Safe Work Practices on Low Voltage and Mechanical Apparatus

Summary:
This work instruction supports the Power System Safety Rules and its requirements assembled under Work on Low Voltage and Mechanical Apparatus - Category 4 and describe safe work practices to be followed for the control of hazardous situations.

It applies to the installation, maintenance, repair, inspection and testing of Low Voltage and Mechanical Apparatus in the charge of a Controller.

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When referring to TransGrid’s policies, frameworks, procedures or work instructions, please use the latest version on the Wire PSSR Page or Power System Safety Rules @ TransGrid
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1. Overview

1.1. Purpose

This work instruction supports the Power System Safety Rules and its requirements assembled under Work on Low Voltage and Mechanical Apparatus - Category 4 and describe safe work practices to be followed for the control of hazardous situations.

1.2. Policy Base

<table>
<thead>
<tr>
<th>Document No.</th>
<th>Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD SR G1 100</td>
<td>Power System Safety Rules</td>
</tr>
</tbody>
</table>

1.3. Reference Documents

<table>
<thead>
<tr>
<th>Document No.</th>
<th>Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS4836:2011</td>
<td>Safe working on or near low-voltage electrical installations and equipment</td>
</tr>
<tr>
<td>GD SR G2 140</td>
<td>Operating Process for Access to Low Voltage and Mechanical Apparatus</td>
</tr>
<tr>
<td>GD SR G2 141</td>
<td>Access for Work on Low Voltage and Mechanical Apparatus.</td>
</tr>
<tr>
<td>GM AS P2 001</td>
<td>Protection Metering Withdrawal Instruction</td>
</tr>
</tbody>
</table>

1.4. Scope

This work instruction applies to the installation, maintenance, repair, inspection and testing of all Low Voltage and Mechanical Apparatus in the charge of a Controller.

1.5. Accountability

<table>
<thead>
<tr>
<th>Responsible person</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager – Health, Safety &amp; Environment</td>
<td>Maintenance and ownership of this standard</td>
</tr>
<tr>
<td>Manager – Training</td>
<td>Implementation of training programs associated this standard</td>
</tr>
<tr>
<td>Authorised persons</td>
<td>Comply with this standard</td>
</tr>
</tbody>
</table>

1.6. Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-Low Voltage (ELV)</td>
<td>A voltage not exceeding 50 volts alternating current or 120 volts ripple free d.c.</td>
</tr>
<tr>
<td>Low Voltage (LV)</td>
<td>A nominal voltage exceeding Extra Low Voltage but not exceeding 1,000 volts a.c. or 1,500 volts d.c.</td>
</tr>
<tr>
<td>Mechanical (MECH) apparatus</td>
<td>Any equipment that has the ability to rotate, or is pneumatic or hydraulic in nature or contains stored energy through mechanisms, liquid, thermal or gas</td>
</tr>
<tr>
<td>PMWI</td>
<td>A Protection Metering Withdrawal Instruction which describes the isolations to be performed prior to the commencement of work</td>
</tr>
<tr>
<td>LVMPRI</td>
<td>A Low Voltage Mechanical Preparation Restoration Instruction which is used to ensure safe work conditions are in place for work under an Access Authority</td>
</tr>
</tbody>
</table>
1.7. Document Location

Block diagram showing location of document in relation to others.

2. Introduction

This work instruction was developed as a guide to assist in selecting the correct safe work practices to be used when performing work on or near low voltage or mechanical (LV/MECH) apparatus in the charge of a Controller. Work may only commence on or near LV/MECH apparatus when it has been made safe for work and an LV/MECH Access Authority has been issued.

Work on or near electrical installations not in the charge of the Controller shall comply with Category 3 of the Power System Safety Rules.

The safe work practices contained within this work instruction protect workers from the hazardous occurrences or effects that can develop on or around LV/MECH apparatus.

This could be caused by operation of the apparatus, or through indirect interference from activities such as panel drilling, installation of new LV wiring, investigation of faulty supervisory alarms, etc., and result in injury to workers, inadvertent operation of HV equipment or preventing operation of HV equipment.

This work instruction sets out a range of hazardous situations, the controls (safeguards) to be implemented and describes the safe work practices which must be observed.

These safe work practices are to be used in conjunction with TransGrid’s Risk Assessment Process. The process may identify that additional controls are required for particular tasks and situations.
3. Low Voltage and Mechanical Apparatus Hazards

Prior to undertaking work on LV/MECH apparatus, hazards shall be identified and controlled. The following hazards shall be considered:

3.1. Identification of equipment that is safe for work

Equipment on which work is to be carried out must be readily identifiable. Where necessary a means of identification shall be fixed to it which will remain effective throughout the course of the work.

