air gap insulation, dislodgement of temporary insulation or excessive structural wind mechanical loading. For more on this, see Appendix 4 (International Beaufort's Scale) in this manual.

#### Note:

HV live work is only permitted when wind velocities are less than 45 km/h, or 40 km/h when using a gin pole to lift conductors.

### Inadequate lighting

- Suspend work if there is inadequate light to provide clear vision. For more on this, see work practice 1.0 (Introduction to HV live work) in this manual.

### References

- High Voltage Live Work Manual:
  - work practice 1.0 (Introduction to HV live work)
  - work practice 2.1 (Onsite risk assessment)
  - Appendix 1 (Apparent temperature index)
  - Appendix 4 (International Beaufort's Scale)
- Work Practice Manual, work practice 2.12 (Electrical storms)

### 2.8 Incident reporting

#### Purpose

This work practice provides high voltage (HV) live workers with information and guidance on reporting incidents.

#### Scope

This work practice applies only to the reporting of an incident. For guidelines to use in the case of an emergency, see work practice 2.13 (Rescue and emergencies) in this manual.

#### Incidents

An HV live work incident is defined as any of the following events.

- Electric shock or other serious injury sustained by any member of the work team or general public.
- A flashover at, or close to, the work, irrespective of its cause.
- Complete or partial breakdown of any insulating tool or equipment, irrespective of whether or not flashover occurred.
- The electrical or mechanical failure of any HV live work tool which did, or could have the potential to, cause an accident.
- Operation of an auto-recloser on an HV live work site is a reportable incident and all HV work must cease.

#### Instructions

- Inform Network Operations Control (NOC) immediately of any incident.
- All live line incidents must be reported in accordance with Western Power's incident reporting procedures.
- Report the incident, including details (e.g. fire, personal injury (including electric shock, even if it's just a tingle), network asset damage), to both of the following within an hour of the incident happening:
  - your formal leader
  - the Incident Hotline on 1300 CALL WP (1300 2255 97)
- Unless permission has been given by Safety, Health and Environment (SHE), do not remove any equipment or plant from a worksite where there has been an incident. This will assist with the accurate assessment of the contributing factors to the incident. Such equipment may also pose a risk to personnel or property if moved.

### References

- High Voltage Live Work Manual, work practice 2.13 (Rescue and emergencies)

### 2.9 Job briefing process

#### Purpose

This work practice provides high voltage (HV) live workers with:

- a uniform methodology and minimum key requirements for the job briefing process, which must be done before every job commences
- an understanding of the roles and responsibilities of the worksite team leader, safety observer and site coordinator

#### Scope

This work practice is applicable to:

- all HV live work teams performing planned or unplanned work on Western Power construction sites
- multiple teams working on the same construction site

#### Instructions

The job briefing process must be performed before the commencement of any task and as required throughout the duration of the task. This process outlines the tasks that are to be accomplished, the location, tools, equipment and material requirements, and safety rules or procedures that apply.

Key elements of the job briefing process include:

- adherence to permit procedures
- the procedures that will be used during the job
- voltage to be worked on
- suitability of equipment
- roles of each team member and task allocation
- allocation of identification armbands
  - worksite team leader – blue armband (optional)
  - safety observer – green armband
  - site coordinator – orange armband
- hazards associated with the task and the control measures
- work area establishment and set up
- emergency response plan
- communication (clear, concise and confirmed)

### Note:

For more on hazard identification, risk assessment and control measures, see work practice 2.1 (Onsite risk assessment) in this manual.

### Worksite team leader

The worksite team leader directs team members to accomplish a task safely, efficiently and within the constraints of the relevant standards, procedures and practices.

Worksite team leaders are appointed based on their assessed competence and suitability for the role. They must understand the role responsibilities and obligations, and lead the team effectively.

The worksite team leader at any construction site must do the following:

- Meet with the site coordinator and record the site coordinator's name and contact number on the risk assessment.
- Ensure that all team members actively participate in the job briefing process, including selecting procedures to use for the task (from the relevant *High Voltage Live Work Procedures* manual) and allocating roles appropriately.
- Perform a risk assessment and document all relevant details, including:
  - identifying the hazards and associated risk controls
  - the procedures selected from the relevant *High Voltage Live Work Procedures* manual

The risk assessment must then be signed by all of the team members.

- Ensure that all team members hold current competencies and authorisations to perform the task.
- Provide supervision and coaching where required.
- Where a Safe Work Method Statement (SWMS) for a specific task is available, any hazards that are not identified by the SWMS must be recorded on the risk assessment. For more on SWMS, see work practice 2.27 (Construction site hazard management forms) in the *Work Practice Manual*.
- Appoint a safety observer and issue them with a green safety observer armband. For more on this, see work practice 2.9 (Job briefing process) in this manual.



- Ensure that team members are wearing the required personal protective equipment (PPE) and that they use it properly. For more on this, see:
  - work practice 2.10 (Personal protective equipment (PPE) requirements) in this manual
  - section 3 (Personal protective equipment) in the *Work Practice Manual*
- Ensure that permit procedures are followed, if required.
- Confirm that all tools and items of equipment are visually inspected, cleaned and within test date and are safe to use. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- Report any incidents immediately by calling 1300 CALL WP (1300 2255 97).

### Safety observer

- The safety observer for HV live work must be fully trained and authorised in the work methods being used.
- A HV live worker under supervision cannot be a safety observer unless under the direct supervision of a fully authorised HV live worker.

#### Important

- A safety observer is mandatory on any task where HV live line methods are being used. Where there are multiple HV live work teams, a safety observer must be nominated for each team unless determined otherwise by a risk assessment.
- The safety observer must use one sharp blast of the 'safety observer' whistle to:
  - stop work
  - warn personnel of any risk or non-compliance
- All personnel, on hearing the whistle, must immediately stop work and communicate with the safety observer.

If during the task the designated safety observer's view is impaired by obstruction, they must inform the work team and may, for short periods, transfer the role to a HV live worker aloft. This is provided that the designated safety observer is able to:

- reassume the role of safety observer when the person aloft can no longer safely observe
- perform or supervise a rescue when required

When this occurs, all members of the work team must be aware at all times as to who is performing the role of safety observer.

**Note:**

- Transfer of the safety observer's role to a HV live worker aloft must only be temporary.
- The HV live worker taking on the safety observer's role must not perform any work while acting as safety observer.
- Repositioning the designated safety observer on the ground must always be the preferred option.

For more on this, see work practice 2.2 (Safety observer role) in the *Work Practice Manual*.

**Site coordinator**

Whenever work is being done at a Western Power construction site, one worksite team leader must act as the site coordinator.

'Team' refers to a group of two or more people working on the same task at a construction site.

**Single team onsite**

If there is only one team onsite, the worksite team leader is the default site coordinator.

**Multiple teams onsite**

When more than one team is working on any construction site, the site coordinator is determined by the following criteria.

- If there is a single work team onsite and other team/s arrive later – the initial worksite team leader will be the site coordinator and will maintain these duties unless otherwise agreed to by the worksite team leaders. They will remain the site coordinator until they have completed their work and intend to permanently leave the construction site.
- If more than one team attends a construction site at the same time – the team leader of the team that will remain onsite for the longest amount of time will be the site coordinator unless an alternative arrangement is agreed to by the worksite team leaders.
- If the initial site coordinator's team intends to permanently leave the construction site, they must consult the remaining worksite team leaders and reassign the site coordinator role.

The new site coordinator must be:

- informed of the change and accept the role
- briefed by the outgoing site coordinator

- This applies equally to all members of the Network Total Workforce (NTW). No preference is to be assumed by either Western Power or contractors.
- The site coordinator role may be rotated during tasks/projects of long duration.

### **Note:**

- The site coordinator does not take charge of other teams or their work.
- Worksite team leaders must still delegate specific tasks or duties within the team and ensure that their teams adhere to all the mandatory safety requirements such as permits and risk assessments.
- When any of these roles are transferred to another person a formal handover must take place between all of the personnel involved.

### **Small teams and switching operators' onsite**

Small teams are required to be part of the collective group at a construction site, but are not required to perform site coordinator duties. A small team consists of:

- two operators
- two switching operators performing switching activities

### **Site coordinator responsibilities**

The site coordinator must do the following:

- Wear the orange 'Site coordinator' armband for the duration of their role.
- Coordinate with the other worksite team leaders and discuss the following site-specific details:
  - Type of permits that are in place.
  - Individual team tasks (what, where, how) and schedules.
  - Contact details (worksite team leaders, local emergency services).
  - Any special/abnormal conditions (specialised plant, visitors, and deliveries).
- Have their name recorded on each team's risk assessment.
- Be available onsite at all times when anyone else is onsite.
- Respond to or escalate queries by other worksite team leaders in regard to the overall task/project.
- Be familiar with construction site access requirements. All people requiring entry must comply with work practice 5.17 (Construction site access) in the *Work Practice Manual*.

### Visitors to the site

Anyone who is approached by a visitor must direct them to the site coordinator, who will either:

- request that the visitor wait offsite and then the site coordinator will call the relevant worksite team leader to come and take charge of the visitor and perform a construction site induction

or

- perform a construction site induction and then direct the visitor to the relevant worksite team leader

If there is no valid reason for the visitor to be onsite, the site coordinator has the authority to ask the visitor to leave the construction site immediately. This applies to all visitors, including Western Power personnel.

### References

- High Voltage Live Work Manual, work practices:
  - 2.1 (Onsite risk assessment)
  - 2.10 (Personal protective equipment (PPE) requirements)
- Work Practice Manual:
  - work practice 2.2 (Safety observer role)
  - work practice 2.27 (Construction site hazard management forms)
  - section 3 (Personal protective equipment)
  - work practice 5.17 (Construction site access)

### 2.10 Personal protective equipment (PPE) requirements

#### Purpose

This work practice provides advice and instruction on the selection, use, maintenance and storage of approved PPE that is specifically applicable to personnel carrying out high voltage (HV) live work.

#### Scope

This work practice applies to all personnel carrying out HV live work using:

- glove and barrier method
- insulated stick method.

#### Note:

This work practice is not intended as a comprehensive guide to all PPE used for work on the Western Power Network. Instead, it is a specific guide for personnel carrying out HV live work. Information on PPE can be found in Western Power's PPE catalogue (via busbar). General requirements can be found in section 3 (Personal protective equipment) in the *Work Practice Manual*.

#### Training

All HV live work personnel must be trained in the correct fitting, use and maintenance of their PPE. Any HV live worker who is unsure about the correct fitting, use or maintenance of the PPE must ask their formal leader for advice.

#### Responsibility

The user is responsible for ensuring the care, maintenance, inspection, testing and replacement of PPE allocated to them.

#### Instructions

- PPE must not be used in isolation of other risk controls.
- The minimum PPE requirements for personnel carrying out HV live work are:
  - high visibility flame retardant (level one) clothing. For more on this, see work practice 3.1 (Clothing and personal protective equipment requirements) in the *Work Practice Manual*:
    - long sleeved shirt (buttoned to the wrist) and long trousers
  - or
  - overalls (buttoned to the wrist).

- safety footwear
- eye protection relevant to the risk (according to *AS/NZS 1337.1:2010 – Personal eye protection - Eye and face protectors for occupational applications*)
- gloves relevant to the risk
- head protection relevant to the risk
- insulated gloves and sleeves:
  - must be worn when performing glove and barrier HV live work
  - are not mandatory when performing insulated stick HV live work.

### Note:

Items such as neck chains, earrings and other body adornments must not be worn while carrying out HV live work. For more on this, see work practice 1.0 (Introduction to HV live work) in this manual.

### HV insulated gloves and sleeves

All HV insulated gloves and sleeves must have a working voltage rating that is equal to or greater than the voltage that is being worked on. HV insulated gloves and sleeves have a label that clearly indicates the voltage class and are also colour coded. Working voltage is the maximum phase-to-phase voltage for which the equipment can be used and is generally less than the rated voltage as safety factor is applied.

The relationship between class, rated voltage and maximum working voltage is outlined in Table 2, below. Rated voltage is the voltage stated by the manufacturer. As a safety factor, Western Power requires that the maximum working voltage be 5kV less than the rated voltage. Western Power only uses Class 3 and 4 HV insulated gloves and sleeves:

- Class 3 (green label):
  - has a working voltage (phase-to-phase) of 25kV
  - must not be used for glove and barrier work on voltages in excess of 22kV.
- Class 4 (orange label):
  - has a working voltage (phase-to-phase) of 35kV
  - must not be used for glove and barrier work on voltages in excess of 33kV.

**Table 1: Working voltages for Class 3 and 4 gloves and sleeves**

Class	Rated voltage (kV)	Working voltage (kV)
3	30	25
4	40	35

**Note:**

Wear a minimum of Class 0 (1000V) rated gloves along with protective outers at all times when working on the single wire earth return of a (SWER) system.

- HV insulated rubber gloves and sleeves are made of two layers of different colours so that defects are easier to detect. The outer layer represents less than 20% of the overall thickness.
- HV insulated gloves and sleeves must never be worn inside out.
- Inner gloves may be worn beneath the HV insulated gloves to give comfort and assist in the absorption of perspiration.
- Outer protective gloves designed for use with HV insulated gloves must be worn over the HV insulated gloves at all times during HV live work. Contact with energised conductors or apparatus must be restricted to the working area of the outer glove.
- All parts of the outer protective gloves must be treated as conductive. For example, when working with polymer disc insulators, the glove should never be placed over the insulating sheds when in contact with a live conductor as this could bridge the insulation and cause a flashover.

**Overlap of HV insulated gloves and sleeves**

- A minimum overlap must be maintained between:
  - the HV insulated glove cuff and the outer protective glove's cuff
  - the HV insulated glove cuff and the start of the sleeve.
- The overlap must be measured at full arm extension.
- The purpose of maintaining the overlap is to ensure that no uninsulated part of the worker's arm is exposed (resulting in it being uninsulated).
- The minimum overlap distances for Class 3 and 4 gloves is in accordance with *AS 5804.2-2010 – High-voltage live working – Glove and barrier work* and is shown in Table 2, below. An example is also shown in Figure 1, below.

**Table 2: Overlap requirements for Class 3 and 4 gloves and sleeves**

Class	Overlap (mm)
3	100
4	150



**Figure 1: Overlap between insulated glove, outer glove and sleeve**

### Ergonomics

It is essential that the HV insulated gloves and sleeves be sized to suit the individual and the overlap sizing requirements.

### Inspection

Prior to commencement of work and at any time when their condition may be in doubt, HV insulated gloves and sleeves must be inspected using all of the following methods:

- Wipe clean to remove any contaminants.
- Carry out visual inspection, inside and out.
- Confirm within electrical test date.
- Roll test.
- Air test (gloves only). For more on this, see the 'Air testing gloves' section, below.



**Note:**

HV insulated gloves and sleeves that become soiled with any oil, grease or other damaging substances must be wiped clean as soon as it is practical.

HV insulated gloves and sleeves must be withdrawn from service if:

- they do not properly inflate (gloves only – this indicates that there is a leak present)
- the outside colour has been damaged and the inner colour can be seen
- a hole is evident when roll testing
- cracks are present during roll testing between the fingers
- there is any evidence of physical or chemical damage.

The following must be checked during a visual inspection.

**Cracking**

Cracking may occur when the rubber has been stressed due to folding or compressing after exposure to sunlight or ozone. Cracking is often found along the sleeve after being stored incorrectly for a long period.

Cracking is generally found on the palm area of the glove where the rubber has been subject to a combination of mechanical (compression) and electrical stresses. This usually takes the form of a series of cracks that can quickly worsen. For examples, see Figures 2 and 3, below.



**Figure 2: Roll testing to identify cracking**



**Figure 3: Typical cracking at elbow of sleeve**

### **Abrasion, scratches and cuts**

Such damage is usually caused by inadvertent contact with sharp or abrasive objects and can result in a complete failure of the insulation. Cuts can increase in size very quickly when the glove or sleeve is placed under strain. For an example, see Figure 4, below.



**Figure 4: Signs of abrasions**

### **Chemical damage and heat**

Exposure to chemicals, fumes, or heat may cause soft spots on the rubber where the elasticity has been reduced. These areas may feel tacky to touch. For an example, see Figure 5, below.

Energised conductors and electrical apparatus under load and/or with poor joints can exhibit high temperatures that may damage the insulating properties of gloves and sleeves. Insulated products such as gloves and sleeves will possibly soften and suffer insulation degradation at or above 70°C. For more on this, see work practice 2.15 (Temperature of conductors and electrical apparatus) in this manual.



**Figure 5: Signs of chemical damage**

### Tracking

Tracking is caused by excessive current leakage and usually leaves a carbonised path on the surface of the rubber. It generally occurs during routine electrical testing and is normally found on the cuff area of the glove or sleeve. For examples, see Figure 6, below.



**Figure 6: Evidence of tracking (left) and cuts (right)**

### Air testing HV insulated gloves

- All HV insulated gloves must be air tested prior to commencing work. The HV insulated gloves must be tested both outside and inside out.
- Simple air testing can be achieved by stretching the end of the gauntlet, pressing it together and rolling as shown in Figure 7, below. This can also be achieved by using a special peg for sealing the end of the gauntlet. Once the glove is inflated, listen closely for leaks. This procedure must be repeated with the glove inside out.
- Mechanical inflators may also be used as shown in Figure 8, below.
- HV insulated gloves that fail the air test due to leaks must be removed from service and discarded immediately.



**Figure 7: Air testing of gloves to check for leaks**



**Figure 8: Glove inflator**

### Testing

HV insulated gloves and sleeves must be electrically tested at least every six months to ensure that the insulating qualities of the equipment have not deteriorated. Tests must be carried out by an approved HV testing provider to the standard *ASTM F496-14a – Standard Specification for In-Service Care of Insulating Gloves and Sleeves*. Reference should also be made to:

- *ASTM D120-14a – Standard Specification for Rubber Insulating Gloves*
- *ASTM D1051-14a – Standard Specification for Rubber Insulating Sleeves*
- *ASTM F696-06(2011) – Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens.*

#### **Note:**

The six month testing requirement is based on light use. Heavy use will require more frequent testing.

### Care and maintenance

HV insulated gloves and sleeves must be cleaned at least once a week, or more frequently when in heavy use, as follows:

1. Only use products approved by the manufacturer.
2. Dispense a small amount of cleaning product onto a rag then use the rag to wipe HV live work equipment.
  - Do not dilute cleaning products in water or allow cleaning products to be directly poured into wash trough.
  - Dirty rags and HV cleaning wipes must be disposed of in designated waste bins.
3. Rinse with clean water to remove the cleaning product residue. This can be done in a wash trough.
4. Position to allow drying away from direct sunlight and heat. High temperature environments (i.e. over 65°C) must be avoided.
5. Apply pure talcum powder or an approved glove manufacturer's glove dusting powder to the inside surface of the insulating gloves and sleeves.

#### Important

- Cleaning product must only be applied to a rag or wipe and never used directly in a wash trough. The wash trough must only be used to rinse.
- Cleaning products for HV rubber goods are not 'quick break' which means our oil/water separators may not be able to separate the oil/grease and water before it discharges.

HV insulated gloves and sleeves that become soiled with any oil, grease or other damaging substances must be wiped clean as soon as possible to avoid chemical damage to the glove.

HV insulated gloves and sleeves must be recorded in the equipment management system. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.

### Repair

HV insulated gloves and sleeves must not be repaired. Gloves and sleeves that have failed must be disposed of and recorded in the equipment management system.

## Storage

HV insulated gloves and sleeves must be stored in an approved bag and/or a dry location that allows the glove or sleeve to maintain its natural shape. Care should be taken not to fold, compress or distort the glove or sleeve in any way that might cause stretching during storage as this may result in stress within the rubber.

If storage is required for long periods, dust the inside and outside surfaces with pure talcum powder or an approved glove manufacturer's glove dusting powder. Storage must be away from the effects of UV rays, chemicals, oils, solvents, heat sources and even artificial light (which can produce ozone).

HV insulated gloves and sleeves that are beyond their six monthly electrical test date must be quarantined and recorded in the equipment management system. Quarantined insulated gloves and sleeves must pass an electrical test before being returned to service.

## Outer gloves

Outer gloves must be inspected prior to use and withdrawn from service when damaged or when excessive dirt or holes are present (see Figure 9, below).



**Figure 9: Unacceptable outer leather glove with hole**

## Head protection

Head protection is required to reduce the risk of injury from falling objects, arc flash burns and the effects of exposure to UV radiation.

### Safety helmets

Western Power approved safety helmets must be worn during HV live work. For more on this, see work practice 3.3 (Head protection) in the *Work Practice Manual*.

### Eye protection

HV live workers must wear approved, non-conductive, framed, non-metallic, medium impact eye protection when carrying out HV live work. Approved safety glasses are the minimum eye protection required for HV live workers. Tinted lenses must not be used in low light conditions. A risk assessment may determine that additional measures are required. For more on this, see work practice 3.1 (Clothing and personal protective equipment requirements) in the *Work Practice Manual*.

### Other PPE

Information on other PPE such as goggles, arc flash face shields, hearing and respiratory protection can be found in work practice 3.4 (Other personal protective equipment) in the *Work Practice Manual*.

### References

- AS/NZS 1337.1:2010 Personal eye protection – Eye and face protectors for occupational applications.
- AS 5804.2-2010 High voltage live working - Glove and barrier work.
- ASTM D120-14a Standard Specification for Rubber Insulating Gloves.
- ASTM D1051-14a Standard Specification for Rubber Insulating Sleeves.
- ASTM F496-14a Standard specification for In-Service Care of Insulating Gloves and Sleeves.
- ASTM F696–06(2011) Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens.
- High Voltage Live Work Manual, work practices:
  - 1.0 (Introduction to HV live work)
  - 2.15 (Temperature of conductors and electrical apparatus)
  - 5.1 (Equipment maintenance).
- Work Practice Manual, section 3 (Personal protective equipment).

### Further reading

- Occupational Safety and Health Act 1984 (WA).
- Occupational Safety and Health Regulations 1996 (WA).
- Western Australian Code of Practice – Personal Protective Clothing and Equipment 2002.

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### 2.11 Electromagnetic fields (EMFs)

#### Purpose

The purpose of this work practice is to ensure that high voltage (HV) live workers and ground support personnel have an awareness and understanding of:

- electric fields and magnetic fields
- how EMF strengths vary with voltage and current
- current scientific assessment of health effects
- the national standards for occupational exposure
- typical exposure levels for HV live workers

#### Background

We are all exposed to EMFs in many aspects of everyday life. EMFs are found in the non-ionising part of the electromagnetic spectrum (between 0 Hz and 3 kHz). They exist around electrical apparatus and appliances wherever there's a voltage present (electric field) and a current (magnetic field). HV live workers are exposed to EMFs in the course of their work, as are ground support crew such as EWP, crane and borer operators working underneath, or in close proximity to, energised overhead powerlines.

#### Electric fields

Distribution voltages create a significantly weaker field than transmission voltages.

When working on live conductors or apparatus, HV live workers are exposed to electric fields. The strength of the field depends on:

- the voltage of the conductor or apparatus
- the worker's proximity to the conductor or apparatus

#### Field strength

- Electric field strength diminishes between the energised conductor and the live worker in relation to the distance. For example, if you are:
  - 10 m from a 22 kV conductor, the field strength will be 2.2 kV/m
  - 1 m from a 22 kV conductor, the field strength will be 22 kV/m

This means that exposure when doing glove and barrier work is higher than when doing stick work.

- Nearby conductors in multiple phase or dual circuits can affect electric field strength.

## Magnetic fields

Magnetic fields exist around all energised conductors and apparatus through which a current flows and the field strength varies according to the size of the current. A lightly loaded line during a non-peak period will have a significantly weaker magnetic field than the same line during peak loading.

When working on live conductors or apparatus, live workers are exposed to magnetic fields. The strength of the field depends on:

- the current of the conductor or apparatus
- the worker's proximity to the conductor or apparatus

### Field strength

- Magnetic field strength diminishes rapidly as you move away from the source. For example:
  - at the conductor, field strength may be 30,000 milliGauss (mG)
  - 5 cm away, field strength will decrease to 15,000 mG

This means that exposure to more vulnerable parts of the body, such as the head and torso, is significantly lower than the extremities, such as the hands. This is an important factor with glove and barrier HV live workers.

- Additional factors that can affect magnetic field strength are:
  - adjacent magnetic fields from other nearby circuits, e.g. dual circuits or nearby transmission lines
  - the configuration of the line, e.g. horizontal, vertical or crucifix
- The relationship between magnetic fields can significantly increase or reduce their strengths.

## Effects of exposure

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the World Health Organisation (WHO) have concluded that current evidence does not confirm the existence of any health consequences from exposure to low level EMFs.

## Occupational exposure standards

Although there is insufficient evidence to indicate any health consequences from EMFs, the scientific community recommends taking precautionary measures.

The ARPANSA interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields suggest occupational exposure limits as shown below.

- **Electric fields** – 10 kV/m per working day (continuous). Short term exposure to root mean square (RMS) electric field strengths (measured in kV/m) between 10 kV/m and 30 kV/m are permitted, provided the RMS field strength (kV/m) times the duration of exposure (hours) does not exceed 80 for the whole day.

**Note:**

Maximum exposure is based on constant, direct contact. The actual exposure is significantly less because direct contact will never be constant.

- **Magnetic fields** – 0.5 milliTesla (mT) or 5,000 mG per working day (continuous). Short term exposure (body and head) for up to two hours per working day should not exceed 5 mT or 50,000 mG. When restricted to the limbs, exposures up to 25 mT or 250,000 mG can be permitted. The magnetic field will decrease rapidly between the hand closest to the source and the upper arm.

### Typical occupational exposures

Data from ARPANSA and the electricity network industry indicates the exposure of HV live workers is within the current limits. Some examples are provided in the *Glove and barrier work* section, below.

**Note:**

The following examples are indicative only, and actual values will vary greatly depending on the line voltages, configuration, current and clearances.

### Glove and barrier work

The magnetic field exposure typical range is approximately 0.03–0.35 mT (300–3,500 mG) measured around 300 mm from the centre conductor. Closer proximity to the conductor may increase exposure levels on the arms up to 2 mT (20,000 mG) for short periods, although this is based on a maximum load scenario. These typical exposures are well within the occupational exposure standard.

Electric field exposure on a typical 22 kV line will be (at maximum), phase-to-earth value at the conductor (12.7 kV/m). Direct glove contact with the conductor will be limited in terms of exposure times over a continuous working day. Shielding and distance from the conductor will further reduce the exposure level and ensure it is within the occupational exposure standard.

### Stick work

Magnetic field exposure for stick work will be significantly less than glove and barrier due to the greater distance of the body and hands from the source of the field.

Electric field exposure while working to the minimum approach distances (MADs) should also be within occupational exposure limits.

### References

- Australian Radiation Protection and Nuclear Safety Agency - Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields (1989) Radiation Health Series No.30, <http://www.arpsa.gov.au/pubs/rhs/rhs30.pdf>
- Australian Standard AS 5804.1 – 2010 – High-voltage live working – General
- World Health Organisation, [www.who.int/topics/electromagnetic\\_fields/en/](http://www.who.int/topics/electromagnetic_fields/en/)

### Further Reading

- Energy Networks Association, [www.ena.asn.au](http://www.ena.asn.au), Electric & Magnetic Fields – What we know
- National Health and Medical Research Council of Australia, [www.nhmrc.gov.au](http://www.nhmrc.gov.au)

### 2.12 Ferroresonance

#### Purpose

The purpose of this work practice is to provide a basic knowledge of:

- what ferroresonance is and how it is caused
- how the effects of ferroresonance can be prevented

#### Scope

This work practice applies to all high voltage (HV) live workers involved in work where ferroresonance may occur.

#### Ferroresonance

- Ferroresonance is a condition that may occur on a three-phase system when:
  - an unloaded delta/star distribution transformer becomes energised or de-energised by single-phase HV switching
- and
  - the length of underground cable exceeds the critical cable length for the transformer (creating a high enough capacitance to equal the inductance reactance of the transformer) with no load on the low voltage (LV) side of the transformer. For the critical cable length, see Tables 1 and 2.
- Ferroresonance on a three-phase system most often occurs when using:
  - HV disconnectors
  - drop out fuses
  - encapsulated single-phase switchgear
  - live techniques to make or break loads
- Ferroresonance results in overvoltages that may significantly exceed the rated voltage of items such as cables, transformers, insulation. This may cause:
  - injury to personnel
  - damage to electrical apparatus
  - third party assets
- Tests have shown that excessive phase-to-earth voltages, up to 3.3 times the normal voltage, may be developed in distribution circuits conducive to ferroresonance. Once developed, they have a steady value that persists for the duration of the switching operation. This sustained overvoltage will shorten the insulation life of distribution equipment, by accelerating its deterioration.

## Instructions

### General

There are two methods to eliminate ferroresonance while switching.

- Energising and de-energising via three-phase switching simultaneously (e.g. pole top switch).
- Connecting a load to the LV side of the transformer by means of a load box (see Figure 1). When de-energising or making live a combination of transformer and HV cable when operating un-ganged switching devices (e.g. drop out fuses).

#### Note:

The LV side of the transformer must be offloaded before switching the HV.

### Connecting the load box

- Prior to connecting to the transformer, ensure that the load box is operating:
  - Turn the circuit breaker 'ON'.
  - Use an ohmmeter to check that there is a resistance on each resistor from phase-to-neutral.
  - Turn the circuit breaker 'OFF'.
- Position the load box in a safe position that does not restrict movement, cause a trip hazard, etc. If necessary, assign a safety observer to keep people away from the load box when the switching is to occur and while the load box is energised.
- Ensure that there is no other load connected to the transformer.
- Ensure that the load box circuit breaker switches are in the 'OFF' position.
- Connect the load box to the transformer's LV terminals (or associated equipment where the LV is accessible), ensuring that the earth and neutral connections are made first.
- Switch the load box circuit breaker switches to the 'ON' position.
- Energise or de-energise the transformer and HV cable combination according to the switching/commissioning requirements.

### Disconnecting the load box

- When disconnecting the load box, ensure that the circuit breaker switches are in the 'OFF' position.
- Remove the load box from the transformer's LV terminals ensuring that the earth and the neutral are removed last.

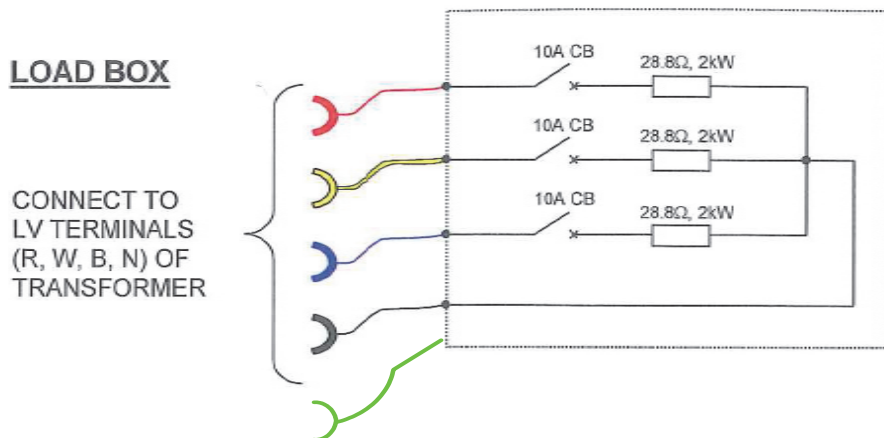


Figure 1: Load box

Table 1: PILC cable – Critical cable lengths (in metres) for ferroresonance

Transformer (kVA)	Cable size			
	25 mm <sup>2</sup>	70 mm <sup>2</sup>	95 mm <sup>2</sup>	185 mm <sup>2</sup>
160	18 m	11 m	10 m	8 m
315	36 m	23 m	20 m	15 m
500	57 m	36 m	33 m	24 m
630	72 m	45 m	41 m	30 m
1000	114 m	72 m	65 m	47 m

Adapted from: *Ferroresonance - calculations for cable critical cable lengths* (DM# 3270851)

**Table 2: XLPE cable – Critical cable lengths (in metres) for ferroresonance**

System voltage 11 kV					
Transformer (kVA)	Cable size				
	35 mm <sup>2</sup>	95 mm <sup>2</sup>	185 mm <sup>2</sup>	240 mm <sup>2</sup>	400 mm <sup>2</sup>
63	17 m	12 m	9 m	8 m	7 m
160	43 m	30 m	24 m	21 m	17 m
315	84 m	59 m	46 m	41 m	33 m
500	133 m	93 m	74 m	64 m	52 m
630	168 m	117 m	93 m	81 m	65 m
1000	267 m	186 m	146 m	129 m	104 m
System voltage 22 kV					
Transformer (kVA)	Cable size				
	35 mm <sup>2</sup>	95 mm <sup>2</sup>	185 mm <sup>2</sup>	240 mm <sup>2</sup>	400 mm <sup>2</sup>
63	4 m	3 m	2 m	2 m	2 m
160	11 m	7 m	6 m	5 m	4 m
315	21 m	15 m	12 m	10 m	8 m
500	33 m	23 m	18 m	16 m	13 m
630	42 m	29 m	23 m	20 m	16 m
1000	67 m	46 m	37 m	32 m	26 m
System voltage 33 kV					
Transformer (kVA)	Cable size				
	50 mm <sup>2</sup>		185 mm <sup>2</sup>		
63	2 m		1 m		
160	4 m		3 m		
315	8 m		7 m		
500	13 m		11 m		
630	16 m		13 m		
1000	26 m		21 m		

Adapted from: *Ferroresonance - calculations for cable critical cable lengths* (DM# 3270851)



### References

- High Voltage Live Work Manual, work practices:
  - 2.0 (Safe working principles)
  - 2.9 (Job briefing process)
  - 2.10 (Personal protective equipment (PPE) requirements)
- Ferroresonance - calculations for cable critical cable lengths (DM# 3270851)

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### 2.13 Rescue and emergencies

#### Purpose

The purpose of this work practice is to provide guidelines specifically for high (HV) voltage live workers to use in the case of an emergency involving electric shock, personal injury, flashover, unplanned operation of a circuit breaker or other network protective device, fire or network damage.

The instructions are intended to be additional to the relevant work practices in the *Work Practice Manual*, section 2 (Safety).

#### Instructions

##### Basic rescue principles

- Assess and manage the hazards and risk – particularly to the rescuer.
- Call for assistance.
- Isolate or remove the injured person/s and the rescuer from the hazards.
- Rescue any unconscious or injured persons and return them to a safe position on the ground if possible.
- Administer first aid including resuscitation where required.

#### Important

The most important considerations are the hazards and risks to the rescuers.

##### Electrical safety

Conductors or electrical apparatus must always be treated as energised unless isolated, proven de-energised, earthed and released under a permit.

Where the injured person is still contacting live conductors or apparatus, the connection needs to be broken as quickly as possible to prevent further injury.

##### Contact or electrical flashover

In the event of electrical contact or flashover:

1. Contact Network Operations Control (NOC) advising of incident and request de-energising of feeder if required.
2. Call emergency services, if required.
3. If possible, isolate and de-energise the apparatus.

4. Break contact using an approved HV insulating stick or by approved HV live work gloves if glove and barrier work is being carried out from a mobile elevated work platform (EWP).
5. Lower the injured person to the ground using the method relevant to the platform they are on:
  - ladder/platform
    - pole top rescue
    - manoeuvre worker/s to an EWP
  - EWP
    - base controls
    - bleeding down of the boom
    - emergency descent device (EDD)
6. Remove the injured person from the EWP and try and minimise any further injury or trauma. Use the EWP bucket tilt features if necessary.
7. Administer first aid, including resuscitation where required.

### Important

The rescuer must maintain HV minimum approach distances (MADs) from any conductive plant and equipment.

- If the injured person is in an EWP and the rescuer needs to approach or operate the EWP to carry out the rescue, they need to consider the following:
  - Is the EWP correctly earthed?
  - Is the EWP in contact with any potentially energised electrical conductors or apparatus?
  - Could operation of the EWP cause further exposure to risks?
  - Is the EWP still safe to operate?
  - Is the rescuer competent to operate the EWP from the ground?
- The rescuer must also consider the risk of step and touch potential when accessing vehicles, poles or structures. For more on this, see work practice 2.14 (Step and touch potential) in this manual.
- Personnel on a vehicle suspected of being or becoming energised should remain on the vehicle until the electrical supply has been isolated and proven de-energised.

- If the person needs to evacuate from the vehicle before the electrical supply has been isolated and proven de-energised, they must jump clear of the vehicle and land with both feet together. Once free of the vehicle, move away by making small hops with the feet together. For more on this, see work practice 2.18 (Pyrolysis in vehicle tyres) in the *Work Practice Manual*.

### Note:

EWPs must be operated in accordance with work practice 4.1 (Mobile elevated work platforms (EWP)) in the *Work Practice Manual*.

## Fires

When a fire occurs, personnel must stop work and act according to the evacuation plan. For more on this, see work practices 2.1 (Worksite evacuation plan) and 2.16 (Fire precautions for field work) in the *Work Practice Manual*.

## Reporting incidents

See work practice 2.8 (Incident reporting) in this manual.

## Emergency contact numbers

**Emergency** (Fire, Police, Ambulance): 000

**Emergency switching** (to stop injury or damage during the emergency)

Network Operations Control (NOC): 9427 0626

**To report an incident** (after the emergency has passed)

Incident Hotline: 1300 CALL WP (1300 2255 97)

**For assistance coping with natural or man-made emergencies**

SES 132 500

### Note:

For more emergency contact information, see *Work Practice Manual*, Appendix 4 (Emergency contact information).

## References

- High Voltage Live Work Manual, work practice 2.14 (Step and touch potential)
- Work Practice Manual:
  - section 2 (Safety)
  - Appendix 4 (Emergency contact information)

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### 2.14 Step and touch potential

#### Purpose

The purpose of this work practice is to provide a basic understanding of step and touch potential and how to control these hazards.

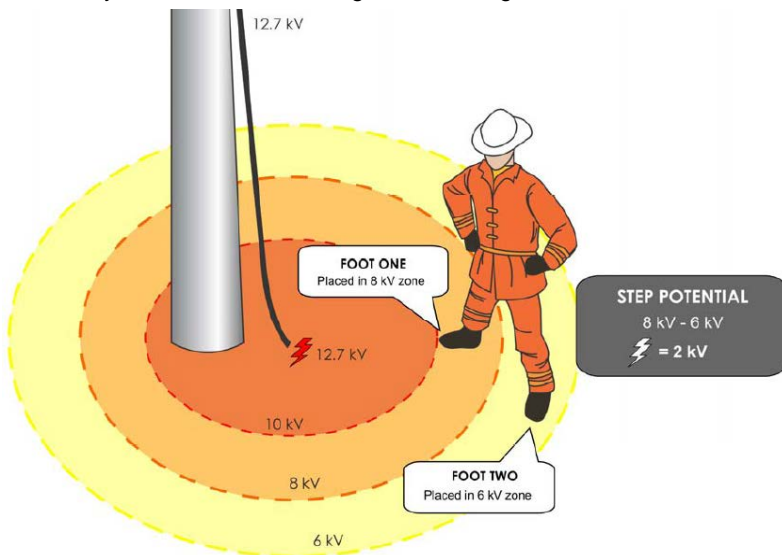
#### Scope

This work practice applies to all high voltage (HV) live workers, including ground support personnel such as operators of elevated work platforms (EWPs), cranes and other mobile plant.

#### Background

##### Step potential

Step potential is a shock hazard that occurs when a person is close to or steps towards an energised contact site. The step potential that passes through the body is calculated by the difference in voltage of the energised soil between their feet.



This figure is taken from *Electrical System Safety Rules (ESSR)*

**Figure 1: Step potential (22 kV system)**

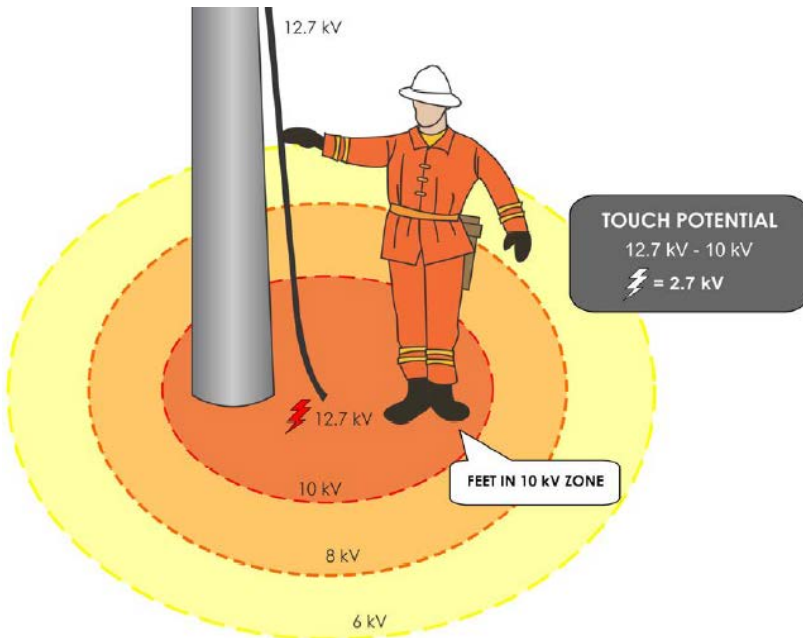
In Figure 1, the fault current is travelling down a conductor to the ground. This conductor is energising the surrounding ground, the voltage diminishing in a radial pattern from the contact site. Standing with one foot in the 8 kV voltage zone and a

second foot in the 6 kV voltage zone, this person could experience a hazardous shock of up to 2 kV.

The example shown in Figure 1 is indicative only and the extent to which voltages diminishes as they move away from the source will vary greatly with soil resistivity.

### Touch potential

Touch potential is experienced when contact is made with an energised object. The touch potential that passes through the body is equal to the difference between the voltage of the energised object and the voltage of the zone where the feet are placed, remembering that voltage diminishes in a radial pattern from the contact site.



This figure is taken from *Electrical System Safety Rules (ESSR)*

**Figure 2: Touch potential (22 kV system)**

In Figure 2, the fault current is travelling down a conductor to the ground. This conductor is energising the surrounding ground, the voltage diminishing as it moves away from the contact site. Touching the 12.7 kV conductor while standing within the 10 kV voltage zone could yield a hazardous shock of up to 2.7 kV.

The example shown in Figure 2 is indicative only and the extent to which voltage diminishes as they move away from the source will vary greatly with soil resistivity.



### Instructions

- Step and touch potential hazards must be included in all:
  - pre-job planning
  - job briefings and risk assessments. For more on this, see work practice 2.9 (Job briefing process) in this manual.
- Common sources of step and touch potential include the following:
  - energisation of mobile plant. For more on this, see *the Earthing of mobile plant* section in work practice 4.0 (Mobile plant and related equipment for HV live work) in this manual.
  - permanent and temporary earths
- Measures must be taken to prevent personnel and vehicles that are not involved in the task from entering the work area, to prevent injury from hazards such as step and touch potential. To prevent access and define the work area, use measures such as:
  - warning signs
  - flashing lights
  - barriers
  - traffic controls

### References

- High Voltage Live Work Manual work practices:
  - 2.9 (Job briefing process)
  - 4.0 (Mobile plant and related equipment for HV live work)
- Electrical System Safety Rules (ESSR)

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### 2.15 Temperature of conductors and electrical apparatus

#### Purpose

The purpose of this work practice is to provide a basic understanding of the potential risks associated with elevated temperatures on conductors and electrical apparatus.

#### Risk

Risk management of potentially elevated temperature conditions is essential to ensure the safety of high voltage (HV) live workers.

The risks from elevated temperatures are:

- burn injuries from direct contact
- burn injuries from joint and/or conductor failure
- glove insulation failure due to temperature degradation of the natural rubber
- insulation failure due to thickness reduction and degradation of dielectric properties
- insulated stick and/or attachment failure due to epoxy softening

The above risks can be increased by the application of insulated items (e.g. insulated blankets and barriers) to the conductor as these items also provide thermal insulation of the conductor and reduction in energy radiation and wind cooling.

