

## Operating Process for Access to High Voltage Apparatus

**Summary:**

This procedure supports the Power System Safety Rules and its requirements assembled under the Operation of High Voltage Switchgear - Categories 5, 6 and 7.

It applies to the Operation of High Voltage Switchgear for the purpose of issuing an access authority and subsequent Restoration.

This document also provides general guidance and background information related to the operation of various types of high voltage apparatus.

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Process owner: Manager Health, Safety & Environment		
Author:	J Mason, Safety Rules Coordinator	
Reviewers:	J Workman, Safety Manager D Moore, Trainer	
Approver:	K McCall, Manager Health, Safety & Environment	

When referring to TransGrid's policies, frameworks, procedures or work instructions, please use the latest version published on the Wire [PSSR Page](#) or [Power System Safety Rules @ TransGrid](#).

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## 1. Overview

### 1.1. Purpose

This procedure supports the Power System Safety Rules and its requirements assembled under the Operation of High Voltage Switchgear - Categories 5, 6 and 7.

### 1.2. Policy Base

Document no.	Document
GD SR G1 100	<a href="#">Power System Safety Rules</a>

### 1.3. Reference Documents

Document no.	Document
GD SR G2 151	Access for Work on High Voltage Substation Apparatus
GD SR G2 161	Access for Work on High Voltage Overhead Lines
GD SR G2 171	Access for Work on High Voltage Transmission Cables
GD SR G2 010	Use of High Voltage Preparation and Restoration Instructions
GD SR G4 153	Proving High Voltage Conductors De-energised
GD SR G4 154	Portable Earthing of High Voltage Conductors
GD SR G4 155	High Voltage Operating Rods
GD SR G3 142	Safe Work Practises on LV/MECH Apparatus

### 1.4. Scope

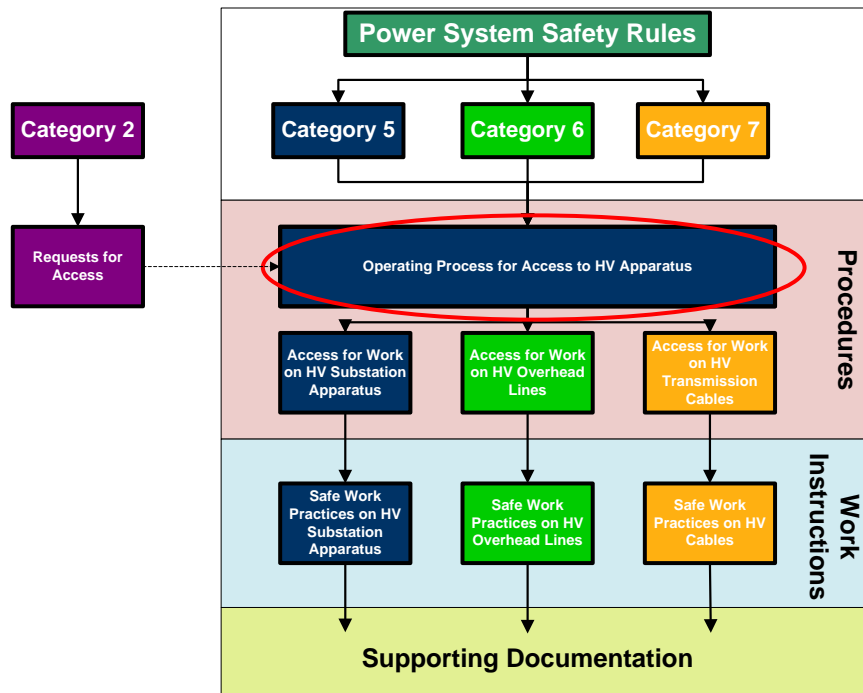
This process applies to the operation of high voltage switchgear for the purpose of issuing an access authority and subsequent restoration. This document also provides general guidance and background information related to the operation of various types of high voltage apparatus.

### 1.5. Accountability

Responsible person	Responsibility
Manager – Health, Safety & Environment	Maintenance and ownership of this procedure
Manager – Training	Implementation of training programs associated this procedure
Authorised persons	Comply with this procedure

## 1.6. Document Location

Block diagram showing relationship to other documents



## 2. Operating Requirements

### 2.1. Introduction

The operation of high voltage switchgear is required for the purpose of issuing an access authority on high voltage apparatus including overhead lines and cables.

The sections within this procedure cover the generic sequence required to safely prepare high voltage apparatus ready for the issue of an access authority and the generic restoration sequence required after cancellation of an access authority. This procedure also covers general operating requirements for logging, tagging and locking of high voltage switchgear.

This procedure should be read in conjunction with procedures for access to high voltage apparatus which cover the issue and cancellation of access authorities:

- Access for Work on High Voltage Substation Apparatus;
- Access for Work on High Voltage Overhead Lines; and
- Access for Work on High Voltage Transmission Cables.