3.2. Dangerous voltages

Dangerous voltages can occur from:

- Open circuit CT secondary circuits;
- Induction on cable sheaths, conductors; and
- Capacitors.

3.3. Exposed live conductors

Dangers can arise from:

- Exposed or live adjacent equipment;
- Bare or damaged conductors;
- Inadvertent energisation;
- Short circuit conditions (battery); and
- Inadequate precautions or isolations for LV work.

3.4. Pressure Systems & Stored Energy

Dangers can arise from the accidental release of stored energy from:

- Mechanical systems such as springs and other mechanisms;
- Gas systems such as accumulators;
- Batteries;
- Pressure storage vessels such as air systems and SF6 circuit breakers.

3.5. Rotating or moving parts

Some equipment can operate automatically without warning. Dangers can arise from rotating and moving parts such as HV apparatus control mechanisms, pumps and fans.

3.6. Other factors

Risks can be increased by:

- Cramped working conditions and Confined spaces;
- Multiple sources of supply;
- Damp situations;
- Environmental factors, e.g. heat, cold, vibration, noise and proximity of other work functions;
- Working at heights;
- Operational pressures to carry out work or to restore electricity supply;
- Unstable work area;
- Material containing asbestos;
- Hazardous substances;
- Inappropriate practices and procedures; and
- Working alone.
### 3.7. Low Voltage and Mechanical Hazardous Situations

The following table lists typical situations encountered when working on LV and MECH apparatus and the controls to be implemented.

<table>
<thead>
<tr>
<th>Situations</th>
<th>Hazards</th>
<th>Controls</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decommissioning, cutting and removal of cables</td>
<td>Live LV Cables</td>
<td>Safe work practises: <a href="#">Cables</a></td>
<td>This document Section 4.5</td>
</tr>
<tr>
<td>Work on secondary circuits of CT's</td>
<td>Dangerous Voltages</td>
<td>PMWI LV/MECH Access Authority Safe work practises: <a href="#">CT Secondary Circuits</a></td>
<td>GM AS P2.001 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.6</td>
</tr>
<tr>
<td>Electrical work e.g. relay maintenance; panel drilling; testing for the integrity and operability of energised circuits and apparatus or other work on or near live exposed conductors</td>
<td>Exposed live conductors</td>
<td>LVMPRI or PMWI LV/MECH Access Authority Safe work practises: <a href="#">Work on or near live exposed conductors</a></td>
<td>GD SR G2 140; GM AS P2.001 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.8</td>
</tr>
<tr>
<td>Fault finding</td>
<td>Exposed live conductors</td>
<td>Safe work practises: Authority for work Work on or near live exposed conductors</td>
<td>This document Section 4.2 This document Section 4.8</td>
</tr>
<tr>
<td>Electrical work on circuits containing capacitors</td>
<td>Dangerous Voltages</td>
<td>LVMPRI LV/MECH Access Authority Safe work practises: <a href="#">Capacitors</a></td>
<td>GD SR G2 140 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.9</td>
</tr>
<tr>
<td>Work on batteries and power supplies</td>
<td>Short circuit conditions Hazardous areas</td>
<td>LVMPRI LV/MECH Access Authority Safe work practises: <a href="#">Batteries, Chargers and Power Supplies</a></td>
<td>GD SR G2 140 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.10</td>
</tr>
<tr>
<td>Installation and commissioning of electrical circuits</td>
<td>Exposed live conductors</td>
<td>LVMPRI LV/MECH Access Authority Safe work practises: Testing electrical work prior to energising; and Unfinished electrical work</td>
<td>GD SR G2 140 PSSR 4.1 &amp; GD SR G2 141 This document Sections 4.11 &amp; 4.12</td>
</tr>
<tr>
<td>Work on mechanical systems such as springs and other mechanisms; Gas systems such as accumulators; pressure storage vessels such as air systems; and SF6 circuit breakers</td>
<td>Pressure Systems &amp; Stored Energy</td>
<td>Isolating Mechanical Apparatus and LVMPRI LV/MECH Access Authority Safe work practises: <a href="#">Mechanical apparatus</a></td>
<td>GD SR G2 140 Section 7 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.13</td>
</tr>
<tr>
<td>Work on mechanical moving parts such as CB mechanisms, pumps and fans</td>
<td>Rotating or moving parts</td>
<td>Isolating Mechanical Apparatus and LVMPRI LV/MECH Access Authority Safe work practises: <a href="#">Mechanical apparatus</a></td>
<td>GD SR G2 140 Section 7 PSSR 4.1 &amp; GD SR G2 141 This document Section 4.14</td>
</tr>
</tbody>
</table>

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**Safe Work Practices on Low Voltage and Mechanical Apparatus**

**Revision No:** 1

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4. Safe Work Practices on Low Voltage, Extra Low Voltage, and Mechanical Apparatus

Safe work practices are applicable to all Low Voltage (LV), Extra Low Voltage (ELV) and Mechanical (MECH) Apparatus working situations.