HV live workers must be aware of:

- the maximum temperature limits relating to working on conductors and joints, the limitations of glove, barrier and stick insulation and their susceptibility to higher temperatures
- the requirement to visually inspect all joints before working on or adjacent to them to ensure they are not at risk. Temperatures within the joint can range from ambient to close to melting point. Aluminium is particularly vulnerable to this condition

#### Background

HV live work is carried out on live electrical apparatus that may be exposed to a wide range of load conditions, such as:

- almost negligible loads on lightly loaded rural spur lines
- maximum design rating loads
- short term overloads under emergency conditions

High currents can cause elevated temperatures in conductors and electrical apparatus. Temperatures will depend on:

- conductor types
- ambient temperature
- current
- solar radiation
- wind speed
- humidity
- other environmental factors

Elevated temperatures can be a potential risk to HV live work as the higher temperatures may compromise the integrity of conductors, joints and insulated equipment, i.e. gloves, sleeves, barriers and insulated sticks. This risk has particular significance for the glove and barrier work methods where HV live workers are in close proximity to, or in contact with, the conductor.

### Instructions

Risk management can be achieved by:

- being aware of the maximum conductor and joint temperatures at which HV live work is allowable
- visually inspecting all joints before working on the conductors
- including the risk of elevated conductor and joint temperatures in the risk assessment
- considering doing work de-energised where risks of elevated temperatures cannot be adequately managed

The maximum allowable conductor/joint temperatures for HV live work are provided in Table 1, below. If the conductor/joint temperature is above 70°C, consideration must be given to the following:

- contacting Network Operations Control (NOC) to isolate the line to replace suspect joints or for completion of the task under fault conditions
- contacting NOC to switch the load to reduce conductor/joint temperature. The identified conductor/joint temperature will need to be reassessed prior to commencing work.
- personnel in the field who identify conductors/joints above 70°C must email the details to the OAM Works clarification mailbox:

OAM.Works.clarification@westernpower.com.au

- This information will be used as condition information (local knowledge) to help risk assess and prioritise conductor replacements on the distribution network that could impact safety or reliability
- For more on the OAM Works clarification mailbox, see *TWC Internal Update – OAM Clarification Mailbox* (DM# 8893077)

**Table 1: Maximum temperature limits for HV live work equipment use**

Item	Effect on item when conductor exceeds maximum allowable temperature	Temperature (°C)
Plastic products (e.g. hard covers)	<ul style="list-style-type: none"> <li>• Plastic begins to soften</li> <li>• Possible reduction in thickness</li> </ul>	70
Rubber products (e.g. gloves, sleeves, mats)	<ul style="list-style-type: none"> <li>• Rubber begins to soften</li> <li>• Possible reduction in thickness</li> </ul>	70
Insulated sticks	<ul style="list-style-type: none"> <li>• Epoxy resins (glue) bonding the metallic fittings to the stick begin to break down</li> </ul>	80

Conductors and joints must be inspected for signs of elevated temperature prior to carrying out HV live work where reliance will be placed on the integrity of gloves, sleeves and barriers. Conductor and joint temperatures must be included as an item in all HV live work risk assessment.

As a general guide, the average daytime temperature of most aluminium conductors running at their manufacturer's maximum rated current carrying capacity is around 70°–75°C. Conductors operating well below their maximum rated current carrying capacity should be well below this temperature. However, conductor temperature is affected by wind, ambient temperature, solar radiation and other factors.

Bad joints may occur even under low load situations and the HV live worker must always inspect joints and look for signs of heat stress. These may include signs of:

- discolouration of the joint and adjacent conductors
- electrical arcing, blackening and damage
- partial melting, elongation or distortion of fittings and/or adjacent conductors
- corrosion
- loose or poorly made joints, e.g. incorrect crimp lugs used

### References

- TWC Internal Update – OAM Clarification Mailbox (DM# 8893077)

### 3.0 Training, competency and auditing requirements

#### Purpose

The purpose of this section is to provide information and guidance on:

- selecting applicants for high voltage (HV) live work training
- training applicants
- determining levels of authorisation and supervision
- auditing and compliance

This work practice has been developed to be in line with *AS 5804.1-2010 High-voltage live working – General*.

#### Scope

This section applies to:

- HV live workers
- applicants for HV live work
- the formal leaders of:
  - HV live workers
  - applicants for HV live work
- Field Assessors
- Power Training Services WA (PTSWA)
- Safety, Health and Environment
- other personnel that may carry out HV live work audits

It does not apply to personnel performing:

- live washing and application of silicone grease
- HV vegetation work

#### Instructions

All personnel who perform HV live work on the Western Power Network must undergo selection and ongoing assessment of competencies. This is done to maintain a safe system of work in accordance with:

- industry best practice
- *AS 5804.1-2010 High-voltage live working – General*

**Note:**

All documentation associated with the following must be recorded in the individual HV worker's personal file:

- selection
- training
- ongoing assessment

**References**

- AS 5804.1-2010 High-voltage live working – General



### 3.1 Selection for HV live work training

#### Purpose

The purpose of this work practice is to outline the process used to select applicants for high voltage (HV) live work training.

#### Overview

A formal selection process is used to choose personnel who wish to be nominated for training in any HV live work method.

Formal leaders are responsible for nominating applicants, either internal (Western Power) or external, for HV live work training and must ensure that the formal selection process is followed. All information must be kept in the applicant's personnel file.

The formal selection process is composed of:

- criteria to be met by the applicant
- actions to be taken by the formal leader

#### Criteria to be met by the applicant

The applicant must:

- have a good safety record
- hold a current *High Risk Work Licence (WP)* that is required to operate boom-type elevating work platforms (boom length 11 metres or greater)

#### Qualifications

- To be selected for an HV live work training program or familiarisation course, an applicant must have all of the necessary qualifications and experience. The requirements vary depending upon the type of program or course and are described below.
- All prerequisites for the must be fully met and evidence provided prior to training.

#### HV live work training program

The applicant must:

- hold a Certificate III in either Electrical Supply Industry (ESI) Distribution or ESI Transmission, awarded under the Australian Qualifications Framework (AQF), for the relevant type of HV live work to be entered (i.e. distribution or transmission)

- have a minimum of 12 months of relevant and unsupervised HV overhead line work on the Western Power Network within the last three years

### **HV live work gap training program**

The applicant must:

- hold an HV live work qualification
- have a minimum of 12 months relevant and unsupervised HV overhead line work on any transmission or distribution network within the last three years
- have HV live work experience
- undergo a recognition of prior learning (RPL) assessment

### **HV live work familiarisation course**

The applicant must:

- have a minimum of 12 months relevant and unsupervised HV overhead line work on any transmission or distribution network within the last three years
- hold an ESI Distribution or Transmission HV live work qualification, awarded under the AQF, for the relevant stream of live work to be entered

**or**

- have a minimum of 12 months relevant and unsupervised HV overhead line work on any transmission or distribution network within the last three years
- have been granted an equivalency (by Power Training Services WA (PTSWA)) of the ESI Distribution or Transmission HV live work qualification, for the relative stream of live work to be entered

### **Actions to be taken by the formal leader**

The formal leader must conduct or arrange the following before nominating an applicant for a HV live work training program or familiarisation course:

- Formal interview
- Medical examination
- Safety attribute evaluation

### **Formal interview**

The formal leader must conduct an interview to assess the applicant's ability to:

- demonstrate personal attributes of responsibility, concentration and teamwork
- prepare for the job
- assess and control risks

For the questions to be asked during the interview, see Appendix 2 (HV live work training – Interview questions) in this manual.

### Medical examination

The medical examination is used to:

- assess applicants for HV live work training
- reassess HV live workers every three years

The medical examination is comprised of two parts:

- Commercial Drivers Medical Assessment – this covers:
  - all of the requirements for driving a commercial vehicle
  - part of the requirements for HV live work
- musculoskeletal screen – this covers the remaining part of the requirements for HV live work

The Commercial Drivers Medical Assessment must be undertaken every three years in order to renew the licence. Western Power has aligned the timing of the HV live work medical examination to a three-yearly timeframe to be the same as the commercial driving licensing medical assessment. This means that HV live workers only need to undergo one medical examination every three years, instead of two separate examinations.

### References

- High Voltage Live Work Manual, Appendix 2 (HV live work training – interview questions)

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### 3.2 Training

#### Purpose

The purpose of this work practice is to provide information regarding training courses for high voltage (HV) live workers. Training is conducted by Power Training Services WA (PTSWA).

#### Training courses

- All prerequisites for the following training must be fully met and evidence provided prior to training.
- Qualifications and/or authorisations will depend upon successful completion of the course or program.

#### HV live work training

This is for lineworkers who hold a Certificate III in either Electricity Supply Industry (ESI) Distribution or ESI Transmission, awarded under the Australian Qualifications Framework (AQF), for the relevant stream to be entered, and who have completed 12 months practical experience on the Western Power network.

#### Retraining

HV live workers must complete HV live work training again if:

- their authorisation has lapsed more than 24 months
- or
- they failed to successfully complete either of the following courses:
    - HV live work refresher
    - HV live work familiarisation

#### HV live work gap training

This is for HV live workers who have HV live work qualifications and current HV live work experience and as a result of a recognition of prior learning (RPL) assessment are required to undergo gap training to meet the requirements of ESI Certificate III and Certificate IV. Gap training for these certificates can be taken simultaneously.

#### HV live work familiarisation

This is for applicants being employed for HV live work on the Western Power network who have already attained Certificate III in ESI and the relevant Certificate IV units of competency for HV live work.

### HV live work refresher

This is for HV live workers who have failed to renew their HV live work authorisation through the annual assessment before the anniversary date. This course can only be taken for authorisation that had lapsed not more than 24 months from the anniversary date. Workers who have failed to successfully complete the HV live work familiarisation course must undergo retraining.

### 3.3 Authorisation and supervision

#### Purpose

The purpose of this work practice is to outline the levels of authorisation and supervision required for high voltage (HV) live work.

#### Authorisation

Authorisation to perform HV live work:

- may only be granted in accordance with the requirements outlined in this section of the manual
- is granted by the Network Authorisations team and recorded on the HV live worker's Network Authority Card (NAC)
- is valid for one year and must be renewed annually

#### Important

Authorisation may be withdrawn if there is a serious non-compliance involving a safety breach.

#### Levels of authorisation

There are two levels of authorisation:

- Under Supervision
- Unsupervised

#### Under Supervision

Personnel seeking Under Supervision authorisation must provide proof of successful completion of:

- a current medical examination. For more on this, see work practice 3.1 (Selection for HV live work training) in this manual.
  - one of the following:
    - statement of attainment for HV live work, awarded under the Australian Qualifications Framework (AQF) for the relevant stream of live work to be entered
- or**
- academic transcript showing successful completion of off-job components as part of training to achieve full units of competence for HV live work, awarded under the AQF for the relevant stream of live work to be entered

**Note:**

Personnel who provide statements of attainment or academic transcripts not issued by Power Training Services WA (PTSWA) must show evidence that they have successfully completed the *HV Live Work Familiarisation* course delivered by PTSWA.

The requirements and responsibilities of supervising personnel are outlined in the *Supervision* section in this work practice.

**Unsupervised**

Personnel seeking Unsupervised authorisation must provide proof of successful completion of the following:

- a current medical examination. For more on this, see work practice 3.1 (Selection for HV live work training) in this manual.
  - one of the following:
    - the prescribed workbook as part of the *HV Live Work Familiarisation* course provided by PTSWA
- or**
- statement of attainment for HV live work, awarded under the AQF for the relevant stream of live work to be entered

**Note:**

Personnel who provide statements of attainment or academic transcripts not issued by PTSWA must show evidence that they have successfully completed the *HV Live Work Familiarisation* course delivered by PTSWA.

**Renewal of authorisation**

- The renewal of authorisations is conducted annually by PTSWA (see the *Annual assessment* section, below).
- Personnel seeking renewal of authorisation must provide proof of successful completion of the following:
  - a current medical examination. For more on this, see work practice 3.1 (Selection for HV live work training) in this manual.
  - knowledge and skills assessment conducted by PTSWA, and/or successful completion of any prescribed refresher training conducted by PTSWA or approved registered training organisation (RTO)



### Annual assessment

To ensure ongoing safety, competence and adherence to work practices, HV live workers undergo annual formal competency assessments, conducted by PTSWA. The following conditions apply to the annual assessment:

- Documentary evidence of assessments must be retained for audit and compliance purposes. For more on auditing and compliance requirements, see work practice 3.4 (Auditing, compliance and field assessment) in this manual.
- Competency is only valid for 12 months.
- The due date for reassessment is 12 calendar months from completion of the last training or assessment.
- Personnel who fail to complete the reassessment successfully by the anniversary date of their last training or assessment:
  - are not permitted to perform or be the safety observer for HV live work
  - must successfully complete the relevant training course, as outlined in work practice 3.2 (Training) in this manual

### Supervision

Personnel who have an Under Supervision authorisation must work under supervision of a person holding an Unsupervised authorisation. This applies until the Network Authorisations team has upgraded the supervised worker's authorisation from Under Supervision to Unsupervised.

The two levels of supervision that apply to HV live work are described below.

#### Note:

No-one can provide Immediate Supervision and Direct Supervision simultaneously.

### Immediate Supervision

This is a supervision method where the supervisor is:

- only supervising one trainee while the trainee is working, i.e. one-to-one
- physically close enough to the trainee so that the supervisor can immediately take physical control of the trainee's activities regardless of the work location, e.g. at the pole top or working on equipment or apparatus

Immediate Supervision is required for personnel who are working on a task that has not yet been signed off in their *High Voltage Distribution Live Line Glove and Barrier On-the-Job Training Workbook*.

### Direct Supervision

This is a supervision method where the supervisor:

- supervises a maximum of two trainees, i.e. two-to-one
- must remain at the worksite and close to the trainee, within sight of the trainee and be able to communicate directly with the trainee. However, the supervising worker does not necessarily have to be standing alongside the trainee.

Direct Supervision is required for personnel who are working on a task that has been signed off in their *High Voltage Live Line Glove and Barrier Familiarisation On-the-Job Workbook* but a statement of attainment for live work has not yet been issued.

### References

- High Voltage Live Work Manual, work practices:
  - 3.1 (Selection for HV live work training)
  - 3.2 (Training)
  - 3.4 (Auditing, compliance and field assessment)

### 3.4 Auditing, compliance and field assessment

#### Purpose

The purpose of this work practice is to provide an outline of the key audit, compliance and field assessment requirements associated with HV live work, including:

- types of audits
- frequency of audits
- audit and non-compliance processes

#### Background

An annual audit of HV live work crews is required to:

- ensure compliance with the relevant Australian standards
- provide an overview of how well Western Power is complying with these standards

These audits may be combined with field assessments of the competency of individual HV live worker.

#### Instructions

##### Audits

- A full audit of HV live work must be carried out at least every 12 months in accordance with *AS 5804.1-2010 - High-voltage live working – General, Section 12 – Auditing*. The audit must involve all personnel actively involved in HV live work and be formally recorded.
- All HV live workers must also undergo one partial or brief audit once a year, ideally at the midpoint between the full audits. For more on this, see the *Partial and brief audits* section, below.
- External auditors may be used on a predetermined basis to ensure that any internal auditors and processes are checked. External audits are the responsibility of Safety, Health and Environment.
- The frequency of all audits is dependent on the results of previous audits and the type, complexity, experience or competency of the team or individuals involved. Previous incidents, near misses or breaches of critical HV live work principles or procedures may also necessitate more regular audits.

## Partial and brief audits

Partial and brief audits may be carried out more frequently than every 12 months.

- Partial audits – Must cover all aspects of the full audit but some items may be covered in less depth.
- Brief audits – Must focus on core safety issues such as adherence to work practices and recognition of safe work practices.

## Depot audits

Depot audits are carried out to check on HV live work equipment storage facilities, use of the equipment management system and other items not covered by competency auditing or field assessments. Depot audits are the responsibility of Safety, Health and Environment.

## Audit process

HV live work auditors must be authorised by Western Power to assess HV live work. Auditors must do the following:

- Carry out audits in accordance with *AS 5804.1-2010 - High-voltage live working – General, Section 12 – Auditing*.
- Organise pre-audit meetings with the formal leaders of the areas being audited no less than four weeks prior to the audit. The audit meeting must cover the audit requirements and expectations of the audit.
- Make audit checklists available to the work party in advance and ensure they comply with the minimum requirements of *AS 5804.1-2010 - High-voltage live working – General, Appendix D – Audit Check Sheets: Minimum Content*.
- Strive to establish a cooperative environment and promote the audit as a positive opportunity for continuous improvement for HV live worker safety.
- Submit a written report that covers the results of all audits with descriptions, explanations and recommendations on areas of non-compliance, where appropriate.
- Hold an audit close-out meeting with the formal leaders of the areas being audited to summarise the audit findings and facilitate discussion about the audit, particularly in regard to any recommendations.

## Non-compliances

- All non-compliances must be recorded in accordance with the requirements of Western Power and must include recommendations for non-compliance resolution.
- Serious non-compliances involving safety breaches may involve disciplinary action in accordance with Western Power policies.

### Field assessments

During a field assessment, HV live workers are assessed on their compliance with a range of requirements, including:

- authorisations and availability of *HV Live Work Manual*
- Vicinity Authority permits, auto reclose settings and onsite communications
- pre-job and/or onsite risk assessment
- safety observers
- inspection of equipment, testing and storage
- mobile plant
- personal protective equipment (PPE)
- minimum approach distances (MADs), drop zone, use of barriers and control of conductors
- rigging and supporting, making or breaking of taps

### References

- AS 5804.1-2010 - High-voltage live working – General

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### 4.0 Mobile plant and related equipment for HV live work

#### Purpose

The purpose of this work practice is to outline the minimum requirements for using mobile plant and related equipment when performing high voltage (HV) live work.

#### Instructions

Mobile plant such as insulated elevated work platforms (EWPs) and cranes are used with HV live work techniques to support energised conductors and lift loads that are on or near energised conductors and apparatus.

When using mobile plant on or near energised conductors and apparatus for live work techniques, the following requirements must be considered prior to starting work:

- Safe working loads (SWL) or working load limits (WLL) of the mobile plant and equipment.
- Insulation of the mobile plant.
- Minimum approach distances (MADs) for the uninsulated part of the plant load.
- Earthing of mobile plant.
- Inspection of existing pole-top structures or assemblies using an EWP.
- Locating people, cranes, EWPs and vehicles outside of any possible pole assembly or aerial failure pathway.

#### Drop zone

- The drop zone is an exclusion zone that must be established below any elevated work or suspended load.
- Establish the drop zone before commencing work. The area of the drop zone will depend on the following:
  - Type of work.
  - Size and weight of equipment and materials being used in the elevated work area.
  - Height of the work.
- The boundary of the drop zone must be agreed on by all members of the team during the job briefing process and must be noted on the risk assessment. For more on this, see the following work practices in this manual:
  - 2.1 (Onsite risk assessment)
  - 2.9 (Job briefing process).

- Access to the drop zone must be controlled and the method of control must be decided during the risk assessment.
- The drop zone will affect the positioning and movement of the following, where if applicable:
  - All personnel onsite.
  - Safety observers.
  - Vehicles and moving EWP.
  - Ladders and work platforms.
  - Barriers and/or signs to mark the perimeter of the drop zone.
  - Traffic management.
- Effective communication must be maintained between team members working aloft and those on the ground.

**Note:**

If site conditions change, the drop zone must be reviewed and altered if required. Changes must be recorded on the risk assessment.

### Mobile EWPs

- Fall arrest systems must be worn and attached to the designated anchor point before ascending in an EWP.
- An EWP bucket must not cross beneath or above another unless the occupants of the higher bucket stop work while this movement is in progress.
- For more on EWPs, see work practice 4.1 (Mobile elevated work platforms (EWPs)) in this manual.

**Note:**

When working above a drop zone, where possible:

- hand tools must be attached to the EWP bucket to prevent them dropping
- large tools, power tools and equipment must be attached by means of a suitable lanyard.

### Equipment and materials

The following controls must be used to reduce the risk of an object falling:

- Lifting large or heavy loads – consider the safest method of lifting these into the elevated work area. Do not exceed the SWL/WLL of the lifting device.



- Secure loads – if using the EWP to lift large items, use slings or ropes that are suitably rated to hold the load.
- Organise the EWP – limit the amount of equipment and tools that are taken into the EWP to only those items that are necessary to complete the task.
- Tools – tool-bags and other equipment must be hung on the inside of the EWP. Where possible, attach hand tools to prevent them from dropping.

### Cranes and EWPs

- Prior to commencing work, crane operators and doggers must be instructed on the procedure and MADs that are to be used. Crane operators and doggers must be under the constant supervision of a nominated member of the HV live work team who is qualified and authorised in the live work method that is being performed.
- When using an insulated EWP with a telescopic boom, the boom must be fully extended. This will ensure that the insulated requirement (as specified on the HV certification of the equipment) relevant for the voltage that is being worked on is obtained.
- Parts of the crane or EWP that are uninsulated must stay outside the MAD. See Table 1, below.
- Conductor support attachments and lifting beams for use with cranes and EWPs must be constructed and tested to Australian standards. For more on this, see work practice 4.2 (EWP and crane-mounted support equipment) in this manual.
- Cranes and EWPs must be earthed. This is to reduce step and touch potentials and to decrease fault clearance times that may be associated with electrical faults generated at the site. For more on this, see the 'Earthing of mobile plant' section, below.
- When supporting energised components, appropriate insulation which is rated to meet the electrical and mechanical loads must be fitted between energised components and the crane or EWP. For more on this, see the 'Insulation of plant, load and conductors' section, below.
- Consideration must be given to movement of the conductor due to wind and changes in temperature.

### Important

When moving vehicles on the worksite, ensure that:

- the vehicle boom is stowed before moving the vehicle
- there is adequate clearance if the vehicle is to pass under any conductors
- vehicle extensions and protrusions (e.g. gin pole assemblies on EWPs and crane-mounted masts) do not collide with overhead lines and vegetation.

### SWL/WLL considerations and limitations

When lifting loads with an EWP or crane, the total load to be lifted must be:

- within the SWL/WLL of the EWP or crane (this information is specified in the boom chart of the equipment)

#### Note:

Ensure that you include all items carried in the EWP bucket, e.g. hand tools, when calculating the total load to be lifted.

- within the SWL/WLL of any attachments used to lift the load, including boom attachments such as lifting jibs and insulators
- determined or calculated and noted on the risk assessment .

### Lifting jibs

Cranes and EWPs may be used with a lifting jib in HV live maintenance or work to lift cross-arms, switchgear, conductors and any load that is within the SWL/WLL of the jib and the crane/EWP. Lifting jibs that are used in conjunction with a crane or EWP must:

- be engineered and tested to meet their rated SWL/WLL
- have the SWL/WLL clearly marked
- be used within the manufacturers SWL/WLL. For more on this, see work practice 4.2 (EWP and crane-mounted conductor support equipment) in this manual.

### • Important

EWP lanyard attachment anchor points **must not** be used for any other purpose other than the attachment of lanyards for the EWP basket occupants.

MADs for the uninsulated part of the plant and loads

When mobile plant is used to lift loads near energised HV conductors or other HV electrical apparatus, ensure that the MAD (outlined in Table 1, below) is maintained between the uninsulated portion of the mobile plant and the energised HV conductor or HV electrical apparatus. If the MAD of a bare conductor cannot be maintained, insulated barriers can be applied to reduce the MAD. Insulated barriers may not be used on HV conductors above 66kV.

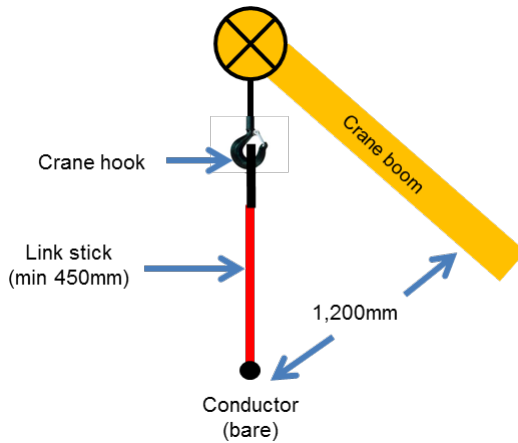
Table 1: Uninsulated mobile plant and loads – MADs

System voltage (kV)	Live HV conductor status	MADs from live HV conductor (mm)
6.6 – 33	bare	1,200
6.6 – 33	one level of insulation <sup>1</sup>	450
6.6 – 33	two levels of insulation <sup>2</sup>	Accidental contact
66	bare	1400
132	bare	1800

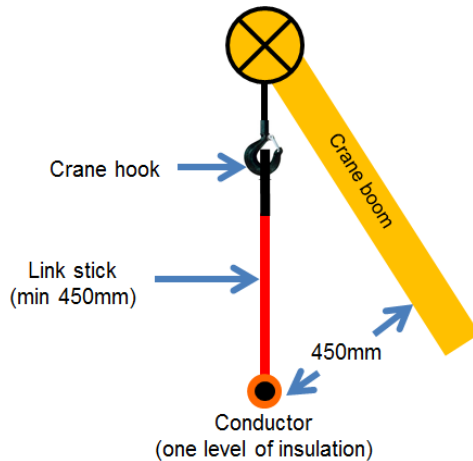
1. **One level of insulation** – one level of insulated barrier (rubber mat or rigid barrier) applied either on the energised conductor, plant, load or machinery.
2. **Two levels of insulation** – two levels of insulated barrier (rubber mats or rigid barriers) applied on the energised conductor plant or electrical apparatus, or one level of insulated barrier applied on the energised conductor plus another level of barrier (insulation) applied on the plant or electrical apparatus.

Insulation requirements for uninsulated plant - when lifting energised loads or conductors

A MAD of 1,200mm must be maintained between any uninsulated energised conductor and uninsulated plant such as a crane. The MAD between the crane hook and conductor can be reduced to 450mm when a rigid insulated and tested load bearing device (i.e, link stick or polymeric insulator) is used. See Figure 1 below.



**Figure 1. Insulated link stick lifting a bare energised conductor**



**Figure 2. Insulated link stick lifting a energised conductor with one level of insulation**

Where one level of insulation is applied to the energised conductor the MAD between the insulated conductor and crane can be reduced to 450mm as shown in Figure 2 above.

When lifting energised loads or conductors, ensure that:

- MADs are always maintained between energised conductors and/or electrical apparatus and any uninsulated parts of the plant as shown in Table 1
- a rigid insulated (minimum insulation of 450mm) and tested device (i.e insulated link stick or polymeric insulator) that is rated to the conductor voltage is installed between the lifting attachment point and the energised load or conductor.
- where insulated barriers are installed to reduce MADs they must extend the necessary distance to maintain MADs to any uninsulated part of the plant.
- loads are always applied in a vertical direction.

### Insulators

Insulators, such as polymers, are used to insulate mobile plant and electrical apparatus from energised conductors, apparatus and second points of contact. These insulators must be electrically and mechanically tested prior to use and rated every six months.

### Earthing of mobile plant

- Mobile plant must be earthed to ground or a known earth when working on or near any above ground HV electricity conductors (whether energised or de-energised).
- Before use, inspect the earth lead and confirm:
  - that the test date is not expired
  - the tightness of bolted connections
  - the general condition of earthing leads.
- Earth leads must be:
  - a minimum of 150mm<sup>2</sup> aluminium when working on 66kV and 132kV lines
  - a minimum of 95mm<sup>2</sup> aluminium when working on 1kV to 33kV lines
  - bolted to the vehicle or plant chassis or connected with a screw-on clamp (spring-loaded clamps are not permitted). For examples, see Figures 2 and 3, below.
  - connected to a temporary earth electrode or earthing point.

- Where a permanently installed earth point is not available, pole reinforcing steel columns are the next preferred earth point. The last preference for the earthing point is the temporary earth electrode.
- Temporary earth electrodes:
  - should be placed close to vehicles to reduce touch potentials
  - must be barriered to a minimum radius of two metres to guard against step and touch potentials
  - must be inserted into the ground to a minimum depth of 300mm and up to a maximum depth of 600mm. Although calling 'Dial Before You Dig' is not mandatory, care must be taken to avoid driving earth electrodes into an underground service.
- Where more than one mobile plant is involved:
  - if they are within a distance of two metres of any part of each other – they must be connected (bonded) to a common earthing point
  - if they are separated by more than two metres – each mobile plant must have its own direct earth connection applied and there must be a minimum of five metres between the earth points.
- A G-clamp must be used to securely connect the earth lead to the permanently installed earth point or temporary earth electrode.

### Note:

Spring loaded clamps must not be used to secure the earth lead to either the vehicle, temporary earth electrode or permanently installed earth point.

- Personnel must stand on an equipotential mat while operating base controls on a stationary vehicle or plant which is on or near live HV overhead electrical apparatus. Attach the earthing lead of the equipotential mat (either bolted or clamped) to the approved bonding point or a clean metal surface on the vehicle.
- **Do not** connect the vehicle earth lead to any of the following – LV neutral, SWER wire or down earth. A separate temporary earth electrode must be used.

### Note:

EWPs with insulated booms do not have to be earthed when working on or near conductors that are earthed or shorted. However, the vehicle must be earthed when being used for the application of portable earths.



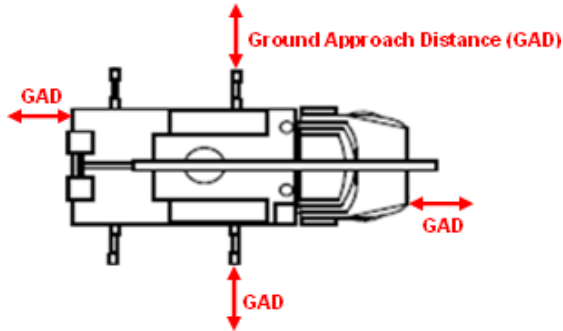
**Figures 1 and 2: Examples of EWP earth connections**

**Ground approach distance (GAD)**

Everyone involved in EWP operations must maintain a GAD around the base of the EWP (stabilisers/outriggers included) when used near live apparatus (see Table 2 and Figure 3, below).

**Table 2: Mobile plant ground approach distance (GAD)**

Voltage of conductor	Ground approach distances (mm)*
Low voltage	1,000
High voltage 1kV up to 33kV	1,200
66kV	1,500
132kV	1,800
Over 132kV	3,000



**Figure 3: Ground approach distance example**

**Note:**

When temporary earth electrodes are used, these must be barriered off to a radius of at least two metres (see *AS 5804.1-2010 High-voltage live working – General*).

**References**

- AS 5804.1-2010 High-voltage live working – General.
- High Voltage Live Work Manual, work practices:
  - 2.1 (Onsite risk assessment)
  - 2.9 (Job briefing process)
  - 4.1 (Mobile elevated work platforms (EWPs))
  - 4.2 (EWP and crane-mounted support equipment).



### 4.1 Mobile elevated work platforms (EWPs)

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on:

- types of EWPs and their limitations in relation to HV live work
- the importance of boom insulation
- compliance with standards
- safety requirements

#### Background

Mobile EWPs are a critical part of the equipment necessary to carry out HV live work safely. The insulated sections of the EWP form part of the insulating system for HV live workers using the glove and barrier method.

It is essential that HV live workers understand the type of EWP being used, the requirements for that EWP and the applicable standards.

There are three categories of EWP suitable for HV live work in Western Power. These are defined by *AS 5804.1 High-voltage live working – General*:

- Category A – Designed for work in which the boom is considered primary insulation and where all conductive components at the platform end are equipotentially bonded together. They are equipped with a lower test electrode system for monitoring all leakage current.
- Category B – Designed for work in which the boom is considered secondary insulation and does not have conductive components at the platform or any equipotential bonding. They are equipped with a lower test electrode system for monitoring all leakage current.
- Category C – Designed for work in which the boom is considered secondary insulation and does not have conductive components at the platform or any equipotential bonding. They are not required to be equipped with a lower test electrode system for monitoring all leakage current.

#### Note:

- All categories can be used for insulated stick work.
- Only categories B and C have been approved for glove and barrier work in Western Power.

## Instructions

- EWPs must:
  - comply with the requirements of *AS 1418.10 Cranes, hoists and winches – Mobile elevating work platforms*
  - have an insulated upper boom or fly boom rated and tested for the voltage to be worked on
  - be designed and manufactured for work in which the boom is considered insulation
  - have an emergency descent device (EDD) installed to the basket of the EWP that must be positioned for easy access
  - have a release mechanism operable while wearing glove and barrier live work gloves
  - be uncluttered and free of tools and equipment that are not essential for the work to be carried out
  - have all tool holders kept inside the basket
  - have anchor points for the fall arresters easily accessible to release the lanyard from the basket quickly in case of an emergency
  - have clean lanyards of the non-conductive web type. The lanyard restrains the high voltage live worker to the boom or basket of the EWP providing protection against falls. This creates a potential electrical path between the high voltage live worker and the EWP boom bypassing the insulating basket liner. Dirty or damp lanyards reduce the insulation levels of the EWP basket liner.
- The insulated section of the EWP boom must never be bypassed by any uninsulated medium. Remove any washing hose that bypasses the boom's insulated section.

For more on this, see:

- work practice 5.2 (Maintenance of EWPs and fitted hydraulic tools) in this manual
- work practice 2.6 (Mobile elevated work platform (EWP) safety) in the *Work Practice Manual*

### Glove and barrier work

EWP's used for glove and barrier work must:

- be fitted with an approved, insulated basket liner rated and tested at 50 kV. When not in use, the basket liner must be covered to keep the inside clean and moisture free.
- have all insulated sections visually inspected and wiped clean with an approved product immediately prior to use

### References

- High Voltage Live Work Manual, work practice 5.2 (Maintenance of EWPs and fitted hydraulic tools)
- Work Practice Manual, work practice 2.6 (Mobile elevated work platform (EWP) safety)
- AS 1418.10 Cranes, hoists and winches – Mobile elevating work platforms

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### 4.2 EWP and crane-mounted conductor support equipment

#### Purpose

This work practice outlines how to use elevated work platforms (EWPs) and cranes with rated and tested support attachments and lifting beams to lift loads or support energised conductors using Western Power methods.

#### Important

This work practice only applies to high voltage (HV) apparatus on the Western Power distribution network (i.e. 1kV to 33kV).

#### Safety

The following points apply when using EWP, crane-mounted conductor support attachments and all attachment types.

#### Positioning the EWP/crane

- The following issues must be considered when positioning the EWP/crane:
  - Pole height.
  - Vehicle access.
  - Low voltage (LV) circuits.
  - The EWP/crane capacity (must be within the working task range).
- Once the best site for positioning the EWP/crane has been identified, the base of the EWP/crane must be levelled using stabilisers.

#### Preliminary checks

The requirements that must be checked before starting work are outlined in the following work practices in this manual:

- 4.0 (Mobile plant and related equipment for HV live work)
- 5.2 (Maintenance of EWPs and fitted hydraulic tools).

#### Note:

All EWP and crane-mounted conductor support equipment must be used in accordance with HV live work procedures and manufacturer's guidelines.

## Lifting conductors – general rules

- Fit the wire holders up to support the conductors. If misaligned, adjust the wire holders along the lifting or supporting device.
- Ensure that the conductors are secured or trapped in the wire holders before releasing the conductor (e.g. ties, suspension insulator lock pin). Conductors must be controlled at all times to avoid inadvertent movement.
- Raise the boom of the EWP/crane to lift the conductors clear of the working area while ensuring that mid-span clearances, personal clearances, mobile plant clearances and secondary points of contact are not compromised.  
Apply additional insulated barriers and other controls where necessary.
- When rotating or moving conductors, ensure that support equipment does not come into contact with plant or equipment.
- Once work has been completed, reverse this process to replace the conductors onto the insulators.

### Important

- EWPs, cranes and support equipment must be operated within the manufacturer's safe working load (SWL) or working load limit (WLL).
- All loads (e.g. personnel, tools, equipment) must be combined when determining the total load applied to the EWP.

## Attachment safety

- EWP and crane-mounted conductor support equipment must be removed immediately after use.
- If moving an EWP with conductor support equipment attached, the movement of the EWP must be observed and guided by a safety observer.
  - Consider the following factors:
    - Distance to be travelled.
    - Terrain.
    - Clearance height along the route.
  - The EWP must not exceed 6km/h or the safety observer's walking speed, whichever is slower.

### Types of conductor support attachments and lifting beams

The Western Power approved EWP and crane-mounted conductor support attachments and lifting beams are outlined in Table 1, below, and are described in the following sections in this work practice:

- Conductor support attachments – EWP-mounted only
- Conductor support attachments – EWP and crane-mounted
- Conductor support attachments and lifting beams – crane-mounted only.

The support attachments and lifting beams must be certified and marked to the relevant Australian Standard and be tested every six months to the standard requirements.

**Table 1: Approved attachments**

Attachment or lifting beam*	Approved for use with...	
	EWP	Crane
Gin pole	✓	
Aichi sub-boom and winch assembly with auxiliary arm and mast	✓	
Angle bridle	✓	
Bull wheel	✓	
Hasting boom-mounted auxiliary arm and mast	✓	✓
Chance boom-mounted auxiliary arm and mast		✓
Lifting beam		✓
Custom made lifting beams with SWL/WLL indicated		✓
Sling with insulator/link stick		✓

\* Conductor support attachments can be used for HV live work provided that the load of the conductor that is to be lifted is within the SWL/WLL of the plant and support equipment. The angle, extension and height must be taken into consideration when calculating the SWL/WLL.

### Conductor support attachments – EWP-mounted only

Of the nine attachments described in this work practice, four are applicable to EWPs only. These are outlined below.

## Gin poles

An EWP-mounted gin pole, sometimes referred to as an EWP lift mast, is a versatile and effective tool used for repositioning conductors vertically or horizontally clear of the work area.

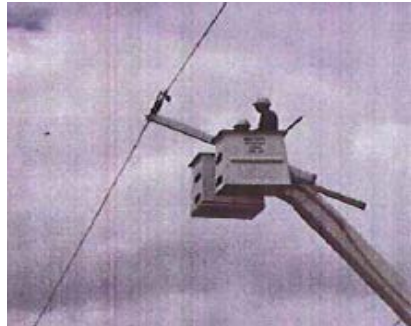
This allows for a clear work area so that the following can be replaced:

- Insulators and cross-arms.
- Poles (this could be a higher pole or a same-sized pole).

The gin pole can be used on multi and single conductor lifts (see Figures 1 and 2, below).



**Figure 1: Three conductors supported by a gin pole**



**Figure 2: Single conductor supported by a gin pole**

The EWP-mounted gin pole assembly consists of a mast complete with an auxiliary arm containing wire holders, arm braces and a boom mounting bracket. The gin pole components and their load ratings for EWP's must be operated within the manufacturer's SWL/WLL.



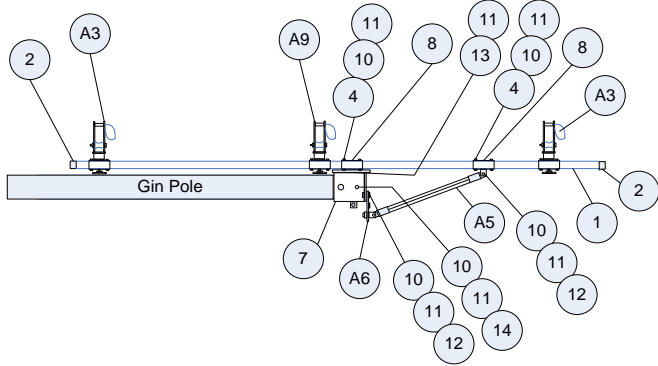
### Gin pole assembly (horizontal)

Assembly used to displace conductors horizontally. Figure 3 displays an example of a horizontal gin pole assembly, and Table 2 lists its components.



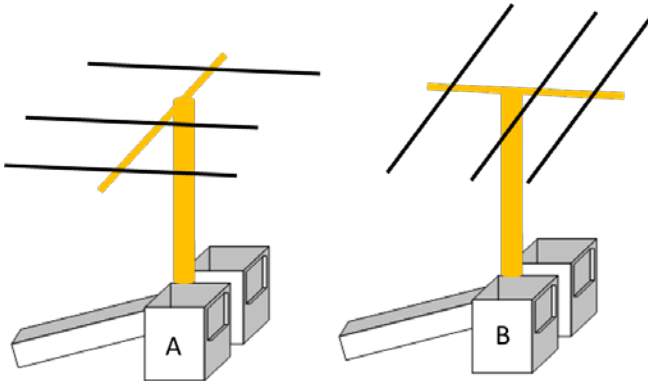
**Figure 3: Gin pole assembly (horizontal) on dual-bucket EWP**

Table 2: Gin pole components (horizontal)

			
No.	Description	Material	Qty
1	Stick, 0/Dia. 38 x 3050 LG.	Fibreglass	2
2	Cap, Protective, 1/Dia 38.	Rubber	4
A3	Conductor Retainer, Large, Outer, (Rotating) Assembly	Steel	2
4	Bracket, Clamping, Brace	Steel	1
A5	Brace, Support, C/W Swivel End	Fibreglass	1
A6	Adaptor Plate, Brace Securing	Steel	1
7	End Cap, Adaptor	Steel	1
8	Adaptor Plate	Steel	1
A9	Conductor Retainer, Large, Centre, (Rotating) Assembly	Steel	1
10	Nut, Hex, Ordinary, M12	Steel	8
11	Washer, Spring	Steel	10
12	Bolt, Hex, HD. M12 x 45 LG	Steel	3
13	Screw, Hex, HD. M12 x 25 LG.	Steel	2
14	Bolt, Hex, HD. M12 x 120 LG	Steel	1

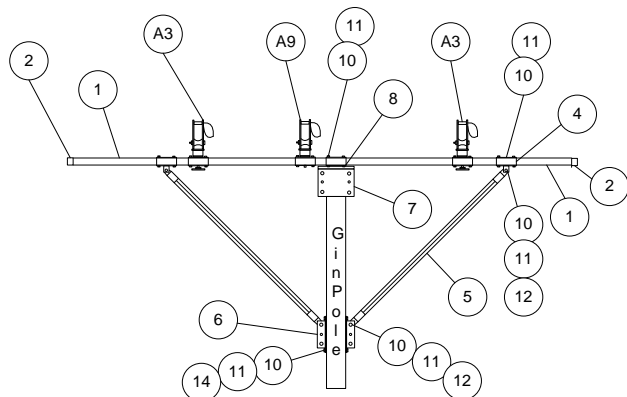
### Gin pole assembly (vertical)

A gin pole and auxiliary conductor support arm can be used to displace conductors vertically. The gin pole assembly and auxiliary conductor support arm can be used with the EWP at 180° (A) or 90° (B) to the conductors as shown in Figure 4. Gin pole components (vertical) are listed in Table 3.



**Figure 4: Gin pole assembly (vertical) on dual bucket EWP**

**Table 3: Gin pole components (vertical)**

 <p>The diagram illustrates a vertical gin pole assembly. A central vertical pole is labeled 'Gin Pole'. At the top, a horizontal stick (1) is supported by two large conductor retainers (A3) and a central one (A9). The retainers are secured with nuts (10) and washers (11). Support braces (5) are attached to the pole with brackets (6) and secured with bolts (14). End caps (7) and adaptor plates (8) are also shown. Various other components like clamping brackets (4) and additional nuts/washers/bolts (10, 11, 12) are labeled. The entire assembly is shown in a perspective view.</p>			
No.	Description	Material	Qty
1	Stick, 0/Dia. 38 x 3050 LG.	Fibreglass	2
2	Cap, Protective, 1/Dia 38.	Rubber	4
A3	Conductor Retainer, Large, Outer, (Rotating) Assembly	Steel	2
4	Bracket, Clamping, Brace	Steel	2
5	Support Brace	Fibreglass	2
6	Bracket, Securing, Brace	Steel	2
7	End Cap, Adaptor	Steel	1
8	Adaptor Plate	Steel	1
A9	Conductor Retainer, Large, Centre, (Rotating) Assembly	Steel	1
10	Nut, Hex, Ordinary, M12	Steel	13
11	Washer, Spring ( 1/Dia. 13)	Steel	14
12	Bolt, Hex, HD. M12 x 45 LG	Steel	4
13	Screw, Hex, HD. M12 x 25 LG.	Steel	2
14	Bolt, Hex, HD. M12 x 120 LG.	Steel	3

## Gin pole setup

- Carry out all preliminary safety and equipment checks.
- When using a gin pole, there are two options for positioning the EWP turntable:
  - Positioned vertically under the centre line of the powerline.
  - Positioned square (perpendicular) to the pole and swivel the cross-arm of the lift mast 90°.
- Fit the gin pole
  1. To adjust the length of the gin pole:
    - a. loosen the friction drive
    - b. extend or retract the gin pole to the desired length
    - c. tighten the friction drive and engage the locking pin.
  2. Assemble the cross-arm section, braces and wire holders on the gin pole (see Tables 2 and 3 for a diagram and components).

### Note:

The configuration, either horizontal or vertical, will depend on the job briefing and the structure that is being worked on.