Refer to the Wire [PSSR Page](#) or [Power System Safety Rules @ TransGrid](#)

## 2.2. Requirements to make high voltage apparatus safe to work on or near

High voltage apparatus is made ready for work by use of a High Voltage Preparation and Restoration Instruction (HVPRI) to ensure safe working conditions are in place before any access authorities are issued and work commences. The HVPRI will include specific instructions for:

- Isolation of the high voltage apparatus including locking open of points of isolation and affixing tags where relevant. These points of isolation shall include low voltage sources, which can cause the conductors to become live at high at high voltage.
- Verifying that the high voltage conductors have been de-energised;
- Earthing of the high voltage conductors and,
- Taking Local Safety Precautions.

**Note:** Local Safety Precautions for isolation of hazardous low voltage and mechanical apparatus are detailed in a Low Voltage or Mechanical Preparation and Restoration Instruction (LVMPRI).

## 2.3. High voltage preparation and restoration instructions

High voltage preparation and restoration instructions detail operating steps to carry out switching and communication between switcher and Controller. Each operating step requires the following **8 step method** to be applied:

1. Read the HVPRI step;
2. Take the HVPRI to the point of operation;
3. Check the equipment description against the HVPRI;
4. Prepare to perform the required actions;
5. Check again the equipment description and required actions against the HVPRI;
6. Perform the required actions;
7. Check device has operated and all actions have completed correctly; and
8. Cross off the step in the HVPRI.

## 2.4. Identification of persons carrying out HVPRI

Persons authorised PSSR Category 5.5, 5.6 or 6.5 carrying out HV switching duties are required to wear a specially marked vest to identify that they are carrying out High Voltage switching and other workers are not to distract them from this task.

“Switching in Progress” vests are available to order through Stores:

- Stock Code: 360310 Size M
- Stock Code: 360311 Size L
- Stock Code: 360312 Size XL
- Stock Code: 360313 Size XXL





### 3.1. On arrival to site

The switcher shall set up following the steps listed below:

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Collect PRI from printer and ensure collation is correct	Not required when using switching tablet	GD SR G2 010
2	5.5, 6.5	Check RFA matches PRI		
3	5.5, 6.5	Check PRI against work requested	Reference HVOD to confirm correct equipment, earthing etc.	
4	5.5, 6.5	Switcher to notify Controller that they are onsite	Or notify using switching tablet	
5	5.5, 6.5	Write out required Tags (Do Not Operate or Warning Tags)	PRI number & date	
6	5.5, 6.5	Collect required number of O1 locks	Suitable locks may also be left at equipment	
7	4.3, 5.5	If required, source LVMPRI for equipment to be worked on & write tags to suit required Isolations	Step performed if enough time prior to switching commencing	GD SR G2 151
8	5.5, 6.5	Lay out any required portable earths and connect to approved Earthing points at ground level	Step performed if enough time prior to switching commencing	

### 3.2. Preparation

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Receive Clearance from Controller to carry out PRI	CB's normally de-energised by Controller steps	GD SR G2 010
2	5.5, 6.5	Follow steps of PRI	Carry out PRI to blocking step stated by Controller	

Depending on the type of equipment, operating sequences will vary. The following sections describe generic sequences for different types of equipment.

### 3.2.1. De-energising or Offload - Operation of Circuit Breaker

Step	Safety Rules Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Go to Control Panel of CB or CB symbol on HMI that matches name on PRI.		This document Section 7.1
2	5.5, 6.5	Check associated current or power indication	Panel meters, Power meter or HMI	
3	5.5, 6.5	If required place auto re-close switch to 'NON-AUTO'		
4	5.5, 6.5	Open requested CB.	Via Control Discrepancy Switch (CDS) or HMI	
5	5.5, 6.5	After CB has been opened, check associated current or power indication is nil.	Panel meters, Power meter or HMI	
6	5.5, 6.5	Cross out step in the PRI requesting the CB to be opened.	Use a non-obliterating line	GD SR G2 010
7	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise controller and receive clearance to proceed.	

### 3.2.2. De-energising or Offload – Confirm Operation of Circuit Breaker

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	If required place auto re-close feature to 'NON-AUTO'		This document Section 7.1
2	5.5, 6.5	Proceed into Switchyard		
3	5.5, 6.5	Check CB indicators are showing open.		
4	5.5, 6.5	Cross out step in the PRI requesting the CB to be confirmed open.	Use a non-obliterating line	GD SR G2 010
5	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.3. Isolation - Operation of Motorised Disconnecter

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Go to control panel of Disconnecter or Disconnecter symbol on HMI that matches name on PRI		This document Section 7.3