Low Voltage examples ---- 240V DC batteries, 240V DC control supplies, 240/415V AC circuits

Extra Low Voltage examples ---- 50-120V DC batteries, 120V DC control supplies

Mechanical examples ---- any equipment that has the ability to rotate, or is pneumatic or hydraulic in nature or contains stored energy through mechanisms, liquid, thermal or gas contained within the equipment.

To work on LV/Mech Apparatus, it is necessary to determine whether it is safe to do so. This is done before starting work by applying the TransGrid Risk Assessment Process at each and every work site. The process shall identify all reasonably foreseeable hazards and environmental considerations (e.g. position of exposed energised conductors or live conductive parts, cramped conditions, moving equipment, hot or wet conditions and other factors).

4.1. Isolation Procedures

The switching, isolation or disconnection procedures and other necessary precautions appropriate to the work being carried out shall be carried out in accordance with Operating Process for Access to LV/Mech Apparatus.

4.2. Authority for work

For normal routine maintenance or construction work an Access Authority shall be issued before any work commences on apparatus in the charge of a Controller, in accordance with Access for Work on LV/Mech Apparatus.

Fault finding or other emergency work under the direction of the Controller would not normally require an Access Authority to be issued. Controls for work on or near live exposed conductors must be in accordance with section Work on or near live exposed conductors.

4.2.1. Testing of LV/Mech apparatus

Where the testing of apparatus is required a Testing LV/Mech Access Authority shall be issued in accordance with PSSR Rule 4.2.3.

4.3. Assessment

Safety shall not be compromised because of operational pressures to carry out the work. All work shall be planned and organised to minimise the risks associated with the work. An assessment shall be carried out at the work site before starting work to assess risks that have the potential to cause harm or damage.

If any person is required to work on or near LV/MECH apparatus, a person authorised PSSR Category 4.3 shall identify appropriate control measures to be adopted.

In some cases the identification and possibility of encroaching on or near energised ELV and LV conductors or apparatus will be obvious, e.g. terminal strips, cables and bus rails. In other cases it will not be immediately obvious, e.g. power tools drilling into structures and work equipment that can extend onto conductors.

4.3.1. Awareness

All persons, including electrical workers, supervisors, safety observers and those assisting workers working on or near LV/MECH apparatus, shall understand the scope of the work and the potential hazards involved.
4.3.2. Trafficable areas

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

4.3.3. Illumination

Work areas shall be provided with lighting that is both adequate and suitable for the work and emergency evacuation.

4.3.4. Identify the safe area of work

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

4.4. Tools and equipment for work

4.4.1. Tools and PPE

Tools, PPE and barriers for work on or near live ELV or LV conductors shall have insulation rating of 650V or higher and their condition inspected prior to commencing an activity. Typical examples include:

- **LV Insulated Tools**
- **LV Insulated Gloves**
- **LV Insulated Barriers**

Tools, electrical equipment or plant with exposed conductive parts such as metallic tape measures, rules, reinforced tapes and ladders, shall not be used on or near live ELV or LV conductors.
4.4.2. Inspection of tools and equipment prior to use

All tools and testing equipment shall be inspected to ensure it is functioning correctly and in a serviceable condition prior to each use. Unserviceable tools or equipment shall not be used e.g. hand tools with damaged insulation.

4.4.3. Short circuiting and earthing equipment

There is no specific Australian Standard for this type of equipment for ELV and LV use, so the following should be used as a guide:

- Conductors should be stranded with a current carrying capacity suitable for the application;
- The current carrying capacity of the shorting and earthing conductors should relate to the size of the circuit conductors;
- Cables should be at least single insulated (with PVC or similar);
- Connections should be bolted or screwed via spade type terminals, not attached with alligator clips; and
- The short circuiting and earthing device should be electrically continuous from phase to phase and phase to earth.

4.5. Cables

4.5.1. Decommissioning of ELV and LV cables

During decommissioning of cables a person authorised PSSR Category 4.3 is to ensure cables and their conductors are:

- Positively identified;
-Disconnected or isolated from all energy sources and the isolation secured with Do Not Operate tags;
- Proven de-energised; and
- LV rated insulation is applied to exposed conductors and cable ends.