3. Position the wire holders in the approximate positions of the conductors they will be supporting and ensure that the clearances between the phases comply with the phase-to-phase clearances. For more on this, see the following work practices in this manual:
  - 9.0 (Distribution insulated stick method)
  - 10.0 (Transmission insulated stick method).
- The SWL/WLL of a gin pole depends on three factors:
  - The angle of the gin pole from the horizontal plane.
  - The extension of the gin pole.
  - The height of the applied loading above ground.

See Tables 4–8 for the loadings for Abbey and BHB gin poles. For other makes of EWP gin pole, refer to the manufacturer's specifications.

**Table 4: Gin pole loadings all angles for BHB AEP 115 and 116**


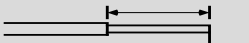
This table shows the loads relative to extension alpha settings and mast angle.

Gin pole angle from horizontal	Gin pole extension position									Gin pole angle from horizontal
	A	A-B	B	B-C	C	C-D	D	D-E	E	

for vertical lift	Gin pole loadings all angles (kg)									for horizontal push/pull
0°	745	617	543	490	460	417	398	363	340	90°
10°	745	630	554	499	463	426	408	376	350	80°
20°	745	699	585	528	485	454	417	398	367	70°
30°	745	745	649	571	522	485	454	422	399	60°
40°	745	745	745	699	617	545	508	481	454	50°
50°	754	754	754	754	726	635	585	544	745	40°
60°	745	745	745	745	745	745	745	745	745	30°
70°	745	745	745	745	745	745	745	745	745	20°
80°	745	745	745	745	745	745	745	745	745	10°
90°	745	745	745	745	745	745	745	745	745	0°

**Table 5: Applied loadings above ground for BHB AEP 115 and 116**

This table shows arm extension distances (alpha settings) and SWLs/WLLs.

	A	A-B	B	B-C	C	C-D	D	D-E	E
Arm extension (alpha setting)									
	757	909	1062	1214	1367	1519	1672	1824	1977
Arm extension (mm)									
Maximum SWL/WLL (kg)	745	617	543	490	460	417	398	363	340

**Table 6: Gin pole loadings all angles for ABBEY SK 2240/57 and ABBEY SW 1000/16**

This table shows the load relative to extension alpha settings and mast angle.

Gin pole angle	Gin pole extension position								
	A	A-B	B	B-C	C	C-D	D	D-E	E

from horizontal	Vertically applied loads All unit position (in kN & kg)								
0°	7.30kN	5.87kN	5.33kN	4.89kN	4.51kN	4.19kN	3.91kN	3.66kN	3.44kN
	744kg	599kg	544kg	499kg	460kg	427kg	399kg	373kg	351kg
10°	7.30kN	5.95kN	5.41kN	4.96kN	4.58kN	4.25kN	3.96kN	3.71kN	3.50kN
	744kg	607kg	552kg	506kg	467kg	433kg	404kg	378kg	357kg
20°	7.30kN	6.22kN	5.65kN	5.18kN	4.78kN	4.44kN	4.15kN	3.89kN	3.66kN
	744kg	634kg	576kg	528kg	487kg	453kg	423kg	397kg	373kg
30°	7.30kN	6.71kN	6.10kN	5.60kN	5.17kN	4.80kN	4.48kN	4.20kN	3.96kN
	744kg	684kg	622kg	571kg	527kg	489kg	457kg	428kg	404kg
40°	7.30kN	7.30kN	6.84kN	6.28kN	5.80kN	5.39kN	5.04kN	4.72kN	4.45kN
	744kg	744kg	697kg	640kg	591kg	550kg	514kg	481kg	454kg
50°	7.30kN	7.30kN	7.30kN	7.30kN	6.83kN	6.36kN	5.94kN	5.58kN	5.25kN
	744kg	744kg	744kg	744kg	696kg	649kg	606kg	569kg	535kg
60°	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.05kN	6.65kN
	744kg	744kg	744kg	744kg	744kg	744kg	744kg	719kg	678kg
70°	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN
	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg
80°	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN
	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg
90°	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN	7.30kN
	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg	744kg

Gin pole angle from horizontal	Gin pole extension position								
	A	A-B	B	B-C	C	C-D	D	D-E	E
	Vertically applied loads All unit position (in kN & kg)								
0° to 90° inclusive	Horizontally applied push/pull loads (kN/kg) Load application height: 8m to 12 m only Top jib angles from horizontal: -10° to +10° only								
	4.42kN	4.42kN	4.42kN	4.42kN	4.42kN	4.42kN	4.42kN	4.42kN	4.42kN
	451kg	451kg	451kg	451kg	451kg	451kg	451kg	451kg	451kg

**Table 7: Applied loadings above ground for Abbey SK 2240/57 and Abbey SW 1000/16**

Gin pole – Maximum SWL/WLL at index min (A) to max (E) distances shown		
kg	mm	Indicator position
745	1270	A
545	1575	B
455	1880	C
400	2185	D
340	2490	E

**Note:**

The Nifty Lift NL185K – MH gin pole has a rated capacity of 750kg at any angle and length.



**Table 8: Applied loadings above ground for ABBEY SW 600/19**

Gin pole – Maximum SWL/WLL at index min (A) to max (E) distances shown		
kg	mm	Indicator position
350	1270	A
295	1575	B
205	1880	C
150	2185	D
90	2490	E

### Aichi sub-boom and winch assembly

An EWP-mounted Aichi sub-boom and winch assembly can be used to hold an auxiliary arm and mast so that multiple conductors can be repositioned vertically. This allows for a clear work area so that the following can be replaced:

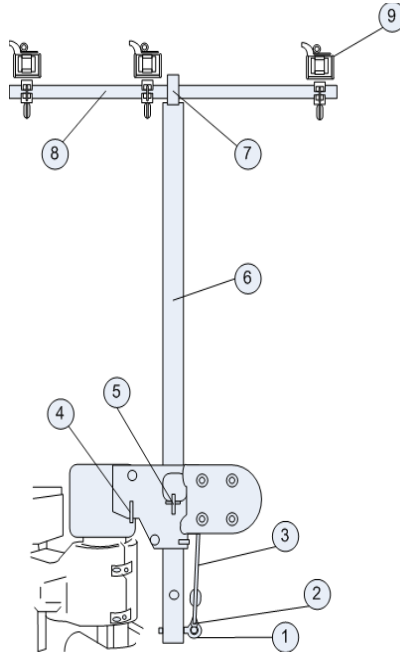
- Insulators and cross-arms.
- Poles (this could be a higher pole or a same-sized pole).

The auxiliary arm and the conductor traps are assembled on the top of the sub-boom and are used to trap the conductors. The winch then lifts the sub-boom up to displace the conductors to height required. See Figure 5 for an example and Table 9 for a list of components.



**Figure 5: Aichi sub-boom and winch assembly supporting multiple conductors via an auxiliary arm and mast**

**Table 9: Aichi SN 15 auxiliary arm and mast assembly components**



No.	Description	Material	Qty
1	Eye-nut	Steel	1
2	Shackle	Steel	1
3	Winch rope		1
4	Winch bracket set pin	Steel	1
5	Sub-boom set pin	Steel	1
6	Sub-boom	Epoxiglass	1
7	Sub-boom cross-arm head	Steel	1
8	Temporary cross-arm	Epoxiglass	1
9	Guide roller	Steel and Epoxiglass	3

### Safety

The following safety rules must be followed when using the Aichi sub-boom and winch assembly.

- The maximum conductor weight that can be lifted with this assembly is 175kg.
- This must only be used on intermediate structures (alignment) or in-between horizontally configured structures.
- The main boom must not be used to lift the conductors. The sub-boom is used to lift conductors. The winch operates the sub-boom.
- The main boom must be extended to the required length, indicated on the boom extension, to attain and maintain the full insulation value of the EWP.

### Aichi setup

1. Carry out all preliminary safety and equipment checks.
2. Set up the EWP on a firm and level surface and then lower the basket to the ground.
3. Pull out the winch bracket set pin, raise the winch bracket fully and then insert the winch bracket set pin again to lock the winch bracket.
4. Insert the sub-boom into the winch bracket and then lock the sub-boom to the winch bracket with the sub-boom set pin.
5. Replace the sub-boom winch head with the sub-boom cross-arm head and secure with a bolt.
6. Install the temporary cross-arm onto the sub-boom cross-arm head and then install the guide rollers.
7. Unwind the winch rope, remove the hook from the winch rope, install the eye-nut on the tail end of the sub-boom and then connect the winch rope to the eye-nut using the shackle.
8. Remove the winch bracket set pin, raise the sub-boom fully to set it vertically and then lock the winch bracket with the winch bracket set pin again.
9. Reverse the above setup process to stow the temporary cross-arm and the sub-boom.

### Angle bridle (SWL/WLL 300kg)

This support fitting is fitted to a gin pole for single conductor support at angle points in the powerline. An example is shown in Figure 6, below. The fitting has traps for the conductor.



**Figure 6: Angle bridle**

### Angle bridle setup

- Carry out all preliminary safety and equipment checks.
- Set up the EWP on a firm and level surface and then lower the basket to the ground.

### Insulator replacement method

1. Position EWP in line with bi-section of angle.
2. Fit bridle and guard to gin pole.
3. Push conductor each side of angle clamp.
4. Release conductor from insulator and move away to allow insulator to be changed.
5. Reattach conductor to new insulator.

### Pole replacement method

1. Position new pole close to old pole.
2. Push conductor each side of angle clamp then loosen bolts and clamps.
3. Release conductor from insulator and slew to new pole, moving clamp along.
4. Reattach conductor to new insulator then tighten bolts and clamps.

### Bull wheel (SWL/WLL 2000kg)

This support fitting is fitted to a gin pole for single conductor support at angle points in the powerline. An example is shown in Figure 7, below. The fitting has traps for the conductor and can be used in the horizontal or vertical plane.



**Figure 7: Bull wheel**

#### Bull wheel setup

- Carry out all preliminary safety and equipment checks.
- Set up the EWP on a firm and level surface and then lower the basket to the ground.

#### Insulator change method

1. Position EWP in line with bi-section of angle.
2. Fit bull wheel to gin pole.
3. Push conductor on one side of angle clamp.
4. Release conductor from insulator and move away to allow insulator to be changed out.
5. Reattach conductor to insulator.

#### Pole replacement method

1. Position new pole close to old pole.
2. Push conductor to release tension, loosen bolts and clamps.
3. Release conductor from insulator and slew to new pole then move clamp along.
4. Reattach conductor to new insulator then tighten bolts and clamps.

## Conductor support attachments – EWP and crane-mounted

Of the nine attachments described in this work practice, one is applicable to both EWPs and cranes. This is outlined below.

### Hastings boom-mounted auxiliary arm and mast assembly

The Hastings boom-mounted auxiliary arm and mast assembly can be used to lift single-phase or three-phase live conductors. See Figures 8 and 9 for examples and Table 10 for a list of components. This attachment is for common use with either EWPs or cranes. It is designed for vertical lift only.

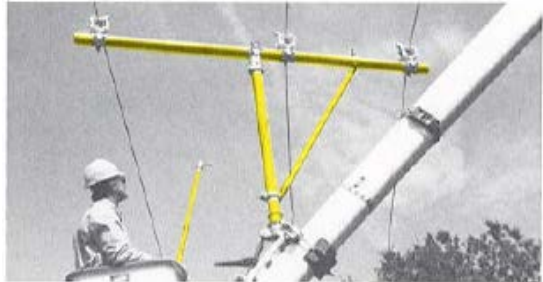
The Hastings attachment can be used for poles, cross-arms and insulator change out, including lifting conductors at mid span. The lift arm can be mounted to the boom. The boom mounting assembly features a ratchet which allows the auxiliary arm to be positioned under load from a 0° to 45° angle.

#### Position

The mast must be positioned perpendicular to the conductors being lifted. The ratchet is used to position the mast. The mast can be rotated to position the conductor traps by removing the locking pin at the bottom of the mast.



**Figure 8: Single conductor supported by a Hastings boom-mounted auxiliary arm and mast assembly (EWP-mounted)**



**Figure 9: Three conductors supported by a Hastings boom-mounted auxiliary arm and mast assembly (EWP-mounted)**

### Safety

The following safety rules must be followed when using the Hastings boom-mounted auxiliary arm and mast assembly.

- Conductors must be lifted vertically only. Slewing is not permitted.
- The attachment mast must be fixed to the centre of the lifting arm at all times.
- The SWL/WLL for this assembly, when EWP-mounted is:
  - for a single-conductor lift:
    - attachment at 130kg, basket at 125kg
    - or
    - attachment at 95kg, basket at 150kg.
  - for a three-conductor lift:
    - attachment at 153kg, basket at 100kg
    - or
    - attachment at 105kg, basket at 125kg.
- When mounted on an EWP, the general practice is to have only one HV live worker in the basket. If another HV live worker is required (e.g. three-phase lift), that person must be positioned on a ladder (insulated stick method only) or in another EWP. This is to maintain the allowable load combinations.

#### Note:

The allowable load combinations above are based on the following EWP models:

- Abbey SW 500/40.
- GMJ T16-3505.
- BHB AEP16.
- Nifty Lift 160 RKT.

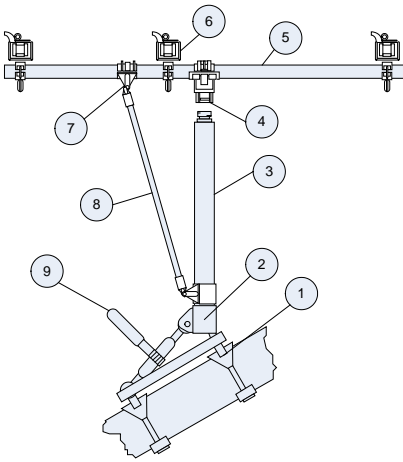
For other models, consult the EWP manufacturer.

### Important

While the boom bracket is attached to the EWP:

- the EWP must be treated as **uninsulated**
- glove and barrier work **must not** be performed from the EWP
- stick work may be performed from the EWP bucket.

**Table 10: Hastings boom-mounted auxiliary arm and mast assembly components**

			
No.	Description	Material	Qty
1	Boom bracket	Steel	1
2	Pivot stud and locking pin	Steel	1
3	Mast	Epoxiglass	1
4	Swivel support	Steel	1
5	Arm assembly	Epoxiglass	1
6	Wire holder	Steel	3
7	Brace clamp	Steel	1
8	Brace	Epoxiglass	1
9	Ratchet	Steel	1



### Hastings setup

1. Carry out all preliminary safety and equipment checks.
2. Set up the EWP/crane on a firm and level surface then lower the boom to the ground.
3. Install the boom bracket assembly as close as possible to the basket with the ratchet facing the basket.
4. Adjust the screws until the boom bracket fits snugly under the boom. Tighten all four tail nuts uniformly until the base assembly is clamped firmly onto the boom.
5. Attach the mast by sliding it onto the pivot stud. Place the locking pin through this to stabilise the mast.
6. Place the swivel support assembly on the adaptor casting at the top of the mast.
7. Install the lifting arm assembly on the swivel support.
8. Install the brace and the brace clamp, ensuring the brace clamp snugly fits onto the arm.
9. Tighten the swivel support assembly, ensuring that the clamp snugly fits the arms.
10. Place the wire holders on the cross-arm in the desired locations. If using the stick method, mount the clamp so that the eye nut is toward the HV live worker's position for possible later adjustment with an insulating stick.
11. Rotate the lifting arm to be at a right angle to the conductors.
12. The Hastings boom mounted auxiliary arm and bracket must be removed immediately after use and not left on the EWP

### Conductor support attachments and lifting beams – crane-mounted only

Of the nine attachments described in this work practice, four are applicable to cranes only. These are outlined below.

#### Chance boom-mounted auxiliary arm and mast assembly

The Chance boom-mounted auxiliary arm and mast assembly may only be mounted on cranes. The maximum mechanical rating of the beam is 450kg however this needs to be de-rated in accordance with the wire holders and epoxy insulators being used. The maximum vertical loading of the roller wire holders is only 90kg so this will reduce the maximum balanced loading to 270kg. If epoxy insulators are used they only have a vertical loading of 68kg so the maximum

balanced loading will be reduced to only 200kg. See Figure 10 for an example and Table 11 for a list of components.



**Figure 10: Chance boom assembly supporting multiple flat configuration conductors via an auxiliary arm on a crane**

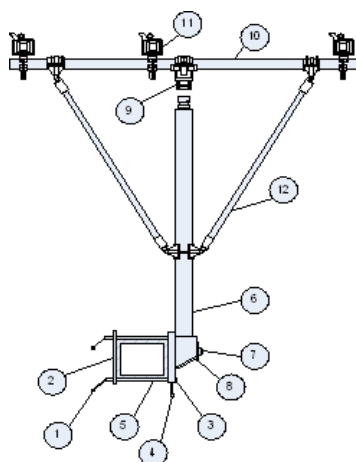
### Safety

The following safety rules must be followed when using the Chance boom-mounted auxiliary arm and mast assembly.

- Do not attempt to use this mast and arm assembly on EWP's.
- Must only be used on derrick-strength boom arms designed to handle 900kg or more. If boom units with lesser ratings are used, the lifting and maneuvering application of this unit must be reduced.
- The brace pole assembly may be installed either parallel or perpendicular to the crane boom, but must be kept as near parallel to the auxiliary arm as possible.
- The single wire holder is used for heavier conductors and is installed in place of the cross-arm clamp assembly. This fitting is preferred when handling only one conductor.
- Conductors must only be lifted vertically. The lifting beam must be kept in a vertical position.
- Must only be used on intermediate structures.
- Keep the mast as near as possible to vertical while holding up the conductors. Avoid slewing the conductors to the side to create, for example, line angles that may tip the boom unit.
- The lifting arm must be at a right angle to the conductors.

### Chance boom-mounted auxiliary arm and mast assembly setup

1. Carry out all preliminary safety and equipment checks.
2. Set up crane on a firm and level surface then lower the boom to the ground.
3. Remove the two bottom tail nuts to allow back up channels to be swung aside and place the entire base assembly over the boom section.
4. Reinsert the assembly by securing through bolts into the proper holes in the back up channels, depending on boom depth, then install washers and tail nuts.
5. Adjust the eye screws until the clamping angle fits snugly under the boom. Tighten all four tail nuts uniformly until the base assembly is clamped firmly onto the boom.
6. Attach the mast by sliding it onto the pivot stud, then the following parts in order:
  - a. Plain washer.
  - b. Lock washer.
  - c. Second plain washer.
  - d. Special wing nut.
7. Tilt the mast to the desired working position and tighten the special wing nut, with the tooth pattern in mesh, until the lock washer is fully compressed.
8. Place the arm clamp assembly on the adaptor casting at the top of the mast.
9. Install the cross-arm in the clamp and secure with the eyebolt. Strength ratings are based on the cross-arm being gripped at the centre.
10. Place the wire holders on the cross-arm in the desired locations. If using the stick method, mount the clamp so that the eye nut is toward the HV live worker's position for possible later adjustment with an insulating stick.
11. After use, remove the bracket.

**Table 11: Chance boom-mounted auxiliary arm and mast assembly components**

No.	Description	Material	Qty
1	Bottom tail nuts	Steel	4
2	Back up channels	Steel	1
3	Bottom thru bolts	Steel	4
4	Eye screw	Steel	1
5	Clamping angle	Steel	2
6	Epoxiglass mast	Epoxiglass	1
7	Pivot stud	Steel	1
8	Wing nut	Steel	1
9	Arm clamp assembly	Steel	1
10	Cross-arm	Epoxiglass	1
11	Wire holders	Epoxiglass and steel	3
12	Brace pole assembly	Epoxiglass	2

### Lifting beams

#### Components

The following additional insulation equipment, rated and tested to 33kV, is required to support the conductors when using a lifting beam (see Figure 11, below).

- Mobile plant and equipment.
- Attachments above the beam:
  - 2 x 1 tonne (minimum) web sling (the preferred angle is normally 60°, although this must be checked on the manufacturers name plate as in Figure 12)
  - and**
  - 2 insulators rated and tested to the voltage being worked on (tested and tagged at six month maximum intervals)
  - or**
  - 2 strain link sticks suitably rated for the load (tested and tagged at six month maximum intervals).
- Attachments below the beam:
  - 5 sets – brackets and bolts 70kN.
  - 3 D-shackles 70kN.
  - 3 sets – gates 70kN.
  - Suitable rollers.
  - One of the following:
    - 3 polymeric insulators rated and tested to the voltage being worked on (tested and tagged at six month maximum intervals)
  - or**
  - 3 strain link sticks (tested and tagged at six month maximum intervals)
  - or**
  - a suitable combination of insulator and strain link sticks.



**Figure 11: Typical lifting beam**



**Figure 12: Manufacturer plate on lifting beam**

### Lifting beam setup

1. Carry out all preliminary safety and equipment checks.
2. Attach the lifting beam (set up as in Figure 11 and the 'Components' section, above) to the crane hook and extend the crane boom out and above the HV conductors. Maintain MADs from the crane boom.
3. Lower the boom to place all three conductors into the polymeric insulators or strain link sticks approximately half a hard cover distance along the conductors from the pin.
4. Raise the lifting beam vertically to take the conductor weight.
5. Unlash all phases and double cover any phase that may drop alongside the pin and cross-arm. The angle of the cross-arm or pole may determine which phase will be unlashed first.
6. With all phases secured in the polymeric insulators or strain link sticks so that they cannot dislodge, raise the boom to provide personnel with the MAD that is suitable for the voltage present.

### Custom made lifting beams with SWL/WLL indicated

Lifting beams may be custom made for use with HV live work, but must be:

- engineered and tested for the purpose of meeting the rated SWL/WLL
- have the SWL/WLL stamped/labelled on the beam
- used with insulators rated to both the voltage and the SWL/WLL being worked when lifting live conductors. For an example, see Figures 13 and 14, below.



**Figures 13 and 14: Conductor support using custom made lifting beam made for Western Power**

### Sling with insulators/link sticks

The following support assembly, rated and tested from 6.6kV to 33kV, may be used for lifting and supporting a conductor. For an example, see Figure 15, below.



**Figure 15: Single conductor support assembly**

The following equipment is required when lifting a single conductor:

- 2 suitable web slings.
- 1 string with two sets of:
  - 33kV rated and tested polymeric insulator (tested at six month intervals)**or**
  - strain link sticks.
- Suitable shackle.
- Suitable gates.

### **Sling with insulators/link sticks setup**

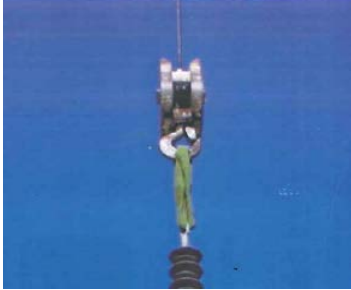
1. Carry out all preliminary safety and equipment checks.
2. Set up crane on a firm and level surface then lower the boom to the ground.
3. Locate the crane in a position so that the uninsulated portion of the crane maintains a minimum of 1.2m clearance from the conductor that it supports at all times, as shown in Figure 16, below.



**Figure 16: Position of the crane to the line**

4. Attach the insulator to the crane using the web sling as shown in Figure 17, below. Loop the web sling through the insulator and attach it to the crane. Lift the insulator using the crane. At the bottom of the insulator, attach the gate using suitable shackles, as shown in Figure 18, below.





**Figures 17 and 18: Conductor support assembly**

5. The gate is positioned around the conductor and securely fastened with a pin before the conductor is removed from the structure.

### References

- AS 5804.1-2010 High-voltage live working – General.
- AS 5804.2-2010 High-voltage live working – Glove and barrier work.
- AS 5804.3-2010 High-voltage live working – Stick work.
- High Voltage Live Work Manual, work practices:
  - 4.0 (Mobile plant and related equipment for HV live work)
  - 5.2 (Maintenance of EWP's and fitted hydraulic tools)
  - 9.0 (Distribution insulated stick method)
  - 10.0 (Transmission insulated stick method)

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### 5.0 Care and maintenance of equipment

#### Purpose

To provide the high voltage (HV) live worker with information and guidance on the minimum requirements for the care of HV live work equipment. Detailed information on specific equipment can be found in the following work practices in this section.

#### Background

The care and maintenance of HV live work tools and equipment is essential to performing safe HV live work.

HV live work equipment must:

- be designed, tested and approved specifically for work on live HV apparatus
- have an electrical and mechanical rating suitable for the intended use. This rating will be supplied by the manufacturer and must meet or exceed the relevant standards.
- be in a serviceable condition that is suitable for use. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- must have a unique identification number and be recorded in a documented equipment management system. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.

#### Note:

Composite insulators used for lifting are not supplied with a safe working load (SWL) or working load limit (WLL) rating by the manufacturer, so the SWL/WLL must be calculated. For more on this, see work practice 10.3 (Displacing conductors using crane and lifting beam – transmission stick method) in this manual.

#### Instructions

To ensure that the insulating and mechanical quality of HV live work equipment is not compromised, all HV live work equipment must be:

- maintained in a clean and dry condition
- laid on a tarpaulin, container or a rack at the worksite – not directly onto the ground
- kept clear of deteriorating contaminants, e.g. creams, sunscreens, paint solvents, hydraulic oils

- stowed and transported in a manner which ensures that the equipment is not exposed to excess moisture, dust, abrasion or any other deteriorating effects
- be visually inspected for mechanical and insulating properties prior to use and removed from service if it is defective or if the condition is in doubt
- periodically inspected
- cleaned regularly to remove any contamination
- tested as required by Western Power or a preferred supplier

### Items subjected to loading

All load bearing equipment must be:

- visually inspected prior to use for mechanical damage
- periodically inspected
- rated for an SWL/WLL and, wherever possible, have the SWL/WLL clearly identified on the device. The SWL/WLL of every load bearing device must be recorded in the equipment management system.

Inspections must ensure that the item will be capable of meeting its load limits. If any damage is present that will compromise the item's capacity to carry the load, it must be removed from service. Before the item can be returned to service, it must pass a proof test by a tester accredited by the National Association of Testing Authorities, Australia (NATA). The formula for a proof test and the SWL/WLL must be provided to the test lab.

Proof test = (SWL or WLL) x (2 x 9.81)

### Grouping of equipment of similar material

In this section of the manual, tools and equipment of similar material have been categorised, as shown in Table 1, below. This table is not extensive but is designed to provide an understanding of the types of equipment that make up each category.

**Table 1: Categories of equipment\***

Category	Equipment
Insulating sticks	Wire tongs Ratchet cutters, gripalls, wire holding stocks Universal hand sticks Pole platforms

Category	Equipment
Mechanical	Wire tong saddles Snubbing brackets Wheel tightener assemblies Accessories for universal hand sticks Pole platforms Lifting equipment
Flexible insulating barriers	Mats, hoses and connectors Gloves and sleeves
Rigid insulating barriers	Conductor covers, cross-arm covers, pole covers
Insulated bridging/jumper equipment	Temporary bypass equipment
Rope	Live work rope Insulated rope

\* Some equipment is included in multiple categories, e.g. pole platforms, as this has an insulating component and a mechanical component.

### References

- High Voltage Live Work Manual, work practices:
  - 5.1 (Equipment maintenance)
  - 10.3 (Displacing conductors using crane and lifting beam – transmission stick method)

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### 5.1 Equipment maintenance

#### Purpose

This work practice outlines how the high voltage (HV) live worker must ensure that HV live work tools and equipment are maintained in a serviceable condition and are suitable for use. The equipment maintenance process is based on *AS 5804 High-voltage live working* and involves:

- visual and periodic inspection
- care and maintenance
- testing
- storage and transportation of equipment and tools
- documentation and recording of information regarding equipment testing, inspection, cleaning, repair, service life and disposal.

#### Note:

Gloves and sleeves are classified as personal protective equipment and are covered in work practice 2.10 (Personal protective equipment (PPE) requirements) in this manual.

#### Background

The electrical and structural integrity of HV equipment and tools is critical to the safety of the HV live worker. Inspection, care, maintenance, testing and storage requirements must be strictly followed. Personnel must maintain HV live work equipment and ensure that it is in a serviceable condition.

Insulated equipment must be kept free from contamination so that it does not lose its dielectric insulating properties. Surfaces must be smooth, glossy or semi-glossy and water should bead on the surface when wet (hydrophobic) as shown in Figure 1, below.



**Figure 1: Good hydrophobic surface (left) and poor surface (right)**

**Note:**

Hydrophobic – a surface that is water-repellent and results in water beading on the surface. Streams allow tracking or electrical leakage to occur. As the leakage increases, so does the risk.

### Equipment management system

- Each item of HV live work equipment must have a unique identification number and be recorded in an equipment management system. The equipment management system must, as a minimum, record the following:
  - Owner and location (e.g. glove and barrier team A, Metro North).
  - Purchase date and manufacturer.
  - Type of equipment, identification number.
  - Specifications, size, working voltage, safe working load (SWL) or working load limit (WLL), safety factor. The SWL/WLL must be marked on load-bearing equipment.

**Note:**

The SWL/WLL must also identify what configuration it applies to, e.g. tension, compression, bending.

- Electrical testing – the standard tested to, due date and test date, tester and results.
  - Mechanical testing – the standard tested to, due date and test date, tester and results.
  - Date and details of maintenance or repairs, including who performed it.
  - Date, details and results of periodic inspections, including who performed it and whether it resulted in a pass or fail.
  - In service date, quarantine dates, disposal date.
  - Condition.
  - Other comments.
- The equipment management system must be used to ensure compliance with Western Power's specific requirements for the selection and purchasing of HV live equipment to be used on the network.
- The equipment management system is audited as part of the audit process. For more on this, see work practice 3.4 (Auditing and compliance) in this manual.



- The equipment management system and all equipment records must be made available to all members of the HV live work team.

### Instructions

These instructions are presented according to equipment type. However, the basic requirements that must be met for all equipment is summarised below.

- **Visual inspection** – All HV live work equipment must be visually inspected and cleaned prior to use each day.
- **Periodic inspection** – All HV live work equipment must undergo a periodic inspection every six months. A periodic inspection is a more detailed version of the visual inspection and must be recorded in the equipment management system.
- **Cleaning** – Maintaining the mechanical integrity, dielectric and hydrophobic properties of HV live work equipment is dependent on the care and maintenance that the equipment receives.
- **Testing:**
  - All HV live work insulating equipment must be subjected to a full electrical test at specified intervals to ensure that the insulating qualities of the equipment have not been reduced. The equipment must be tested by an approved HV testing provider to the relevant standard. The periodic testing intervals shown in Table 1, below, are the minimum requirement and are based on average usage. Heavy usage, or usage in adverse conditions, may require more frequent testing.
  - All testing and test results must be recorded in the equipment management system and be available for HV live workers.
  - The formal leader is responsible for ensuring that equipment tests are carried out to schedule by an external service provider, accredited to test to the referenced standards.
  - Equipment that has failed its periodic test must be repaired and retested (where permitted) or destroyed. All destroyed items must be recorded in the equipment register. The destruction must be carried out in a manner that does not allow the equipment to be reused.
  - Although mechanical testing is not a mandatory requirement, equipment can be sent to a National Association of Testing Authorities, Australia (NATA) accredited tester, if the structural integrity is in doubt.

**Table 1: Periodic testing intervals for HV live work tools**

Equipment		Testing interval	Reference standard
All insulated sticks	dry	12-monthly	AS 5804.3-2010
	wet	24-monthly	AS 5804.3-2010
Flexible insulated barriers	blankets	6-monthly	AS 5804.2-2010
	mats	6-monthly	AS 5804.2-2010
Insulated gloves and sleeves		6-monthly	AS 5804.2-2010
Conductor support equipment		12-monthly	AS 5804.2-2010 AS 5804.3-2010
Rigid insulated barriers		12-monthly	AS 5804.2 -2010 AS 5804.3-2010
Insulated EWP		6-monthly	AS 5804.2-2010 AS 5804.3-2010
Insulated EWP's basket liner		6-monthly	AS 5804.2-2010
Insulated hydraulic hose		6-monthly	AS 5804.2-2010
Insulated bridging/jumper equipment		6-monthly	AS 5804.3-2010
Insulated rope		6-monthly	AS 5804.3-2010

- **Storage and transportation of equipment and tools** – All HV live work equipment must be stowed and transported in a manner that ensures that the electrical insulating qualities and mechanical strength are not reduced or compromised. It may be necessary to dismantle HV live work tools to ensure that they can be transported in a secure manner. Storage compartments and containers must be well ventilated to protect against moisture, dust, excess humidity and condensation.

### Insulated sticks and support equipment

Insulated sticks are manufactured by winding glass fibre onto unicellular polyurethane foam core and are designed to withstand 100kV per 300mm for five minutes.

The insulating ability of the stick relies heavily on the dielectric and hydrophobic properties of the surface. During use, the surface of the insulated stick is subject to scratches, knocks, dirt and other contaminants that may cause a significant

reduction in the dielectric and hydrophobic properties of the stick. This is why it is important to conduct visual inspections prior to use.

During use, it is also possible for insulated sticks to be mechanically over stressed to the point that cracks appear in the wall of the fibreglass and fill with contaminants.

**Note:**

Insulated sticks must be wiped with a clean cloth and silicone applied prior to use and at any time they are exposed to moisture.

### Visual inspection

Insulated sticks must be visually inspected prior to use.

- Look for signs of overstressing, which are evidenced by distorted or cracked parts.
- Check metal parts for excessive wear and other visible damage.
- Inspect the stick's surface along the entire length for deep cuts, scratches, nicks, gouges, dents, delamination, water damage, loss of gloss, tracking and flashover damage.
- Check the hydrophobic qualities of the insulated stick.
- Check that the insulated stick is within its electrical test date.
- Check the hand guard that is used to determine the minimum approach distance (MAD). This must be suitable for the voltage to be worked on.

### Periodic inspection

All insulated sticks must undergo a periodic inspection every six months. A periodic inspection is a more detailed version of the visual inspection and must be recorded in the equipment management system. The additional details to check for during a periodic inspection are listed below.

#### Hydrophobic surface

- To check the hydrophobic properties of an insulated stick:
  - wipe down with a clean cloth
  - apply silicone
  - spray with clean water
  - observe the appearance of the stick. If it does not have a glossy appearance and the water does not bead on the surface (as shown in Figure 1) then the stick must be further cleaned and/or treated with wax until a good hydrophobic surface has been achieved.

- If an insulated stick cannot be cleaned or treated to a point where the surface is glossy with good hydrophobic characteristics, it must pass both wet and dry electrical testing before being returned to service. For examples, see Figures 2 and 3, below.



**Figure 2: Structurally damaged stick with hole (top left) must be destroyed. Scratched stick with very poor surface (top centre) must be removed from service and repaired or destroyed. Example of good hydrophobic surface (top right). Stick surface (bottom) must be glossy and clean.**



**Figure 3: Flashover damaged (left) and badly scratched (right) sticks must be removed from service and repaired or destroyed.**

### MAD clearance marker and hand guard

- The MAD clearance marker and hand guard must be positioned a minimum of 450mm from the live end of the insulated stick. For an example of a hand guard, see Figure 4, below.
- If both ends of the insulated stick are to be used, two markers and hand guards must be used.

#### **Note:**

Prior to starting work, check the clearance marker and hand guard to ensure that the correct MAD is indicated for the voltage to be worked on.



**Figure 4: MAD clearance marker and hand guard**

### Cleaning

To ensure that insulated sticks maintain their insulating quality they must be cleaned regularly with an approved cleaning product to remove any contamination. For examples, see Figure 5, below.



**Figure 5: (Clockwise from left) insulated stick wipes, general purpose cleaner, epoxy refinish kit, silicone cloth and non-metallic pads**

#### **Note:**

Only cleaning agents and surface treatments approved by the manufacturer or Western Power may be used.

### Light contamination

- For light contamination, a silicone treated wiping cloth can be used to wipe down the insulated sticks prior to the daily visual inspection. Disposable wipes and a silicone spray can also be used. The silicone impregnated cloth will remove light dirt and dust and will also leave a fine silicone film on the surface of the insulated stick. This helps maintain the hydrophobic and dielectric properties of the insulated stick.

## Medium contamination

- If contamination or marks on the insulated stick cannot be removed by with a silicone cloth, a special insulated stick cleaner wipe must be used. The insulated stick cleaner wipes also leave a fine silicone film on the surface of the insulated stick.

## Heavy contamination

- When contamination cannot be removed by a silicone cloth or by insulated stick cleaner wipes, an all-purpose cleaner from the insulated stick manufacturer must be used.
- This cleaner must be applied with a clean, soft cloth or sponge. If the contaminants cannot be removed with the cloth or sponge, a non-metallic cleaning pad can be used.
- Heavier cleaning with general purpose cleaning fluid and/or non-metallic pads will need to be followed by a surface treatment with fibreglass wax. This must be high grade Carnuba wax (see Figure 6, below). Waxing must only be applied to insulated sticks that have been satisfactorily cleaned. Hydrophobic testing must be carried out after waxing.



**Figure 6: Insulated stick wax**

- If an insulated stick cannot be cleaned or treated to a point where the surface is glossy with good hydrophobic characteristics, it must be tagged out, removed from service and either destroyed or sent for restoration by a competent service provider. The insulated stick must also pass both wet and dry electrical testing before being returned to service.

## Refinishing surfaces

- After extended periods of use, insulated sticks may show signs of wear such as nicks, scratches, scrapes, and general exposure that wiping with a silicone cloth or cleaning agent cannot remove. Rather than discard these insulated sticks, they may be restored by a competent service provider specialising in insulated stick testing and repair.
- After being refinished, the insulating stick must pass both wet and dry electrical testing before being returned to service. This can usually be done by the same company that does the refinishing.

- All details of refinishing and testing must be recorded in the equipment management system.

### Testing

- Before sending an insulated stick for testing, perform the following steps. This must be done to avoid electrical flashover and stick damage during testing.
  - Clean thoroughly.
  - Wax to ensure that the surface has good dielectric and hydrophobic properties.
- Insulated sticks are tested as follows, in accordance with *AS 5804.3-2010 High-voltage live working – Stick work*:
  - **Dry** – 75kV AC per 300mm of stick.
  - **Wet** – 75kV AC per 300mm of stick.

See Table 1 for frequency of testing.

- Insulated sticks must satisfy the test criterion of *ASTM F711 Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools* and there must be no excessive leakage current over the entire length of the stick. Test failures and flashovers normally occur when leakage current is at 200µA or more.
- Interim testing between electrical tests may be undertaken with handheld devices such as the one shown in Figure 7, below. Several insulated stick manufacturers have suitable insulated stick testers available. The manufacturer's instructions for testing must be followed.
- Insulated stick testers can be used to carry out interim dry and wet testing but use a lower voltage than the 75kV AC required for the electrical testing. The leakage current is amplified to give the same results as when using full voltage. In terms of acceptable leakage current there is a safety factor of approximately 4:1 as the maximum allowable leakage current is 75µA.



**Figure 7: Insulated stick tester**

**Note:**

If any physical damage to the surface is reported, the stick must undergo a full wet electrical leakage test. The interim testing must never be used as a substitute for electrical testing by a professional test facility.

**Storage**

To prevent damage caused by surface abrasion, sticks must be stowed and transported on racks or in holders which secure the sticks to avoid movement between the fibreglass surface of the stick and other surfaces. All sticks must be:

- stowed and transported in a manner that ensures that the equipment is not exposed to excess moisture, dust, abrasion or any other deteriorating effects (see Figure 8, below)
- kept clean of deteriorating contaminants, e.g. creams, sunscreens, paint solvents and hydraulic oils
- laid on a rack (see Figure 9, below) or tarpaulin when onsite.



**Figure 8: Depot and vehicle storage for insulated sticks**



**Figure 9: Portable insulated stick stands**



### Mechanical and metallic equipment

#### Visual inspection

- All mechanical and metallic equipment such as saddles, clamps, cutters and trunnions must be visually inspected prior to use and checked for mechanical damage and signs of:
  - cracking, fatigue, loose parts and excessive wear
  - corrosion, distortion and heat stress
  - physical stress, bending and other visible damage.
- Ensure that all moving parts are free running.
- All load bearing equipment must be rated for an SWL/WLL and, wherever possible, have the SWL/WLL clearly identified on the device. The SWL/WLL of every load bearing device must be recorded in the equipment management system.

#### Periodic inspection

All equipment must undergo a periodic inspection every six months. A periodic inspection looks at the same things as a visual inspection but is done in a very meticulous manner and must be recorded in the equipment management system.

##### **Note:**

All periodical inspections of load bearing equipment must be carried out by a dogger.

#### Cleaning

- All metallic HV live work tools and equipment must have their moving parts and threads checked to ensure that they are free of contaminants.
- Wipe off any contaminants or water using a clean cloth.
- Ensure that cutter heads are free of metallic fragments and residue.

#### Testing

- There are no testing requirements for mechanical and metallic equipment as the visual and periodic inspections are deemed sufficient.
- If the structural integrity of equipment is found to be suspect through inspection, the equipment must be:
  - send to a NATA-accredited testing service to undergo structural examination and testing **or**
  - removed from service, destroyed and replaced with a new item.

### Storage

- All metallic equipment must be stowed and transported in compartments or containers that are moisture proof and designed to ensure that they cannot contact and damage any adjacent equipment. For an example, see Figure 10, below.
- All metallic equipment with moving parts must be stowed in such a way as to minimise dust or other contaminants that could affect the moving parts.



**Figure 10: Example of good storage of mechanical and metallic equipment**

### Insulated barriers

#### Visual inspection – flexible and rigid

Insulated barriers must be inspected prior to use (see Figure 11, below, for an example). All barriers must be cleaned and inspected over the entire surface and checked for:

- chemical damage – discolouration
- electrical damage – arcing and tracking
- mechanical damage – cracking, abrasions, cuts, tears (including corona cutting)
- contamination – dirt, grease, silicon and other pollutants.



**Figure 11: Visually inspecting the inside of a flexible barrier**

### **Periodic inspection – flexible and rigid**

All flexible and rigid barriers must undergo a periodic inspection every six months. A periodic inspection is a more detailed version of the visual inspection and must be recorded in the equipment management system. The additional details to check for during a periodic inspection are listed below.

#### Flexible barriers

- The surface of all flexible barriers and blankets must be smooth and free of damage in order to maintain their rated level of insulation. For examples of damage, see Figure 12, below.



**Cuts and mechanical damage**



**Abrasions and scratches**



**Cracking**



**Rope damage**



**Chemical damage**



**Electrical tracking**

**Figure 12: Visual inspection of flexible barriers**

- Flexible barriers must be roll tested by rolling the surface gently between the fingers or hands to expose defects and embedded materials.
- Mechanical damage such as abrasions, scratches and cuts can only be identified by close inspection of the entire surface.
- Rope burns can be identified by an indentation in the barrier and signs that the surface of the barrier material has been worn away.
- Chemical damage can be identified by bulging or blistering of the surface. The area around the chemical damage may also feel soft, sticky or rough in texture.
- Electrical damage will usually result in electrical tracking but may also result in small holes or arc flashes across a large surface area.

### Rigid barriers

- The surface of all rigid barriers must be free of holes and cracks in order to maintain their rated level of insulation.
- Rigid barriers are particularly prone to damage where:
  - they interface with insulators and tie wires
  - locking and clamping pins are used to secure the barrier
  - barriers have pre-formed joints for connection with other barriers.

## **Cleaning**

### Flexible insulated barriers

- All flexible insulated barriers must be wiped clean and inspected prior to use. Flexible insulating barriers must be kept clear of grease, oils or any personal oil-based creams or substances. For examples, see Figure 13, below.
  1. Only use products approved by the manufacturer.
  2. Dispense a small amount of cleaning product onto a rag and then use the rag to wipe HV live work equipment.
    - Do not dilute cleaning products in water or allow cleaning products to be directly poured into wash trough.
    - Dirty rags and HV cleaning wipes must be disposed of in designated waste bins.
  3. Rinse with clean water to remove the cleaning product residue. This can be done in a wash trough.
  4. Position to allow drying away from direct sunlight and heat. High temperature environments (i.e. over 65°C) must be avoided.

5. Once cleaned and dry, the flexible insulated barriers and blankets should have a smooth, glossy to semi-glossy appearance.
6. Apply a manufacturer-approved powder to all surfaces after cleaning.

### Important

- Cleaning product must only be applied to a rag or wipe and never used directly in a wash trough. The wash trough must only be used to rinse.
- Cleaning products for HV rubber goods are not quick break which means our oil/water separators may not be able to separate the oil/grease and water before it is discharged.