2	5.5, 6.5	Check Disconnecter name and number on control panel or HMI and check against PRI again.		
3	5.5, 6.5	OPEN requested Disconnecter via CDS switch or HMI.	Problems that arise with the operation need to be referred to the Controller. Local operation may be permitted where remote operation is unserviceable	
4	5.5, 6.5	Check indication on CDS or HMI	Confirm disconnecter indication is showing open.	
5	5.5, 6.5	Cross out step in the PRI requesting the disconnecter to be opened	Use a non-obliterating line	
6	5.5, 6.5	Proceed into Switchyard to listed Disconnecter		
9	5.5, 6.5	Check all phases of disconnecter are OPEN	Visual checks shall be made to ensure that arms are fully open on all three phases	
10	5.5, 6.5	Place Local / Remote Switch to "OFF" or "Local"		
11	5.5, 6.5	Isolate motor supplies and apply tags per PRI step	<b>Using one of the following methods:</b> <ul style="list-style-type: none"> <li>• Electrical interlock "OFF" as part of mechanical isolation</li> <li>• Removal of Fuses / Links; or</li> <li>• Switch "OFF" Thermal Over Load or Motor Supply MCB</li> </ul>	
12	5.5, 6.5	Lock OPEN and apply tags specified by the PRI.	Mechanically locked to prevent manual operation, where practicable	
13	5.5, 6.5	Cross out step in the PRI requesting the disconnecter to be checked open, locked and tags applied.	Use a non-obliterating line	GD SR G2 010
14	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.4. Isolation - Operation of Manual Disconnecter

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Proceed into Switchyard		This document Section 7.3
2	5.5, 6.5	Check CB indicators are showing OPEN.	On all poles - if provided and that the CB is in a satisfactory condition	
3	5.5, 6.5	Proceed to listed Disconnecter		

4	5.5, 6.5	OPEN Disconnecter	The person carrying out the operation shall stand on the operator mat provided and not watch the contacts while the disconnecter is operated. The manual opening or closing operation of a disconnecter (or similar switch) shall be carried out in one complete and continuous movement.	
5	5.5, 6.5	Check all phases of disconnecter are OPEN	Visual checks shall be made to ensure that arms are fully open on all three phases	
6	5.5, 6.5	Lock OPEN and apply tags specified by the PRI		
7	5.5, 6.5	Cross out step in the PRI requesting the disconnecter to be checked open, locked and tags applied.	Use a non-obliterating line	GD SR G2 010
8	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.5. Isolation – Voltage Transformer

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Identify correct VT Marshalling Box per PRI		
2	5.5, 6.5	Identify correct secondary isolation links		
3	5.5, 6.5	ISOLATE as required by PRI	Appropriate tools and PPE for work on or near live LV exposed conductors. When SAD of 250mm from live exposed LV conductors not being operated cannot be maintained: <ol style="list-style-type: none"> <li>1. LV gloves shall be worn; or</li> <li>2. Work shall be performed in accordance with an approved SWMS</li> </ol>	GD SR G3 142
4	5.5, 6.5	Apply tags as requested by PRI		
5	5.5, 6.5	Cross out step in the PRI requesting isolation of the voltage transformer secondary's		
6	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.6. Earthing - Preparation

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Collect Operating Rods & Proving De-energised device.		GD SR G4 153 GD SR G4 155
2	5.5, 6.5	Inspect all equipment to be used for correct assembly and condition before use.	HV operating rod, proving de-energised tester and earthing equipment	GD SR G4 155 GD SR G4 154 GD SR G4 153

The following sections describe the generic earthing sequence required for different types of apparatus.

### 3.2.7. Earthing - Earth Switch Manual

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Proceed to earth switch identified on PRI.		
2	5.5, 6.5	Set proving dead device to correct voltage and prove against a known supply of the same voltage that is being earthed.	Safe approach distances are to be maintained from all high voltage conductors whilst proving a high voltage conductor de-energised.	GD SR G4 153
3	5.5, 6.5	Check conductors that are to be earthed are de-energised and re-test against a known supply of the same voltage that is being earthed.		GD SR G4 153
4	5.5, 6.5	Place proving dead device back onto conductors that are to be earthed adjacent to phase nearest earth switch		GD SR G4 153
5	5.5, 6.5	Unlock earth switch and CLOSE	The person carrying out the operation shall stand on the operator mat provided and not watch the contacts while the disconnecter is operated. The manual opening or closing operation of an earth switch shall be carried out in one complete and continuous movement	
6	5.5, 6.5	Check that all phases are closed correctly	Visual checks shall be made to ensure that contacts are secured by contact pressure or drive tension and arms are fully home on all three phases	
7	5.5, 6.5	Lock CLOSED (if required) and apply tags specified by the PRI	If earths form part of testing, locking is not required and a "Warning" tag to be applied.	
8	5.5, 6.5	Cross out step in the PRI requesting the earth switch to be closed.	Use a non-obliterating line	GD SR G2 010
9	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.8. Earthing - Earth Switch Motorised