4.5.2. Cutting and removal of cables

Prior to carrying out work that involves the cutting and removal of existing cables, a person authorised PSSR Category 4.3 is to ensure cables and their conductors are:

- Positively identified;
- Isolated from all energy sources and the isolation secured with Do Not Operate tags; and
- Proven de-energised.

Workers cutting and removing cables must ensure cables are positively identified to prevent the wrong cable being cut. Example methods of identification are:

- Visual:
  - Segmenting and removing cables in manageable sections;
  - Tracing the cable hand over hand; and
  - Pulling and pushing of the cables.

- Signal Injection:
  - A transmitter is connected to the cable to be traced and sends a carrier signal which a non-contact receiver detects.

4.6. Current transformer secondary circuits

The secondary circuit of a current transformer (CT) must not be open circuited while the primary circuit of the CT is live, as a high voltage may be induced in the secondary winding of the CT and on associated secondary circuits and links.

CT secondary links and circuits must be short circuited and earthed prior to opening any part of the circuit.
4.7. **Work on de-energised conductors**

Work on de-energised low voltage apparatus shall only proceed if the apparatus is isolated and any other exposed conductors or conductive parts in the work area are either:

- De-energised and isolated; or
- Separated by LV barriers or an appropriate distance based on a risk assessment.

All electrical apparatus shall be treated as energised until proven de-energised.

4.8. **Work on or near live LV conductors**

Fault finding, testing for the integrity and operability of energised circuits and apparatus or other work on or near live LV conductors shall only be performed when it is not practical to de-energise. Persons working on or near live LV conductors shall apply a safe system of work that includes:

a) A Risk Assessment and/or Work Method Statement is completed prior to the commencement of the work and appropriate control measures are documented and implemented for all identified hazards;

b) Exposed live conductors must be clearly identified and their isolation points identified and accessible.

c) All jewellery or conductive material must be removed prior to commencing work on or near LV conductors

d) Where there is potential for inadvertent contact with live exposed conductors the use of; guards and barriers, LV insulating covers over the exposed conductors, or wearing of LV insulating gloves must be used.

e) The work area is clear of any obstructions, adequate access and egress are available and a LV rescue kit is available at the work area;

f) Where the Risk Assessment and/or Work Method statement identifies that it is necessary to have a safety observer, then work shall not be undertaken without the presence of a safety observer competent in LV rescue and CPR; and

g) Appropriate tools, personal protective equipment (PPE) and/or LV barriers are used.

LV Insulated Tools + LV Insulated Gloves or LV Insulated Barriers

4.9. **Capacitors**

Capacitors and associated circuitry shall be proved de-energised and fully discharged before commencing work on them and their associated circuit wiring. This may be achieved by using and maintaining, for the duration of the work, approved safe discharging devices or by following the manufacturer’s instructions. Immediately before performing work a voltage tester shall be used to prove that these units are discharged. The voltage tests shall be on an appropriate DC scale of the tester.

Care shall be taken against the harmful effects of arcing when applying discharging devices. Short-circuiting or earthing of capacitor terminals with metal objects such as spanners or screwdrivers can result in electrocution, arcs, flash burns or electric shock and shall not be attempted. Refer [Short circuiting and earthing equipment](#).
4.10. Batteries, chargers and power supplies

Persons carrying out work that involves Batteries, Chargers and Power Supplies must ensure:

- The site Workplace Risk Assessment is reviewed;
- Controls noted on battery room doors are implemented;
- Battery rooms are adequately ventilated by means of the natural or forced ventilation provided;
- Eye wash facilities are available;
- Correct PPE for battery work is worn;
- Personal effects such as pens, keys, metal watches, jewellery, are removed prior to commencing work. If personal items such as wedding rings cannot be removed, they should be covered with gloves or other material to prevent accidental contact between them and live electrical parts;
- Only insulated tools are used;
- Battery supplies are isolated;
- Chargers and power supplies are checked for residual charge or proven de-energised; and
- Workers are aware of and control stored energy retained by the battery.

Risk of injury from explosion, fire and associated equipment damage exist in battery rooms, especially during recharge. Actions that should not be undertaken in battery rooms include:

- Any form of hot work including welding or brazing;
- Use of a hacksaw, drilling or grinding of any type;
- Impact of a hammer or chisel onto concrete or metal; or
- Rubbing or movement of plastics, nylons and polyvinyl materials.

Refer also to: W.A.R.A - Batteries, Chargers and Power Supplies

4.11. Testing electrical work prior to energising

To assist with the tests required prior to energising, reference should be made to:

- AS 3017 - Electrical installation testing; and
- AS 4836 - Safe working on low-voltage electrical installations.