**Figure 13: Inspecting and cleaning flexible line hose and blankets**

### Rigid insulated barriers

- All rigid insulated barriers must be wiped clean and inspected prior to use. Rigid insulating barriers must be kept clear of grease, oils and any oil-based creams or substances.
- The surface of all rigid insulating barriers must be smooth and free of damage in order to maintain the correct rated level of insulation.
- Wash with a specifically designed cleaning agent (as recommended by the manufacturer), thoroughly rinse with clean water and position to allow drying in the air away from direct UV light. High temperature environments (i.e. over 65°C) must be avoided.
- Once cleaned and dry, the rigid insulated barriers and blankets should have a smooth, glossy to semi-glossy appearance.

### **Note:**

All insulated barriers must be washed at least once a week when in use or more often if required.

## Testing

### Flexible insulated barriers

- Flexible insulated barriers are tested:
  - to their rated voltage
  - in accordance with AS 5804.2-2010 (see Table 1, above).
- The relationship between class, rated voltage and maximum working voltage is outlined in Table 2, below.
  - Rated voltage is the voltage stated by the manufacturer.
  - Working voltage is the maximum phase-to-phase voltage for which the equipment can be used and is generally less than the rated voltage as safety factor is applied.
  - As a safety factor, Western Power requires that the maximum working voltage be 5kV less than the rated voltage.

**Table 2: Rated and maximum working voltages for Class 3 and 4 flexible insulated equipment**

Class	Rated voltage (kV)	Working voltage (kV)
3	30	25
4	40	35

- All flexible insulated equipment has its class clearly marked on it. Western Power only permits Class 3 and Class 4 to be used on the network for HV live work.

### Rigid insulated equipment

- Rigid insulated barriers must be visually inspected and cleaned thoroughly before being sent for testing.
- Rigid insulated barriers must be tested to their rated voltage and in accordance with the relevant testing standards.

## Repair

Flexible and rigid barriers must not be repaired and barriers deemed to be unserviceable must be destroyed and the equipment management system updated accordingly.

### Storage

All insulated barriers must be stored where they are not exposed to UV light. See Figure 14 for an example of a storage method.

#### Flexible insulated equipment

- Blankets – insulated blankets must be stowed and transported either flat or rolled up in blanket rolls or canisters. Do not stow in a folded, creased or compressed manner or with any overhang from a shelf. Talcum powder must be applied to all flexible barriers and blankets if stowed for long periods.
- Other flexible barriers – insulated line hoses, connectors and flexible covers must be stowed in a manner that will ensure that they are not distorted or subjected to mechanical stress. Items such as line hose can be stowed in horizontal racks or upright in storage bins. All storage containment must be free of sharp edges and bare metal that could scratch or damage the surface.

#### Rigid insulated barriers

- Rigid barriers must be stowed and transported in a manner that ensures that they are not distorted or subjected to mechanical stress. Barriers can be stowed in horizontal racks or upright in storage bins. All storage areas must be free of sharp edges and bare metal that could scratch or damage the surface.



**Figure 14: Example of a flexible and rigid barrier storage method**

### Rope

#### **Visual inspection – insulating rope and live work rope**

- The visual inspection must check for:
  - contaminants and moisture
  - excessive wear

- abrasions and broken fibres
- flattening
- powdered fibres inside the strands
- other chemical, electrical and physical damage.
- Rope must be cleaned of contaminants and moisture prior to use. For more on this, see the 'Cleaning' section, below.
- Rope must not be laid out on the ground. It must be kept in clean dry containers or placed on tarps to protect against contaminants.
- Damaged and unserviceable ropes must be immediately removed from service and destroyed. The equipment management system must be updated accordingly.

### Important

Ropes used for HV live work must not be used for any other purpose.

### Periodic inspection – insulating rope and live work rope

All rope must undergo a periodic inspection every six months. A periodic inspection looks at the same things as a visual inspection but is done in a very meticulous manner and must be recorded in the equipment management system.

Insulated rope's most used ends must be removed to minimise possible contamination and deterioration.

### Cleaning

#### Live work rope

- Contaminants and moisture must be wiped clean with an absorbent cloth.

#### Insulating rope

- Contaminants and moisture must be wiped clean with an absorbent cloth before wiping with a silicone-impregnated cloth over the entire length.

### Testing

#### Insulating rope

- Insulated rope must be tested in accordance with *ASTM F1701 - 12 Standard Specification for Unused Rope with Special Electrical Properties* before being placed in service. Insulating rope must be tested a minimum of every six months after being placed in service (see Table 1, above). Heavy usage may require testing at more frequent intervals.



- All electrical testing of insulating rope must be recorded in the equipment management system.
- Interim electrical tests with an approved field rope tester must be carried out:
  - at six-monthly intervals (alternating with periodical electrical testing)
  - over at least three sections (a minimum of 5m in length)
  - if insulated rope is suspected of contamination or damage.

### Live work rope

- Must be electrically tested prior to being placed in service in accordance with *ASTM F1701 - 12 Standard Specification for Unused Rope with Special Electrical Properties*. There are no requirements for ongoing periodic electrical testing.

### **Storage – insulating rope and live work rope**

- All live work rope and insulating rope must be stowed and transported in a manner which prevents damage from sharp objects, batteries, chemical and acid fumes.
- Rope must be stowed and transported in a sealed container with a moisture-depleting medium.
- Rope must be stored and transported in a dry environment where the rope is not exposed to contamination or direct sunlight.
- During field work, ropes should be taken and returned directly from their container. If this cannot be achieved, the rope must be kept clean and free from contaminants by storing and using them on clean, dry tarpaulins.

For more on this, see work practice 6.8 (Live work rope and insulated rope) in this manual.

## **Insulated bridging/jumper equipment**

### **Visual inspection**

- All insulated bridging/jumper equipment must be wiped clean and inspected prior to use.
- Insulators must be visually inspected and checked for good hydrophobic surfaces and signs of damage, cracks and/or electrical tracking.
- Inspections must look for cuts, gouges and signs of deterioration in the insulation and also signs of mechanical stress and damage. For more on this, see the 'Mechanical and metallic equipment' section, above.

- The rating of the insulated cable must be stamped on the cable every 1.2m and must be visible.
- All points of electrical contact must be checked for their electrical security and to ensure that the threads on the clamps run freely.

### Periodic inspection

Insulated bridging/jumper equipment must undergo a periodic inspection every six months. A periodic inspection looks at the same things as a visual inspection but is done in a very meticulous manner and must be recorded in the equipment management system.

### Cleaning

- All insulated bridging/jumper equipment must be wiped clean and inspected prior to use and kept free of dirt, grease, oils and any personal oil-based creams or substances.
- All points of electrical contact must be clean.
- Wash with an approved cleaning agent, thoroughly rinse with clean water and position to allow air drying out of direct sunlight.

### Testing

- Insulated bridging/jumper equipment must be tested every six months in accordance with *AS 5804.3-2010 High-voltage live working – Stick work*.

### Storage

Insulated bridging/jumper equipment must be stowed in a manner that ensures that they:

- are not distorted or subjected to mechanical stress
- cannot be damaged by exposure to oil-based substances or chemicals.

### Fall arrest systems and lanyards

For more on the inspection, care and maintenance of fall arrest systems and lanyards, see work practice 2.7 (Fall arrest systems and pole tope rescue kits) in the Work Practice Manual.

### References

- AS 5804.1-2010 High-voltage live working - General.
- AS 5804.2-2010 High-voltage live working - Glove and barrier work.
- AS 5804.3-2010 High-voltage live working - Stick work.
- ASTM F170 -12 Standard Specification for Unused Rope with Special Electrical Properties.
- ASTM F711-02 (2013) Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.
- High Voltage Live Work Manual, work practices:
  - 2.10 (Personal protective equipment (PPE) requirements)
  - 3.4 (Auditing, compliance and field assessment)
  - 6.8 (Live work rope and insulated rope).
- Work Practice Manual, work practice:
  - 2.7 (Fall arrest systems and pole tope rescue kits)

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### 5.2 Maintenance of EWP and fitted hydraulic tools

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on elevated work platform (EWP) and fitted hydraulic tools:

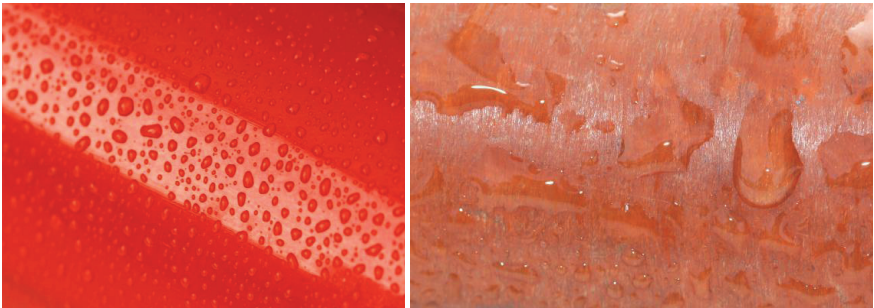
- insulation
- care and maintenance
- inspection requirements
- testing requirements

#### Background

EWPs are a critical part of the equipment necessary to safely carry out HV live work. The insulated sections of the EWP form part of the two levels of insulation for HV live workers using the glove and barrier method.

During normal operating conditions and periods of non-use, dust and condensation can cause a pasty film on the inner and outer surfaces of the boom. Some dust has a metallic base and can become conductive and corrosive. This can seriously degrade the insulation properties of the EWP and may make it unsafe for HV live work.

When the boom surface areas are contaminated, water tends to pool or sheet off rather than beading up (for an example, see Figure 1, below). This pooling or sheeting of water on contaminated booms can prevent the booms from meeting the required electrical standards and pose a potential hazard in the field.



**Figure 1: Good hydrophobic surface (left) and poor hydrophobic surface with water pooling/sheeting (right)**

## Instructions

### Elevated Work Platforms

#### Visual inspection

##### Prior to use

- All insulating components must be washed, cleaned and inspected for signs of cracking or deterioration. For more on washing and cleaning, see the Fleet Services presentation, *Boom washing procedure prior to electrical testing*, (DM# 12646707).
- Damage must be identified and repaired before moisture penetration can occur.
  - If the resin coating is damaged by dragging conductors, falling tools or tree branches, it may allow water to penetrate through the cracked or crazed resin causing the fibreglass to lose its structural strength and electrical resistance.
  - Damaged fibreglass must be repaired to prevent water getting into the glass fibres. Water ingress can weaken the structure mechanically and impair the electrical insulation.
- Insulating sections must be inspected for signs of:
  - bulges in the fibreglass
  - cuts, chips or flakes, cracks or crazing in the resin coating
  - grooves, grazes, bruises, holes
  - burn marks, aluminium marks
- The tray of the vehicle must be kept clear of debris and line hardware.
- The turret controls must be accessible from the boom in all positions.

#### **Note:**

Ensure that non-insulated hoses are disconnected to create a minimum 800 mm gap across the insulated section of the boom.

##### Weekly

The following must be checked at least once a week for damage:

- Fibreglass covers that protect greasing points.
- Covers that protect the basket swivelling mechanisms.
- Mounting points for any lifting devices that may be attached to the basket.  
When the lifting jib is not installed, a nylon plug must be placed in the housing

for the lifting jib to prevent any energised conductors or loops entering the housing. The base of the mounting for the jib must also have a permanent nylon plug installed.

- Any covers which protect hydraulic hose connections must be intact.
- All hydraulic connections must be checked for oil leaks.

### Cleaning

The insulation properties of fibreglass booms deteriorate with the accumulation of dirt, grease, tree sap and other contaminants. These contaminants must be removed by cleaning.

- Only use approved cleaning products. For more on this, see the *Approved cleaning products* section, below.
- **Do not use** abrasive materials or products such as steel wool, wire bushes and Ajax as they will scratch the gel coat surface and destroy the surface gloss and its hydrophobic properties.
- Booms and baskets must be washed at least every six weeks to retain their hydrophobic properties.
- High pressure water cleaning units must not be used on the insulated sections of EWP's. Water and/or detergent may enter the fibreglass through small fissures in the gel coat, possibly degrading the structural integrity and insulating characteristics of the boom. Only use mains pressure hoses to wash EWP booms.

For more on EWP washing and cleaning, see the Fleet Services presentation, *Boom washing procedure prior to electrical testing*.

#### Approved cleaning products

EWP's may only be cleaned using products that are approved by Western Power or the EWP manufacturer. The following cleaning products are examples of those that are approved for cleaning EWP's (for examples, see Figure 2, below):

- Multi-Purpose D-10 Degreaser (Industrial Chemical Technologies)
- Boom Wash Concentrate (American Polywater Corporation)
- Fibreglass Buffing Compound (Boatcare)
- Live Line Tool Clean and Wax Wipe and Buffing Wipe (American Polywater Corporation)
- Hot Stick Cleaner and Water Repellant (American Polywater Corporation)



Figure 2: Approved cleaning products

## Testing

- All insulated EWPs used in HV live work must be electrically tested:
  - before being placed into service
  - before being returned to service (e.g. after modification or repair)
  - if they are suspected of being damaged
  - periodically – at least every six months

### Note:

The six-monthly frequency for periodic testing is a minimum based on normal use. Heavy use and/or visual inspections may determine that more frequent testing is warranted.

A grace period of 21 days is permitted as stated in AS 1418.10:2011 - *Cranes, hoists and winches - Mobile elevating work platforms*.



- EWP's must be submitted for testing in a clean condition.
- All testing, including periodic testing, must:
  - meet the requirements of *AS 1418.10:2011 - Cranes, hoists and winches - Mobile elevating work platforms*
  - prove the insulating qualities of the booms, basket liner, hydraulic circuits and detachable hydraulic tool hoses. Failure to do so may expose HV live workers, ground crew and the general public to increased risks from insulation failure step and touch potential and also network outages caused by flashovers.
- A current test compliance label and test certificate must be affixed in a prominent position in the vehicle to indicate that the EWP has passed the required tests. The label must also indicate the due date for the next test.

### Storage

All HV live work equipment must be stowed and transported in a manner that ensures that the electrical insulating qualities and mechanical strength are not reduced or compromised. It may be necessary to dismantle HV live work tools to ensure that they can be transported in a secure manner.

Storage compartments and containers must be well ventilated to protect against moisture, dust, excess humidity and condensation. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.

### Hydraulic tools

Hydraulic tools are subject to the requirements of:

- *AS 1418.10:2011 Cranes, hoists and winches - Mobile elevating work platforms*
- *ANSI/SIA A92.2 - 2009 Vehicle-Mounted Elevating and Rotating Aerial Devices*

These standards include the following requirements:

- Hoses connected to hydraulic tools must be made of an insulating material. For more on this, see the *Hydraulic hoses* section, below.
- Do not mix hydraulic fluid types. To reduce the risk of contamination, hydraulic equipment and tools must be assigned to a specific vehicle and must not be interchanged between vehicles.
- The system hydraulic fluid pressure and flow rates from the EWP must match the system requirements of the hydraulic tools being used, according to the manufacturer's specifications.

- The hydraulic hoses connecting the hydraulic tool to the EWP outlet must be made of an approved electrically insulating type and must be at least one metre long, but no more than three metres long.

### Hydraulic hoses

- Hydraulic hoses must meet the following category requirements provided in AS 3791-1991 *Hydraulic hose*:
  - electrical performance (category 100R6)
  - rupture performance (category 100R7)
- All hydraulic hoses must meet the anticipated working pressure requirements.
- All permanently fixed hoses must be installed by an approved hydraulic fitter.
- Do not mix hydraulic fluid types. To reduce the risk of contamination, hydraulic equipment and tools must be assigned to a specific vehicle and must not be interchanged between vehicles.
- Vacuum exclusion valves must be fitted to the hydraulic circuit of all EWPs with a reach greater than 11 m.
- Do not use fire-resistant hydraulic fluids, as most are water-based (i.e. conductive).
- Inspect hydraulic hoses prior to use and clean them with an appropriate solvent that does not leave a residue on the hose.
- Hydraulic hoses must be inspected for defects at least every six months.
- If any hydraulic fluid is spilled while using hydraulic tools, use an oil spill kit to clean up the spill before the tool is used again. For more on this, see work practice 11.7 (Oil and chemical spills) in the *Work Practice Manual*.

### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance)
- Fleet Services presentation, Boom washing procedure prior to electrical testing (DM# 12646707)
- Work Practice Manual, work practice 11.7 (Oil and chemical spills)
- ANSI/SIA A92.2 - 2009 Vehicle-Mounted Elevating and Rotating Aerial Devices
- AS 1418.10:2011 Cranes, hoists and winches - Mobile elevating work platforms
- AS 3791:1991 Hydraulic hose

### 6.0 Tools and equipment

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on the selection and use of tools and equipment. This section covers:

- insulated barriers
- insulated hand sticks
- conductor support and strain equipment
- accessories
- bridging
- live work rope and insulated rope.

#### Instructions

Only approved tools and equipment are permitted for HV live work on the Western Power Network. New tools must only be implemented after:

- testing the procedure and the tool in a de-energised situation
- submitting the procedure and the tool or approval to an HV Live Line Work Group
- including the tool in this manual as a standard work technique
- appropriate training in the use of the tool and associated procedure.

#### Important

Experimenting with new tools and/or improvising is **not** permitted during HV live work.

All tools and equipment must:

- have a unique identification number and be recorded in a documented equipment management system. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- be inspected, cleaned, tested, stored and transported in accordance with work practice 5.1 (Equipment maintenance) in this manual
- only used within the limits set by the manufacturer and for the purpose for which the manufacturer intended, such as:
  - safe working load (SWL) or working load limit (WLL)
  - voltage rating.

### SWL/WLL

All load-bearing equipment must be clearly marked with its SWL/WLL. If this is not already marked on the equipment by the manufacturer:

1. obtain the equipment's SWL/WLL from the manufacturer's data sheet or website
2. clearly mark the SWL/WLL on the equipment using one of the following:
  - stickers or tags – where the insulating integrity of the equipment will not be compromised
  - engraving – metal components only.

When using equipment with multiple load-bearing components, the SWL/WLL of all components must be taken into account.

Conductor support equipment may have multiple SWL/WLL values depending on whether the support arm is:

- braced or unbraced
- balanced or unbalanced.

#### Important

All load-bearing equipment must have the SWL/WLL clearly marked.

### Custom tools and equipment

In the case of in-house developed tools and equipment, they must only be used within their electrical and mechanical test limits and approved by the HV Live Line Work Group. For more on the following types of tools and equipment, refer to the relevant work practice in this section.

### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance)

6.1 Flexible insulating barriers

Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on flexible insulating barriers.

Instructions

Insulated barriers must be:

- used to cover all secondary points of contact
- rated for the voltage being worked on
- used within their electrical insulation rating
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual.
- overlapped when joining barriers and secured with blanket pegs. For more on this, see the ‘Overlapping flexible insulating barriers’ section, below.
- removed from service and destroyed if damaged and unserviceable.

Table 1: Working voltages for Class 3 and 4 insulating barriers

Class	Rated voltage (kV)	Working voltage (kV)
3	30	25
4	40	35

Overlapping flexible insulating barriers

Where multiple insulating barriers are used, they must be overlapped to ensure that there are no gaps between the barriers. Some barriers, such as flexible line hose, can be securely connected together using grooved interlocks or special couplers like the flexible line hose couplers. Other barriers without any means of interlocking must have a minimum overlap of 150mm.

Locking pins, cable ties or blanket pegs must be used to secure the barrier where there is no other means of restraint.

Types of flexible insulating barriers

The following are the flexible insulating barriers that are approved for use on the Western Power Network.

### Insulated flat slotted blanket

Insulated flat slotted blankets are manufactured in a flat configuration, in a range of sizes and have a slot running from one side to the centre of the blanket. This slot allows for specific applications around odd shaped electrical apparatus. Insulated slotted blankets must be the appropriate rating for the voltage being worked on. Used with other flexible or ridged covers, insulated slotted blankets can provide excellent coverage of the line hardware.



### Insulated flat blanket

Insulated flat blankets are manufactured in a range of sizes and have eyelets around the edges used to secure the blanket in place. The blanket is effective in insulating bulky line hardware items such as isolators and disc insulator assemblies. Insulated flat blankets can be combined with other flexible or rigid covers to provide an excellent system of insulation.



### Flexible line hose

Flexible line hoses are manufactured in a variety of lengths and are mainly used to insulate conductors. These covers completely enclose the conductor, and can be joined together using a flexible line hose coupler to extend the length of insulation coverage. They are available with or without a fixed coupler end.



### Flexible line hose coupler

A flexible line hose coupler is used to join line hoses together when the hoses do not have a fixed connector end.



### Blanket peg

Blanket pegs must be used to secure insulating blankets in position. They can be wood or plastic and are available in a variety of sizes.



### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance).

## 6.2 Rigid insulating barriers

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on rigid insulating barriers.

### Instruction

Insulated barriers must be:

- used to cover all secondary points of contact
- rated for the voltage being worked on
- used within their electrical insulation rating
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual.
- overlapped when joining barriers. For more on this, see the 'Overlapping insulating barriers' section, below.
- removed from service and destroyed if damaged and unserviceable.

**Table 1: Working voltages for Class 3 and 4 insulating barriers**

Class	Rated voltage (kV)	Working voltage (kV)
3	30	25
4	40	35

### Overlapping rigid insulating barriers

Where multiple rigid insulating barriers are used, they must be overlapped to ensure that there are no gaps between barriers.

- Most rigid insulating barriers are designed to interlock together using special grooves or couplers.
- Where rigid insulating barriers are not equipped with couplers it may be necessary to use a combination of rigid and flexible barriers. Ensure that the flexible barriers overlap the rigid barriers by a minimum of 150mm.

### Types of rigid insulating barriers

The following are the rigid insulating barriers that are approved for use on the Western Power Network.

### Conductor covers

Conductor covers are manufactured in 1.5m lengths and are designed to insulate the conductors. They are available with or without a grip-all adaptor for installation using a grip-all stick. They are designed to interlock with other conductor covers of similar type and insulated covers to provide a system of insulation. These covers are suitable for use on 25kV and 36.6kV phase-to-phase systems.



### Insulator covers

Insulator covers are designed to insulate pin and post insulators, and can be interlocked with conductor covers. This cover is available in two heights:

- 150mm
- 225mm

Insulator covers can be fitted with a grip-all adaptor for installation using a grip-all stick. These covers are suitable for use on 25kV phase-to-phase systems.



### Dead end covers

Dead end covers are designed to insulate up to two disc insulators and conductor termination fittings. Locking pins and clamping pins can be used to secure this cover in position. Dead end covers must be rated for the voltage being worked on. This cover is suitable for use on 25kV phase-to-phase systems.





### Cross-arm covers

Cross-arm covers are designed to fit over a cross-arm and are slotted so that they can slide around the insulator pin just below the insulator. This provides protection against the tie wire contacting the cross-arm when tying or untying conductors, particularly when the tie is being applied or removed using insulating sticks. Cross-arm covers must be rated for the voltage being worked on. This cover is suitable for use on 25kV phase-to-phase systems.



### Pole covers

Pole covers are designed to insulate a section of pole and range from 0.3–1.8m in length. A number of pole covers can be interlocked to provide a larger area of insulation. This is particularly common during pole erection procedures. They are available in the following diameters:

- 225mm
- 300mm



### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance)

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### 6.3 Insulated hand sticks

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on insulated hand sticks.

#### Background

Insulated sticks have a unicellular polyurethane foam core encased in fibreglass. They are designed to withstand 100 kV per 300 mm for five minutes.

The fibreglass surface has dielectric and hydrophobic properties which contribute to the insulating attributes of the device. During use these attributes can be reduced by scratches, knocks, dirt and other contaminants. This is why it is important to conduct visual inspections prior to use.

During use, insulated sticks can become mechanically overstressed which can cause cracks to appear in the fibreglass and fill with contaminants.

#### Instructions

All insulated sticks must be:

- electrically tested in accordance with work practice 5.1 (Equipment maintenance) in this manual
- registered in the equipment management system
- cleaned and inspected for sound hydrophobic surface, dielectric insulation and mechanical wear or damage prior to use
- periodically inspected
- labelled with a safe working load (SWL) or working load limit (WLL)
- stored and transported in accordance with work practice 5.1 (Equipment maintenance) in this manual
- used within the minimum approach distances (MADs) appropriate to the voltage being worked on
- fitted with a clearance marker or hand guard that indicates the MAD or tool insulation distance
- be removed from service and tagged with an 'Out of service' warning tag if not in a suitable condition for use. In addition, the insulated stick:
  - must be quarantined from all other operation HV live work equipment and not returned to service unless it has been cleaned, inspected,

repaired/refurbished and tested. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.

- must be removed from service and destroyed if it is deemed unserviceable

### Types of insulated hand sticks

The following are the insulated hand sticks that are approved for use on the Western Power Network. The universal hand stick is outlined first, followed by the other types in alphabetical order.

#### Universal hand stick and spline anchorage

Universal hand sticks are available in a variety of lengths and are usually 32 mm or 40 mm in diameter. They are fitted with a spline fitting on either one or both ends for the attachment of a variety of tools and equipment.



#### Angle cog wrench

Angle cog wrenches are manufactured in three lengths, and are used to tighten or loosen nuts. The sticks have a ½" square drive to which sockets can be attached. One feature of the sticks is that the head is adjustable within a range of 140 degrees. A typical application is operating the nuts on suspension clamps, and the bolts of the trunnion clamps, on stand-off post insulators.



#### Grip-all clampstick (shotgun)

Grip-all clampsticks are manufactured in a range of lengths and configurations. They can be used where a sure grip is required, such as the installation and removal of insulating covers, jumpers and live line clamps. The two-action slide mechanism prevents the inadvertent release of the clamp or grip-all adaptor.



### Insulated handles

Insulated handles are designed for the easy attachment of pliers or wire cutters.



### Safety hand guard

A safety hand guard is fitted to an insulating stick to indicate the minimum length of insulation to be maintained between the operator's hand and the metal end of the stick. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.



### Tool hanger

Tool hangers are designed to provide a safe temporary parking location for insulating sticks at or near the working position. Tool hangers can be adjusted to suit cross-arms that are 90 mm to 115 mm in width.



### Wire holding stick

Wire holding sticks are manufactured in two lengths and are used to control conductor tails when forming, bending and positioning bridges. It can also be used for holding conductors during splicing operations. One feature of this stick is that the head fitting can be locked into three different positions to allow the conductor to be controlled from any angle.



### Wire ratchet cable cutters

Wire ratchet cable cutters are manufactured in two lengths and are available with interchangeable cutter heads to cater for aluminium, copper or aluminium



core steel reinforced (ACSR) conductor. To avoid bi-metal contamination, use the appropriate cutter head for the conductor. Cutter heads must be regularly cleaned.

The ratchet action provides a mechanical advantage of 18:1.

### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance)

### 6.4 Conductor support equipment

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on conductor support equipment.

#### Instructions

Conductor support equipment must:

- be used to control the conductor at all times to avoid inadvertent contact with secondary points of contact
- be recorded in the equipment management system
- only be used within the safe working load (SWL) or working load limit (WLL) of the manufacturer and for the purpose that the manufacturer intended
- only be used within their electrical insulation rating (where applicable)
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual.
- be removed from service and destroyed if damaged and unserviceable
- all insulated equipment must be electrically tested in accordance with work practice 5.1 (Equipment maintenance) in this manual.

Conductor support equipment must be selected to ensure that the:

- insulation length of the device is suitable to the voltage being worked on
- SWL/WLL is appropriate to the work being done and the loads applied
- usage is in accordance with manufacturer's recommendations.

The SWLs/WLLs listed in Tables 1 and 2 are based on the manufacturer's specifications for Chance<sup>®</sup> equipment and are only for use with the glove and barrier method and the distribution insulated stick method. For equipment other than Chance<sup>®</sup>, refer to the manufacturer's handbook.

Other than chains and slings used with cranes or other load bearing devices, there are no mechanical testing requirements for metal HV live work equipment (e.g. roller wire holder) as the visual and periodic inspections are deemed sufficient. However, if an inspection reveals that the structural integrity of equipment is suspect, the equipment must be sent to a testing service or removed from service. The testing service, accredited by the National Association of Testing Authorities (NATA), will structurally examine and test the equipment.

For more on this, see work practice 5.1 (Equipment maintenance) in this manual.

Table 1: SWLs/WLLs for wire tong applications

Support type	Assembly	Components	Maximum working load per conductor (kg)
Saddles lever lift	Wire tongs with saddles and wire tong block clamp on holding stick (see Figure 1)	Lift stick – 50mm x 3.66m Holding stick – 38mm x 3m	125
		Lift stick – 63mm x 3.66m Holding stick – 38mm x 3m	216
Saddles lever lift	Wire tong with saddles and swivel wire tong band on lift sticks (see Figure 2)	Lift stick – 50mm x 3.66m Holding stick – 38mm x 3m	125
		Lift stick – 63mm x 3.66m Holding stick – 38mm x 3m	216
Lever lift	Wire tongs, lever lift, link stick, and rope blocks used on heavy conductors (see Figure 3)	Lift stick – 50mm x 3.66m Holding stick – 38mm x 3m	159
		Lift stick – 63mm x 3.66m Holding stick – 38mm x 3m	454

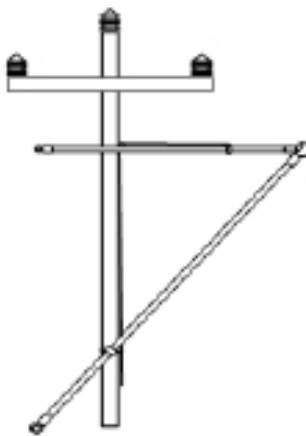


Figure 1: Wire tongs with saddles and wire tong block clamp on holding stick



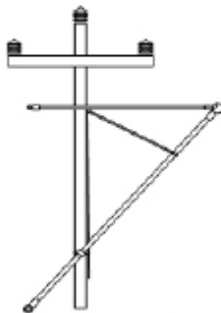


Figure 2: Wire tong with saddles and swivel wire tong band on lift sticks

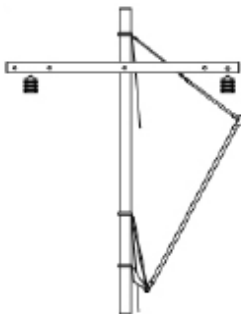


Figure 3: Wire tongs, lever lift, link stick, and rope blocks used on heavy conductors

Table 2: SWLs/WLLs for conductor support equipment

Support type	Description	Vertical load per wire holder (kg)	Maximum total load (kg)	Side load per wire holder (kg)
Cross-arm support* 1 wire holder	Temporary conductor support – arm mounted	68	68	45
Cross-arm support* 2 wire holder	Temporary conductor support – arm mounted	68	136	45
Temporary cross-arm 1 wire holder	Temporary conductor support – pole mounted	68	68	45

Support type	Description	Vertical load per wire holder (kg)	Maximum total load (kg)	Side load per wire holder (kg)
Temporary cross-arm 2 wire holder	Temporary conductor support – pole mounted	68	136	45

\* This item **must not** be attached to wooden cross-arms. It may only be attached to steel cross-arms.

## Types of conductor support equipment

The following are the items of conductor support equipment that are approved for use on the Western Power Network.

### C-type wire holder

C-type wire holders are fitted in the suspended position to support the conductor. It can be used in conjunction with the range of temporary conductor support equipment, auxiliary arms or extension arms.



### Cross-arm mounted extension arm

This extension arm is manufactured in a range of diameters and lengths. It is designed to attach to the end of a cross-arm to provide a temporary support for up to two conductors. It is ideal for providing a separation of the conductors (e.g. pole erection and recovery).



The SWLs/WLLs are:

- 25kg unbraced
- 68kg braced.

### Important

This item must not be attached to wooden cross-arms. It may only be attached to steel cross-arms.

### Epoxy insulator

Epoxy insulators are added to a wire holder when using temporary conductor support equipment on 22kV or 33kV systems to increase the insulation of the equipment. Refer to the manufacturer's specification for epoxy insulator requirements on 22kV or 33kV systems.



The SWLs/WLLs are:

- 68kg vertical load (either compression or tension)
- 45kg side load.

### Fork type wire holder

Fork type wire holders are fitted in the upright position to support the conductor. They can be used in conjunction with the range of temporary conductor support equipment, auxiliary arms or extension arms.



### Auxiliary arm

Auxiliary arms are used to support the conductors to allow for the replacement of pole-top hardware. Two 63mm wire tong saddles are used to mount the mast of the auxiliary arm to the pole. Two braces can be fitted to increase the SWL/WLL of the rig. The rubber glove arm can be mounted either above or below the conductors. Line deviation is not permitted when using this rig.



## Insulator cradle

Insulator cradles are used to support the string of insulators during insulator replacement. They are designed to:

- attach the string to the pole and the cradle to allow for individual insulators to be replaced
- or
- pivot at the pole to lower the insulator string to a vertical position for a complete string replacement.

The cradle is typically used at strain or flying angle constructions.



## Lever lift

Lever lifts are fitted to the pole using a chain tightener. The lever lift is attached to the butt ring of the wire tong by inserting a cotter pin. A tensioning device is then attached between the lever lift clevis and an anchor point higher up the structure. By operating the tensioning device, the lever lift raises or lowers the wire tong stick to move the conductor.



The SWLs/WLLs are:

- 360kg with extensions
- 450kg without extensions.

## Roller wire holder

Roller wire holders are fitted in the upright position on the cross-arm of the auxiliary arm and facilitate conductor movement. They are more commonly used in conjunction with the elevated work platform (EWP) boom-mounted auxiliary arm where it is necessary for the conductors to run freely.



## Rope snubbing bracket

Rope snubbing brackets are fitted to the pole using a chain tightener and are used as anchor points for ropes or tensioning devices.



### Temporary conductor support, pole-mounted

Temporary conductor supports, pole-mounted, are manufactured in two lengths (750mm and 1200mm) and are fitted to poles using a chain tightener or a ratchet strap. They are used to temporarily support conductors out of the immediate work area.

The SWLs/WLLs are 68 kg per wire holder, and:

- the 750mm arm is limited to 1 wire holder
- the 1200mm arm is limited to 2 wire holders.



### Wire tongs

Wire tongs are manufactured in a range of diameters and lengths. The most commonly used wire tongs used for working on distribution voltages are 38mm and 63mm.

Wire tongs are used in conjunction with lever lifts and/or wire tong saddles to support and move conductors. Each wire tong is fitted with adjustable jaws on one end and a butt swivel ring on the other.



### Wire tong band

Wire tong bands are attached to a wire tong down from the jaw. A tensioning device is attached between the band and an anchor point on the structure. This anchor point must be at a position that is horizontally higher than the band.

The distance must be adequate to provide the required insulation between the tensioning device and the conductor.



### Wire tong block clamp

Wire tong block clamps attach to a wire tong between the jaw and the wire tong saddle. A tensioning device is fitted between the band and the shackle of the wire tong saddle to assist in the control of the wire tong in heavy conductor applications.



### Wire tong saddle

Wire tong saddles are fitted to the pole using a chain tightener. A pole clamp is usually attached to the wire tong saddle to encase the wire tong. The pole clamp can be adjusted to allow the wire tong to slide through the clamp or to be held firm. Pole clamps are available to suit all diameter sizes of wire tongs.



Additional clearance from the pole or crossarm can be achieved by fitting a wire tong saddle extension between the saddle and the pole clamp. For more information on the use of this equipment, see the following work practices in this manual:

- 8.2 (Rigging conductor support equipment – glove and barrier method)
- 9.2 (Rigging conductor support equipment – distribution insulated stick method).

### Wire tong stirrup

Wire tong stirrups can be attached to any 63mm conductor support stick used on the horizontal to enable a 38mm wire tong to be attached for bracing purposes.



### References

- High Voltage Live Work Manual, work practices:
  - 5.1 (Equipment maintenance)
  - 8.2 (Rigging conductor support equipment – glove and barrier method)
  - 9.2 (Rigging conductor support equipment – distribution insulated stick method)

### 6.5 Conductor strain equipment

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on conductor strain equipment.

#### Instructions

Conductor strain equipment must:

- be used to control the conductor at all times and avoid inadvertent contact with secondary points of contact
- be recorded in the equipment management system
- only be used within the safe working load (SWL) or working load limit (WLL) of the manufacturer and for the purpose that the manufacturer intended
- only be used within their electrical insulation rating (where applicable)
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual.
- be removed from service and tagged with an out of service warning tag if in an unsuitable condition for use. The equipment must be quarantined from all other operation HV live work equipment and not returned to service unless it has been cleaned, inspected, repaired/refurbished and tested. Unserviceable equipment must be removed from service and destroyed.
- all insulated equipment must be electrically tested in accordance with work practice 5.1 (Equipment maintenance) in this manual.

Conduction strain equipment must be selected to ensure that the:

- insulation length of the device is suitable to the voltage being worked on
- SWL/WLL is appropriate to the work being done and loads applied

Specific conductor strain equipment, such as spiral link sticks, is available from several manufacturers in various models, lengths, diameters and with significantly different SWLs/ WLLs.

#### Important

The SWL/WLL must be clearly marked on all load bearing equipment used for HV live work.

## Types of conductor strain equipment

The following are the items of conductor strain equipment that are approved for use on the Western Power Network.

### Insulated link sticks

#### Note:

When using insulated link sticks, the tool's insulation distance is equal to the minimum approach distance (MAD). If it is anticipated that the insulated section of the stick will be breached while carrying out a task (e.g. tying and untying conductors) then the MAD marker will need to be moved to compensate for this breach. For example, if the tie wire breaches the insulation of the stick by 100mm while untying a conductor then the MAD from the end of the stick will need to be increased by 100mm to compensate for this distance. For more on this, see the following work practices in this manual:

- 8.0 (Glove and barrier method)
- 9.0 (Distribution insulated stick method)
- 10.0 (Transmission insulated stick method).

### Roller link stick

Roller link sticks are designed to spread and hold conductors apart, and slide along the conductor to the desired position.



### Spiral link stick

Spiral link sticks have a spiral fitting on one end and a ring fitting on the other. They are designed to insulate tensioning devices from anchor points or as an insulating medium. A grip-all ring is also fitted to the spiral end to facilitate easy application using a grip-all stick.



### Strain link stick

Strain link sticks are available in multiple lengths and are manufactured with a safety latch hook on one end and a ring on the other. They have similar applications to the spiral link sticks described above.





### Pulley block rope tackle

Pulley block rope tackles are used to provide mechanical assistance in situations where a tensioning device is required. The pulley block is manufactured from material that provides high dielectric qualities and so can be tested and rated.

The block assemblies must be fitted with safety hooks. The tackle must be reeved with polypropylene rope suitable for the sleeve diameter of the block.



### Strap hoist

Strap hoists are used to provide mechanical assistance in situations where a tensioning device is required. All components of the strap hoist, including the strap, must be treated as a conductor. Strap hoists are available with rings on all latches and control levers for stick method applications.



Only webbing models may be used for HV live work.

### Reference

- High Voltage Live Work Manual, work practices:
  - 5.1 (Equipment maintenance)
  - 8.0 (Glove and barrier method)
  - 9.0 (Distribution insulated stick method)
  - 10.0 (Transmission insulated stick method)

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### 6.6 Accessories

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information on HV live work accessories.

#### Instructions

Accessories must:

- only be used within the safe working load (SWL) or working load limit (WLL) of the manufacturer and for the purpose for which the manufacturer intended
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual
- be removed from service and sent for proof testing if visual inspection identifies mechanical damage, then destroyed if testing determines unserviceable recorded in the equipment management system

#### Types of accessories

The following are the items of accessories that are approved for use on the Western Power Network.

##### Note:

The accessories detailed below have a universal fitting to facilitate fitting to a universal insulated hand stick.

#### Aerosol can holder

Aerosol can holders secure an aerosol can to a universal stick and facilitates the application of lubricants. Non-conductive rope is attached to the holder to operate the aerosol can.



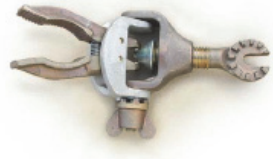
## Adjustable insulator fork

Adjustable insulator forks are designed to hold disc insulators when removing or replacing discs. It can be adjusted to suit the various size insulators by rotating the insulating stick. The tool is designed to clamp the insulator at the junction of the porcelain/glass shell and the socket cap.



## All-angle pliers

All-angle pliers are designed to grasp from any angle and are opened and closed by rotating the spline screw. The pliers are generally used as a holding device for loose hardware.



## Ball socket adjuster

Ball socket adjusters are used to control the tongue and clevis to facilitate the coupling of insulators to suspension clamps.



## Butt ring extension

Butt ring extensions are attached to the swivel end of a wire tong stick to allow for tensioning devices to be attached without damaging the stick.



## Chuck blank

Chuck blanks are used to attach nonstandard tools to the spline fitting end of an insulated stick.



## Clevis pin holder

Clevis pin holders are used for installing clevis pins and bolts.



### Conductor cleaning brushes

Conductor cleaning brushes are used to clean the conductors in readiness for completion of an electrical connection.



### Cotter key pusher

Cotter key pushers are used to remove 'W pins' from ball socket insulators. The straight end is used to push the pin out and the curved end is used to push the pin back into position.



### Cotter key holder (split pin holder)

Split pin holders are used to install split pins. This tool will hold the split pin in position for easy insertion into a clevis pin or bolt.



### Extension chains

Extension chains are used to lengthen the chain on chain tighteners to fit large diameter poles.



### Grip-all adaptor

Grip-all adaptors are designed to fit into the grip-all clamp stick to provide for the attachment of universal tools.



### Hack saw

Hack saws are used for cutting metal at various angles near live conductors.



### Hot rodder tool

Hot rodder tools are used for applying pre-formed attachments to conductors, e.g. armour rods, line splices.



### Locating pin

Locating pins are used as a drift for aligning bolt holes to assist in the insertion of bolts and clevis pins.



### Serviette ring

Serviette rings are used to apply preformed attachments to conductors in a similar manner to the hot rodder tool.



### Skinning knife

Skinning knives are used for cutting or scraping insulation from live conductors.



### Split pin puller

Split pin pullers are the principal tool used to remove split pins.



### Rotary blade

Rotary blades are used for removing tie wire from conductors that are secured to pin insulators.



### W-key replacement tool

W-key replacement tools are used for replacing the W-shaped key used in ball and socket insulators.



### References

- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance)

### 6.7 Bridging equipment

#### Purpose

The purpose of this work practice is to provide high voltage (HV) live workers with information and guidance on bridging equipment.

#### Instructions

Bridging equipment must:

- only be used within their electrical insulation and continuous current rating
- maintained in a serviceable condition and be suitable for use. For more on cleaning, inspection, testing, storage and transportation, see work practice 5.1 (Equipment maintenance) in this manual.
- be recorded in the equipment management system
- be removed from service and tagged with an 'Out of Service' warning tag if in an unsuitable condition for use. The equipment must be quarantined from all other operational HV live work equipment and not returned to service unless it has been cleaned, inspected, repaired/refurbished and tested. Unserviceable equipment must be removed from service and destroyed.

#### Types of bridging equipment

The items of bridging equipment that are approved for use on the Western Power Network are described below.

For more on the application of bridging equipment, see the following work practices in this manual:

- 8.4 (Energising/de-energising and bypassing conductors and apparatus – glove and barrier method)
- 9.3 (Energising/de-energising and bypassing conductors and apparatus – distribution insulated stick method).

#### Insulated hanger

The insulated hanger has a clamp on one end and a double stud fitting on the other. The tool is designed to attach to the conductor using either the insulated stick method or the glove and barrier method for the temporary parking of bypass jumper cables during energising/de-energising procedures.



Insulated temporary bypass jumper cables

There are two types of insulated temporary bypass jumper cables, outlined below:

- insulated glove and barrier jumper cables
- insulated jumper cable with duckbill clamps.

The current ratings that apply to both types of jumper cable are shown in Table 1, below.

Table 1: Temporary bypass jumper cables current ratings\*

		15kV	25kV	35kV
Cable size		Continuous current rating (Amps)		
AWG#	mm			
# 2	6.544	200		
1/0	8.251	260	260	260
2/0	9.266	300	300	
4/0	11.684	400		

\* This data is based on temporary bypass jumpers manufactured by Chance®. Other manufacturers will have different current ratings.

# American Wire Gauge.

Insulated glove and barrier jumper cables

Insulated glove and barrier jumper cables can be used to temporarily bypass permanent bridging. They can only be installed using the glove and barrier method. These insulated cables are available in 15kV, 25kV or 35kV and in four cable sizes (see Table 1, above).



Insulated jumper cable with duckbill clamps

Insulated jumper cables with duckbill clamps can be used to temporarily bypass permanent bridging. They can be installed and removed with a grip-all clamp stick or by hand using the glove and barrier method. These insulated cables are available in 15kV, 25kV or 35kV insulation and in four cable sizes (see Table 1, above).