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Proceed to earth switch identified on PRI.		
2	5.5, 6.5	Set proving dead device to correct voltage and prove against a known supply of the same voltage that is being earthed.	Maintain safe approach distance from all high voltage conductors	GD SR G4 153
3	5.5, 6.5	Check conductors that are to be earthed are de-energised and re-test against a known supply of the same voltage that is being earthed.		GD SR G4 153
4	5.5, 6.5	Place proving dead device back onto conductors that are to be earthed adjacent to phase nearest earth switch		GD SR G4 153
5	5.5, 6.5	Unlock earth switch and CLOSE	The person carrying out the operation shall stand on the operator mat provided and not watch the contacts while the disconnecter is operated	
6	5.5, 6.5	Check that all phases are closed correctly	Visual checks shall be made to ensure that contacts are secured by contact pressure or drive tension and arms are fully home on all three phases	
7	5.5, 6.5	Place Local Remote Switch to "OFF" or "Local"		
8	5.5, 6.5	Isolate motor supplies and apply tags per PRI step	<b>Using one of the following methods:</b> <ul style="list-style-type: none"> <li>• Electrical interlock "OFF" as part of mechanical isolation</li> <li>• Removal of Fuses / Links; or</li> <li>• Switch "OFF" Thermal Over Load or Motor Supply MCB</li> </ul>	
9	5.5, 6.5	Lock CLOSED (if required) and apply tags specified by the PRI	Mechanically locked to prevent manual operation, where practicable	
10	5.5, 6.5	Cross out step in the PRI requesting the earth switch to be closed.	Use a non-obliterating line	GD SR G2 010
11	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.9. Earthing - Portable Earths

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Collect portable earths and lay in position as per the PRI, connecting the earths to approved earthing points.	Confirm earth stub is securely mounted on the structure and ensure that the earthing equipment is in a serviceable condition	GD SR G4 154

Step	PSSR Authorisation	Task	Comments	Reference Document
2	5.5, 6.5	Check location of conductors to be earthed against the PRI	Refer to this document <a href="#">Section 7</a> for additional requirements for different HV apparatus types	
3	5.5, 6.5	Set proving dead device to correct voltage and prove against a known supply of the same voltage of the conductors to be earthed.	Maintain safe approach distance from all high voltage conductors	GD SR G4 153
4	5.5, 6.5	Check conductors that are to be earthed are de-energised and re-test against a known supply of the same voltage of the conductors to be earthed.		GD SR G4 153
5	5.5, 6.5	Place proving dead device back onto a phase of the circuit previously proved de-energised.		GD SR G4 153
6	5.5, 6.5	Apply the earth clamp on phase to be earthed.		
7	5.5, 6.5	Repeat Steps (5) & (6) above for each phase to be earthed. Apply tags specified by the PRI to each earth lead.		
8	5.5, 6.5	Remove tester from conductor		
9	5.5, 6.5	Cross out step in the PRI requesting the earths to be applied	Use a non-obliterating line	GD SR G2 010
10	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.2.10. Earthing – Voltage Transformer Secondaries

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Identify correct VT Marshaling Box per PRI		
2	5.5, 6.5	Identify correct secondary isolation links		
3	5.5, 6.5	Prove de-energised at secondary isolation links	Using approved two-pole voltage & continuity tester	GD SR G4 153
4	5.5, 6.5	Earth as required by PRI	When SAD of 250mm from live exposed LV conductors not being operated cannot be maintained: <ul style="list-style-type: none"> <li>• LV gloves shall be worn; or</li> <li>• Work shall be performed in accordance with an approved SWMS</li> </ul>	GD SR G3 142

5	5.5, 6.5	Apply tags as required by PRI		
6	5.5, 6.5	Cross out step in the PRI requesting earthing of voltage transformer secondaries.	Use a non-obliterating line. If a blocking step, advise Controller and receive clearance to proceed.	GD SR G2 010

### 3.3. Access Authority Issue and Cancellation

Apparatus	PSSR Authorisation	Task	Comments	Reference Document
Substation HV Apparatus	5.4	Issue HV Access Authority Cancel HV Access Authority	Access for Work on High Voltage Substation Apparatus	GD SR G2 151
Overhead Lines	6.4	Issue Field Access Authority Cancel Field Access Authority	Access for Work on High Voltage Overhead Lines	GD SR G2 161
Transmission Cables	7.5	Issue Cable Access Authority Cancel Cable Access Authority	Access for Work on High Voltage Transmission Cables	GD SR G2 171

### 3.4. Restoration

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Receive clearance from Controller to carry out PRI	Carry out PRI to blocking step stated by Controller	GD SR G2 010
2	5.5, 6.5	Follow steps of PRI	Cross out steps as completed with a non-obliterating line	