These publications give guidance on how to carry out the relevant tests and alternative methods may be adopted providing the alternate methods achieve the safety outcome intended.

4.12. Unfinished electrical work

When work is left unfinished, suitable measures shall be taken to ensure that persons are not exposed to hazards. These measures may include:

- Insulating exposed conductors;
- Physically securing cables;
- Tagging and taping off cables;
- Informing relevant parties that work is not complete;
- Taking reasonable precautions to ensure that cables cannot become live;
- Ensuring that points of isolation are clearly labelled in relation to circuits; or
- Short circuit conductors to earth to prevent energisation.
4.13. Bonding of conductors

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

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

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

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

Appropriate tools and personal protective equipment (PPE) shall be used when attaching or removing temporary bonding conductors.

![LV Insulated Tools](image1)

![LV Insulated Gloves](image2)

4.14. Mechanical apparatus

When work is to be performed on mechanical apparatus all materials, substances, agents or conditions that pose a risk to the health and safety of the persons required to work on the mechanical apparatus shall be isolated in accordance with Operating Process for Access to LV/Mech Apparatus, Section 7 - Mechanical Operating Work.

Control measures taken to isolate mechanical apparatus shall:

a) Prevent the activation or energising of apparatus or services including secondary sources of energy that are likely to adversely cause the activation or energising of the mechanical apparatus;

b) Ensure, if required, the mechanical apparatus is unwound, un-tensioned or drained, vented and depressurised;

c) Prevent the introduction of materials or substances through equipment such as piping, ducts, vents, drains, conveyors, service pipes;

d) Prevent the uncontrolled movement or rotation of the mechanical apparatus; and

e) Ensure, where practicable, that the devices isolating the mechanical apparatus are tagged and secured.
5. Change history

<table>
<thead>
<tr>
<th>Revision no</th>
<th>Approved by</th>
<th>Amendment</th>
</tr>
</thead>
</table>
| 1           |             | All significant new additions and alterations from Revision 0 have been highlighted in this version by a vertical sidebar. The following has also been altered:  
  • Revised accountability for this work instruction;  
  • Attachments deleted |

6. Implementation

This work instruction is to be implemented in conjunction with the implementation of TransGrid’s Power System Safety Rules. It will be available as a resource, published on the Wire.

7. Monitoring and Review

The Manager/Health, Safety & Environment is responsible for the ongoing monitoring and review of the documents associated with the Power System Safety Rules. This can include but is not limited to:

(a) Requesting regular feedback on the effectiveness of procedures and work instructions. Appropriate feedback tools include focus groups and online assessments;

(b) Where a change has occurred in our processes; and

(c) Recommendations arising from incidents.

8. Attachments

Attachment 1 - Gloves
**Attachment 1 – Gloves**

Electrical safety insulating gloves are among the most important articles of personal protection for electrical workers. A glove system consists of:

| Insulating gloves - Classified by the level of voltage and protection they provide. |
| Liner gloves - Reduce the discomfort of wearing rubber insulating gloves in all seasons, for year round use. |
| Outer protector gloves - Worn over rubber insulating gloves to provide mechanical protection against cuts, abrasions and punctures. |

**Inspection before use**

Before use, insulating gloves are to be visually inspected for use by date, cuts, tears, perishing and distortion. Gloves are to be pressure tested for pinholes by sealing the entry to the glove and compressing the air trapped within by rolling the glove on itself. Listen for escaping air to detect holes, loss of air indicates that the glove is defective. **Insulating gloves found to be defective or out of date shall not be used.**

| Step 1: Hold glove downward and grasp cuff. | Step 2: Twirl glove towards your body to trap air inside. Squeeze glove to look for damage | Step 3: Hold glove to face and feel & listen for escaping air |

**Precautions in use**

Care should be taken to avoid mechanical damage caused by abrasion or sharp edges. Remove all jewellery and sharp objects from your hands or arms before wearing gloves. Insulating gloves are not be exposed unnecessarily to heat or light or allowed to come into contact with solvents, oils or other chemical agents. If outer protective gloves are used at the same time as insulating gloves, they should be shorter than, and worn over, the insulating gloves. If the outer gloves become damp, oily or greasy, they should be removed. They should also be removed from the insulating gloves when the latter are not in use.

When insulating gloves become soiled, they are to be washed with mild soap and water and allowed to dry before storing.

**Storage**

Insulating gloves shall be stored in their natural shape, removed from outer protective gloves, inside a canvas bag and away from chemicals, direct heat, and out of direct sunlight. Tools and equipment must not be stored in the same bag as insulating gloves.

**Procurement**

[Safety Gloves - Stockcodes](#)