### Temporary cut-out tool

Temporary cut-out tools provide fused protection during maintenance of HV live lines. The tools are designed to be attached using a grip-all stick but can also be attached using the glove and barrier method. They are primarily used during energising/de-energising techniques and for the replacement of permanent fuse units. These tools are available in various kV ratings and must be selected to match the system voltage being worked on.



### Tie back clamp

The tie back clamp is used to secure the tail of a bridge that has been disconnected onto the conductor under tension. It can be used with both the insulated stick method and the glove and barrier method.



### References

- High Voltage Live Work Manual, work practices:
  - 5.1 (Equipment maintenance)
  - 8.4 (Energising/de-energising and bypassing conductors and apparatus – glove and barrier method)
  - 9.3 (Energising/de-energising and bypassing conductors and apparatus – distribution insulated stick method)

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### 6.8 Live work rope and insulated rope

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on rope used for HV live work.

#### Background

- There are two types of rope used in HV live work:
  - **Live work rope** is not designed for contact with energised apparatus and must never be placed within the minimum approach distance (MAD). Live work rope has good insulating properties but is not manufactured to the same standards as insulated rope and is not subjected to the same rigorous testing and maintenance.
  - **Insulated rope** is specifically designed, manufactured, tested and maintained to ensure appropriate insulation to allow use within the MAD. Insulated rope must be routinely tested.
- Both live work rope and insulated rope must be visually inspected prior to use and stored in a clean and dry environment. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- Western Power only uses polypropylene rope for live work rope and insulating rope as it has good dielectric properties and is well suited to use in the electrical industry. The drawbacks of polypropylene are that it can be affected by environmental factors. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- Both live work rope and insulated rope must have a safety factor of at least 6.

#### Instructions

- Live work rope and insulating rope are important tools and the HV live worker must be aware of:
  - types of rope suitable for live work
  - limitations and uses of different types of rope
  - minimum standards required for live work and insulating rope
  - minimum sizes
  - safe working loads (SWLs) or working load limits (WLLs)
  - care, maintenance and storage requirements
  - testing requirements
  - inspection requirements

- effects of temperature and other environmental effects on rope.
- All rope used for HV live work must either be live work rope or insulated rope. Environmental conditions, such as rain, fog and humidity must be considered when using both live work rope and insulated rope as these factors can seriously reduce the rope's insulating properties. Damp or wet rope must never be used for HV live work.
- If rope is to be used on a capstan or pulley block, the size of the rope must be suitable for the sleeve diameter of the block. The capstan must be kept clean to avoid damaging or contaminating the rope.
- The SWL/WLL of the rope must be suitable for the load or force applied.

### Important

Ropes used for HV live work must not be used for any other purpose.

### Note:

Both live work rope and insulating rope must be maintained, inspected, tested and stored in accordance with work practice 5.1 (Equipment maintenance) in this manual.

### Live work rope

Live work rope must comply with one of the following:

- *AS 4142.2-1993 Fibre ropes – Three-strand hawser-laid and eight-strand plaited.*
- *ASTM F1701-12 Standard Specification for Unused Rope with Special Electrical Properties.*
- *CI-1301:2007 Polypropylene Fiber Rope 3-Strand And 8-Strand Constructions.*

Live work rope:

- is not designed for direct use with energised conductors
- must be used in series with other insulated tools or devices when attaching to live conductors or electrical apparatus
- must not be used within the MAD. If a risk assessment indicates a chance of the rope coming into contact with live conductors or electrical apparatus, additional insulated barriers or insulated rope must be used.
- is typically used as tackles, hauling lines and tag ropes

- must be kept clean and free of contaminants. Wherever possible, the rope should be taken from and returned directly to a container. If sealed, the container must have a moisture depleting agent. If this cannot be achieved, the rope should be laid out on clean and dry tarpaulins.

### Insulated rope

Insulated rope:

- must comply with *ASTM F1701-12 – Standard Specification for Unused Rope with Special Electrical Properties*
- must be electrically tested and comply to the above standard prior to being placed in service
- must be periodically tested a minimum of every six months (or more if frequently or heavily used)
- must be field tested between periodic testing
- must not be used for any other purpose and must be clearly identified and labelled as insulating rope. There must be no opportunity for conventional live work rope to be inadvertently mistaken for insulated rope.
- must be used wherever the work method indicates that the rope is likely to come into contact with energised conductors or electrical apparatus
- must be kept clean and free of contaminants to maintain its insulating qualities. Rope should be taken from, and returned directly to, a sealed container with a moisture depleting agent. If this cannot be achieved, the rope should be laid out on clean and dry tarpaulins.

### Cleaning, inspection, testing and storage – all rope

For instruction and information on the cleaning, inspection, testing and storage of all rope, see work practice 5.1 (Equipment maintenance) in this manual.

### SWL/WLL of rope

The HV live worker must give consideration to how the SWL or WLL of rope is reduced with increases in temperature. Table 1, below, shows how a 16mm rope is affected by temperature.

**Table 1: Temperature effect on 16 mm<sup>2</sup> rope**

Air temperature	Rope strength*	Rope SWL/WLL (kg)
23°C	100%	410
38°C	81%	332
52°C	70%	287

\* The percentage loss of strength may vary slightly according to manufacturer and size of rope but the above is a good indication of typical loss of strength with temperature increase.

### Calculating SWL/WLL of polypropylene rope

The SWL/WLL is the maximum working load or force that can be applied as defined by the rope manufacturer. To calculate the SWL/WLL we need to multiply the diameter<sup>2</sup> by a factor of 1.8.

$$\begin{aligned}
 \text{The SWL/WLL} &= 16\text{mm}^2 \times 1.8 \\
 &= 256 \times 1.8 \\
 &= \mathbf{460\text{kg}}
 \end{aligned}$$

The SWL/WLL of polypropylene rope is approximately six times less than the breaking strain.

#### **Note:**

If there is a knot on any working section of the rope, the SWL/WLL must be de-rated by a factor of 0.5.

### Using a block and tackle

If the load to be lifted is greater than the SWL/WLL of the rope, it may still be possible to safely lift the load using a block and tackle. This is because a block and tackle can provide a safer, more efficient way of lifting an object as the mechanical advantage between the pulleys reduces the load on the rope (also known as 'pull on the fall line').

There will be some efficiency loss as block and tackles are not 100% efficient due to friction. Well-maintained tackles have an efficiency loss of approximately 10%. Efficiency loss due to friction is also known as 'friction loss'.

The following calculation is used to determine the pull on the fall line.

$$\text{Pull on the fall line} = \frac{\text{Friction Loss} + Wt}{\text{No. of wheels}}$$

where:

$Wt$  = Weight of object

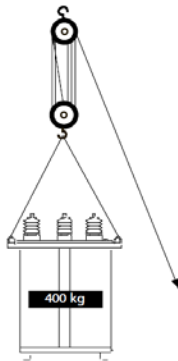
Friction Loss = No. of wheels (Efficiency Loss +  $Wt$ )

### Example

A 16mm polypropylene rope (with a SWL/WLL of 460kg, as determined in the earlier example, is being used to lift a **400kg** transformer with a **six** wheel pulley block and tackle (as shown in Figure 1) that has an efficiency loss of **10%**.

The pull on the fall line is determined using the following calculation:

The mechanical advantage of using the block and tackle means that the pull on the fall line (i.e. the load on the rope) is 107kg, which is well within the rope's SWL/WLL of 460kg.



**Figure 1: Example of load on block and tackle**

### References

- AS 4142.1 1993 – Fibre Ropes - Care and usage.
- AS 4142.2-1993 Fibre Ropes - Three-strand hawser-laid and eight strand plaited.
- ASTM F1701-12 Standard Specification for Unused Rope with Special Electrical Properties

- CI 1301:2007 Polypropylene Fiber Rope 3-strand And 8-strand Constructions.
- High Voltage Live Work Manual, work practice 5.1 (Equipment maintenance).



### 7.0 Conductors and insulators

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on:

- conductors:
  - conductors and conductor types
  - deterioration of conductors and conductor assessment
  - conductor weight and tension loadings for commonly maintained constructions, conductor sizes, and span lengths
  - mechanical load limitations
  - conductor preparation prior to the installation of connectors or taps
- insulators

#### Risk management

In order to properly manage the risks associated with working with conductors and insulators, HV live workers require an understanding of:

- the types of conductor used in Western Power's Network
- the characteristics, risks load, and other limitations associated with each type of conductor
- the types of insulators used in Western Power's Network
- the characteristics, limitations, inspection, and test requirements associated with each type of insulator

#### Risks associated with mechanical loads

Small movements can significantly alter the weights and forces applied to conductors and HV live equipment. Calculations must be completed to ensure that equipment is only used within the rated safe working load (SWL) or working load limit (WLL) and that the movement of conductors is always controlled.

Information on assessing conductor loading can found throughout many of the work practices in this section. The calculated loadings are stated in kilograms to allow simple application of the SWL/WLL for HV live work rigs All tables that provide pre-calculated conductor loadings have been rounded up to the next kilogram.

For more information on the following, see the relevant chapter in the *Distribution Overhead Line Design Manual*:

- tensions for conductors – *Conductor Tensioning for New and Existing Distribution Lines*
- insulators – *Insulators*

### References

- Distribution Overhead Line Design Manual, chapters:
  - Conductor Tensioning for New and Existing Distribution Lines
  - Insulators

## 7.1 Intermediate structures

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance when changing mechanical loads on intermediate structures.

### Instructions

When changing mechanical loads on intermediate structures, calculations must be used to ensure that:

- the safe working load (SWL) or working load limit (WLL) of the equipment is not exceeded
- increases in conductor tension (when moving/relocating conductors with the selected HV live equipment) do not place excessive strain on adjacent ties, terminations or structures

### Level and sloped terrain

Outlined below is the calculation that must be used to determine the loads exerted on HV live line equipment and structures when performing tasks on level or sloped terrain (see Figures 1 and 2 below, respectively).

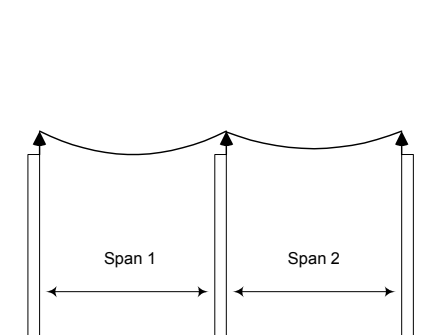


Figure 1: Level terrain

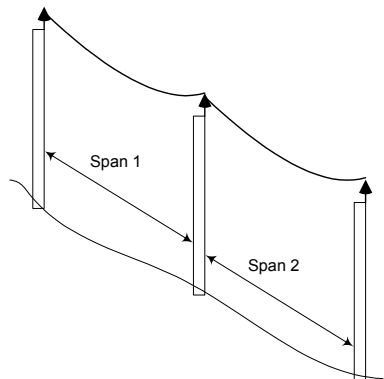


Figure 2: Sloped terrain

The following calculation may be used for Figures 1 and 2 to determine the total conductor load (kg) to be lifted. The tension of the conductor is irrelevant to this calculation.

$$W_t = \frac{W (\text{Span 1} + \text{Span 2})}{2}$$

where:

$W_t$  = total conductor load to be lifted

$W$  = mass per metre of conductor (kilograms per metre (kg/m))

Span = span length in metres

Therefore, the terrains depicted in Figure 1 and Figure 2 can be calculated as follows.

### Example

Given a situation where Span 1 is 80 m, Span 2 is 70 m and the conductor size is 7/4.75 AAC with a weight of 0.34 kg/m (see tables in work practice 7.5 (Conductor mechanical data) in this manual), the load calculation for the terrain is as follows:

$$\begin{aligned} W_t &= \frac{W (\text{Span 1} + \text{Span 2})}{2} \\ &= \frac{0.34 (80 + 70)}{2} \\ &= \frac{0.34 (150)}{2} \\ &= 0.34 \times 75 \\ &= 25.5 \text{ kg} \end{aligned}$$

Given this result, you would select for the task an HV live line rig with an SWL/WLL greater than or equal to 26 kg.

### Raised and lowered terrain

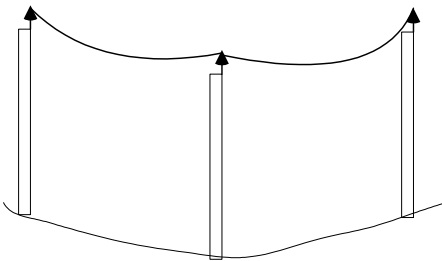
These load calculations are not able to be used for raised (hilltop) or lowered terrain (see Figures 3 and 4), due to variables such as:

- stringing tension
- heights
- temperatures

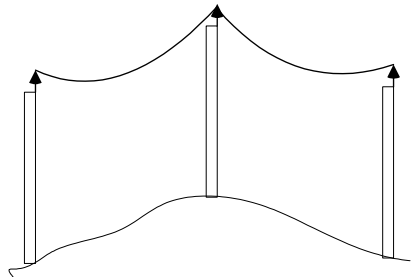
Refer to the tables in the following work practices in this manual, to determine the total conductor load for raised (hilltop) or lowered terrain:

- 7.4 (Vertical loads on raised (hilltop) terrain)
- 7.7 (Vertical loads on lowered terrain)

HV live work in these situations must be scoped during the pre-job planning, including appropriate surveying or engineering calculations.



**Figure 3: Lowered terrain**



**Figure 4: Raised (hilltop) terrain**

### References

High Voltage Live Work Manual, work practices:

- 7.4 (Vertical loads on raised (hilltop) terrain)
- 7.5 (Conductor mechanical data)
- 7.7 (Vertical loads on lowered terrain)

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## 7.2 Angle structures

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance when changing mechanical loads on angle structures.

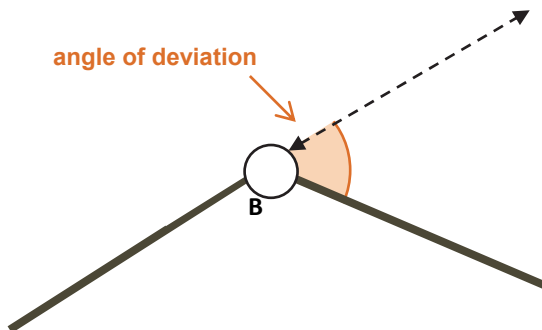
### Instructions

Determining conductor loadings for angle structures requires a calculation and a reference to the design data of the particular line. The tables in work practice 7.6 (Conductor angle loads) in this manual, detail pre-calculated conductor loads for common conductor sizes, span lengths and stringing tensions. These calculations are in accordance with Western Power stringing charts and are based on the line's angle of deviation.

The methods of calculating angles of deviation, shown below, will enable HV live workers to make an accurate assessment of conductor angle loads and select appropriate HV live work equipment, provided that stringing tensions are available.

### Angle of deviation

The angle of deviation is the angle that the line deviates away from the imaginary extension of the reference line if the reference line continued in a straight line (see Figure 1, below).



**Figure 1: Angle of deviation**

## Methods of calculating angles of deviation

### Method 1: Digital angle finder



**Figure 2: Digital angle finder**

A digital angle finder, as shown in Figure 2, gives a digital reading of the inside angle between the overhead lines. This tool is aligned as close as possible to the angle of the overhead line. The position is shown as 'B' in Figure 1.

The inside angle reading is then used to calculate the angle of deviation, using the formula below:

Angle of deviation = straight angle – inside angle

where:

Straight angle =  $180^\circ$

#### Example 1

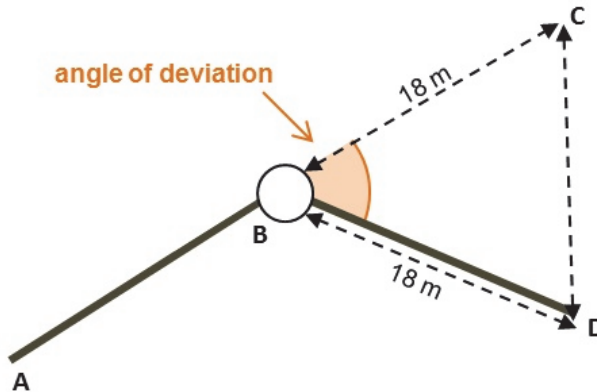
The inside angle between the overhead lines is  $70^\circ$ .

Angle of deviation =  $180 - 70$

=  **$110^\circ$**



## Method 2: Outside triangle distances



**Figure 3: Using outside triangle distances**

The following steps can be used, as shown in Figure 3, to calculate the angle of deviation.

1. Extend the line AB, along the ground, by 18 m to point C.
2. Measure 18 m, along the ground parallel to the line, from point B to point D.
3. Measure the distance between point C and point D.
4. Multiply the measurement of point C to point D by 3.2. This result will be the angle of deviation in degrees. Round up to whole degree.

From here, use the tables in work practice 7.6 (Conductor angle loads) in this manual to determine the conductor angle loads and appropriate safe working loads (SWL) or working load limits (WLL) for HV live work equipment.

### Example 2

In this example, C to D is 14 m, the conductor size is 6/1/3.00 aluminium core steel reinforced (ACSR) and the line tension is 25%. This gives us:

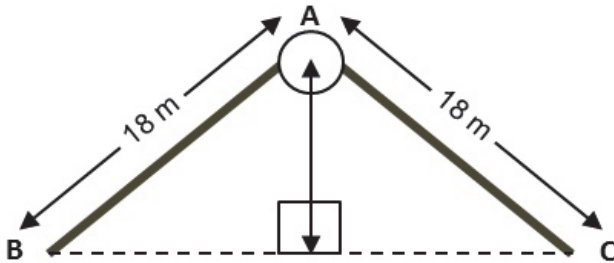
$$\text{Angle of deviation} = 14 \times 3.2 = 44.8^\circ$$

Round up = **45°**

Using the *Conductor angle loads* table in work practice 7.6 (Conductor angle loads) in this manual, we can determine that with a conductor size of 6/1/3.00 ACSR, a line tension of 25%, and a 45° angle of deviation, the conductor angle load is 291 kg.

As a result, you would select for the task HV live work equipment with an SWL/WLL greater than or equal to 291 kg.

### Method 3: Bisecting line



**Figure 4: Bisecting line A–D**

The following steps can be used, with Figure 4, to calculate the angle of deviation of a line when no angles are given.

1. From Point A (the structure), measure 18 m along the line. Do this either side of the structure to make two points, B and C. Make these measurements along the line, however, points B and C will be directly under the line on the ground.
2. Sight a line from point B to point C along the ground.
3. Halve the distance from point B to point C to create point D.
4. Determine the distance along the ground from point A to point D ensuring that point D intersects the line BC at right angles.
5. The conductor angle load can then be calculated using the following formula.

$$Wt = D1 \times \frac{2(MCT)}{18}$$

where:

Wt = Conductor angle load

D1 = Determined distance from Point A to Point D

MCT = Maximum conductor tension (minimum breakload x percent tension)

### Example 3

In this example,  $D1 = 6.89$  m, the conductor size is 6/1/3.00 ACSR and the line tension is 25%.

Using the *Conductor mechanical data* table in work practice 7.5 (Conductor mechanical data) in this manual, we can determine that the minimum breakload is 1519 kg.

$$\text{MCT} = 1519 \times 0.25 = 380 \text{ kg}$$

$$Wt = D1 \times 2 \left( \frac{\text{MCT}}{18} \right)$$

$$= 6.89 \times 2 \left( \frac{380}{18} \right)$$

$$= \mathbf{291 \text{ kg}}$$

As a result, you would select for the task HV live work equipment with a SWL/WLL greater than or equal to 291 kg.

### References

- High Voltage Live Work Manual, work practices:
  - 7.5 (Conductor mechanical data)
  - 7.6 (Conductor angle loads)

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### 7.3 Tension

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on conductor tensioning.

#### Background

The percentage tension of the calculated breaking load (CBL) for conductors varies according to the conductor type and the situation in which the conductor is being used. Tensions on Western Power distribution conductors will vary from 7% of CBL for all aluminium alloy conductor (AAAC) in short bay urban situations to 25% of CBL for steel conductors in longer bay rural situations. For more on tensions for conductors, see the *Conductor Tensioning for New and Existing Distribution Lines* chapter in the *Distribution Overhead Line Design Manual*.

Tension may be increased to allow for the replacement of insulators, cross-arms, or poles. However, tensions must be within allowable maximums as referenced in work practice 7.6 (Conductor angle loads) in this manual. HV live work equipment can be used to support conductors and increase conductor tension.

Increasing the tension is only possible when the safe working load (SWL) or working load limit (WLL) of the HV live work equipment is greater than or equal to the total (initial and additional) conductor loads (kg) that need to be applied to the conductor.

$$\text{SWL or WLL} \geq (\text{initial conductor load} + \text{additional conductor load})$$

The conductor angle loads tables in work practice 7.6 (Conductor angle loads) in this manual detail the maximum conductor loads that can be applied to tensioned conductors. These have been designed in accordance with conductor tensioning tables in the *Conductor Tensioning for New and Existing Distribution Lines* chapter in the *Distribution Overhead Line Design Manual*.

#### References

- High Voltage Live Work Manual, work practice 7.6 (Conductor angle loads)
- Distribution Overhead Line Design Manual, chapter Conductor Tensioning for New and Existing Distribution Lines

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### 7.4 Vertical loads on raised (hilltop) terrain

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with basic information about conductor vertical loads on raised (hilltop) terrain.

#### Background

Hilltop terrain exists when one pole is geographically higher than the two adjacent poles that it is connected to (see Figure 1, below).

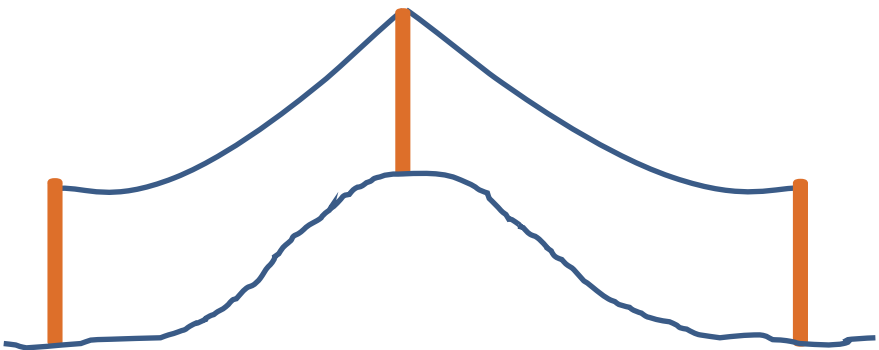
Conductors attached to poles on hilltop terrain are likely to have significant downward forces. These forces are the result of:

- the weight of the line that connects the pole to the others
- the vertical downward force created by the line being tensioned to the two poles located lower than the pole on the hilltop

HV live workers must be aware of these forces in order to remain in control of conductors and avoid overloading HV live work equipment and plant. Table 1, below, gives the maximum vertical loads for raised (hilltop) terrain.

The information in this work practice is not intended as a comprehensive guide for conductors in all situations. For more on this, see the *Distribution Overhead Line Design Manual*, chapters:

- *Conductor Tensioning for New and Existing Distribution Lines*
- *Conductors and Fittings*



**Figure 1: Example of hilltop terrain configuration**

**Table 1: Vertical force of conductor – raised (hilltop) terrain (kg)**

Height of centre pole above adjacent structures (metres)		15	30		45		
Sum of spans each side of the pole (metres)		200	200	350	200	350	550
Conductor		Vertical force (kg)					
Stranding and wire diameter	Type						
7/2.50	AAC	53	97	67	141	92	74
7/3.00	AAC	74	135	93	195	127	103
7/3.75	AAC	112	203	141	294	193	158
7/4.50	AAC	159	287	200	416	274	224
7/4.75	AAC	178	322	224	465	306	250
19/3.25	AAC	232	421	292	610	400	325
7/2.50	AAAC	72	135	88	197	124	94
7/3.00	AAAC	104	194	127	284	178	136
7/4.75	AAAC	241	448	296	656	415	319
19/3.25	AAAC	329	615	403	901	566	431
7/0.064	HDBC	60	106	76	153	103	87
7/0.080	HDBC	93	165	118	237	159	135
7/0.104	HDBC	155	275	198	396	267	226
19/0.064	HDBC	160	283	204	407	275	233
7/0.136	HDBC	259	459	332	659	446	380
19/0.083	HDBC	266	472	340	678	458	389
19/0.101	HDBC	391	693	501	996	673	574
6/1/2.50	ACSR/GZ	92	173	113	253	159	120
6/1/3.00	ACSR/GZ	131	245	160	359	225	171
6/1/3.75	ACSR/GZ	201	376	246	550	346	264
6/4.75+7/1.60	ACSR/GZ	294	548	361	802	506	388
30/7/2.50	ACSR/GZ	555	1,042	675	1,529	953	717



Height of centre pole above adjacent structures (metres)		15	30		45		
Sum of spans each side of the pole (metres)		200	200	350	200	350	550
Conductor		Vertical force (kg)					
Stranding and wire diameter	Type						
30/7/3.00	ACSR/GZ	786	1,476	958	2,165	1,352	1,019
30/7/3.50	ACSR/GZ	1,057	1,983	1,289	2,908	1,817	1,373
6/186+7/062	ACSR	294	548	361	802	506	388
3/2.75	SC/AC	185	359	219	533	318	222
3/3.00	SC/AC	221	427	261	634	379	264
3/3.25	SC/AC	258	500	305	741	443	309
3/3.75	SC/AC	328	634	388	940	563	394
3/2.75	SC/GZ	184	354	218	523	315	223
7/1.60	SC/GZ	93	174	113	255	159	120
7/2.00	SC/GZ	227	437	270	646	390	277
7/2.75	SC/GZ	429	825	510	1,221	736	522
7/3.75	SC/GZ	797	1,532	947	2,268	1,368	970

## References

- Distribution Overhead Line Design Manual, chapters:
  - Conductor tensioning for new and existing distribution lines
  - Conductors and fittings

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## 7.5 Conductor mechanical data

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with basic information on conductor mechanical data.

### Background

The information in this work practice is not intended as a comprehensive guide for conductors in all situations. For more on this, see the *Distribution Overhead Line Design Manual*, chapters:

- *Conductor Tensioning for New and Existing Distribution Lines*
- *Conductors and Fittings*

**Table 1: Calculated breaking load (CBL) for conductors**

Size	Type*	CBL (kg)	Approximate mass (kg/m)
7/2.50	AAC	586	0.0943
7/3.00	AAC	807	0.135
7/3.75	AAC	1,213	0.212
7/4.50	AAC	1,713	0.305
7/4.75	AAC	1,917	0.34
19/3.25	AAC	2,519	0.433
7/2.50	AAAC	834	0.0943
7/3.00	AAAC	1,203	0.135
7/4.75	AAAC	2,763	0.339
19/3.25	AAAC	3,813	0.433
7/0.064	HDBC	622	0.13
7/0.080	HDBC	964	0.203
7/0.104	HDBC	1,606	0.343
19/0.064	HDBC	1,652	0.356
7/0.136	HDBC	2,664	0.591
19/0.083	HDBC	2,745	0.599
19/0.101	HDBC	4,032	0.886

Size	Type*	CBL (kg)	Approximate mass (kg/m)
6/1/2.50	ACSR/GZ	1,070	0.119
6/1/3.00	ACSR/GZ	1,519	0.171
6/1/3.75	ACSR/GZ	2,324	0.268
6/4.75+7/1.60	ACSR/GZ	3,385	0.404
30/7/2.50	ACSR/GZ	6,495	0.675
30/7/3.00	ACSR/GZ	9,187	0.973
30/7/3.50	ACSR/GZ	12,338	1.32
6/186+7/062	ACSR	3,385	0.404
3/2.75	SC/AC	2315	0.118
3/3.00	SC/AC	2753	0.141
3/3.25	SC/AC	3222	0.165
3/3.75	SC/AC	4079	0.22
3/2.75	SC/GZ	2,264	0.139
7/1.60	SC/GZ	1,084	0.115
7/2.00	SC/GZ	2,794	0.177
7/2.75	SC/GZ	5,282	0.326
7/3.75	SC/GZ	9,809	0.609

\* For the full name and a description of each type of conductor, see work practice 7.8 (Conductor characteristics) in this manual.

## Reference

- High Voltage Live Work Manual, work practice 7.8 (Conductor characteristics)
- Distribution Overhead Line Design Manual, chapters:
  - Conductor Tensioning for New and Existing Distribution Lines
  - Conductors and Fittings

### 7.6 Conductor angle loads

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on conductor angle loads.

#### Background

The information in this work practice is not intended as a comprehensive guide for conductor angle loads in all situations. For more on this, see the *Distribution Overhead Line Design Manual*, chapters:

- *Conductor Tensioning for New and Existing Distribution Lines*
- *Conductors and Fittings*

**Table 1: Conductor angle loads – All aluminium conductor (AAC)**

Conductor size	7/2.50 AAC		7/3.00 AAC		7/3.75 AAC		7/4.50 AAC		7/4.75 AAC		19/3.25 AAC	
Calc. min breaking force	586		807		1,213		1,713		1,917		2,519	
Tension at 25%	147		202		303		428		479		630	
Tension at 33%	195		269		404		571		639		840	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%	25%	33%	25%	33%
5°	13	17	18	23	26	35	37	50	42	56	55	73
10°	26	34	35	47	53	71	75	100	84	111	110	146
15°	38	51	53	70	79	106	112	149	125	167	164	219
20°	51	68	70	93	105	140	149	198	166	222	219	292
25°	63	85	87	116	131	175	185	247	208	277	273	364
30°	76	101	104	139	157	209	222	296	248	331	326	435
35°	88	118	121	162	182	243	257	343	288	384	379	505
40°	100	134	138	184	207	277	293	390	328	437	431	574
45°	112	150	154	206	232	310	328	437	367	489	482	642
50°	124	165	170	227	257	342	362	483	405	540	532	710
55°	135	180	186	248	280	374	396	527	443	590	582	775
60°	147	195	202	269	303	404	428	571	479	639	630	840

Table 2: Conductor angle loads – All aluminium alloy conductor (AAAC)

Conductor size	7/2.50 AAAC		7/3.00 AAAC		7/3.75 AAAC		7/4.50 AAAC		7/4.75 AAAC		19/3.25 AAAC	
Calc. minimum breaking force	983		1,417		2,213		3,182		3,549		4,507	
Tension at 25%	246		354		553		795		887		1,127	
Tension at 33%	328		472		738		1,061		1,183		1,502	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%	25%	33%	25%	33%
5°	21	29	31	41	48	64	69	93	77	103	98	131
10°	43	57	62	82	96	129	139	185	155	206	196	262
15°	64	86	93	123	144	193	208	277	232	309	294	392
20°	85	114	123	164	192	256	276	368	308	411	391	522
25°	106	142	153	205	240	319	344	459	384	512	488	651
30°	127	170	183	245	286	382	412	549	459	612	583	778
35°	148	197	213	284	333	443	478	638	533	711	677	903
40°	168	224	242	323	378	504	544	725	607	809	771	1,027
45°	188	251	271	362	423	564	609	812	679	905	862	1,150
50°	208	277	300	399	468	624	673	897	750	1,000	953	1,270
55°	227	303	327	436	511	681	735	979	819	1,092	1,041	1,387
60°	246	328	354	472	553	738	795	1,061	887	1,183	1,127	1,502

**Table 3: Conductor angle loads – Hard drawn bare copper (HDBC), part 1**

Conductor size	7/0.064 HDBC		7/0.80 HDBC		7/0.104 HDBC		7/0.136 HDBC	
Calculated minimum breaking force	622		964		1,606		2,663	
Tension at 25%	156		241		402		666	
Tension at 33%	207		321		535		888	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%
5°	14	18	21	28	35	47	58	77
10°	27	36	42	56	70	93	116	155
15°	41	54	63	84	105	140	174	232
20°	54	72	84	112	139	186	231	308
25°	67	90	104	139	174	232	288	384
30°	80	107	125	166	208	277	345	460
35°	93	125	145	193	241	322	400	534
40°	106	142	165	220	275	366	455	607
45°	119	159	184	246	307	410	510	679
50°	131	175	204	272	339	453	563	751
55°	144	191	222	297	371	494	615	820



**Table 4: Conductor angle loads – Hard drawn bare copper (HDBC), part 2**

Conductor size	19/0.064 HDBC		19/0.083 HDBC		19/0.101 HDBC	
Calculated minimum breaking force	1,652		2,745		4,033	
Tension at 25%	413		686		1,008	
Tension at 33%	551		915		1,344	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%
5°	36	48	60	80	88	117
10°	72	96	120	160	176	234
15°	108	144	179	239	263	351
20°	143	191	238	318	350	467
25°	179	238	297	396	437	582
30°	214	285	355	474	522	696
35°	248	331	413	550	606	808
40°	282	377	469	626	689	919
45°	316	421	525	700	772	1,029
50°	349	466	580	774	852	1,137
55°	381	509	634	845	931	1,241
60°	413	551	686	915	1,008	1,344

**Table 5: Conductor angle loads – Aluminium conductor, steel reinforced (ACSR), part 1**

Conductor size	6/1/2.50 ACSR		6/1/3.00 ACSR		6/13.75 ACSR		6/4.75+7/1.61 ACSR	
Calculated minimum breaking force	1,071		1,519		2,325		3,385	
Tension at 25%	268		380		581		846	
Tension at 33%	357		506		775		1,128	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%
5°	23	31	33	44	51	68	74	98
10°	47	62	66	88	101	135	148	197
15°	70	93	99	132	152	202	221	295
20°	93	124	132	176	202	269	294	392
25°	116	155	164	219	252	336	366	489
30°	139	185	197	262	301	401	438	584
35°	161	215	228	304	349	466	509	678
40°	183	244	260	346	397	530	579	772
45°	205	273	291	388	445	593	648	864
50°	226	302	321	428	491	655	716	954
55°	247	330	351	468	537	716	782	1,042
60°	268	357	380	506	581	775	846	1,129

**Table 6: Conductor angle loads – Aluminium conductor, steel reinforced (ACSR), part 2**

Conductor size	30/7/2.50 ACSR		30/7/3.00 ACSR		30/7/3.50 ACSR		6/1.86+7/0.62 ACSR	
Calculated minimum breaking force	6,496		9,188		12,339		3,385	
Tension at 25%	1,624		2,297		3,085		846	
Tension at 33%	2,165		3,063		4,113		1,128	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%
5°	142	189	200	267	269	359	74	98
10°	283	377	400	534	538	717	148	197
15°	424	565	600	800	806	1,074	221	295
20°	564	752	798	1,063	1,071	1,428	294	392
25°	703	938	995	1,326	1,336	1,781	366	489
30°	841	1,121	1,189	1,585	1,597	2,129	438	584
35°	976	1,302	1,381	1,841	1,855	2,473	509	678
40°	1,110	1,481	1,571	2,094	2,109	2,812	579	772
45°	1,243	1,657	1,758	2,344	2,361	3,147	648	864
50°	1,373	1,831	1,942	2,589	2,608	3,478	716	954
55°	1,500	2,000	2,121	2,828	2,849	3,798	782	1,042
60°	1,624	2,165	2,297	3,063	3,085	4,113	846	1,129

**Table 7: Conductor angle loads – Steel core, aluminium clad conductor (SCAC)**

Conductor size	3/2.75 SCAC		3/3.00 SCAC		3/3.25 SCAC		3/3.75 SCAC	
Calculated minimum breaking force	2,315		2,753		3,222		4,079	
Tension at 25%	579		688		806		1,020	
Tension at 33%	772		918		1,074		1,360	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%
5°	50	67	60	80	70	94	89	119
10°	101	135	120	160	140	187	178	237
15°	151	202	180	240	210	281	266	355
20°	201	268	239	319	280	373	354	472
25°	251	334	298	397	349	465	442	589
30°	300	399	356	475	417	556	528	704
35°	348	464	414	552	484	646	613	817
40°	396	528	471	628	551	734	697	930
45°	443	590	527	702	616	822	780	1,040
50°	489	652	582	776	681	908	862	1,150
55°	534	713	636	848	744	992	942	1,256
60°	579	772	688	918	806	1,074	1,020	1,360

**Table 8: Conductor angle loads – Steel conductor galvanised (SCGZ)**

Conductor size	3/2.75 SCGZ		7/1.60 SCGZ		7/2.00 SCGZ		7/2.75 SCGZ		7/3.75 SCGZ	
Calculated minimum breaking force	2,264		1,084		2,794		5,282		9,810	
Tension at 25%	566		271		699		1,321		2,452	
Tension at 33%	755		361		931		1,761		3,270	
Angle of deviation	Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)		Tension (kg)	
	25%	33%	25%	33%	25%	33%	25%	33%	25%	33%
5°	49	66	24	32	61	81	115	154	214	285
10°	99	132	47	63	122	162	230	307	428	570
15°	148	197	71	94	182	243	345	460	640	854
20°	197	262	94	125	243	323	459	611	852	1,135
25°	245	327	117	156	302	403	572	762	1,062	1,416
30°	293	391	140	187	362	482	684	911	1,269	1,692
35°	340	454	163	217	420	560	794	1,059	1,474	1,966
40°	387	516	185	247	478	637	903	1,204	1,677	2,236
45°	433	577	207	277	535	713	1,011	1,347	1,877	2,502
50°	479	638	229	306	591	787	1,117	1,489	2,074	2,765
55°	523	697	250	334	645	860	1,220	1,626	2,265	3,020
60°	566	755	271	361	699	931	1,321	1,761	2,452	3,270

## References

Distribution Overhead Line Design Manual, chapters:

- Conductor Tensioning for New and Existing Distribution Lines
- Conductors and Fittings

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## 7.7 Vertical loads on lowered terrain

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with basic information on conductor vertical loads in lowered terrain.

### Background

A lowered terrain exists when one pole is geographically lower than the two adjacent poles that it is connected to. Typically this occurs when a pole is placed at the bottom of a gully or valley.

Conductors attached to poles in lowered terrain are likely to have significant vertical uplift forces and HV live workers must be aware of these forces in order to remain in control of conductors and electrical apparatus at all times. Table 1, below gives the maximum vertical load for lowered terrain.

The information in this work practice is not intended as a comprehensive guide for conductors in all situations. For more on this, see the *Distribution Overhead Line Design Manual*, chapters:

- *Conductor Tensioning for New and Existing Distribution Lines*
- *Conductors and Fittings*

**Table 1: Vertical force of conductor – lowered terrain (kg)**

Size	Type*	Sum of the spans each side of the pole (metres)									
		100	200	250	300	350	400	450	500	550	600
7/2.50	AAC	5	9	12	14	17	19	21	24	26	28
7/3.00	AAC	7	14	17	20	24	27	30	34	37	41
7/3.75	AAC	11	21	27	32	37	42	48	53	58	64
7/4.50	AAC	15	31	38	46	53	61	69	76	84	92
7/4.75	AAC	17	34	43	51	60	68	77	85	94	102
19/3.25	AAC	22	43	54	65	76	87	97	108	119	130
7/2.50	AAAC	5	9	12	14	17	19	21	24	26	28
7/3.00	AAAC	7	14	17	20	24	27	30	34	37	41
7/4.75	AAAC	17	34	42	51	59	68	76	85	93	102
19/3.25	AAAC	22	43	54	65	76	87	97	108	119	130
7/0.064	HDBC	7	13	16	20	23	26	29	33	36	39

Size	Type*	Sum of the spans each side of the pole (metres)									
		100	200	250	300	350	400	450	500	550	600
7/0.080	HDBC	10	20	25	30	36	41	46	51	56	61
7/0.104	HDBC	17	34	43	51	60	69	77	86	94	103
19/0.064	HDBC	18	36	45	53	62	71	80	89	98	107
7/0.136	HDBC	30	59	74	89	103	118	133	148	163	177
19/0.083	HDBC	30	60	75	90	105	120	135	150	165	180
19/0.101	HDBC	44	89	111	133	155	177	199	222	244	266
6/1/2.50	ACSR/GZ	6	12	15	18	21	24	27	30	33	36
6/1/3.00	ACSR/GZ	9	17	21	26	30	34	38	43	47	51
6/1/3.75	ACSR/GZ	13	27	34	40	47	54	60	67	74	80
6/4.75+ 7/1.60	ACSR/GZ	20	40	51	61	71	81	91	101	111	121
30/7/2.50	ACSR/GZ	34	68	84	101	118	135	152	169	186	203
30/7/3.00	ACSR/GZ	49	97	122	146	170	195	219	243	268	292
30/7/3.50	ACSR/GZ	66	132	165	198	231	264	297	330	363	396
6/186+ 7/062	ACSR	20	40	51	61	71	81	91	101	111	121
3/2.75	SCAC	6	12	15	18	21	24	27	30	32	35
3/3.00	SCAC	7	14	18	21	25	28	32	35	39	42
3/3.25	SCAC	8	17	21	25	29	33	37	41	45	50
3/3.75	SCAC	11	22	28	33	39	44	50	55	61	66
3/2.75	SCGZ	7	14	17	21	24	28	31	35	38	42
7/1.60	SCGZ	6	12	14	17	20	23	26	29	32	35
7/2.00	SCGZ	9	18	22	27	31	35	40	44	49	53
7/2.75	SCGZ	16	33	41	49	57	65	73	82	90	98
7/3.75	SCGZ	30	61	76	91	107	122	137	152	167	183

\* For the full name and a description of each type of conductor, see work practice 7.8 (Conductor characteristics) in this manual.



### References

- High Voltage Live Work Manual, work practice 7.8 (Conductor characteristics)
- Distribution Overhead Line Design Manual, chapters:
  - Conductor Tensioning for New and Existing Distribution Lines
  - Conductors and Fittings

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## 7.8 Conductor characteristics

### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with guidance on conductor:

- types and characteristics
- deterioration caused by corrosion and wind effects
- assessment and limitations

HV live workers must have an understanding of the material characteristics of each type of conductor in order to understand the potential risks associated with them. This is especially important when moving conductors.

### Types

Conductor types that can be found on the HV parts of Western Power's HV network are listed in Table 1, below.

**Table 1: Conductor types found on Western Power's HV network\***

Conductor	Abbreviation
All aluminium conductor	AAC
All aluminium alloy conductor	AAAC
Aluminium conductor, steel reinforced (aluminised)	ACSR/AZ
Aluminium conductor, steel reinforced (galvanised)	ACSR/GZ
Hard drawn bare copper	HDBC
Steel core, aluminium clad conductor	SCAC
Steel conductor galvanised	SCGZ

\* Table 1 is restricted to those conductors on which HV live work is carried out.

#### Note:

For detailed information on conductors, see the *Distribution Overhead Line Design Manual*.

### Characteristics

Reduction of sound metal within a conductor is generally caused by corrosion and/or vibration and can lead to significant reductions in the conductor diameter

and mechanical strength. Assessment of conductor condition prior to changing mechanical loads is essential.

**Note:**

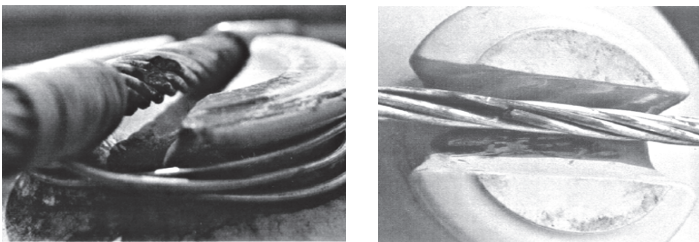
Most conductor damage occurs at support points as this is where the forces due to movement of the conductors are transferred into the supporting structure.

**Important**

Copper conductors smaller than 7/0.080 (7/14) must not be worked on using HV live work methods. This does not apply to removing or replacing bridges that are connected to the non-tensioned conductor tails.

**AAC and AAAC**

AAC is almost pure aluminium and is generally not prone to corrosion unless situated close to the ocean, salt lakes or high pollution industrial sites. The main source of damage to AAC is from vibration which usually occurs between the tie wires and insulator sheds as shown in Figure 1, below. AAC conductors are being phased out in favour of AAAC.



**Figure 1: Examples of vibration damage to AAC**

AAAC (see Figure 2, below) is slightly less conductive than AAC but has greater mechanical strength and hardness. This allows for longer spans or less sag in comparison to AAC. AAAC is one of Western Power's most common conductors and has similar characteristics to AAC in terms of corrosion resistance but its greater mechanical strength and hardness mean it is not so prone to vibration problems (although it must still be checked for signs of vibration).