#### 3.4.1. Removal of Earthing - Earth Switch

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Identify correct earth switch per PRI		
2	5.5, 6.5	Remove Tags, unlock and OPEN earth switch.	<b>If motorised earth switch:</b> <ul style="list-style-type: none"> <li>Restore motor supplies; and</li> <li>Place local / remote switch to local</li> </ul>	
3	5.5, 6.5	Check that all three (3) phases have opened correctly	Visual checks shall be made to ensure that arms are fully open on all three phases	

4	5.5, 6.5	Lock OPEN the earth switch	<b>If motorised earth switch:</b> <ul style="list-style-type: none"> <li>Place local / remote switch to OFF</li> </ul>	
5	5.5, 6.5	Cross out step in the PRI requesting the earth switch opened.	Use non – obliterating line	
6	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.4.2. Removal of Earthing - Portable Earths

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Check correct location of portable earths to be removed per the PRI		
2	5.5, 6.5	Remove tags		
3	5.5, 6.5	Remove earths	Return to correct storage location at completion of PRI	GD SR G4 154
4	5.5, 6.5	Cross out step in the PRI requesting the earths to be removed	ONLY after all three phases are removed	
5	5.5, 6.5	Proceed to next step on PRI	If a blocking step, advise Controller and receive clearance to proceed.	

### 3.4.3. Removal of Earthing – VT Secondaries

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Identify correct VT Marshalling Box per PRI		
2	5.5, 6.5	Identify correct secondary isolation links		
3	5.5, 6.5	Remove Tags		
4	5.5, 6.5	Remove earth(s)	Appropriate tools and PPE for work on or near live LV exposed conductors. When SAD of 250mm from live exposed LV conductors not being operated cannot be maintained: <ul style="list-style-type: none"> <li>LV gloves shall be worn; or</li> <li>Work shall be performed in accordance with an approved SWMS</li> </ul>	GD SR G3 142
5	5.5, 6.5	Cross out step in the PRI requesting removal of earthing from the voltage transformer secondaries.	Use a non-obliterating line	GD SR G2 010

6	5.5, 6.5	Proceed to next step on PRI.	If a blocking step, advise Controller and receive clearance to proceed.	
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### 3.4.4. Return to Service

Step	PSSR Authorisation	Task	Comments	Reference Document
1	5.5, 6.5	Receive clearance from Controller to carry out PRI	Carry out PRI to blocking step stated by Controller	
2	5.5, 6.5	Check associated CB is OPEN		
3	5.5, 6.5	Identify correct VT Marshalling Box per PRI		
4	5.5, 6.5	Identify correct secondary isolation links		
5	5.5, 6.5	RESTORE as required by PRI	Appropriate tools and PPE for work on or near live LV exposed conductors. When SAD of 250mm from live exposed LV conductors not being operated cannot be maintained: <ul style="list-style-type: none"> <li>• LV gloves shall be worn; or</li> <li>• Work shall be performed in accordance with an approved SWMS</li> </ul>	GD SR G3 142
6	5.5, 6.5	Cross out step in the PRI requesting restoration of the VT secondaries		
7	5.5, 6.5	Proceed to next step on PRI.		
8	5.5, 6.5	Proceed to the listed disconnecter		
9	5.5, 6.5	Remove Tags		
10	5.5, 6.5	Unlock disconnecter	<b>If motorised disconnecter:</b> <ul style="list-style-type: none"> <li>• Restore motor supplies; and</li> <li>• Place local / remote switch to REMOTE</li> </ul>	
11	5.5, 6.5	CLOSE Disconnecter/s as per the PRI	If motorised disconnecter CLOSE requested Disconnecter remotely	
12	5.5, 6.5	At the apparatus visually confirm Disconnecter/s CLOSED	Visual checks shall be made to ensure that contacts are secured by contact pressure or drive tension and arms are fully home on all three phases  If manual disconnecter, the disconnecter shall then be secured against movement caused by wind, vibration or magnetic forces etc., by inserting the holding bolt in the operating handle	
13	5.5, 6.5	Cross out step in the PRI requesting the disconnecter to be closed		
14	5.5, 6.5	Proceed to next step on PRI.		



Step	PSSR Authorisation	Task	Comments	Reference Document
15	5.5, 6.5	If required by PRI place auto re-close switch on 'AUTO'		
16	5.5, 6.5	Advise Controller when blocking step has been reached and that equipment is ready for service	CB's normally energised by Controller steps	
17	5.5, 6.5	File 'used PRI' and associated documentation	In designated filing cabinet.	

## 4. Site log and incidents

### 4.1. Operating functions that are not steps in a PRI

Operating functions that are not steps in a PRI shall be fully recorded in the site log. Examples of relevant functions are:

- Operational switching of circuit breakers without the use of a PRI;
- Switching of HV equipment during an emergency without the use of a PRI;
- Local operation of an Auto Reclose/ Auto Close/ Time Switch Control that is not a step in a PRI;
- Messages to and from the Controller relating to significant occurrences, unusual conditions and observations at the station (including circuit breaker operations not included in a HVPRI); and
- Any other matter affecting the safe and efficient operation of the substation.