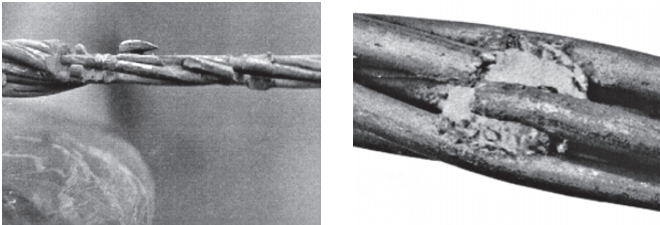


**Figure 2: New AAAC**

### ACSR/AZ and ACSR/GZ

The steel reinforcing in ACSR conductors provides around eight times the mechanical strength compared to AAC or AAAC conductors. ACSR conductors are generally used for rural lines where the current-carrying requirements are low but mechanical strength is required for long spans.

ACSR conductors are prone to corrosion, particularly when situated close to the ocean, salt lakes and high pollution industrial areas (see Figure 3, below). Problems can also occur at the ends of aluminium alloy armour rods. ACSR is also prone to vibration problems as the conductor has little self-damping capability.



**Figure 3: Examples of corroded ACSR**

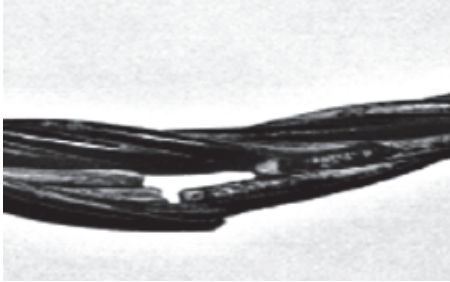
### HDBC

HDBC conductors generally do not suffer the same corrosion issues as SCAC, SCGZ, ACSR/AZ and ACSR/GZ. However, they do suffer from a type of corrosion which leaves a green scale over time (see Figure 4, below). This scale can etch into the surface of the copper and decrease the overall diameter of the conductor, weakening the mechanical strength.



**Figure 4: Example of scale damage on HDBC**

HDBC conductors tend to be found in older parts of the network and are more likely to be damaged from temporary overload and clashing during storms (see Figure 5, below).



**Figure 5: Example of physical damage on HDBC**

### SCAC and SCGZ

Steel conductors have a high mechanical strength and are generally used for long spans.

SCGZ rusts extensively and fails prematurely, particularly in coastal areas, around salt lakes or high pollution industrial areas. These conductors also have a tendency to suffer from broken strands that often protrude from the conductor and can cause a potential flash over hazard when moving conductors.

SCAC has been used in preference to SCGZ as it has superior corrosion resistance.

Steel tie wires have a tendency to deteriorate quicker than the conductor and also suffer from vibration.

### Deterioration caused by wind effects

#### Aeolian vibration

Aeolian vibration is wind-induced vibration that occurs when a stream of air passes across the conductor and eddies are formed on the leeward side. These eddies alternate from the top to the bottom and create alternating pressures that tend to produce movement at right angles to the wind direction. Aeolian vibration tends to occur during winter when conductor tensions increase due to lower temperatures.

Aeolian vibration is more likely to be found in:

- long spans in open country
- ACSR and SCAC conductors
- spans with a high tension
- taller-than-standard poles or structures

The most common types of Aeolian vibration damage are excessive wear of conductor strands at:

- support points where the conductor movement is restricted
- rigid splices and dead ends

### Sway oscillation

Sway oscillation occurs during wind gusts and causes the conductors to sway back and forth in a horizontal plane. This can cause damage to conductor strands at the tie wires as shown in Figure 6, below. The movement at the insulator can also result in broken tie wires and conductor damage from rubbing against the insulator.



**Figure 6: Example of damage from sway oscillation**

### Instructions

Conductors and fittings on both sides of the structure to be worked on must be inspected and checked for signs of:

- corrosion
- vibration
- annealing
- damage by lightning
- strand damage
- vandalism
- fatigue
- creep
- any other signs of visual damage

Armour rods

Armour rods are used to reduce wear and damage on the conductor. .... For an example, see Figure 7, below.

Important

Amour rods must not be removed under tension.



Figure 7: Example of armour rod

Temperature

HV live workers must be aware of the conductor and joint temperatures at which HV live work is allowable. For more on this, see work practice 2.15 (Temperature of conductors and electrical apparatus) in this manual.

Clearances

Bare overhead conductor clearances must meet the requirements outlined in work practice 6.8 (Conductor clearances) in the *Work Practice Manual*. Conductor movement must be controlled at all times.

Table 2: Conductor assessment and limitations

Type	Assessment and limitations
AAC & AAAC	<ul style="list-style-type: none"><li>• Check tie wires for breaks or signs of corrosion and broken conductor strands around the insulator.</li><li>• Check conductor for signs of clashing and broken strands along the bay length.</li><li>• Check for corrosion.</li><li>• Check any full tension joints for corrosion or signs or breakdown.</li><li>• Broken tie wires or conductor strands must be repaired prior to moving conductors.</li></ul>



Type	Assessment and limitations
<b>ACSR/AZ &amp; ACSR/GZ</b>	<ul style="list-style-type: none"> <li>• Check tie wires for breaks or signs of corrosion, damage around armour rods and broken conductor strands around the insulator.</li> <li>• Check conductor for signs of clashing and broken strands along the bay length.</li> <li>• Check for corrosion.</li> <li>• Check joints for signs or breakdown.</li> <li>• Broken tie wires or conductor strands must be repaired prior to moving conductors.</li> </ul>
<b>HDBC</b>	<ul style="list-style-type: none"> <li>• Check tie wires on adjacent poles for breaks or signs of corrosion and broken conductor strands around the insulator.</li> <li>• Check conductor for signs of clashing and broken strands along the bay length.</li> <li>• Check for corrosion.</li> <li>• Check joints for signs of breakdown.</li> <li>• Check for reddish colouring, which indicates annealing. This significantly reduces the mechanical strength of the conductor.</li> <li>• Broken tie wires or conductor strands must be repaired prior to moving conductors.</li> <li>• Copper conductors smaller than 7/0.080 (7/14) must not be worked on using HV live work methods. This does not apply to removing or replacing bridges that are connected to the non-tensioned conductor tails.</li> </ul>
<b>SCAC &amp; SCGZ</b>	<ul style="list-style-type: none"> <li>• Check tie wires for breaks or signs of corrosion, damage around armour rods and broken conductor strands around the insulator.</li> <li>• Check conductor for signs of clashing and broken strands along the bay length.</li> <li>• Check for corrosion.</li> <li>• Check joints for signs or breakdown.</li> <li>• Broken tie wires or conductor strands must be repaired prior to moving conductors.</li> </ul>

### References

- High Voltage Live Work Manual, work practice 2.15 (Temperature of conductors and electrical apparatus)
- Distribution Overhead Line Design Manual
- Work Practice Manual, work practices:
  - 6.8 (Conductor clearances)
  - 6.9 (Stringing and tensioning bare overhead conductors)
  - 6.14 (Aerial conductor repair)

### 7.9 HV insulators

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with guidance on HV insulators, including:

- types and characteristics
- inspection
- testing
- conditions where HV live work cannot be undertaken
- the minimum number of sound insulators required for HV live work

This work practice is specific to HV live work and is not intended to be a comprehensive guide to all aspects of insulators. For more on insulators, see the *Insulators* chapter in the *Distribution Overhead Line Design Manual*.

#### Background

The condition of insulators is particularly important to HV live workers as reduced insulation properties can result in an increased risk of step and touch potential and flashover when carrying out HV live work.

#### Types and characteristics

##### Types

The HV insulator types that can be found on Western Power's HV network are:

- glass
- ceramic (i.e. porcelain)
- polymeric/composite

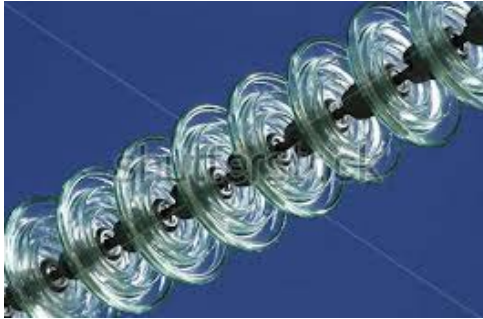
##### Characteristics

##### Basics

Insulator material generally has a very high dielectric strength ( $> 10$  kV/mm) but the surface dielectric strength can be significantly reduced by moisture and contamination. The design of the insulator sheds is critical to how moisture and contamination affect the dielectric strength. Problems with insulators usually occur at the interface between the body of the insulator and the end caps.

## Glass

Glass disc insulators are common on the Western Power Network. These insulators consist of an annealed and toughened glass insulator, a cast cap and a pin or connector that is cemented into the unit. See Figure 1, below, for an example.



**Figure 1: String of glass disc insulators**

Glass insulators have the following characteristics:

- high dielectric and tensile strength (compared to porcelain)
- long service life – relatively unaffected by ageing
- transparent – impurities, flaws and damage can easily be detected
- moisture can easily condense on the surface, trapping dust and pollutants which can create a leakage path
- may be susceptible to radio and television interference

## Ceramic

Ceramic post and disc insulators are common on the Western Power Network. These insulators generally consist of aluminium silicate mixed with plastic kaolin, feldspar and quartz to obtain the hard glazed appearance. See Figure 2, below, for examples.



**Figure 2: Ceramic post insulator (left) and disc insulator (right)**

Ceramic insulators have the following characteristics:

- good service life
- opaque – impurities, flaws and damage are not always visible
- they are prone to small internal punctures that are difficult to identify by visual or audible inspection

### **Polymeric/composite**

Polymeric/composite insulators are constructed with at least two insulating parts:

- a fibreglass reinforced plastic (FRP) core
- an external polymer envelope moulded to the core

Metal end fittings are attached to the core as shown in Figure 3 and 4 below. Any damage to the sheath that allows water to get to the fibreglass core will lead to either electrical or mechanical failure of the insulator.

Western Power uses polymeric and composite insulators that use enhanced silicon polymers (ESP) and ethylene vinyl acetate (EVA).

Some polymeric/composite insulators may suffer from UV exposure over time and become dull and powdery. This can severely affect the hydrophobic and insulating properties of the insulator.



**Figure 3: Polymeric strain insulator (long rod)**

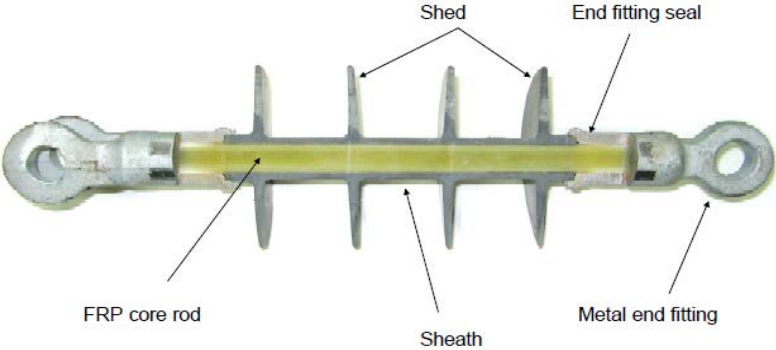


Figure 4: Cut-away view of polymeric strain insulator

Instructions

Before commencing HV live work on or near insulators, all insulators on the structures being worked on and adjacent structures must be visually inspected and, where necessary, tested to ensure that there is adequate insulation. See Table 1, below, for a summary of the requirements.

Note:

If the HV live work team is not satisfied with the results or the minimum insulation requirements are not met, HV live work must be suspended and the work performed under de-energised conditions.

Table 1: Minimum requirements when working near insulators

Insulator type	Requirements		
	Inspection	Test	Minimum number of sound discs
Glass disc	✓	Dependent on inspection	✓
Ceramic disc – transmission	✓	✓	✓
Ceramic disc – distribution	✓	✗	✓
Ceramic post	✓	✗	✗
Polymeric/composite	✓	✗	✗

### Note:

Polymeric insulators used as part of a tool for HV live work, e.g. lifting rigs, must be tested.

## Inspection

Both an audible and a visual inspection must be carried out.

### Audible inspection

Insulators should be free of any unusually loud corona discharge or other noises.

### Visual inspection

Check for:

- physical damage:
  - glass and ceramic insulators:
    - no more than a third of the outer radius or more than 25% of the surface may be damaged
    - cracks completely through the depth of the insulator
    - excessive pollution
  - polymeric/composite insulators:
    - rust-coloured stains on the metal end near the seal
    - damage to the sheath that has exposed the fibreglass reinforced plastic core. See Figure 5, below, for an example.
    - dull powdery sheds with little or no gloss or semi-gloss on the surface and potentially significantly reduced hydrophobic and insulating properties
    - excessive pollution



**Figure 5: Damaged polymeric insulator on surge diverter**

- flashover – obvious signs of electrical arc damage to the surface
- electrical stress – signs such as tracking and surface discharging. See Figures 6 and 7, below, for examples.

### Important

Visual inspections must look for potential electrical pathways on insulators. Damage and/or pollution may appear minimal but if it provides a linear pathway across the insulator the risk of flashover must be mitigated.



**Figure 6: Signs of electrical tracking on polymeric insulator**





**Figure 7: Signs of electrical tracking near end fitting on polymeric insulator**

If the inspection identifies any damage to the insulators, continue as follows:

- glass and ceramic – see the *Minimum number of sound discs* section, below
- polymeric/composite – consult Table 2, below

**Table 2: Guide for working with damaged polymeric/composite insulators**

Conditions	Action
Insulator in sound condition	HV live work can commence
Minor damage to the sheds of the insulator (such as bird damage) where the critical areas such as sheath and core have not been affected. No signs of tracking. Less than 25% of the surface damaged	HV live work can commence
Moderate to severe damage to the insulator e.g. more than a third of the outer radius of the sheds or 25% of the surface damaged, deep cracks or signs of tracking on metal end cap, noise and signs of corona.	No HV live work to be considered

**Minimum number of sound discs – Glass and ceramic**

To provide adequate insulation to ensure the safety of the HV live workers, there must be a minimum number of electrically sound and functioning glass or ceramic disc insulators. To determine this, consult Table 3, below. If the minimum number of sound insulators is:

- not present – no HV live work to be considered

- present:
  - glass – HV live work can commence
  - ceramic – see the *Testing* section below

### Post or pin type insulators – Ceramic

Post or pin type ceramic insulators are one piece and can vary greatly in shed design. As a general guide, no more than a third of the outer radius of the sheds or 25% of the insulators surface should be damaged.

**Table 3: Minimum number of electrically sound standard profile glass or ceramic discs**

Nominal line voltage (kV)	Minimum number of sound insulators
6.6	1
11	1
22	1
33	2
66	3
132	4

\* The recommendations in the above table are general and are based on electrical air flashover of the string, with the disc insulators having a pitch or spacing of 146 mm. For the minimum requirements for disc insulators with different pitch or spacing, see AS 5804.1-2010 *High-voltage live working – General*.

### Safety

Any insulator or string of insulators exhibiting physical damage or signs of electrical stress, such as elevated noise levels or surface discharging, must be treated with caution. The following risk control measures must be considered:

- perform work de-energised under an electrical access permit (EAP)
- provide protection against elevated risk of step and touch potential

### Testing

#### Glass

Testing for glass insulators is dependent on the visual and audible inspection. Visual inspections will generally identify any problems with glass insulators. However, the effectiveness of visual inspections can be hampered by heavy

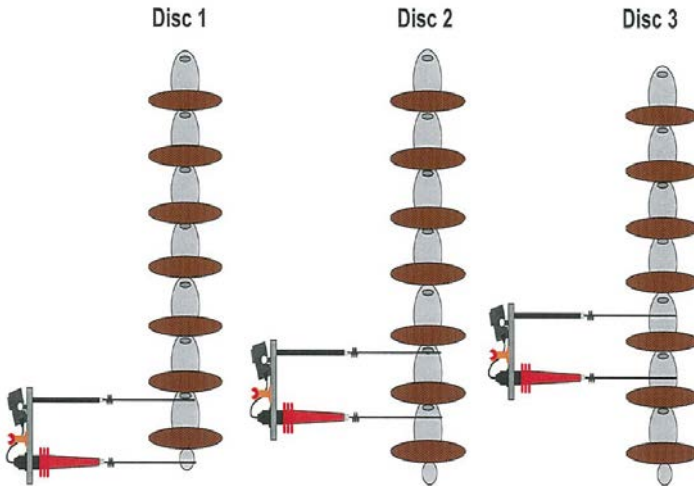
pollution. Testing should still be carried out if there is any doubt about the insulation integrity of the insulator.

### **Ceramic**

Ceramic disc insulators are not required to be tested at distribution voltages up to 33 kV as it is often not possible. However, all ceramic disc insulators at transmission voltages must be tested even if they pass the audible and visual inspections.

Testing process:

1. Ensure probes are firmly connected then connect the tester to the hand stick.
2. Check the read out display to ensure that it is functioning. If there is no read out or the read out is not normal, change the battery. If it fails, return the instrument for repair.
3. Ensure that another person (recorder) is in readiness for recording insulator information on the risk assessment form.
4. Place the probes across the disc dielectric closest to the conductor (disc 1). The red probe must be positioned on the line side of the insulator, as shown in Figure 8, below.
5. Ensure good contact between the probes and the metal fittings of the insulators.
6. Wait for the reading to steady.
7. Convey the disc number and its voltage to the recorder to be recorded in the risk assessment.
8. Repeat steps 4-7 for all discs in the string.
9. Use the information provided below to determine if any discs fail or are in poor condition.
10. Consult Table 3, above. If the minimum number of sound insulators is:
  - not present – no HV live work to be considered
  - present – HV live work can commence



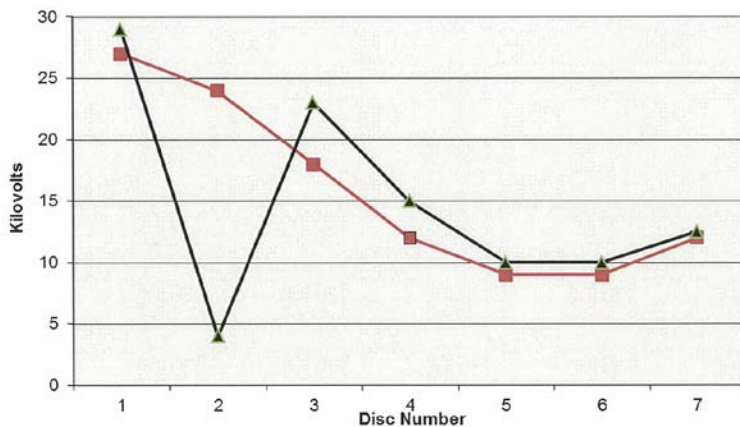
**Figure 8: Test each porcelain insulator on a string**

A significant lower voltage across a disc indicates that it has failed or is in poor condition. This is generally accompanied by a higher voltage across the adjacent discs as they are forced to compensate for the faulty disc. Examples of this testing are shown in Figures 9 and 10, below.



**Figure 9: Testing porcelain insulators**

The brown performance curve in Figure 10, below, indicates a healthy string of insulators. The black curve identifies that disc 2 is performing poorly and shows discs 1, 3, 4, 5, 6 and 7 are more heavily loaded than normal.



**Figure 10: Disc performance**

### Polymeric/composite

There are no in-field testing requirements for polymeric/composite insulators as faults are generally highly visible and can be identified during the visual inspection.

### References

- AS 5804.1-2010 High-voltage live working – General
- Distribution Overhead Line Design Manual, chapter Insulators

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### 8.0 Glove and barrier method

#### Purpose

The purpose of this work practice is to outline the general requirements when using the glove and barrier work method on high voltage (HV) apparatus on the Western Power distribution network (i.e. 1kV to 33kV).

#### Important

The HV live work team must only work on one potential at any given time. Take care to ensure that the work of one person does not compromise the safety of the other.

#### Note:

The glove and barrier method **must not** be used on the transmission network (i.e. voltages over 33kV). Work on apparatus at transmission voltages must be done using the method described in section 10 (Transmission insulated stick method) in this manual.

#### Key requirements

- The glove and barrier method is based on two principles: insulation and separation.
  - Insulation – the HV live worker is double insulated.
    - One level of insulation is provided by working on an electrically rated and tested work platform.
    - The second level of insulation is provided by wearing rated and tested insulated gloves and sleeves.
  - Even when double insulated as described above, HV live workers must also apply insulated barriers to all secondary points of contact within normal reach of the work area.
  - Separation – the conductor is moved away from any second points of contact which may be at different potential.
- HV live workers using the glove and barrier method must always work under a Vicinity Authority (VA).

### Important

No HV live work must be undertaken without an applicable and approved HV live work procedure.

If no applicable HV live work procedure is available, a draft procedure must be produced by the work team intending to do the work. The draft procedure must be submitted to, and approved by, Work Practice Development before it can be used.

### MADs

There are no minimum approach distances (MADs) that apply to glove and barrier work as the gloved hands are in contact with the energised apparatus that is being worked on.

It is important that HV live workers maintain an air insulation gap of 150mm between the uninsulated part of their body and the energised electrical apparatus that is being worked on. This air insulation gap must never be compromised, as compromising the air insulation gap eliminates one of the two independent levels of insulation.

When this air gap cannot be maintained, double insulation must be applied. For more on this, see work practice 8.1 (Double insulation) in this manual.

### Auto-reclose OFF

- The auto-reclose equipment controlling the circuit on which HV live work is to be performed must be disabled for the duration of the work. The reasons for disabling the auto-reclose equipment are as follows:
  - On distribution systems, the surge from the reclose may create additional voltage on the temporary insulation in use, creating a hazard for HV live workers, insulation equipment and electrical apparatus.
  - To limit the damaging mechanical forces resulting from fault currents.
  - If there is an incident at the worksite, the HV live worker has the assurance of knowing that the line will not be re-energised (which could pose a further risk to HV live workers).
- Operation of an auto-recloser on an HV live work site is a reportable incident and all HV work must cease. For more on this, see work practice 2.8 (Incident reporting) in this manual.



### Safe working principles specific to glove and barrier method

The following safe working principles are specific to glove and barrier work. These supplement those outlined in section 2 (Safe working principles) in this manual.

#### Gloves and sleeves

- Insulated gloves and sleeves must:
  - only be used within their test approval dates
  - have a voltage rating greater than or equal to the voltage that is to be worked on
  - be visually inspected inside and out and gloves air tested prior to the commencement of work, or at any time when their condition is in doubt. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
  - thoroughly washed and rinsed with clean water at least once a week, or more when in heavy use
  - never be worn inside-out or without approved protective outer gloves
  - be worn at all times while inside the contact area and must not be removed until outside of the contact area.

The contact area is considered as being one meter or closer to energised HV conductors. Any part or extension of the body (i.e. tools in outstretched hand) which encroaches into this area is considered to be within the contact area.

- Protective outer gloves that are used with HV insulated gloves must be kept free of contamination and must not be used for any other purpose.
- Both personnel in the EWP basket must wear insulated gloves and sleeves.

Gloves and sleeves may be removed by the HV live workers to refresh themselves, but only when the following requirements are met:

- Following discussion and agreement with the safety observer.
- When outside of the contact area.
- Prior to recommencing work, the HV live workers must inform the safety observer and put their gloves and sleeves back on before re-entering the contact area.

### Insulated EWP

- Glove and barrier work may only be performed from an insulated EWP with an insulated liner. For more on this, see the following work practices in this manual:
  - 4.1 (Mobile elevated work platforms (EWPs))
  - 5.2 (Maintenance of EWPs and fitted hydraulic tools).
- Insulated EWPs and insulated liners may only be used within their test approval dates.
- A minimum of 250mm clearance must be maintained between the EWP basket and any second point of contact, unless covered with insulated barriers rated for the highest voltage. When the insulating barriers have been applied to the second point of contact then the EWP basket minimum clearance can be reduced to accidental contact.

### HV live work using two EWPs

The following requirements apply whenever using two EWPs:

- A minimum distance of at least 2m is maintained between the HV live workers in each EWP while any HV live worker is in contact with electrical apparatus.
- All second points of contact must be covered.
- There is a separate safety observer for each EWP.
- The HV live worker must ensure that their work or the movement of the EWP does not compromise the safety of others.
- Tools or equipment are never passed between HV live workers in separate EWPs while any HV live worker is in contact with electrical apparatus.
- Each EWP is earthed in accordance with 4.0 (Mobile plant and related equipment for HV live work) in this manual.

Tools or equipment such as HV jumpers may only be passed from one EWP to the other if:

- HV live workers in each EWP are not in contact with electrical apparatus
- all second points of contact are covered
- there is no risk of equipment inadvertently contacting different potentials
- the HV live workers in the EWPs and their respective safety observers are aware of what is about to occur

Or when both EWPs are outside of the contact area.

### Insulated equipment

- Most glove and barrier insulated equipment starts to soften at 70°C. If the conductor temperature is suspected to be in excess of 70°C, its temperature must be measured using a thermal measuring device or thermometer. If the conductor temperature exceeds 70°C, glove and barrier work must not be performed. For more on this, see work practice 2.15 (Temperature of conductors and electrical apparatus) in this manual.
- Insulated barriers:
  - are used to provide personal protection against inadvertent brush contact with energised electrical apparatus or apparatus that may be at a different potential and temporarily insulate electrical conductors and apparatus
  - must be applied to all secondary points of contact within reach which are, or could be, at a different potential to the apparatus being worked on
  - must **not** be intentionally contacted except with a rated insulated glove or insulated live work stick. Where contact is anticipated, two levels of barrier insulation must be provided. The extent of coverage must provide effective insulation to electrical apparatus and inadvertent contact by the HV live worker

### Secondary points of contact

A secondary point of contact is any conductor, equipment, apparatus, tool, hardware or earth that is, or could be, at a different potential to the potential being worked on, and within normal reach of the working position. Normal arm reach or tool reach may be extended when moving conductor tails. This must be taken into account when determining possible secondary points of contact.

Every second point of contact, including any conductors below the basket, must have insulated barriers applied to it.

While insulated barriers are designed for brush contact only, HV live workers using the glove and barrier method can work in close proximity to the insulated barriers provided that they can maintain an air gap of 150mm between any uninsulated part of the line worker's body and the insulated barrier at all times. This air gap of 150mm acts as a level of insulation. When this air gap cannot be maintained, double insulation must be applied. For more on this, see work practice 8.1 (Double insulation) in this manual.

### Working on a return wire

The return wire has the potential to become energised to the phase voltage under fault conditions. The HV live worker using the glove and barrier method must use the following procedures and principles when working on the return wire:

- GB-Support-01 (Displace and replace return wire) in *High Voltage Live Work Procedures – Glove and Barrier*.

or

- 6.30 (SWER return wire maintenance when the phase conductor is energised) in the *Work Practice Manual*.

### Personnel

The HV live work team has the final say as to when they can or cannot do a task, or whether they need to rest or rotate personnel. For more on this, see work practice 2.1 (Onsite risk assessment) in this manual.

All HV live workers must be authorised in the method that they are using. For more on this, see work practice 3.3 (Authorisation and supervision) in this manual.

### Minimum number of personnel

A minimum of three HV live workers are required for performing glove and barrier work, except when performing the tasks listed in the 'Single person aloft permitted tasks' section below.

### Live HV pole changes

When performing pole changes, a minimum of four HV live workers are required when using the glove and barrier method. This is because tasks must be rotated between team members for the purpose of reducing fatigue.

### Single person aloft permitted tasks

After a risk assessment by the HV live work team, it may be decided that only one HV live worker needs to go aloft to perform a task (one team member must still act as the safety observer). The following tasks are the only ones that may be performed by a single person aloft using the glove and barrier method:

- Structure, conductor and insulator inspection.
- Installation or removal of fault detection equipment.
- Connecting and disconnecting of live line clamps.
- Installation or removal of insulated barriers or covers.
- Installation or removal of spreader ropes.

- Tightening hardware (e.g. cross-arms and insulators).
- Installing line splice.
- Installing vibration dampers.
- Installing bird diverters.
- Tying and untying of conductors only when the conductors are secured in the conductor traps of a gin pole fitted to a separate lifting EWP.

### Note:

Single person aloft tasks only apply to personnel who are authorised as unsupervised in the glove and barrier method. For more on this, see work practice 3.3 (Authorisation and supervision) in this manual.

## Procedures

This section of the *High Voltage Live Work Manual* provides guidance on how to perform HV live work using the glove and barrier method. For detailed procedures using this method, see *High Voltage Live Work Procedures – Glove and Barrier*.

## References

- *AS 5804.1-2010 High-voltage live working – General.*
- *AS 5804.2-2010 High-voltage live working – Glove and barrier work.*
- *High Voltage Live Work Manual:*
  - section 2 (Safe working principles)
  - work practice 3.3 (Authorisation)
  - work practice 4.1 (Mobile elevated work platforms (EWPs))
  - work practice 5.1 (Equipment maintenance)
  - work practice 5.2 (Maintenance of EWPs and fitted hydraulic tools)
  - work practice 8.1 (Double insulation)
  - work practice 10 (Transmission insulated stick method).
- *High Voltage Live Work Procedures – Glove and Barrier, GB-Support-01 (Displace and replace return wire)*
- *Work Practice Manual, work practice 6.30 (SWER return wire maintenance when the phase conductor is energised).*

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### 8.1 Double insulation

#### Purpose

The purpose of this work practice is to provide information and guidance about double insulation and the requirements when using the glove and barrier work method on high voltage (HV) apparatus on the Western Power distribution network.

#### Instructions

Double insulation refers to two levels of insulation through the application of two separate layers of insulating barriers (for an example, see Figure 1, below) and can be achieved by doing one of the following:

- applying one insulating barrier to an energised part and one insulating barrier to an earthed part
- applying two individual barriers to an energised part
- applying two individual barriers to an earthed part



**Figure 1: Example of double insulation (hard covers and flexible barriers)**

Double insulation is required when:

- contact is required between an energised part and an earthed part
- there is any possibility of an uninsulated part of the HV live worker's body making accidental contact with an insulating barrier. HV live workers must not make intentional contact with an insulating barrier with any uninsulated part of their body.
- the mobile plant or attachments might encroach within the minimum approach distance (MAD) of the insulating barriers

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### 8.2 Rigging conductor support equipment – glove and barrier method

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on how to use the glove and barrier method to rig conductor support equipment to conductors under tension.

#### Note:

The figures shown in this work practice focus on conductor support equipment rather than barriers. However, insulated barriers must be used when installing and removing all rigging and conductor support equipment.

#### Safety

Supporting and/or moving a conductor must be done in a manner that ensures total control of the conductor at all times.

An evaluation and risk assessment of the conductor must be done during the pre-job planning stage and/or onsite risk assessment. For more on this, see work practice 7.8 (Conductor characteristics) in this manual.

#### Instructions

When moving a conductor, ensure that:

- a minimum of 450mm is maintained between phase-to-earth
- a minimum of 550mm is maintained between phase-to-phase.

#### Important

- A conductor must never be left unsupported or unrestrained at any time.
- HV live work methods must not be used to displace or tension copper conductors that are 7/16 or smaller.

#### SWL/WLL

- The calculated conductor load:
  - determines the HV live equipment that is to be used for supporting or moving conductors
  - must be matched against the safe working load (SWL) or working load limit (WLL) of the HV live equipment.

- The SWL/WLL must be greater than or equal to the conductor load for the HV live equipment (i.e. rigs) that is to be used.
- The SWL/WLL and the conductor load must be established during the pre-job planning stage.

### **Note:**

For more information on:

- conductor characteristics, loading and calculations, see section 7.0 (Conductors and insulators) in this manual
- the SWL/WLL of conductor support equipment, see work practice 6.4 (Conductor support equipment) in this manual.

## **Support methods**

### **Choosing which support method to use**

An HV live work team's training, experience and collective planning ability will all contribute to the decision on which support methods are appropriate to use to achieve the desired outcome. More than one support method can be used on the same structure at the same time.

### **Physically moving conductors using the glove and barrier method**

A conductor can be repositioned using the glove and barrier method provided that:

- the HV live worker has assessed and determined that the weight of the conductor to be lifted does not exceed their physical ability
- only one conductor is moved at a time. The HV live worker controlling the conductor must not have any other task to perform at the same time (e.g. operating the elevated work platform (EWP) controls or repositioning insulating barriers).
- full control of the conductor can be maintained at all times
- the conductor is repositioned either onto an insulator or onto a temporary conductor support. The conductor may be repositioned onto the cross-arm if double insulation is maintained.
- the two HV live workers in the basket of the EWP do not contact different potentials at the same time.

### Wire tong system

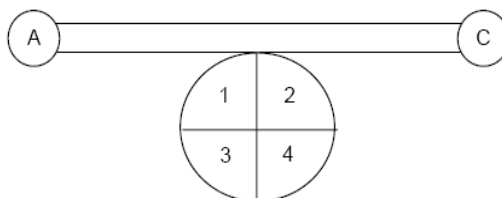
The wire tong system of supporting and moving conductors is versatile because it can be used on all types of structures. The system uses tensioning devices and levers to support and move conductors.

The principle components of the system are wire tongs, lever lifts, wire tong saddles, snubbing brackets and tensioning devices.

- Wire tongs:
  - Lifting tong – this is a 63mm wire tong, and its main function is to lift and support the majority of the conductor weight.
  - Holding tong – this is a 38mm wire tong, and its main function is to hold and control the lateral movement of the conductor.
- Lever lift – main function is to raise and lower the lifting tong.
- Wire tong saddle – a device that is secured to the pole using a chain tightener and has a pole clamp that entraps the wire tong, allowing the wire tong to pivot and slide in and out of the pole clamp. The 63mm wire tong saddle can be used as an anchor point for ropes or tensioning devices.
- Snubbing brackets – these are fitted to the pole using a chain tightener and are used as an anchor point for ropes or tensioning devices.
- Tensioning devices – includes a variety of equipment such as ropes, strap hoists and pulleys that provide a method of moving the conductor in a fully controlled manner.
- Rigging a wire tong – when attaching holding tong saddles to the pole, they must be rigged on the opposite quarter to the conductor (see Figure 1, below, for an example).

When rigging to move:

- conductor A, the holding tong saddle would be rigged to the pole in quarter 4
- conductor C, the holding tong saddle would be rigged to the pole in quarter 3.



**Figure 1: Where to rig a holding tong saddle to a pole**

**Note:**

- To avoid the wire tongs being damaged, the wheel tighteners of all the equipment must be positioned on the opposite side from the working side.
- Wire tongs and associated equipment are usually rigged on the opposite side of the pole to the cross-arm to facilitate replacement of the cross-arm.

## Rigging equipment

### Extension arms

#### Supporting the conductor using a cross-arm mounted temporary conductor support bracket – SWL/WLL 68kg per wire holder

An extension arm is fitted to a cross-arm and, as its name suggests, provides an extension to the existing cross-arm (see Figure 2, below). The arm is manufactured with a threaded screw clamp bracket at one end and a saddle bracket in the middle which can be easily positioned to suit a variety of cross-arm lengths.

#### Important

Cross-arm mounted extension arms must not be attached to wooden cross-arms. They may only be attached to steel cross-arms.

Wire holders are attached to the extension arm at a pre-determined position to facilitate relocation of the conductors into the wire holders to increase the distance between the phases. This increased spacing is particularly beneficial when erecting poles, building switches at the pole top, or increasing the clearance to allow for access to an upper circuit.

It is available in two lengths:

- 1.5m for single wire holders.
- 1.8m for two wire holders.

Wire holders can be either the 'fork' type or the under slung 'C' type. The SWL/WLL of the support brackets is 68kg (vertical load) and 45kg (side load) per wire holder.

An insulator can be fitted between the support bracket and the conductor trap to provide additional insulation. This additional insulation must be fitted when supporting conductors energised at 22kV and 33kV.

### Note:

Inspect the cross-arm and ensure it is stable prior to using this support method.

### Supporting brace

In situations where the existing cross-arm is inadequately braced to support the cross-arm mounted extension arm, a supporting brace must be attached to support the cross-arm. The supporting brace can be a holding tong rigged between a stirrup on the extension arm and a wire tong saddle attached to the pole.

### Applying a supporting brace

- When the extension arm is attached to a cross-arm, the distance between the threaded screw clamp bracket and the supporting loop must be no less than 550mm.
- When supporting two conductors, the minimum conductor separation that must be maintained is:
  - phase-to-phase – 550mm
  - phase-to-earth – 450mm.

### Supporting the conductor using a pole-mounted temporary conductor support bracket – SWL/WLL 68kg per wire holder

The pole-mounted temporary conductor support bracket (see Figure 2, below) attaches to the pole for the temporary support of conductors, bridges, bypass jumpers, etc. It is attached to the pole by either a chain tightener or a strap hoist, with the larger section of the pole-securing bracket facing the ground to provide stability.



**Figure 2: Extension arms – pole mounted**

The temporary conductor support bracket is available in two lengths:

- 750mm for single wire holder (single-phase).
- 1200mm for two wire holders (two-phase).

Wire holders can either be a 'fork' type or an underslung 'C' type. The SWLs/WLLs of the support brackets per wire holder are:

- fork type – 68kg (vertical load)
- C type – 45kg (side load).

## Note:

Wire holder insulators (see Figure 3, below) must be fitted between the support arm and the conductor trap if the voltage exceeds the rated voltage of the support arm.



**Figure 3: Wire holder insulator**

## Auxiliary arm assembly

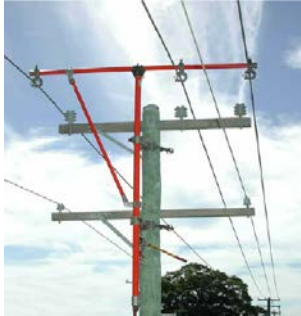
### Supporting conductors using an auxiliary arm assembly

The auxiliary arm assembly consists of a mast, cross-arm, arm braces and wire holders. This assembly is attached to the pole using two lifting wire tong saddles. The cross-arm can be fitted with 'fork' or 'C' type wire holders, depending on whether the arm assembly is rigged above or below the existing cross-arm.

This assembly must always be used with at least one arm brace. A wire holder insulator must be fitted between the support bracket and the conductor trap if the rating of the equipment is below the phase voltage of the line.

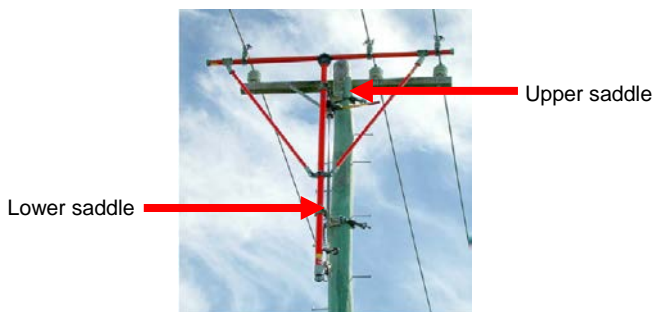
The SWL/WLL of the rig is:

- 68kg with one arm brace attached
- 210kg with two arm braces attached.



**Figure 4: Auxiliary arm – above conductors**

- The most common rigging position for the auxiliary arm is above the conductors, to facilitate the conductors being raised into the wire holders (see Figure 4, above). This position increases separation, providing better access for the basket of the EWP.
- The wire holders should be positioned on the auxiliary arm to align with the conductor position on the existing cross-arm. The minimum conductor separation that must be maintained is:
  - phase-to-phase – 550mm
  - phase-to-earth – 450mm.
- The upper wire tong saddle should be fitted to the pole on the opposite side to the existing cross-arm and as high as possible while maintaining clearances. The lower wire tong saddle should be fitted 1–1.2m vertically below the upper saddle.
- A safety sling or tensioning device must be fitted between the butt ring of the mast and one of the wire tong saddles. The height of the auxiliary arm assembly can be adjusted by loosening off the wire tong pole clamps and operating the tensioning device.



**Figure 5: Auxiliary arm – below conductors**

The main reason that the auxiliary arm is rigged below the conductors (see Figure 5, above) is to enable all conductors to be lifted at the same time by the operation of a tensioning device.

### V-arm support

The V-arm support rig (see Figure 6, below) must only be used for intermediate constructions.

The conductor load must be assessed and the SWL/WLL of the V-arm confirmed to ensure that the load rating is not exceeded.



**Figure 6: V-arm**

### Wire tong rig

The wire tong rig can be applied in four different ways:

- Wire tong rig – Lever lift method – intermediate constructions – SWL/WLL 110kg for the outer two phases, 225kg for the centre phase.
- Wire tong rig – lever lift method – alternate or deviation construction – SWL/WLL 110kg for the outer and centre phases.
- Wire tong rig – standard pole saddle method – SWL/WLL 110kg.
- Wire tong rig – supported pole saddle method – SWL/WLL 450kg.

Wire tong rig – lever lift method – intermediate constructions – SWL/WLL 110kg for the outer two phases, 225kg for the centre phase

This rig (see Figure 7, below) has an SWL/WLL of 110kg and is suitable for straight-line intermediate constructions and minor deviation constructions under six degrees.





**Figure 7: Wire tong rig**

This method is presented in three parts:

- Outer conductors – outlines the rigging of wire tongs suitable for the outer conductors such as on cross-arm constructions and stand-off insulators
- Centre conductors – outlines the rigging of wire tongs suitable for constructions which have the centre phase conductor
- Repositioning of the centre conductor – outlines the rigging required to reposition the centre conductor, e.g. when converting a flat construction to a Delta construction
- **Outer conductor – maximum conductor loading 110kg**
  - All equipment is normally rigged to the pole on the opposite side to the cross-arm.
  - Attach the 63mm lifting tong to the conductor with the jaws facing towards the pole and positioned as close as possible to the insulator.
  - Attach the lever lift to the lifting tong's butt from one end and is secured to the pole by a chain tightener on the other end.
  - Attach the 38mm holding tong to the conductor with the jaws facing down. It should be positioned on the outside of the 63mm lifting tong.
  - Attach the 38mm holding tong saddle to the pole with the tong clamp positioned in the opposite quarter to the conductor.
  - Vertically reposition the conductor by operating the tensioning device which is attached to the lever lift. To move the conductor horizontally, slide the 38mm wire tong through the clamp.

- **Centre conductor – maximum conductor loading 225kg**

This rig is suitable for constructions which have the centre conductor either attached to the cross-arm within 300mm of the pole or attached to the pole top bracket.

- Attach the upper 63mm lifting tong saddle to the pole on the opposite side to the cross-arm approximately 600mm below the conductor height.
- Attach the 63mm wire tong to the conductor as close as possible to the insulator.
- Attach the lower 63mm wire tong saddle approximately 1.2m directly underneath the upper saddle.
- Rig a tensioning device between the lower 63mm wire tong saddle and the butt ring of the wire tong.
- Reposition the centre conductor by operating the tensioning device.

- **Repositioning of the centre conductor**

This rig is used when the new construction requires the centre conductor to be relocated from the cross-arm to a pole-top bracket.

- The rig is similar to the centre conductor rig (explained above) with the addition of 2 x 16mm ropes and the removal of the lower 63mm lifting tong saddle.
- The 2 x 16mm ropes are fitted with link sticks and are attached onto the conductor.
- Movement is controlled horizontally by the 2 x 16mm side ropes and vertically by the operation of the tensioning device.

**Note:**

An alternative is to attach 1 x 16mm rope fitted with link stick to the conductor and another 16mm rope without link stick to the butt ring of the 63mm lifting tong. Both ropes would be operated from the same side of the pole.

### Wire tong rig – lever lift method – alternate or deviation constructions – SWL/WLL 110kg for the outer and centre phases

This rig (see Figure 8, below) has an SWL/WLL of 110kg and is suitable for alternate constructions and deviation constructions of six degrees and over.



**Figure 8: Alternate or deviation wire tong rig**

This method is similar to that used for intermediate constructions, with the following differences.

- Outer conductor

The rigging for the outer conductor on alternate or deviation constructions is similar to intermediate constructions. However, instead of a holding tong, there is a 16mm side rope connected to a link stick. The link stick is attached to the centre conductor and tensioned using a tensioning device. This device is anchored to a suitable anchor point near the ground and is used to control the horizontal load. The link stick is positioned on the conductor between the jaws of the lifting and holding tongs. Vertical movement remains the same as intermediate constructions.

- Centre conductor

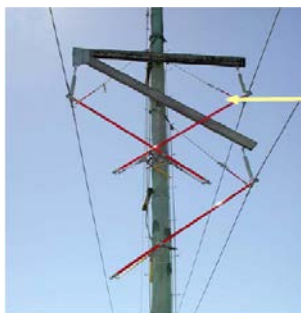
The rigging for the centre conductor on deviation constructions is similar to intermediate constructions, however the bottom saddle is not required. Instead, there is a 16mm side rope connected to a link stick attached to the conductor, and is used to control horizontal movement.

Wire tong rig – standard pole saddle method – SWL/WLL 110kg

**Figure 9: Wire tong saddle method**

A variation to the lever lift method is the standard pole saddle method (see Figure 9, above). This method is used when only one conductor needs to be moved. The only difference between this method and the lever lift method for intermediate constructions is that the lifting wire tongs are secured into pole clamps of lifting wire tong saddles instead of being attached to lever lifts. The tensioning device is coupled between the wire tong saddle and the butt ring of the wire tong.

The vertical repositioning of the conductor is achieved by operating the tensioning device. Horizontal repositioning of the conductor is achieved by sliding the holding wire tong through the clamp.

Wire tong rig – supported pole saddle method – SWL/WLL 450kg

**Figure 10: Supported wire tong saddle method**

The supported pole saddle method (see Figure 10, above) is similar to the standard pole saddle method except that the holding tong is replaced by a link stick that is attached as high as possible to the pole.

If a 16mm rope is used (instead of an 18mm rope), it must be square-rigged through a pulley block at the head of the pole with the fall of the rope connected to a rope tackle or hoist. The rope tackle or hoist is then operated by the ground worker. The conductor can be moved by loosening the wire tong saddle's clamp and operating the tensioning devices.

### Note:

- The tensioning device must never be rigged at or below the conductor height. An insulating medium must be fitted between the conductor and the tensioning device, e.g. a link stick or a synthetic insulator. The tensioning device can be a rope tackle or a hoist.
- The conductor must never be lowered to a position which is horizontally below the height of the wire tong saddle of the lifting wire tong. In multi-phase constructions, the lowest conductor is usually moved first to increase the working clearance.

### Crane support using insulation equipment

When using a crane to support conductors, all lifting equipment must be rated with an SWL/WLL.

Insulated equipment must be:

- visually inspected and wiped cleaned prior to use
- rated to the voltage being worked on.

### Note:

Lifting beams must have insulation between conductor and the lifting beam and between the lifting beam and the crane (see Figure 11, below).



**Figure 11: Lifting beam with insulation between conductor and the lifting beam and between the lifting beam and the crane**

Lifting devices that are positioned at an angle must have an extra de-rating applied. Supports that are positioned at a 60° angle must be de-rated. The formula for de-rating is:

$$\text{SWL/WLL @ 60°} = \text{WLL (of one leg)} \times 1.73$$

**Note:**

The lowest SWL/WLL rating of any individual part of the lifting rig is the maximum lifting capacity of the entire rig.

## Use of polymeric insulators

Polymeric insulators must be:

- visually inspected and wiped cleaned prior to use
- rated to the voltage being worked on
- tested and tagged at six-monthly intervals.

The SWL/WLL of the polymeric insulators must be calculated as this may limit the lifting capacity of the rig. This is done by using the routine test load (RTL) supplied by the manufacturer and applying a de-rating. The formula for the de-rating is:

$$\text{SWL/WLL} = \frac{\text{RTL}}{(2 \times 9.81)}$$

## Additional control methods

As the loading of the conductor nears the SWL/WLL of the equipment, it can be difficult to maintain control of the conductor. This control problem can be experienced as the lifting stick moves upward.

If this problem is experienced or is identified as a potential hazard during the risk assessment process, additional control of the conductor can be achieved by implementing one of the following measures.

- Additional assistance from another HV live worker, i.e. use two people to control the tension devices. Rig a link stick with a 16mm rope tensioning assembly and attach to the conductor (see Figure 12, below).



**Figure 12: Single brace and tensioning device**

- Add a swivel wire tong band on the holding tong and tension it using 16mm rope attached to the pole and control the rope from the ground (see Figures 13 and 14, below).



**Figures 13 and 14: Use of tensioning rope**

- Connect a tensioning device between the butt ring of the holding tong and the pole (see Figure 15, below).



**Figure 15: Tensioning device between butt ring and pole**

**Note:**

The 16mm ropes in the rigs illustrated above can be replaced by either a strap hoist or a rope tackle.

**References**

- High Voltage Live Work Manual:
  - work practice 6.4 (Conductor support)
  - section 7 (Conductors).



### 8.3 Rigging conductor strain equipment

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on conductor strain equipment and how it is used to support and/or move conductors under tension.

#### Background

- Conductor strain equipment is primarily used for:
  - replacing most types of strain insulators
  - tensioning conductors and removing tension from conductors
  - cutting in inline isolation devices.

It can also be used for replacing straight line and angle suspension insulators and cross-arms.

- Tensioning devices used in glove and barrier live line activities include:
  - strap-hoists
  - rope tackles
  - turnbuckles – specifically used as a tensioning device when cutting in an inline isolator.

#### Instructions

##### Rigging a strap-hoist

#### Important

A wire and chain ratchet hoist must not be used to strain or support energised HV conductors.

- Strap-hoists and spiral link sticks must have a suitable safe working load (SWL) or working load limit (WLL) for the tension being applied:
  - The SWL/WLL must be clearly marked on the strap-hoist.
  - The link stick's SWL/WLL can be found in the relevant manufacturer's catalogue.
- When a strap-hoist is to be used between two different potentials, such as on a cross-arm (see Figures 1 and 2, below), it must be used in conjunction with a link stick.



**Figure 1: Strap-hoist and link stick**



**Figure 2: Strap-hoist and link stick used on termination**

### **Important**

Come-along clamps must be used when tensioning conductors using a strap hoist. Pre-formed dead-end wraps must not be used for this purpose.

- Webbing strap ratchet hoists can be used on both sides of a cross-arm or pole while replacing suspension and angle insulators. For an example of a situation where an insulator is being replaced on a running disc angle (RDA) construction, see Figure 3, below.



**Figure 3: Strap-hoist being used on RDA to change insulator**

### Rigging a rope

#### Rope

Live work rope can be used to release tension on a conductor, provided that:

- the live work rope is always used with an insulated strain device such as a link stick and the MAD is maintained
- the live work rope is used in conjunction with a tensioning device (e.g. strap-hoist, rope tackle).

#### Note:

The live work rope must have an adequate SWL/WLL for the conductor tension and a minimum diameter of 16mm. For more on this, see work practice 6.8 (Live work rope and insulated rope) in this manual.

#### Inline isolator

Inline isolators are used to provide a temporary isolation point to allow effective management of outages on the network. Once installed, they are used in a switching schedule as an isolation point.

#### Important

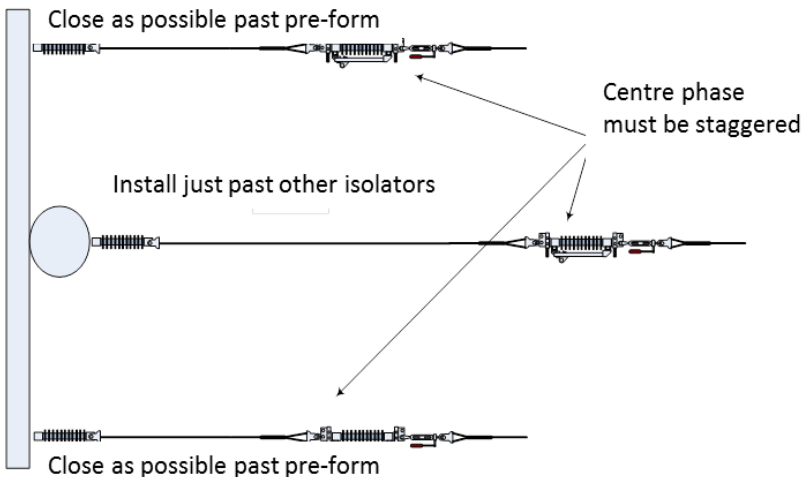
The safety observer must ensure that inline isolators are installed in accordance with this work practice prior to the making or breaking of any electrical connection.

- When using temporary inline isolators, you must ensure that the isolator is:
  - visually inspected and wiped cleaned prior to installation
  - within its electrical test date and that the test period will not expire during the time of the temporary isolator's installation
    - Inline isolators must be tested every six months.
    - The next test date must always be marked on the device.
    - If the test date has expired, the inline isolator must not be used until it has passed another electrical test.
  - installed for as short a period as practically possible and not more than two weeks prior to use.
- Inline isolators installed on the network must be:
  - visually inspected within 30 days
  - physically inspected within 60 days (under a Vicinity Authority (VA))
  - removed within 90 days.

**Note:**

Installation and removal timelines exist to prevent electrical and mechanical wear to the equipment that may then lead to high resistance connections (hotspots) and excessive tension on the overhead conductor.

- Inline isolators must be installed:
  - as close as practically possible to the cross-arm to prevent excess conductor movement (see Figure 4, below)
  - in a staggered configuration to prevent the blades from breaching the phase-to-phase clearance, as this would create a flashover at an open position (see Figure 4, below).

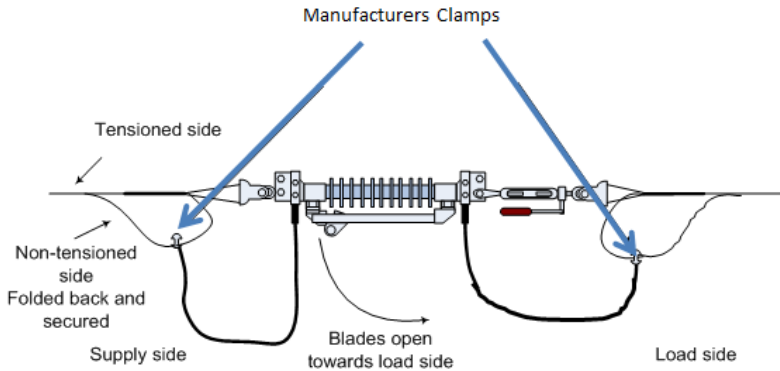


**Figure 4: Staggering inline isolators**

**Note:**

Never re-use pre-form terminations when installing inline isolators.

- Inline isolator taps must be rated to the conductor they are being connected to.
- All electrical connections must be clean, greased and tightened. The manufacturer's clamps must be fitted to the non-tensioned side of the conductor (tail end). This is to prevent development of high resistance connections (hotspots) that could result in the conductor breaking and dropping to the ground (see Figure 5, below).



**Figure 5: Inline isolator (with a ratchet)**

- Ensure that the isolator blades are positioned so that they open towards the conductor being de-energised or isolated (i.e. load side, as shown in Figure 5, above).
- Do not place a shock load on the inline isolators.
- Due to the difference in manufacturer designs, inline isolators must be used in accordance with the manufacturer's instructions and must not be repaired using alternative components or parts that will alter their design or affect their electrical or mechanical ratings. Only the manufacturer's parts or components may be used for repair.
- After installation, perform a visual inspection to ensure that the inline isolator is in the correct open or closed position.

### Operation of an inline isolator

- Inline isolators must:
  - only be operated under the instructions of a switching program
  - only be operated with an insulated stick from within an EWP. The use of a second insulated stick may be required to support the inline isolator.
- After operation, perform a visual inspection to ensure the inline isolator is in the correct open or closed position.

#### Note:

HV live work must not be performed in any bay where temporary inline isolators are installed (other than their installation or removal).

### References

- *High Voltage Live Work Manual*, work practice 6.8 (Live work rope and insulated rope)

## 8.4 Energising/de-energising and bypassing conductors and apparatus – glove and barrier method

### Purpose

The purpose of this work practice is to provide high voltage (HV) live workers with principles for:

- energising and de-energising conductors and apparatus
- bypassing conductors and apparatus (including replacing conductor bridges, electrical connectors and apparatus).

### Instructions

#### Energising/de-energising principles

- Energising and de-energising conductors, cables and apparatus must only be undertaken as an item on a switching program issued by Network Operations Control (NOC). All switching operations must be undertaken under the direct supervision of an authorised switching operator.
- Energising/de-energising can be done with:
  - rated load breaking devices (e.g. temporary drop out fuse (TDO) or inline isolator)

#### Important

If the HV live worker is working on an overhead conductor and cannot physically see the whole length of the line that will be energised, rated load breaking devices must be used.

- non-load breaking devices (e.g. taps and bridges). Before energising/de-energising, confirm that all electrical load has been removed. If in any doubt, do not proceed.

#### Important

- Non-load breaking devices must never be used to make or break load current.
- If using non-load breaking devices, before disconnection, use an ammeter to confirm that there is no electrical load greater than two amps.
- If the HV live worker is working on an overhead conductor and cannot physically see the whole length of the line that will be energised, use a rated load breaking device instead.

Below are the key issues to be aware of when energising/de-energising conductors and apparatus using the glove and barrier method:

- **Making or breaking load current** – The process of connecting or disconnecting the load current drawn from the source by the load. Only use equipment and/or tools rated to make or break the load.

### Important

Equipment and tools rated to make or break loads must only be operated using an insulated stick.

- **Ferranti effect** – When over-voltage (twice the system voltage) arises at the open circuit end of an unloaded underground cable or overhead line due to the inductive and capacitive nature of the line.

### Important

HV live work must not be performed at the open end of an energised underground cable.

- **Ferroresonance** – The occurrence of an unstable over-voltage when a three-phase underground HV line (capacitive component), connected to an unloaded three-phase transformer (inductive component), is disconnected by single-phase means (one phase at a time). To avoid ferroresonance, use one of the following:
  - Three-phase switching, e.g. a gang-operated switch.
  - Single-phase switching, i.e. connect a load box at the low voltage (LV) side of the transformer prior to operating the drop-out fuse (DOF).

For more on this, see work practice 2.12 (Ferroresonance) in this manual.



### Bypassing principles

Bypassing tools and/or equipment are used to temporarily bypass the flow of electrical current through an electrical conductor or apparatus for the purpose of replacing or removing the electrical conductor or apparatus.

#### **Note:**

Bypass jumpers must never be used to energise/de-energise or make and break load current.

The following safety checks must be carried out when using bypassing tools or equipment:

- Ensure that the bypass tools or equipment have a voltage and current rating adequate for the conductor voltage and load. Conductor loads and peak loads can be confirmed on NOC systems. This will involve establishing the feeder load and peak load current from NOC and checking the current rating and voltage rating of the available bypass tool or equipment.
- The bypass equipment must be in test date, wiped clean and inspected prior to use.
- An ammeter must be used to confirm the presence or absence of load on a conductor.
- All bypass equipment must be checked with an ammeter to ensure current is present in the device prior to disconnecting the original connection.
- All electrical connections must be cleaned, greased and checked for tightness.
- The conductor must be fully controlled at all times.
- Ensure that double insulation is applied in locations where the bypass jumper contacts, or could make contact with, the pole, cross-arm or any second point of contact.
- When using temporary bypasses with reclosers in the closed position, ensure that any supervisory and sensitive earth fault (SEF) equipment is disabled and tagged with an 'Information' caution tag, as required by the switching instructions. For more on this, see work practice 8.5 (Installation and maintenance of pole-mounted switches) in this manual.

#### **Note:**

Load in the bypass equipment may be minimal due to differences in resistance between the bypass equipment and conductor. However, the bypass equipment and connections must be checked if a zero reading occurs.

Overhead systems

Energising/de-energising lines under no load conditions

Permanent taps and bridges can be used for energising or de-energising open aerial conductors on system voltages up to and including 33kV, provided there is no load attached.

- This must be performed in accordance with a switching program.
- An ammeter must be used to prove the absence of load. A zero reading may not be possible as electrical apparatus with all load isolated may still carry a charging current. A reading of up to two amps is acceptable.
- The energising/de-energising principles above must be complied with.
- For the maximum length of line to be energised or de-energised under no load conditions, see Table 1 below.

**Table 1: Maximum length of unloaded open aerial lines that can be energised or de-energised by operating open wire taps and bridges**

Voltage (kV)	Maximum conductor length (km)	
	De-energising	Energising
11	15	Line of sight
22	4	Line of sight
33	1.5	Line of sight

Applying a temporary bypass jumper

Bypass jumpers (see Figure1, below) are typically used to bypass devices such as disconnect isolators, air break switches and electrical connections to maintain continuity of supply. Ensure that the bypassing principles are complied with.



**Figure 1: Temporary bypass jumper**

### Applying a TDO device

A common energising/de-energising application is a TDO device (see Figure 2). TDO's must be used for the following:

- to replace an expulsion DOF unit directly supplying transformers
- to energise a circuit to prove that no fault conditions exist, i.e. on a length of cable



**Figure 2: Bypassing via a TDO**

Below are the key points to follow when using a TDO:

- The energising/de-energising principles above must be followed.
- The voltage rating of the TDO must be appropriate for the voltage being worked on.
- A TDO fitted with a fuse element equal to or slightly exceeding the existing fuse element, but no greater than 25A, can be used for energising and de-energising the line.
- When replacing the fuse unit, the existing fuse carrier must be secured prior to replacement with a cable tie or large peg. This will ensure that it is not dislodged during the procedure.
- Consider fire risks when operating within high and extreme fire risk areas. For more on this, see work practice 2.16 (Fire precautions for field work) in the *Work Practice Manual*.

#### Important

Never operate a fuse carrier by the gloved hand. An insulated operating stick must be used.

## Hendrix cable

- Hendrix cable systems can be energised or de-energised under these conditions:
  - Only when performed under the instruction of a switching program.
  - Only after the absence of load has been proven, including removal of all transformer windings.
  - On voltages up to 33kV.
  - On cable sizes up to 185mm<sup>2</sup>.
  - On cables no longer than 1000m.
- During the risk assessment, the HV live work team must ensure that:
  - the phases of the cables to be worked on are clearly identified
  - the remote ends of the cables are in a safe and secure condition
  - new, replaced or repaired cables have been tested according to the commissioning sheet within the past 24 hours (or re-tested, if more than 24 hours has passed since the first test)
  - an insulation resistance test has been performed prior to connecting
  - the Construction Authority has issued a clearance to commission the cable for new and repaired cables
- Bridging tails must be controlled at all times to maintain minimum approach distances (MADs) to secondary points of contact.

## Replacing surge diverters

- Insulated sticks must be used to energise/de-energise surge arresters. Ensure that MADs are not breached when approaching the surge arresters.
- Using insulated sticks as a tool provides an additional control measure for any hazard.

### Key issues to consider when removing surge diverters

- If the existing surge diverters are ceramic, all surge diverters must be replaced.
- Disconnect and discharge the surge diverters before removing the earth connection by:
  - cutting away the active lead
  - discharging the active lead to earth.

This must be performed with insulated sticks and tools.

### Key issues to consider when installing surge diverters

- Only correctly rated and tested composite-type diverters may be installed.
- Prior to installation, prove the integrity of the new composite diverters by completing an insulation test using a 5000V insulation resistance tester (which must display a minimum resistance of 1000MΩ).
- When installing new diverters:
  1. Permanently connect the earth from each diverter so that all the diverter earth leads are bonded and connected to earth.
  2. Connect the new bridge to the phase end of the diverter.
  3. Use a wire holding stick to touch-test the bridge to the live conductor.
  4. Permanently connect the bridge to the live conductor.

### Underground systems

#### Important

HV live work must not be performed at the open end of an energised underground cable.

- Three-phase underground cables may only be energised/de-energised:
  - when performed under the instruction of a switching program
  - using a permanent or temporary switching device, i.e. pole top switch, DOF or TDO
  - using a specifically designed and tested load make/break tool.
- If using a single-phase switching device to energise/de-energise three-phase underground cable, the cable length **must not** exceed the critical cable length at which ferroresonance may occur. For more on ferroresonance and critical cable lengths, see work practice 2.12 (Ferroresonance) in this manual.

If cable lengths are at or near the critical length at which ferroresonance may occur, use one of the following:

  - Three-phase switching, e.g. a gang-operated switch.
  - Single-phase switching – connect a load box at the LV side of the transformer prior to operating the DOFs/TDOs.
- Underground cables can be energised/de-energised at the source of supply end using G&B or DIS procedures.

### Installing recording equipment on an energised conductor

- Recording equipment may be temporarily installed to energised conductors and cables using the glove and barrier method or the insulated stick method.
- The equipment must be rated for the voltage and current being applied.
- If the recording equipment is to be left unattended, a mechanical securing mechanism must be installed from the equipment to the conductor or cable. The electrical connection of the equipment must not be solely relied upon to secure the device.

### References

- High Voltage Live Work Manual, work practice:
  - 2.12 (Ferroresonance)
  - 8.5 (Installation and maintenance of pole-mounted switches)
- Work Practice Manual, work practice 2.16 (Fire precautions for field work)

### 8.5 Installation and maintenance of pole-mounted switches

#### Purpose

The purpose of this work practice is to provide high voltage (HV) live workers with the key principles for installing and maintaining pole-mounted switches.

#### Scope

This work practice applies to HV live workers installing or maintaining the following pole-mounted switches performing HV live work using the glove and barrier method:

- pole-top switches
- reclosers
- load break switches

#### Instructions

##### Key principles

When carrying out work on a load break switch or recloser, the following key principles must be followed.

- Energising/de-energising can only be performed under the instruction of a switching program.
- All switching apparatus must be visually inspected prior to removal and installation.
- Disable the remote control in the control box (if applicable).
- Ensure that supervisory and sensitive earth fault (SEF) equipment is disabled and tagged with an “Information” caution tag (if applicable).
- If closed switches must be opened to perform maintenance, use appropriate temporary bypass bridging tools. For more on this, see work practice 8.4 (Energising/de-energising and bypassing of conductors and apparatus – glove and barrier method) in this manual.
- Ensure that new installation leads of the recloser/switch are connected and the ends are tied back and the recloser/switch is in the open position.
- Ensure that all earth connections are made prior to energising conductors.
- On completion of work, check that the switch is in the correct position in accordance with the switching program.
- Remove the “Information” caution tag and enable supervisory and SEF equipment (if applicable).
- Enable the remote control in the control box (if applicable).

If switching apparatus has the capacity to be operated remotely, the status of the apparatus must be verified with the switching operator. The remote control function must be disabled prior to issuing the Vicinity Authority (VA).

Always perform a commissioning test using the relevant Distribution Commissioning Work Instruction (DCWI) prior to connecting any insulated switch to the live apparatus.

### Important

- If closed switches must be opened to perform maintenance, use appropriate temporary bypass bridging equipment.
- High voltage (HV) live work must not be carried out on reclosers with internal potential transformers (IVTs). For more on this, see work practice 1.0 (Introduction to HV live work) in this manual.

### References

- High Voltage Live Work Manual, work practices:
  - 1.0 (Introduction to HV live work)
  - 8.4 (Energising/de-energising and bypassing of conductors and apparatus – glove and barrier method)



### 8.6 Pole erection and recovery – glove and barrier method

#### Purpose

The purpose of this work practice is to outline how to erect and recover poles and structures that are in close proximity to energised high voltage (HV) conductors.

#### Instructions

- The pole erection/recovery must be carried out under the control and direction of a safety observer and a dogger. For more on these roles, see the following work practices in the *Work Practice Manual*:
  - 2.2 (Safety observer role)
  - 2.20 (Dogger – construction site).
- Insulated gloves must be worn by any HV live worker who is controlling any part of a pole (directly or with cant hooks) that is being raised or lowered near live conductors. The insulating gloves must be electrically rated to the highest voltage on the pole.
- Ensure that the requirements in work practice 2.5 (Use of plant and equipment) and section 4.0 (Mobile plant and related equipment for HV live work) are complied with. These include:
  - safe working load (SWL) and working load limit (WLL) considerations and limitations
  - insulation of the mobile plant, load and machinery
  - earthing of mobile plant and machinery
  - briefing and supervision and of crane operators and doggers

#### MADs and insulating barriers

Insulating barriers may need to be applied when erecting or recovering poles. This depends on whether the mobile plant used infringes upon the minimum approach distances (MADs) as outlined in work practice 4.0 (Mobile plant and related equipment for HV live work), Table 1: Uninsulated mobile plant and loads – minimum clearances, in this manual. If the:

- MADs can be maintained – insulating barriers are not required.
- MADs cannot be maintained – one of the following must be done:
  - apply insulating barriers to the pole or conductors
  - move the conductors to a position so that the MADs can be maintained.

**Note:**

It is advisable to position insulating barriers on the conductor even when MADs can be maintained, as the barriers provide a good sight reference.

**Insulating conductors and poles**

When the MAD of 1200mm between the conductor and any uninsulated items (e.g. crane, pole) cannot be achieved, insulating barriers must be applied to the pole/cross-arm or to the conductors. The amount of insulation applied will depend upon whether the phase-to-earth MAD of 450mm can be maintained between the pole/cross-arm and conductors.

- Single insulation – fit one layer of insulation if the MAD can be maintained. This is a precautionary measure.
- Double insulation – fit two layers of insulation if the MAD cannot be maintained and inadvertent contact is possible. For more on this, see work practice 8.1 (Double insulation) in this manual.

**Repositioning conductors**

Replacing a pole in the same location requires the conductors to be displaced from the existing pole to facilitate its removal.

The methods and equipment used to reposition conductors include:

- a tag rope fitted with link sticks – this releases and spreads the conductors
- an elevated work platform (EWP) fitted with a gin pole to lift the conductors up and away. For more on this, see work practice 4.2 (EWP and crane-mounted conductor support equipment) in this manual.
- other mobile plant and machinery (e.g. crane and lifting beam).

Releasing and spreading the conductors is dependent upon many factors such as conductor condition, conductor weight, conductor span length, conductor ground clearance, adjacent hazards and the presence of subcircuits. Due to the number of factors, the preferred way to release and/or support conductors is to use mobile plant and machinery as this allows for the best method of conductor control.

**Ropes**

When erecting or recovering poles, live work rope and insulated rope is used for two main purposes, listed below. When used for these purposes, the rope must have a rated and tested insulating medium (i.e. link stick) fitted between the rope and the conductor cover.

- Tag ropes – these are used to move the conductors to increase clearance to facilitate pole erection or recovery.
- Conductor cover positioning ropes – these are used to slide the insulating conductor covers along the conductor, to provide insulation either side of the pole during pole erection and recovery.

For more on live work rope and insulated rope, see work practice 6.8 (Live work rope and insulated rope) in this manual.

### Replacing the pole

- Ensure that the MADs are maintained between the conductors and the pole to be erected. All attachments (e.g. cross-arms) must be taken into consideration when calculating sufficient clearance between conductors and the pole.
- If the MADs for mobile plant cannot be maintained, insulating pole covers must be applied:
  - to the upper parts of the pole, which will be at or near the conductor height
  - around the earth leads.

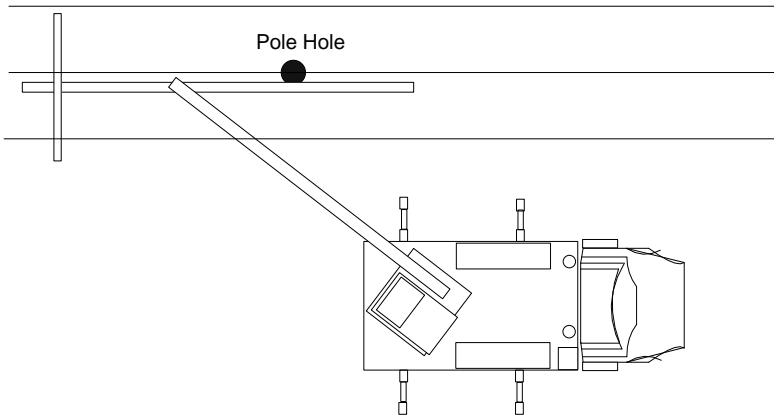
If it is not possible to install insulating pole covers, double insulation must be applied to the conductors.

- The butt of the new pole must be controlled until it is positioned in the pole hole.
- Insulated gloves rated to the highest voltage on the structure must be worn by the G&B worker on the ground when:
  - handling and guiding the pole butt into the pole hole
  - handling the pole when passing the pole between live conductors
  - using cant hooks to rotate the pole.

### Erecting poles

#### Positioning of crane borer

Position the crane borer in a location that will minimise the need for slewing of the boom when the pole is being erected. The most desirable crane borer and pole setup is shown in Figure 1, below. In this position, the majority of the lift is achieved by lifting up and down, jibbing in and out and using the winch rope.



**Figure 1: Crane borer and pole setup**

### Erecting a pole mid-span

Poles are commonly erected mid-span to increase ground clearance or to create a new transformer position to meet new customer needs (see Figure 2, below).



**Figure 2: Insulating barriers applied for a pole being erected mid-span**

### Erecting a pole adjacent to an existing pole

Poles are commonly erected adjacent to an existing pole for convenience (i.e. change over the conductors to the new pole then remove the older pole) and to minimise changes to bay lengths (see Figure 3, below).



**Figure 3: Insulating barriers applied for a pole being erected adjacent to an existing pole**

Adequate clearance is not usually possible when erecting poles adjacent to existing poles, so it is usually necessary for conductors to be repositioned and/or have insulating barriers applied.

The methods and equipment used to reposition conductors include:

- a tag rope fitted with link sticks – this releases and spreads the conductors
- an elevated work platform (EWP) fitted with a gin pole to lift the conductors up and away. For more on this, see work practice 4.2 (EWP and crane-mounted conductor support equipment) in this manual.
- an extension arm – the HV worker repositions the conductors onto an extension arm while using appropriate insulation. For more on this, see work practice 8.2 (Rigging conductor support equipment – glove and barrier method) in this manual.
- other mobile plant and machinery (e.g. crane and lifting beam).

### References

- High Voltage Live Work Manual:
  - work practice 2.5 (Use of plant and equipment)
  - section 4 (Use of plant and machinery)
  - work practice 6.8 (Live work rope and insulated rope)
  - work practice 8.1 (Double insulation)
  - work practice 8.2 (Rigging conductor support equipment – glove and barrier method)
- Work Practice Manual:
  - work practice 2.2 (Safety observer role)
  - work practice 2.20 (Dogger – construction site)

### **8.7 This work practice has intentionally been left blank**

Details on glove and barrier live work techniques using plant and machinery have been moved and can now be found in section 4 (Use of plant and machinery) in this manual.

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### 9.0 Distribution insulated stick method

#### Purpose

The purpose of this work practice is to outline the general requirements when using the distribution insulated stick method on high voltage (HV) apparatus on the Western Power distribution network (i.e. 1kV to 33kV).

#### Important

The HV live work team must only work on one potential at any given time. Take care to ensure that the work of one person does not compromise the safety of the other.

#### Note:

The distribution insulated stick method **must not** be used on the transmission network. Work on apparatus at transmission voltages must be done using the method described in section 10 (Transmission insulated stick method) in this manual.

#### Key requirements

HV live workers using the distribution insulated stick method must always:

- maintain the minimum approach distance (MAD) between energised conductors or electrical apparatus and their body
- use insulated sticks that:
  - can maintain rated insulation between the voltage being worked on, the HV live worker's body and other sources of electrical potential
  - have the structural capacity to adequately manipulate or support the electrical apparatus they are attached to and in contact with
  - are suitable for safe work on energised conductors or electrical apparatus in the specific work environment (i.e. environmental factors must be considered)
  - are within their electrical test date.
- work under a Vicinity Authority (VA).

### Important

No HV live work must be undertaken without an applicable and approved HV live work procedure.

If no applicable HV live work procedure is available, a draft procedure must be produced by the work team intending to do the work. The draft procedure must be submitted to, and approved by, Work Practice Development before it can be used.

### Types of insulated sticks

Insulated fibreglass sticks (also known as hot sticks) are manufactured by winding glass fibre onto a unicellular polyurethane foam core. There are two basic types of insulated fibreglass sticks:

- Hand sticks – used to manipulate or operate electrical apparatus.
- Supporting insulated sticks and supporting rigs – used to support and manipulate conductors or electrical apparatus during HV live work.

### Hand guards

Hand guards indicating the MAD or tool insulation distance must be installed on all hand sticks in a colour that is clearly visible on the stick. Guards must be secured so they do not move during work.

The tool insulation distance is the distance between the part of the stick that is in direct contact with energised apparatus and the hand guard. If there is any likelihood energised apparatus may make contact beyond the metal working end of the stick, such as during tying and untying, the tool insulation distance must be adjusted.

The tool insulation distance must always be equal to or greater than the MAD.

The HV live worker must not encroach on either the MAD or the tool insulation distance.

### MADs

The MADs are shown in Table 1, below.

**Table 1: MADs\* to be maintained by HV live workers for the distribution insulated stick method**

System voltage (kV)	Conductor status	MAD (mm)	Minimum clearances between conductors (mm)		
			Phase-to-earth secured <sup>#</sup>	Phase-to-earth	Phase-to-phase
6.6 – 33	Bare	450	150	450	550

\* The clearances in Table 1 are with the auto-reclose in the OFF position.

<sup>#</sup> Secured – tied-in at the insulator and/or locked into a conductor trap with no possible risk of the clearance being reduced.

### Important

If personnel cannot maintain the MADs from live apparatus, the task must not be performed.

### Auto-reclose OFF

- The auto-reclose equipment controlling the circuit on which HV live work is to be performed must be disabled for the duration of the work. The reasons for disabling the auto-reclose equipment are as follows:
  - On distribution systems, the surge from the reclose may create additional voltage on the temporary insulation in use, creating a hazard for HV live workers, insulation equipment and electrical apparatus.
  - To limit the damaging mechanical forces resulting from fault currents.
  - If there is an incident at the worksite, the HV live worker has the assurance of knowing that the line will not be re-energised (which could pose a further risk to HV live workers).
- Operation of an auto-recloser on an HV live work site is a reportable incident and all HV work must cease. For more on this, see work practice 2.8 (Incident reporting) in this manual.

### Safe working principles specific to distribution insulated stick work method

The following safe working principles are specific to distribution insulated stick work. These supplement section 2 (Safe working principles) in this manual.

- MADs must always be maintained.
- Insulated sticks must be wiped clean and inspected prior to use. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- Insulated sticks must only be used within their test approval dates.
- All secondary points of contact, including energised conductors below, must have rated insulated barriers applied. Secondary points of contact include those that are within reach of items being manipulated by an insulated stick (e.g. conductor tails).

### Insulated EWP

- Insulated EWPs may only be used within their test approval dates.
- A minimum of 250mm clearance must be maintained between the EWP basket and any second point of contact, unless covered with insulated barriers rated for the highest voltage. When the insulating barriers have been applied to the second point of contact then the EWP basket minimum clearance can be reduced to accidental contact.

### Working on a return wire

The return wire has the potential to become energised to the phase voltage under fault conditions. The HV live worker using the insulated stick method must use the following procedures and principles when working on the return wire:

- DIS-Support-01 (Displace and replace return wire) in the *High Voltage Live Work Procedures – Distribution Insulated Stick*

or

- 6.30 (SWER return wire maintenance when the phase conductor is energised) in the *Work Practice Manual*.

### Personnel

The HV live work team has the final say as to when they can or cannot do a task, or whether they need to rest or rotate personnel. For more on this, see work practice 2.1 (Onsite risk assessment) in this manual.

All HV live workers must be authorised in the method that they are using. For more on this, see work practice 3.3 (Authorisation and supervision) in this manual.

### Minimum number of personnel

A minimum of three HV live workers are required for performing distribution insulated stick method, except when performing the tasks listed in the 'Single person aloft permitted tasks' section, below.

### Single person aloft permitted tasks

After a risk assessment by the HV live work team, it may be decided that only one HV live worker needs to go aloft to perform a task (one team member must still act as the safety observer). The following tasks are the only ones that may be performed by a single person aloft using the distribution insulated stick method:

- Structure, conductor and insulator inspection.
- Installation or removal of fault detection equipment.
- Installation or removal of insulating barriers or covers.
- Tying and untying when the conductor is securely trapped and fully controlled.
- Connecting and disconnecting of live line clamps.
- Installation or removal of spreader ropes.
- Tightening hardware (e.g. cross-arms and insulators).
- Installing vibration dampers.
- Installing bird diverters.

#### Note:

Single person aloft tasks only apply to personnel who are authorised as unsupervised in the insulated stick method. For more on this, see work practice 3.3 (Authorisation and supervision) in this manual.

### Procedures

This section of the *High Voltage Live Work Manual* provides guidance on how to perform HV live work using the distribution insulated stick method. For detailed procedures using this method, see *High Voltage Live Work Procedures – Distribution Insulated Stick*.

### References

- AS 5804.1-2010 *High-voltage live working – General*.
- AS 5804.3-2010 *High-voltage live working – Stick work*.
- *High Voltage Live Work Manual*:
  - section 2 (Safe working principles)

- work practice 3.3 (Authorisation and supervision)
- work practice 5.1 (Equipment maintenance)
- Work practice 10.0 (Transmission insulated stick method).
- *High Voltage Live Work Procedures – Distribution Insulated Stick*, DIS-Support-01 (Displace and replace return wire).
- *Work Practice Manual*, work practice 6.30 (SWER return wire maintenance when the phase conductor is energised).

### 9.1 Applying fittings – distribution insulated stick method

#### Purpose

The purpose of this work practice is to outline how to use insulating sticks to apply a range of fittings to a conductor. These fittings are usually applied as part of a more involved task.

#### Important

When applying these fittings, the high voltage (HV) live worker must always:

- maintain the necessary minimum approach distances (MADs)
- apply insulated covers to all secondary points of contact where there are voltage potentials or a difference in potential from the item that is being worked on

#### Instructions

##### Conductor ties

When tying or untying conductors from an insulator, ensure that:

- the insulation of the insulator is not breached
- Phase-to-phase and phase-to-earth MADs are not breached
- the high voltage (HV) live workers personal MADs are not breached

These points can be achieved by:

- covering the cross arm and insulator support pin with insulated covers (for preferred types, see Figures 1 and 2, below) or with insulated blankets and pegs



**Figures 1 and 2: Cross-arm hard cover**

- removing small pieces of tie wire to avoid bridging out the insulator

- maintaining the phase-to-earth and phase-to-earth secured MAD between the structure and any energised part. For example:
  - structure – cross-arm and insulator pin for the two outer phases, pole and insulator pin for the middle phase
  - energised part – conductor, conductor tie wire or wrap and metal part of the insulated stick

For more information on MADs see section 9.0 'Distribution insulated stick method' in this manual.

## Application

### Note:

The conductor must be controlled at all times when applying a conductor tie.

1. Prepare the coil for application by halving the coil (see Figure 3, below).

### Note:

On angle constructions, prepare the tie with the coils facing inwards as they will end up facing out once the tie is crossed over along the conductor.



**Figure 3: Separated tie coil**

2. Wrap the tie around the insulator for one complete rotation. Ensure that the coils are facing down and outwards (see Figure 4, below).



**Figure 4: Tie attached to insulator\***



\* The cross-arm cover has been removed in order to give a clear view of the coils.

### Removal

If the MADs cannot be maintained between the unwound tie and any other conductor or part of the structure, insulated covers must be applied before removing the tie.

### Repair splices and armour rods

#### Important

During the application of repair splices and armour rods, unravelling can occur which can cause the splice or rod to flick back towards the HV live worker and adjacent conductors. To prevent flashover, apply rigid barriers on adjacent conductors.

1. Use a wire holding stick to clamp the three preformed splices or armour rod and splices onto the conductor (see Figure 5, below).
2. Use a hot rodder tool, serviette ring or podger to wrap the three preformed splices onto the conductor.
3. Wrap one splice length at a time over the conductor, starting from the middle of the splice at the repair location. Repeat this using the second splice in the space alongside the first length. Finally, apply the last splice to the remaining space.



**Figure 5: Splice applied to conductor**

## Termination helical fittings

1. Use a wire holding stick to secure the termination by clamping on one leg close to the bend.
2. Use a hot rodder tool, a serviette ring or podger to wrap the secured leg onto the conductor.
3. Transfer the wire holder onto the free leg of the termination and wrap onto the conductor using the tool selected to do the wrapping. Once the free leg has been partially wrapped, transfer the wire holder onto the conductor (see Figure 6, below).
4. Finish wrapping onto the termination.



**Figure 6: Helical termination being applied to a conductor**

## Bolted fittings

There are many items of hardware that may need to be bolted to a conductor. These can include electrical connectors, suspension clamps, recorders and markers. A range of tools are used to support these various fittings, including straight pliers, all-angle pliers and podgers.

One of the items commonly bolted to a conductor is the disc insulator. An example describing how to apply and remove this item is provided below.

### Disc insulator – application

To connect a conductor to a disc insulator with a suspension clamp, use either:

- a clevis bolt and split pin
- a clevis pin and a split pin that is then shaped to the 'W' cotter pin configuration

The following photos and notes illustrate how to connect the conductor to the disc insulator using a suspension clamp.

1. Support the suspension clamp with a podger while inserting the clevis bolt using pliers that have been fitted to extension handles.



2. Use an all-angle cog wrench to thread the nut onto the clevis bolt.



3. Insert the split pin using a split pin inserter.



4. Use pliers to place the tongue of the suspension clamp onto the conductor.



5.
  - a. Position U clamp over the tongue and then apply and tighten the nut.



- b. An alternative to the clevis bolt is a clevis pin. It can be inserted using the clevis pin holder.



### Disc insulator – removal

Figures 7 and 8, below, show the insertion/removal of clevis pins/bolts and split pins.



**Figure 7: Clevis bolt and split pin**



**Figure 8: Clevis pin and split pin**

The 'W' cotter pin configuration can be dislodged using a cotter pin pusher. In both configurations, the disc insulator can be supported using an adjustable insulator fork, while the conductor can be held secure by conductor support/strain equipment or a wire holding stick.

### 9.2 Rigging conductor support equipment – distribution insulated stick method

#### Purpose

The purpose of this work practice is to provide the high voltage (HV) live worker with information and guidance on how to use the distribution insulated stick method to rig conductor support equipment to conductors under tension.

#### Note:

The figures shown in this work practice focus on conductor support equipment rather than barriers. However, barriers must be used when installing and removing all rigging and conductor support equipment.

#### Safety

Supporting and/or moving a conductor must be done in a manner that ensures total control of the conductor at all times.

An evaluation and risk assessment of the conductor must be done during the pre-job planning stage and the conductor must be inspected prior to work. For more on this, see work practice 7.8 (Conductor characteristics) in this manual.

#### Instructions

When moving and displacing conductors ensure that the MADs are maintained as described in section 9.0 'Distributed insulated stick method' in this manual.

When using the phase-to-earth secured clearance of 150mm and the conductor tie wire is to be removed then:

- Prior to un-tying the conductor it must be secured and locked into the conductor trap with a small amount of upward pressure applied.
- You must ensure that there is absolutely no possible risk that the conductor, conductor tie wire or conductor trap will breach the 150mm MAD to any second point of contact while the conductor is being un-tied, moved and displaced.

If the MAD cannot be maintained then insulated barriers must be applied to all second points of contact.

#### Important

- A conductor must never be left unsupported or unrestrained at any time.
- HV live work methods must not be used to displace or tension copper conductors that are 7/16 or smaller.

## Safe Working Load/Working Load Limit

- The calculated conductor load:
  - determines the HV live equipment that is to be used for supporting or moving conductors
  - must be matched against the safe working load (SWL) or working load limit (WLL) of the HV live equipment
- The SWL/WLL must be greater than, or equal to, the conductor load for the HV live equipment (i.e. rigs) that is to be used.
- The SWL/WLL and the conductor load must be established during the pre-job planning stage.

### Note:

For more information on:

- conductor characteristics, loading and calculations, see section 7 (Conductors and insulators) in this manual
- the SWL/WLL of conductor support equipment, see work practice 6.4 (Conductor support equipment) in this manual

## Support methods

### Choosing which support method to use

An HV live work team's training, experience and collective planning ability will all contribute to the decision on which support methods are appropriate to use to achieve the desired outcome. More than one support method can be used on the same structure at the same time.

### Physically moving conductors using the distribution insulated stick method

A conductor can be repositioned using the distribution insulated stick method provided that:

- the HV live worker has assessed and determined that the weight of the conductor to be lifted does not exceed their physical ability
- only one conductor is moved at a time. The HV live worker controlling the conductor must not have any other task to perform at the same time (e.g. operating the elevated work platform (EWP) controls or repositioning insulating barriers).
- full control of the conductor can be maintained at all times

- the conductor is repositioned either onto an insulator or onto a temporary conductor support. The conductor may be repositioned onto the cross-arm if double insulation is maintained.
- the two HV live workers in the basket of the EWP do not contact different potentials at the same time

### Wire tong system

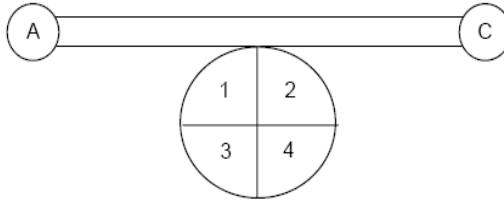
The wire tong system of supporting and moving conductors is versatile because it can be used on all types of structures. The system uses tensioning devices and levers to support and move conductors.

The principle components of the system are wire tongs, lever lifts, wire tong saddles, snubbing brackets and tensioning devices.