**Note:** Such functions must be communicated to the Controller and must only be carried out by an appropriately Authorised Person.

### 4.2. Recording of Site Incidents

When responding to a system incident e.g. equipment trip, then a [Site Incident Record Sheet](#) shall be completed, this includes sections for all protection details etc. Once completed, this form is to be forwarded to the Controller; there is no need to duplicate this information in the switching log book.

## 5. Tags and Labels

Tags and labels are used to indicate temporary abnormal conditions of apparatus. Printed tags and labels are physically attached to equipment whereas electronic tags associated with supervisory systems (SCADA and HMI etc.) are graphic symbols shown adjacent to a device on the display. The following tags and labels are in use:

- Do Not Operate Tag (DT)
- Warning Tag (WT)
- Unusual Condition Label (UCL)
- Control Inhibited Tag (CIT)

### 5.1. Do Not Operate Tags and Warning Tags

Use of DTs and WTs is controlled because they are part of the process to set up safe working conditions on or near high voltage, low voltage and mechanical apparatus in the charge of the Controller. Application and removal of DTs and WTs in this circumstance shall only be carried out by a person authorised PSSR Category 4.3, 5.5, 5.6 or 6.5.

- **Do Not Operate Tag** - PROHIBITS personnel from operating any device switch, control, valve, link etc., to which it is attached.
- **Warning Tag** allows LIMITED OPERATION of the device or control to which it is attached, to the extent indicated on the tag.

#### 5.1.1. Obsolete Do Not Operate Tags or Warning Tags

If a DT or WT is found attached to apparatus which is required to be operated, and it is likely that the tag is obsolete the matter shall be investigated by the Controller, who shall establish from records of Access Authorities whether the tag is no longer applicable and can be removed.

## 5.2. Control Inhibit Tags

Where supervisory control is provided, an electronic Control Inhibit Tag (CIT) shall be used in lieu of a paper tag as part of the safe working conditions established when work is required on or near HV apparatus or for security of the system. The application of a CIT prevents supervisory control of the device.

## 6. Locking Of High Voltage Switchgear

O1 Series – ‘Operator’ key locks are provided for locking of switchgear and other operating purposes and the associated keys are only issued to person’s authorised PSSR Category 5.5, 5.6 and 6.5.

When locking HV switchgear the following points are to be observed:

- (a) HV switches required open for isolation purposes must be locked open unless an approved alternative procedure is available;
- (b) Locks should not be applied to HV switches in substations that are open or closed for system operating requirement only;
- (c) No in-service HV disconnecter in a substation is to be locked closed, unless:
  - Environmental factors could cause maloperation; or
  - When directed by the Controller;
- (d) Earthing switches must be locked in either the open or closed position except when provision is made for a switch to be operated in association with a Testing Access Authority, or when an approved alternative procedure that does not require locking exists for the specific equipment;
- (e) Where a HVPRI requires HV switches to be locked, where practicable, the disconnecter or earthing switch shall be mechanically locked to prevent manual operation;
- (f) When special individual locks are provided for each switch (e.g. on SF6 switchgear), corresponding individual keys will normally be kept in a dedicated key cabinet located in the control room; and
- (g) Where motor operated disconnecter or earthing switches can be operated from local or remote control points, each device shall be isolated from its operating supply source and tags per the HVPRI shall be attached at the point of isolation. This requirement is normally not included as a detailed step in the HVPRI and it is the responsibility of the person carrying out the HVPRI to ensure familiarity with different apparatus types.

## 7. General Operating Principles

### 7.1. Circuit Breakers

Whenever possible, load break switching operations shall be carried out using circuit breakers or load-breaking circuit switches. Some circuit breakers have multiple interrupter units per pole, in which case they are usually provided with grading capacitors to ensure uniform voltage distribution. Also, some types of circuit breakers are fitted with breaking resistors that are connected in parallel with the main contacts for dampening transient recovery voltages. Circuit breakers, in general, may be operated according to system requirements without risk of failure, but nameplate ratings and specific local limitations must be observed.

#### 7.1.1. Operating requirements for circuit breakers

- HV circuit breakers may only be operated as a step in a PRI or with the specific approval of the Controller, except in an emergency. Operations for maintenance checks, testing and commissioning may also take place in accordance with procedures relevant to the work.
- Where a circuit breaker is considered to be defective it should be de-energised by the operation of another circuit breaker to reduce the risk of damage to equipment, danger to personnel and effects on system security.
- Should there be any apparent abnormality within the substation or other reason that suggests that the CB should not be operated, refer to the Controller for advice before proceeding.
- In the case of automatically switched capacitors or reactors (e.g. those controlled by time switches, voltage level etc.) Select control to non-auto before operating the CB.
- Check what instruments are available on the control panel as operating aids, consider their expected behaviour and check that the behaviour occurs during operation.
- Circuit breakers shall preferably be operated remotely, from the Network Operations' control room. Otherwise the circuit breaker shall be operated from the CB control panel in the substation control room/relay room, as follows:

#### *Opening a circuit breaker*

- a) Check whether the circuit is carrying load. If so, check that an alternative parallel supply is available to pick up that load. If this can't be checked locally, receive assurance from the Controller that an alternative supply is available. This principle applies to auxiliary supplies as well as external load. If the ammeter reading is near zero, press the fine scale button (where provided) and watch for pointer movement.
- b) In the case of generating units, gradually reduce the load to zero before switching to avoid frequency or voltage surges, damage to plant and to reduce the breaking duty of the CB.
- c) First select the CB to be opened, and then check that the correct CB has been selected before proceeding to open the CB.
- d) Immediately after opening the CB, check the ammeters to ensure that the expected load drop off or pick-up has occurred on alternative circuits and that no overload has arisen. Check that voltage conditions are satisfactory and that auxiliary supplies are still effective.
- e) Check that the local (at the circuit breaker) indicator on the CB shows 'open' (on all poles - if provided) and that the CB is in a satisfactory condition.
- f) For those CBs where the close operation is performed mechanically by a spring, check that the spring has recharged.

#### *Closing a circuit breaker*

- a) Check local conditions: The CB control switch, in the local cabinet, must be selected to remote. LV/mechanical isolations must have been restored. All associated protection devices must be auto and there should be no relays showing an operation. Any abnormality (relays operated or flags down) should be reported to the Controller and then be reset when requested. There should be no alarms associated with the CB.

- b) If required by the HVPRI, check that the line auto-reclose facility, if provided, is in the non-auto condition. Auto reclose is not normally made non auto where there is duplicate memory protection installed.
- c) If required by the HVPRI, synchronising facilities must be used to check synchronism and matching phase angle and voltage levels across the CB before closing it. Synchronising is normally auto except in power stations.
- d) Select the CB to be closed, and then check that the correct CB has been selected before proceeding to close the CB.
- e) During the close operation, observe the behaviour of ammeter, voltmeter and control room lighting. Should the circuit breaker trip on an attempted closure, these indications are valuable aids in diagnosing whether there has been a HV fault, or some malfunction of protection, or non-latching of the CB.
- f) After the CB has been closed ensure, unless instructed otherwise by the Controller, that:
- g) CB control is restored to the normal remote/supervisory condition;
- h) Auto reclose is normally made auto and Auto closing is normally non-auto, any discrepancies are to be referred to the Controller;
- i) Automatic control of capacitors or reactors (e.g. by time switch, voltage etc) is normally made auto, any discrepancies are to be referred to the Controller;
- j) Check that the local CB indicator is showing 'closed' (on all poles - if provided) and that the CB is in a satisfactory condition;
- k) For those CBs where the close operation is performed mechanically by a spring, check that the spring has been recharged after closing of the CB and all alarms associated with the CB are reset.

### 7.1.2. General limitations - Circuit breakers

#### *Current rating*

Loadings must not exceed the published ratings except when a higher loading is approved for special purposes. Circuit ratings are set out in 300 series OMs, which take into account the current carrying capacity of the circuit breaker.

#### *Rupturing duty*

Generally, circuit breaker operation above rated rupturing capacity is not permitted. However, in specific cases the rated rupturing capacity may be temporarily exceeded with the approval of the Manager/Network Operations. An example would be that if the only alternative would be interruption to supply, then under abnormal conditions normal rupturing capability might be exceeded for the short period during supply re-arrangement.

#### *Circuit breaker maximum duty cycles*

Circuit breakers may have a limit to the number of operations within a given time, as follows:

- *Circuit breakers with breaking resistors*

Some circuit breakers (particularly 500kV and some lower voltage small oil volume circuit breakers) are fitted with breaking resistors to dampen transient recovery voltages (TRV). These resistors are connected in parallel with the main interrupters and following the opening of the main contacts auxiliary interrupters open the breaking resistor circuits. Tripping operations cause heating of the resistors and to avoid the risk of damage due to thermal build-up, the number of successive trips must be limited. In general, circuit breaker specifications allow for an operating sequence of **TRIP - CLOSE - TRIP - 3 MINUTE TIME DELAY - CLOSE - TRIP**. A trip followed by auto-reclose and trip must be counted as two trip operations.

In addition, limitations apply to certain makes of circuit breakers with respect to breaking: load current, fault current, line (or cable) charging current and capacitor charging current. No limitation applies to the frequency of switching transformer magnetising current..