- Wire tongs:
  - lifting tong – this is a 63mm wire tong, and its main function is to lift and support the majority of the conductor weight
  - holding tong – this is a 38mm wire tong, and its main function is to hold and control the lateral movement of the conductor
- Lever lift – main function is to raise and lower the lifting tong.
- Wire tong saddle – a device that is secured to the pole using a chain tightener and has a pole clamp that entraps the wire tong, allowing the wire tong to pivot and slide in and out of the pole clamp. The 63mm wire tong saddle can be used as an anchor point for ropes or tensioning devices.
- Snubbing brackets – these are fitted to the pole using a chain tightener and are used as an anchor point for ropes or tensioning devices.
- Tensioning devices – includes a variety of equipment such as ropes, strap hoists and pulleys that provide a method of moving the conductor in a fully controlled manner.
- Rigging a wire tong – When attaching holding tong saddles to the pole, they must be rigged on the opposite quarter to the conductor (see Figure 1, below, for an example).

When rigging to move:

- conductor A, the holding tong saddle would be rigged to the pole in quarter 4
- conductor C, the holding tong saddle would be rigged to the pole in quarter 3



**Figure 1: Where to rig a holding tong saddle to a pole**

**Note:**

- To avoid the wire tongs being damaged, the wheel tighteners of all the equipment must be positioned on the opposite side from the working side.
- Wire tongs and associated equipment are usually rigged on the opposite side of the pole to the cross-arm to facilitate replacement of the cross-arm.

## Rigging equipment

### Extension arm

Supporting the conductor using a pole-mounted temporary conductor support bracket – SWL/WLL 68kg per wire holder

The pole-mounted temporary conductor support bracket (see Figure 2, below) attaches to the pole for the temporary support of conductors, bridges, bypass jumpers, etc. It is attached to the pole by either a chain tightener or a strap hoist, with the larger section of the pole-securing bracket facing the ground to provide stability.





**Figure 2: Extension arm – pole mounted (without wire holder insulator)**

The temporary conductor support bracket is available in two lengths:

- 750mm for single wire holder (single-phase)
- 1200mm for two wire holders (two-phase)

Wire holders can either be a 'fork' type or an underslung 'C' type. The SWLs/WLLs of the support brackets per wire holder are:

- fork type – 68kg (vertical load)
- C type – 45kg (side load)

**Note:**

Wire holder insulators (see Figure 3, below) must be fitted between the support arm and the conductor trap if the voltage exceeds the rated voltage of the support arm.



**Figure 3: Wire holder insulator**

## Auxiliary arm assembly

### Supporting conductors using an auxiliary arm assembly

The auxiliary arm assembly consists of a mast, cross-arm, arm braces and wire holders. This assembly is attached to the pole using two lifting wire tong saddles. The cross-arm can be fitted with 'fork' or 'C' type wire holders, depending on whether the arm assembly is rigged above or below the existing cross-arm.

This assembly must always be used with at least one arm brace. A wire holder insulator must be fitted between the support bracket and the conductor trap if the rating of the equipment is below the phase voltage of the line.

The SWL/WLL of the rig is:

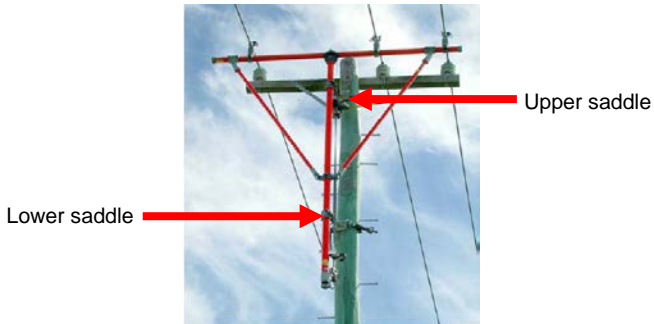
- 68kg with one arm brace attached
- 210kg with two arm braces attached



**Figure 4: Auxiliary arm – above conductors**

- The most common rigging position for the auxiliary arm is above the conductors, to facilitate the conductors being raised into the wire holders (see Figure 4, above). This position increases separation, providing better access for the basket of the EWP.
- The wire holders should be positioned on the auxiliary arm to align with the conductor position on the existing cross-arm. The minimum conductor separation that must be maintained is:
  - phase-to-phase – 550mm
  - phase-to-earth – 450mm
- The upper wire tong saddle should be fitted to the pole on the opposite side to the existing cross-arm and as high as possible while maintaining clearances. The lower wire tong saddle should be fitted 1.0 to 1.2m vertically below the upper saddle.

- A safety sling or tensioning device must be fitted between the butt ring of the mast and one of the wire tong saddles. The height of the auxiliary arm assembly can be adjusted by loosening off the wire tong pole clamps and operating the tensioning device.



**Figure 5: Auxiliary arm – below conductors**

The main reason that the auxiliary arm is rigged below the conductors (see Figure 5) is to enable all conductors to be lifted at the same time by the operation of a tensioning device.

### V-arm support

The V-arm support rig (see Figure 6, below) must only be used for intermediate constructions.

The conductor load must be assessed and the SWL/WLL of the V-arm confirmed to ensure that the load rating is not exceeded.



**Figure 6: V-arm**

## Wire tong rig

The wire tong rig can be applied in four different ways:

- Wire tong rig – Lever lift method – intermediate constructions – SWL/WLL 110kg for the outer two phases, 225 kg for the centre phase
- Wire tong rig – lever lift method – alternate or deviation construction – SWL/WLL 110kg for the outer and centre phases
- Wire tong rig – standard pole saddle method – SWL/WLL 110kg
- Wire tong rig – supported pole saddle method – SWL/WLL 450kg

Wire tong rig – lever lift method – intermediate constructions – SWL/WLL 110 kg for the outer two phases, 225 kg for the centre phase

This rig (see Figure 7, below) has an SWL/WLL of 110kg and is suitable for straight-line intermediate constructions and minor deviation constructions under six degrees.



**Figure 7: Wire tong rig**

This method is presented in three parts:

- outer conductors – outlines the rigging of wire tongs suitable for the outer conductors such as on cross-arm constructions and stand-off insulators
- centre conductors – outlines the rigging of wire tongs suitable for constructions which have the centre phase conductor
- centre conductors that require repositioning – outlines the rigging required to reposition the centre conductors, e.g. when converting a flat construction to a Delta construction

- Outer conductor – maximum conductor loading 110kg
  - All equipment is normally rigged to the pole on the opposite side to the cross-arm.
  - Attach the 63mm lifting tong to the conductor with the jaws facing towards the pole and positioned as close as possible to the insulator.
  - Attach the lever lift to the lifting tong's butt from one end and is secured to the pole by a chain tightener on the other end.
  - Attach the 38mm holding tong to the conductor with the jaws facing down. It should be positioned on the outside of the 63mm lifting tong.
  - Attach the 38mm holding tong saddle to the pole with the tong clamp positioned in the opposite quarter to the conductor.
  - Vertically reposition the conductor by operating the tensioning device which is attached to the lever lift. To move the conductor horizontally, slide the 38mm wire tong through the clamp.

- Centre conductor – maximum conductor loading 225kg

This rig is suitable for constructions which have the centre conductor either attached to the cross-arm within 300mm of the pole or attached to the pole top bracket.

- Attach the upper 63mm lifting tong saddle to the pole on the opposite side to the cross-arm approximately 600mm below the conductor height.
  - Attach the 63mm wire tong to the conductor as close as possible to the insulator.
  - Attach the lower 63mm wire tong saddle approximately 1.2m directly underneath the upper saddle.
  - Rig a tensioning device between the lower 63mm wire tong saddle and the butt ring of the wire tong.
  - Reposition the centre conductor by operating the tensioning device.
- Repositioning of the centre conductor

This rig is used when the new construction requires the centre conductor to be relocated from the cross-arm to a pole-top bracket.

- The rig is similar to the centre conductor rig (explained above) with the addition of 2 x 16mm ropes and the removal of the lower 63 mm lifting tong saddle.
- The 2 x 16mm ropes are fitted with link sticks and are attached onto the conductor.
- Movement is controlled horizontally by the 2 x 16mm side ropes and vertically by the operation of the tensioning device.

**Note:**

An alternative is to attach 1 x 16mm rope fitted with link stick to the conductor and another 16mm rope without link stick to the butt ring of the 63mm lifting tong. Both ropes would be operated from the same side of the pole.

Wire tong rig – lever lift method – alternate or deviation constructions – SWL/WLL 110kg for the outer and centre phases

This rig (see Figure 8, below) has an SWL/WLL of 110kg and is suitable for alternate constructions and deviation constructions of six degrees and over.



**Figure 8: Alternate or deviation wire tong rig**

This method is similar to that used for intermediate constructions, with the following differences.

- Outer conductor

The rigging for the outer conductor on alternate or deviation constructions is similar to intermediate constructions. However, instead of a holding tong, there is a 16mm side rope connected to a link stick. The link stick is attached to the centre conductor and tensioned using a tensioning device. This device is anchored to a suitable anchor point near the ground and is used to control the horizontal load. The link stick is positioned on the conductor between the jaws of the lifting and holding tongs. Vertical movement remains the same as intermediate constructions.

- Centre conductor

The rigging for the centre conductor on deviation constructions is similar to intermediate constructions, however the bottom saddle is not required. Instead,

there is a 16mm side rope connected to a link stick attached to the conductor, and is used to control horizontal movement.

### Wire tong rig – standard pole saddle method – SWL/WLL 110kg

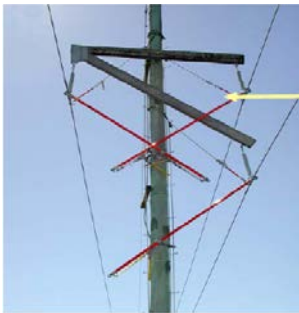


**Figure 9: Wire tong saddle method**

A variation to the lever lift method is the standard pole saddle method (see Figure 9, above). This method is used when only one conductor needs to be moved. The only difference between this method and the lever lift method for intermediate constructions is that the lifting wire tongs are secured into pole clamps of lifting wire tong saddles instead of being attached to lever lifts. The tensioning device is coupled between the wire tong saddle and the butt ring of the wire tong.

The vertical repositioning of the conductor is achieved by operating the tensioning device. Horizontal repositioning of the conductor is achieved by sliding the holding wire tong through the clamp.

### Wire tong rig – supported pole saddle method – SWL/WLL 450 kg



**Figure 10: Supported wire tong saddle method**

The supported pole saddle method (see Figure 10, above) is similar to the standard pole saddle method except that the holding tong is replaced by a link stick that is attached as high as possible to the pole.

If a 16 mm rope is used (instead of an 18mm rope), it must be square-rigged through a pulley block at the head of the pole with the fall of the rope connected to a rope tackle or hoist. The rope tackle or hoist is then operated by the ground worker. The conductor can be moved by loosening the wire tong saddle's clamp and operating the tensioning devices.

**Note:**

- The tensioning device must never be rigged at or below the conductor height. An insulating medium must be fitted between the conductor and the tensioning device, e.g. a link stick or a synthetic insulator. The tensioning device can be a rope tackle or a hoist.
- The conductor must never be lowered to a position which is horizontally below the height of the wire tong saddle of the lifting wire tong. In multi-phase constructions, the lowest conductor is usually moved first to increase the working clearance.

### Crane support using insulation equipment

When using a crane to support conductors, all lifting equipment must be rated with an SWL/WLL.

Insulated equipment must be:

- visually inspected and wiped cleaned prior to use
- rated to the voltage being worked on

**Note:**

Lifting beams must have insulation between conductor and the lifting beam and between the lifting beam and the crane (see Figure 11, below).





**Figure 11: Lifting beam with insulation between conductor and the lifting beam and between the lifting beam and the crane**

Lifting devices that are positioned at an angle must have an extra de-rating applied. Supports that are positioned at a 60 degree angle must be de-rated. The formula for de-rating is:

$$\text{SWL/WLL @ } 60^\circ = \text{WLL (of one leg)} \times 1.73$$

**Note:**

The lowest SWL/WLL rating of any individual part of the lifting rig is the maximum lifting capacity of the entire rig.

### Use of polymeric insulators

Polymeric insulators must be:

- visually inspected and wiped cleaned prior to use
- rated to the voltage being worked on
- tested and tagged at six monthly intervals

The SWL/WLL of the polymeric insulators must be calculated as this may limit the lifting capacity of the rig. This is done by using the routine test load (RTL) supplied by the manufacturer and applying a de-rating. The formula for the de-rating is:

$$\text{SWL/WLL} = \frac{\text{RTL}}{(2 \times 9.81)}$$

### Additional control methods

As the loading of the conductor nears the SWL/WLL of the equipment, it can be difficult to maintain control of the conductor. This control problem can be experienced as the lifting stick moves upward.

If this problem is experienced or is identified as a potential hazard during the risk assessment process, additional control of the conductor can be achieved by implementing one of the following measures.

- Additional assistance from another HV live worker, i.e. use two people to control the tension devices. Rig a link stick with a 16mm rope tensioning assembly and attach to the conductor (see Figure 12, below).



**Figure 12: Single brace and tensioning device**

- Add a swivel wire tong band on the holding tong and tension it using 16mm rope attached to the pole and control the rope from the ground (see Figures 13 and 14, below).



**Figures 13 and 14: Use of tensioning rope**

- Connect a tensioning device between the butt ring of the holding tong and the pole (see Figure 15, below).



**Figure 15: Tensioning device between butt ring and pole**

**Note:**

The 16mm ropes in the rigs illustrated above can be replaced by either a strap hoist or rope tackle.

### References

- High Voltage Live Work Manual:
  - work practice 6.4 (Conductor support equipment)
  - section 7 (Conductors and insulators)

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### 9.3 Energising/de-energising and bypassing conductors and apparatus – distribution insulated stick method

#### Purpose

The purpose of this work practice is to provide high voltage (HV) live workers with principles for:

- energising and de-energising conductors and apparatus
- bypassing conductors and apparatus (including replacing conductor bridges, electrical connectors and apparatus).

#### Instructions

##### Energising/de-energising principles

- Energising and de-energising conductors, cables and apparatus must only be undertaken as an item on a switching program issued by Network Operations Control (NOC). All switching operations must be undertaken under the direct supervision of an authorised switching operator.
- Energising/ de-energising can be done with:
  - rated load breaking devices (e.g. temporary drop out fuse (TDO) or inline isolator)

#### Important

If the HV live worker is working on an overhead conductor and cannot physically see the whole length of the line that will be energised, rated load breaking devices must be used.

- non-load breaking devices (e.g. taps and bridges). Before energising/de-energising, confirm that all electrical load has been removed. If in any doubt, do not proceed.

#### Important

- Non-load breaking devices must never be used to make or break load current.
- If using non-load breaking devices, before disconnection, use an ammeter to confirm that there is no electrical load greater than two amps.
- If the HV live worker is working on an overhead conductor and cannot physically see the whole length of the line that will be energised, use a rated load breaking device instead.

Below are the key issues to be aware of when energising/de-energising conductors and apparatus using the distribution insulated stick method:

- **Making or breaking load current** – The process of connecting or disconnecting the load current drawn from the source by the load. Only use equipment and/or tools rated to make or break the load.

### Important

Equipment and tools rated to make or break loads must only be operated using an insulated stick.

- **Ferranti effect** – When over voltage (twice the system voltage) arises at the open circuit end of an unloaded underground cable or overhead line due to the inductive and capacitive nature of the line.

### Important

HV live work must not be performed at the open end of an energised underground cable.

- **Ferroresonance** – The occurrence of an unstable over voltage when a three-phase underground HV line (capacitive component), connected to an unloaded three-phase transformer (inductive component), is disconnected by single-phase means (one phase at a time). To avoid ferroresonance, use one of the following:
  - Three-phase switching, e.g. a gang-operated switch.
  - Single-phase switching, i.e. connect a load box at the low voltage (LV) side of the transformer prior to operating the drop-out fuse (DOF).For more on this, see work practice 2.12 (Ferroresonance) in this manual.

### Bypassing principles

Bypassing tools and/or equipment are used to temporarily bypass the flow of electrical current through an electrical conductor or apparatus for the purpose of replacing or removing the electrical conductor or apparatus.

#### **Note:**

Bypass jumpers must never be used to energise/de-energise or make and break load current.

The following safety checks must be carried out when using bypassing tools or equipment:

- Ensure that the bypass tools or equipment have a voltage and current rating adequate for the conductor voltage and load. Conductor loads and peak loads can be confirmed on NOC systems. This will involve establishing the feeder load and peak load current from NOC and checking the current rating and voltage rating of the available bypass tool or equipment.
- The bypass equipment must be in test date, wiped clean and inspected prior to use.
- An ammeter must be used to confirm the presence or absence of load on a conductor.
- All bypass equipment must be checked with an ammeter to ensure current is present in the device prior to disconnecting the original connection.
- All electrical connections must be cleaned, greased and checked for tightness.
- The conductor must be fully controlled at all times.
- Ensure that double insulation is applied in locations where the bypass jumper contacts, or could make contact with, the pole, cross-arm or any second point of contact.
- When using temporary bypasses with reclosers in the closed position, ensure that any supervisory and sensitive earth fault (SEF) equipment is disabled and tagged with an 'Information' caution tag, as required by the switching instructions.

#### **Note:**

Load in the bypass equipment may be minimal due to differences in resistance between the bypass equipment and conductor. However, the bypass equipment and connections must be checked if a zero reading occurs.

## Overhead systems

### Energising/de-energising lines under no load conditions

Permanent taps and bridges can be used for energising or de-energising open aerial conductors on system voltages up to and including 33kV, provided there is no load attached.

- This must be performed in accordance with a switching program.
- An ammeter must be used to prove the absence of load. A zero reading may not be possible as an electrical apparatus with all load isolated may still be carrying a charging current. A reading of up to two amps is acceptable.
- The energising/de-energising principles above must be complied with.
- For the maximum length of line to be energised or de-energised under no load conditions, see Table 1 below.

**Table 1: Maximum length of unloaded open aerial lines that can be energised or de-energised by operating open wire taps and bridges**

Voltage (kV)	Maximum conductor length (km)	
	De-energising	Energising
11	15	Line of sight
22	4	Line of sight
33	1.5	Line of sight

### Applying a temporary bypass jumper

Bypass jumpers (see Figure 1, below) are typically used to bypass devices such as disconnect isolators, air break switches and electrical connections to maintain continuity of supply. Ensure that the bypassing principles are complied with.



**Figure 1: Temporary bypass jumper**



### Applying a TDO device

A common energising/de-energising application is a TDO device (see Figure 2).

TDO's must be used for the following:

- to replace an expulsion DOF unit directly supplying transformers
- to energise a circuit to prove that no fault conditions exist i.e. on a length of cable.



**Figure 2: Bypassing via a TDO**

Below are the key points to follow when using a TDO:

- The energising/de-energising principles above must be followed.
- The voltage rating of the TDO must be appropriate to the voltage being worked on.
- The TDO can be attached to the overhead conductor by a grip-all (shotgun) stick.
- A TDO fitted with a fuse element equal to or slightly exceeding the existing fuse element, but no greater than 25A, can be used for energising and de-energising the line.
- When replacing the fuse unit, the existing fuse carrier must be secured prior to replacement with a cable tie or large peg. This will ensure that it is not dislodged during the procedure.
- Consider fire risks when operating within high and extreme fire risk areas. For more on this, see work practice 2.16 (Fire precautions for field work) in the *Work Practice Manual*.

## Hendrix cable

- Hendrix cable systems and HV aerial bundled conductor (ABC) systems can be energised or de-energised under these conditions:
  - Only when performed under the instruction of a switching program.
  - Only after the absence of load has been proven, including removal of all transformer windings.
  - On voltages up to 33kV.
  - On cable sizes up to 185mm<sup>2</sup>.
  - On cables no longer than 1000m.
- During the risk assessment, the HV live work team must ensure that:
  - the phases of the cables to be worked on are clearly identified
  - the remote ends of the cables are in a safe and secure condition
  - new, replaced or repaired cables have been tested according to the commissioning sheet within the past 24 hours (or re-tested, if more than 24 hours has passed since the first test)
  - an insulation resistance test has been performed prior to connecting
  - the Construction Authority has issued a clearance to commission the cable for new and repaired cables
- Bridging tails must be controlled at all times to maintain minimum approach distances (MADs) to secondary points of contact.

### Note:

Use a wire holding stick and cutters to remove existing bridges.

## Replacing surge diverters

- Insulated sticks must be used to energise/de-energise surge arresters. Ensure that the MADs are not breached when approaching the surge arresters.
- Using insulated sticks as a tool provides an additional control measure for any hazard.

### Key issues to consider when removing surge diverters

- If the existing surge diverters are ceramic, all surge diverters must be replaced.
- Disconnect and discharge the surge diverter before removing the earth connection by:
  - cutting away the active lead
  - discharging the active lead to earth.

This must be performed with insulated sticks and tools.

### Key issues to consider when installing surge diverters

- Only correctly rated and tested composite-type diverters may be installed.
- Prior to installation, prove the integrity of the new composite diverters by completing an insulation test using a 5000V insulation resistance tester (which must display a minimum resistance of 1000MΩ).
- When installing new diverters:
  1. Permanently connect the earth from each diverter so that all the diverter earth leads are bonded and connected to earth.
  2. Connect the new bridge to the phase end of the diverter.
  3. Use a wire holding stick to touch-test the bridge to the live conductor.
  4. Permanently connect the bridge to the live conductor.

### Underground systems

#### Important

HV live work must not be performed at the open end of an energised underground cable.

- Three-phase underground cables may only be energised/de-energised:
  - when performed under the instruction of a switching program
  - using a permanent or temporary switching device, i.e. pole top switch, DOF or TDO
  - using a specifically designed and tested load make/break tool.
- If using a single-phase switching device to energise/de-energise three-phase underground cable, the cable length **must not** exceed the critical cable length at which ferroresonance may occur. For more on ferroresonance and critical cable lengths, see work practice 2.12 (Ferroresonance) in this manual.

If cable lengths are at or near the critical length at which ferroresonance may occur, use one of the following:

  - Three-phase switching, e.g. a gang-operated switch.
  - Single-phase switching – connect a load box at the LV side of the transformer prior to operating the DOFs/TDOs.
- Underground cables can be energised/de-energised at the source of supply end using DIS or G&B procedures.

### Installing recording equipment on an energised conductor

- Recording equipment may be temporarily installed to energised conductors and cables using the insulated stick method.
- The equipment must be rated for the voltage and current being applied.
- If the recording equipment is to be left unattended, a mechanical securing mechanism must be installed from the equipment to the conductor or cable. The electrical connection of the equipment must not be solely relied upon to secure the device.

### References

- High Voltage Live Work Manual, work practice 2.12 (Ferroresonance)
- Work Practice Manual, work practice 2.16 (Fire precautions for field work)

### 9.4 Pole erection and recovery – distribution insulated stick method

#### Purpose

The purpose of this work practice is to outline how to erect and recover poles and structures that are in close proximity to energised high voltage (HV) conductors.

#### Instructions

- The pole erection/recovery must be carried out under the control and direction of a safety observer and a dogger. For more on these roles, see the following work practices in the *Work Practice Manual*:
  - 2.2 (Safety observer role)
  - 2.20 (Dogger – construction site).
- Insulated gloves must be worn by any HV live worker who is controlling any part of a pole (directly or with cant hooks) that is being raised or lowered near live conductors. The insulating gloves must be electrically rated to the highest voltage on the pole.
- Ensure that the requirements in work practice 2.5 (Use of plant and equipment) and section 4.0 (Mobile plant and related equipment for HV live work) are complied with. These include:
  - safe working load (SWL) and working load limit (WLL) considerations and limitations
  - insulation of the mobile plant, load and machinery
  - earthing of mobile plant and machinery
  - briefing and supervision and of crane operators and doggers

#### MADs and insulating barriers

Insulating barriers may need to be applied when erecting or recovering poles. This depends on whether the mobile plant used infringes upon the minimum approach distances (MADs) as outlined in work practice 4.0 (Mobile plant and related equipment for HV live work), Table 1: Uninsulated mobile plant and loads – minimum clearances, in this manual. If the:

- MADs can be maintained – insulating barriers are not required.
- MADs cannot be maintained – one of the following must be done:
  - apply insulating barriers to the pole or conductors
  - move the conductors to a position so that the MADs can be maintained.

**Note:**

It is advisable to position insulating barriers on the conductor even when MADs can be maintained, as the barriers provide a good sight reference.

### Insulating conductors and poles

When the MAD of 1200mm between the conductor and any uninsulated items (e.g. crane, pole) cannot be achieved, insulating barriers must be applied to the pole/cross-arm or to the conductors. The amount of insulation applied will depend upon whether the phase-to-earth MAD of 450mm can be maintained between the pole/cross-arm and conductors.

- Single insulation – fit one layer of insulation if the MAD can be maintained. This is a precautionary measure.
- Double insulation – fit two layers of insulation if the MAD cannot be maintained and inadvertent contact is possible. For more on this, see work practice 8.1 (Double insulation) in this manual.

### Repositioning conductors

Replacing a pole in the same location requires the conductors to be displaced from the existing pole to facilitate its removal.

The methods and equipment used to reposition conductors include:

- a tag rope fitted with link sticks – this releases and spreads the conductors
- an elevated work platform (EWP) fitted with a gin pole to lift the conductors up and away. For more on this, see work practice 4.2 (EWP and crane-mounted conductor support equipment) in this manual.
- other mobile plant and machinery (e.g. crane and lifting beam).

Releasing and spreading the conductors is dependent upon many factors such as conductor condition, conductor weight, conductor span length, conductor ground clearance, adjacent hazards and the presence of sub-circuits. Due to the number of factors, the preferred way to release and/or support conductors is to use mobile plant and machinery as this allows for the best method of conductor control.

### Ropes

When erecting or recovering poles, live work rope and insulated rope is used for two main purposes, listed below. When used for these purposes, the rope must have a rated and tested insulating medium (i.e. link stick) fitted between the rope and the conductor cover.

- Tag ropes – these are used to move the conductors to increase clearance to facilitate pole erection or recovery.
- Conductor cover positioning ropes – these are used to slide the insulating conductor covers along the conductor, to provide insulation either side of the pole during pole erection and recovery.

For more on live work rope and insulated rope, see work practice 6.8 (Live work rope and insulated rope) in this manual.

### Replacing the pole

- Ensure that the MADs are maintained between the conductors and the pole to be erected. All attachments (e.g. cross-arms) must be taken into consideration when calculating sufficient clearance between conductors and the pole.
- If the MADs for mobile plant cannot be maintained, insulating pole covers must be applied:
  - to the upper parts of the pole which will be at or near the conductor height
  - around the earth leads.

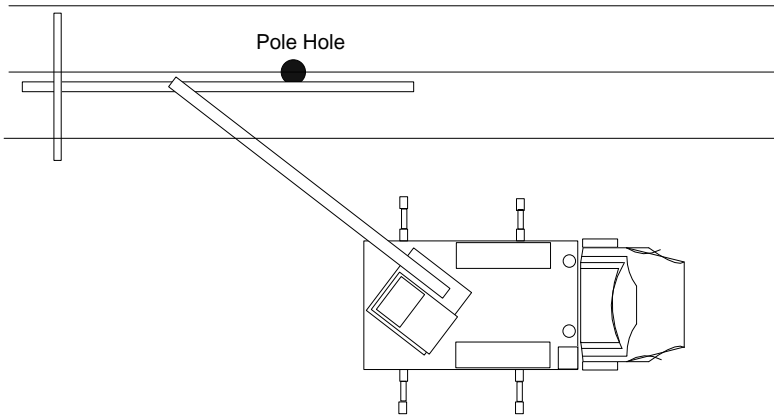
If it is not possible to install insulating pole covers, double insulation must be applied to the conductors.

- The butt of the new pole must be controlled until it is positioned in the pole hole.
- Insulated gloves rated to the highest voltage on the structure must be worn by the DIS worker on the ground when:
  - handling and guiding the pole butt into the pole hole.
  - handling the pole when passing the pole between live conductors
  - using cant hooks to rotate the pole.

## Erecting poles

### Positioning of crane borer

Position the crane borer in a location that will minimise the need for slewing of the boom when the pole is being erected. The most desirable crane borer and pole setup is shown in Figure 1, below. In this position, the majority of the lift is achieved by lifting up and down, jibbing in and out and using the winch rope.



**Figure 1: Crane borer and pole setup**

### Erecting a pole mid-span

Poles are commonly erected mid-span to increase ground clearance or to create a new transformer position to meet new customer needs (see Figure 2, below).



**Figure 2: Insulating barriers applied for a pole being erected mid-span**



### Erecting a pole adjacent to an existing pole

Poles are commonly erected adjacent to an existing pole for convenience (i.e. change over the conductors to the new pole then remove the older pole) and to minimise changes to bay lengths (see Figure 3, below).



**Figure 3: Insulating barriers applied for a pole being erected adjacent to an existing pole**

Adequate clearance is not usually possible when erecting poles adjacent to existing poles, so it is usually necessary for conductors to be repositioned and/or have insulating barriers applied.

The methods and equipment used to reposition conductors include:

- a tag rope fitted with link sticks – this releases and spreads the conductors
- an elevated work platform (EWP) fitted with a gin pole to lift the conductors up and away. For more on this, see work practice 4.2 (EWP and crane-mounted conductor support equipment) in this manual.
- an extension arm – the HV live worker repositions the conductors onto an extension arm by using insulated sticks, tensioning devices, levers and/or pulleys and appropriate insulation. For more on this, see work practice 9.2 (Rigging conductor support equipment – distribution stick method) in this manual.
- other mobile plant and machinery (e.g. crane and lifting beam).

### References

- High Voltage Live Work Manual:
  - work practice 2.5 (Use of plant and equipment)
  - section 4 (Use of plant and machinery)
  - work practice 6.8 (Live work rope and insulated rope)
  - work practice 9.2 (Rigging conductor support equipment – distribution stick method)
- Work Practice Manual:
  - work practice 2.2 (Safety observer role)
  - work practice 2.20 (Dogger – construction site)

### **9.5 This work practice has intentionally been left blank**

Details on distribution stick live work techniques using plant and machinery have been moved and can now be found in section 4 (Use of plant and machinery) in this manual.

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### 10.0 Transmission insulated stick method

#### Purpose

The purpose of this work practice is to outline the general requirements when using the transmission insulated stick method on high voltage (HV) apparatus on the Western Power transmission network (i.e. 66kV up to and including 132kV).

#### Important

The HV live work team must only work on one potential at any given time. Take care to ensure that the work of one person does not compromise the safety of the other.

#### Key requirements

HV live workers using the transmission insulated stick method must always:

- maintain the minimum approach distance (MAD) between energised conductors or electrical apparatus and their body
- use insulated sticks that:
  - can maintain rated insulation between the voltage being worked on and the HV live worker's body and other sources of electrical potential
  - have the structural capacity to adequately manipulate or support the electrical apparatus they are attached to and in contact with
  - are suitable for safe work on energised conductors or electrical apparatus in the specific work environment (i.e. environmental factors must be considered).
- work under a Vicinity Authority (VA).

#### Important

No HV live work must be undertaken without an applicable and approved HV live work procedure.

If no applicable HV live work procedure is available, a draft procedure must be produced by the work team intending to do the work. The draft procedure must be submitted to, and approved by, Work Practice Development before it can be used.

## Types of insulated sticks

Insulated fibreglass sticks (also known as hot sticks) are manufactured by winding glass fibre onto a unicellular polyurethane foam core. There are two basic types of insulated fibreglass sticks:

- Hand sticks – used to manipulate or operate electrical apparatus.
- Supporting insulated sticks and supporting rigs – used to support and manipulate conductors or electrical apparatus during HV live work.

## Hand guards

Hand guards indicating the MAD or tool insulation distance must be installed on all hand sticks in a colour that is clearly visible on the stick. Guards must be secured so they do not move during work.

The tool insulation distance is the distance between the part of the stick that is in direct contact with energised apparatus and the hand guard. If there is any likelihood energised apparatus may make contact beyond the metal working end of the stick, the tool insulation distance must be adjusted.

The tool insulation distance must always be equal to or greater than the MAD.

The HV live worker must not encroach on either the MAD or the tool insulation distance.

## MADs

The MADs are shown in Table 1, below.

**Table 1: MADs for the transmission insulated stick method\***

System voltage (kV)	Conductor status	MAD (mm)	Minimum clearances between conductors (mm)	
			Phase-to-earth	Phase-to-phase
66	Bare	820	1000	1000
132	Bare	1200	1200	1300

\* The clearances in Table 1 are with the auto-reclose function in the OFF position.

### Important

If personnel cannot maintain the MADs from live apparatus, the task must not be performed.

### Auto-reclose OFF

- The auto-reclose equipment controlling the circuit on which HV live work is to be performed must be disabled for the duration of the work. The reason for disabling the auto-reclose equipment is because if there is an incident at the worksite, the HV live worker has the assurance of knowing the line will not be re-energised (which could pose a further risk to HV live workers).
- Operation of an auto-recloser at an HV live work site is a reportable incident and all HV work must cease. For more on this, see work practice 2.8 (Incident reporting) in this manual.

### Safe working principles specific to transmission insulated stick method

The following safe working principles apply to transmission insulated stick work. These supplement those outlined in section 2 (Safe working principles) in this manual.

- MADs must always be maintained.
- Insulated sticks must be wiped clean and inspected prior to use. For more on this, see work practice 5.1 (Equipment maintenance) in this manual.
- Insulating sticks must only be used within their test approval dates.
- When installing or removing down earths from an overhead earth wire, HV live workers must wear Class 4 (36kV) insulated gloves. For more on this, see work practice 6.15 (Down earth assemblies – maintenance) in the *Work Practice Manual*.

### Procedures

This section of the *High Voltage Live Work Manual* provides guidance on the principles of HV live work using the transmission insulated stick method. For detailed procedures using this method, see *High Voltage Live Work Procedures – Transmission Insulated Stick*.

### References

- *AS 5804.1-2010 High-voltage live working – General.*
- *AS 5804.3-2010 High-voltage live working – Stick work.*
- *High Voltage Live Work Manual:*
  - section 2 (Safe working principles)
  - work practice 5.1 (Equipment maintenance).
- *High Voltage Live Work Procedures – Transmission Insulated Stick.*

- *Work Practice Manual*, work practice 6.15 (Down earth assemblies – maintenance)



### **10.1 This section has been left blank intentionally**

Work practice 10.1 (Applying a bolted fitting - transmission insulated stick method) has been replaced by 'TIS-02 Insulator and conductor disconnection/reconnection' in the *High Voltage Live Work Procedures – Transmission Insulated Stick*.

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### **10.2 This section has been left blank intentionally**

Work practice 10.2 (Rigging conductor support equipment – transmission insulated stick method) has been replaced by 'TIS-05 Wire tong support pole saddle method' in the *High Voltage Live Work Procedures – Transmission Insulated Stick*.

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### 10.3 This section has been left blank intentionally

Work practice 10.3 (Displacing conductors using crane and lifting beam – transmission insulated stick method) has been replaced by 'TIS-04 Displacing conductors using crane and lifting beam' in the *High Voltage Live Work Procedures – Transmission Insulated Stick*.

### 10.4 This section has been left blank intentionally

Work practice 10.4 (Crane-mounted conductor support equipment – transmission insulated stick method) has been replaced by 'TIS-03 3-pole construction (cricket wicket) pole change' in the *High Voltage Live Work Procedures – Transmission Insulated Stick*.

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### Appendix 1      Apparent temperature index

Use the table on the following page to help determine the risks associated with performing high voltage (HV) live work in warm weather.

The apparent temperature heat and humidity index is a guide to how hot it really feels when relative humidity is factored in with the ambient temperature. The index is based on shade temperatures and light wind. The apparent temperature may increase in full sunlight by up to 8° C when the sun is at its highest point.

#### References

- Steadman Apparent Temperature table. Obtained 23 February 2015 from [http://www.bom.gov.au/info/thermal\\_stress/#apparent](http://www.bom.gov.au/info/thermal_stress/#apparent)

Apparent temperature (AT) from temperature and relative humidity - after Steadman 1994		Temperature (°C)																		
		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Relative Humidity (%)	0	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
	5	16	17	18	19	20	21	22	23	24	25	26	28	29	30	31	32	33	34	35
	10	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	15	17	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36
	20	17	18	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	25	18	19	20	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	30	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	35	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	40	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	45	19	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	50	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	55	20	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	60	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	65	21	22	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	70	21	23	24	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
	75	22	23	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
	80	22	24	25	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
	85	23	24	26	27	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	90	23	25	26	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	95	23	25	26	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
	100	24	25	27	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44

AT above 50°C

Legend: Red values, apparent temperature above air temperature; blue values, apparent temperature below air temperature

### Appendix 2 HV live work training – interview questions

This appendix contains the questions to be used during the selection process for high voltage (HV) live work. These questions assist in determining an applicant's aptitude and suitability for HV live work.

#### About the interview

##### Important

Results of interviews must be formally recorded and placed in the applicant's personnel file along with all documentation involving the application.

#### Interview panel

The interview panel must include at least:

- one person authorised for HV live work on the Western Power Network
- one independent person

#### Pre-reading

Applicants must be given the opportunity to read the following from the *High Voltage Live Work Manual*:

- section 1 (Introduction to HV live work)
- work practice 2.1 (Onsite risk assessment)
- work practice 2.3 (Permits, network protective devices and communication)
- work practice 4.0 (Mobile plant and related equipment for HV live work)
- work practice 5.1 (Equipment maintenance)
- work practice 7.0 (Conductors and insulators)
- work practice 9.0 (Distribution insulated stick method)

#### Questions and scoring

- The questions are divided into two sections:
  - Aptitude – These questions are about determining the applicant's aptitude and suitability for HV live work and looks at the applicant's existing experience, safety record and attitude.
  - Knowledge – These questions cover core HV live work, safety principles and work practices that are covered in the pre-reading.

- The required response is listed below each question.
- Each question must be scored on a scale from one to six, where four is required as a pass and six is excellent.

### Interview questions

#### Aptitude

##### 1. Current experience

Please tell us about your existing experience with overhead line work.

*The applicant must be able to demonstrate a sound knowledge and depth of experience in overhead line work. Experience should include*

- *qualifications*
- *exposure to transmission, HV, low voltage (LV), faults, etc.*
- *exposure to LV live work*
- *switching*
- *supervising others*
- *length and currency of experience*

##### 2. Safety attitude

Please provide an example of where you have demonstrated safety leadership or initiative by making sound decisions regarding safety. It may have involved risk assessment, control measures or a situation where you refused to accept unsafe behaviour.

*The applicant must be able to provide examples where they have proactively demonstrated leadership by making decisions to:*

- *include additional risk control measures for specific risks*
- *used initiative to find safer alternatives*
- *tackled unsafe behaviours*

##### 3. Motivation

Please tell us why you want to be trained as a high voltage live worker.

*The applicant must be able to provide positive motivational reasons based on challenges and continuous improvement.*

### 4. Working independently and staying focused

Please give an example of where you have worked independently, stayed focused and safely completed the job.

*The applicant must be able to provide examples of:*

- *being able to work independently without constant supervision*
- *staying focused on the job and not being distracted*
- *consistently being able to safely complete tasks within defined timeframes*

### 5. Working relationships and team

Please describe a time where, working as a team, you have been actively involved in resolving a problem, conflict or difference of opinion.

*The applicant must be able to provide clear examples of where they have demonstrated:*

- *a key role in bringing the team together in resolving a problem*
- *resolved a conflict or difference of opinion within the team*

*Examples may include accepting constructive advice from others.*

## Knowledge

### 1. Understanding of HV live work

Please tell us what your understanding of high voltage live work with glove and barrier or insulated sticks is.

*From the pre-reading, the applicant must be able to describe the key concepts of HV live work including a basic understanding of glove and barrier and insulated stick work.*

*The applicant must be able to provide some examples where HV live work is typically used, e.g. changing in-line pole, insulator.*

### 2. Risk assessment

Can you name some of the issues you would need to consider during onsite risk assessment for high voltage live work?

*The applicant must be able to name a minimum of four of the considerations outlined in the work practice 2.1 (Onsite risk assessment) in this manual.*

### 3. Permit system

High voltage live work in Western Power is performed under what permit?

*The applicant must be able to name the Vicinity Authority (VA) permit.*

### 4. Notification

Who must be notified prior to any high voltage live work being undertaken?

*The applicant must be able to identify Network Operations Control (NOC).*

### 5. Levels of insulation

What do you think is meant by two levels of insulation with high voltage live work?

*The applicant must be able to adequately explain the basic concept as outlined in section 1 (Introduction to HV live work) in this manual.*

### 6. Secondary point of contact

What is meant by a secondary point of contact?

*The applicant must be able to adequately explain the basic concept as outlined in section 1 (Introduction to HV live work) in this manual (see below).*

*All electrical apparatus or earth structures operating at different potentials to the primary point of contact under live work.*

### 7. Minimum approach distances (MADs)

What is your understanding of minimum approach distances? Are you familiar with any MADs?

*The applicant must demonstrate awareness of the 450 mm MAD for insulated stick work up to 33 kV as outlined in work practice 9.0 (Distribution insulated stick method) in this manual.*

### 8. Circuit protection

What do you need to ensure with circuit protection prior to high voltage live work?

*The applicant must be able to show awareness that network protective devices must be operational in the circuit being worked on. These devices must be capable of detecting and clearing faults at the worksite.*

### 9. Mobile plant

What must be considered prior to starting work when using mobile plant such as cranes and EWP's?

*The applicant must be able to provide some of the following answers:*

- *safe working loads (SWL) or working load limits (WLL) of the mobile plant and equipment*
- *insulation of the mobile plant*
- *MADs for the uninsulated part of the plant load*
- *earthing of mobile plant*
- *inspection of existing pole top structures or assemblies using an elevated work platform (EWP)*
- *locating people, cranes, EWP's and vehicles outside of any possible pole assembly or aerial failure pathway*

### 10. Care and maintenance

Why is the inspection, cleaning and testing of insulated sticks, gloves, sleeves and other equipment so important?

*The applicant must be able to demonstrate awareness that:*

*The electrical and structural integrity of HV equipment and tools is critical to the safety of the HV live worker. Inspection, care, maintenance, testing and storage requirements must be strictly followed. Personnel must maintain HV live work equipment and ensure that it is in a serviceable condition.*

### 11. Supporting conductors

What must be considered in order to properly manage the risks associated with working on conductors?

*The applicant must have an awareness that the HV live worker needs to understand:*

- *the risks associated with moving conductors and mechanical loads*
- *the different types of conductors in Western Power and the risks associated with each*

### References

High Voltage Live Work Manual:

- section 1 (Introduction to HV live work)
- work practice 2.1 (Onsite risk assessment)
- work practice 2.3 (Permits, network protective devices and communication)
- work practice 4.0 (Mobile plant and related equipment for HV live work)
- work practice 5.1 (Equipment maintenance)
- work practice 7.0 (Conductors and insulators)
- work practice 9.0 (Distribution insulated stick method)



### **Appendix 3      This appendix has intentionally been left blank**

*HV live work training – Peer review* has been removed from this manual as it is no longer in use. Relevant details on the high voltage (HV) live work selection process can be found in section 3 (Training, competency and auditing requirements) in this manual.

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Appendix 4      International Beaufort's Scale

Grade	Denomination	Indicator	Wind velocity km/hr
0	Calm	Smoke rises vertically	0 to 1
1	Light air	Smoke rises almost vertically, motion of air barely detectable	2 to 6
2	Light breeze	Tree and shrub foliage hums, surface of standing water rippled, a light flag in motion	7 to 12
3	Gentle breeze	Tree and shrub foliage hums, surface of standing water rippled, a light flag in motion	13 to 18
4	Moderate breeze	Tree twigs in motion, flags flutter	19 to 25
5	Fresh breeze	Tree branches in motion, surface of standing water covered with small, rolling waves, wind feels unpleasant	26 to 35
6	Strong breeze	Wind howls in forests and buildings, lighter trees in motion, surface of standing water covered with rolling waves and with an occasional choppy wave	36 to 45
7	Moderate gale	Wind bends trees, surface of standing water covered with chopping, rolling waves	46 to 54
8	Fresh gale	Wind bends trees, breaks off twigs, howling of wind in forests audible at a distance, walking against the wind is difficult	55 to 65
9	Strong gale	Wind overturns lighter objects knocks down roofing tiles, breaks off branches and small trees, walking in the wind is very difficult	66 to 77
10	Whole gale	Wind breaks and uproots grown trees	78 to 90
11	Storm	Causes extensive damage to forests and buildings, knocks down pedestrians	91 to 104
12	Cyclone	Causes extensive destruction, knocks down roofs and chimneys, moves heavy objects	Greater than 104

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