- **Circuit breakers without breaking resistors**

SF6 and pressurised head, small oil volume circuit breakers do not require breaking resistors. Although these circuit breakers have no resistor thermal limitations, the general **TRIP - CLOSE - TRIP - 3 MINUTE TIME DELAY - CLOSE - TRIP** operating sequence still applies.

#### **Other operating limitations**

**Hydraulically operated CBs** must not be operated if the hydraulic pressure is below the limits prescribed for the particular CB.

**In the case of SF6 gas interrupters** there is a possibility of the SF6 gas leaking from the interrupter units at a rate of approximately 1% per year, relative to gas quantity. As the gas acts as a damper, these circuit breakers must not be operated if the poles do not contain SF6 gas.

- **Double Pressure CBs:** The operation of double pressure SF6 CBs depends on the SF6 pressure differential between the high and low pressure gas chambers and they must not be operated if this differential pressure drops below the limits prescribed for the CB.
- **Single Pressure CBs:** Single pressure SF6 CBs must generally have a nominal pressure in the interrupter, below which it is recommended that the CB not be operated. Gas pressure monitoring (gas density relay) will initiate an alarm if the SF6 gas pressure drops to a point where lockout is imminent. Lockout circuitry is provided to prevent the CB from being operated if the SF6 pressure is too low for safe operation.

## **7.2. High Voltage Capacitors And Reactors**

### **7.2.1. High Voltage Power Capacitors**

Shunt connected HV power capacitors are used for voltage control. Most such capacitors comprise banks of multiple cans mounted on racks and connected in double star. The mounting racks and the star point(s) are generally not connected to earth.

#### **Capacitor circuit breaker operation**

A circuit breaker shall be used at all times to switch high voltage power capacitors into or out of service. To minimise surges and/or damage when switching the capacitors the designated capacitor circuit breaker should be used, as it will have been designed for capacitor switching duty, with point on wave facility when appropriate.

#### **Capacitor residual charge**

HV DC charge might be left on a capacitor and its framework after removing supply. Because of this, a period of at least ten minutes should elapse between the time a HV capacitor is switched out of service and the start of further operations, which will allow the residual charge to dissipate. Specifically, a capacitor is not to be re-energised until at least ten minutes after being de-energised. This will avoid voltage-doubling effects from switching onto residual HV DC charge, which could cause protection fuses to rupture and possibly damage the capacitor.

### **7.2.2. HV Capacitor Earthing**

The capacitor bank should be earthed by operation of an earthing switch where an earthing switch is provided. As proving de-energised equipment will not indicate the presence of any residual HV DC charge, earthing is not to commence for at least ten minutes after de-energising to allow the residual charge to dissipate and ensure safe conditions for earthing. After having been proven de-energised the star points of the capacitor as well as the supply conductors on each phase must be earthed to effectively short and earth each phase of the capacitor bank. Where the capacitor bank comprises two parallel sections, each with its own star point, the authorised person shall visibly check the connection between the star points for continuity before applying earthing and apply the same procedure to each section if the star points are not connected.

### 7.2.3. High Voltage Power Reactors

Shunt connected HV power reactors are also used for voltage control. Although not subject to the same residual charge problems as capacitors, a circuit breaker shall be used at all times to switch high voltage power reactors into or out of service to minimise surges and/or damage.

### 7.2.4. Operating requirements for control schemes

All control devices shall be selected to the non-auto position before any circuit breaker operation to avoid hunting effects should the control scheme initiate an operation during a manual switching sequence.

Any auto-switching scheme shall be selected to the non-auto position before resetting capacitor or reactor protection MTM relays after fault tripping. This is to prevent an uncontrolled operation of the capacitor or reactor circuit breaker when the protection MTM relays are reset. When the protection MTM relay operates, contacts in the automatic control circuit are broken in order to prevent the scheme reclosing the circuit breaker onto faulted equipment and when the MTM is reset the automatic control circuit is remade and conditions on the network could cause operation of the auto-switching scheme.

- **Automatic Control of Capacitors And Reactors**

HV shunt power capacitors and reactors often have automatic controls that will switch the units in and out of service to assist with system voltage control (refer to Operating Manuals). Where there are automatic controls, the circuit breaker discrepancy (CDS) switch on the control panel will commonly be left with the knob pointing to the “OPEN” status position to prevent a ‘Circuit Breaker Tripped’ alarm being activated every time the automatic control initiates an ‘Open’ command. Such operation causes the lamp to be on over an extended period to indicate a discrepancy and they can burn out. Lamp integrity on these devices should be checked to ensure the indication is reliable and there is no confusion between a blown lamp and a dark lamp condition.

- **Time switch control**

Used on smaller installations where remote supervisory control equipment is not provided.

- **Var control**

Also used on smaller installations where remote supervisory control equipment is not provided or where a local HMI is programmed for local voltage control, but in some cases the equipment might be part of a distributed voltage control scheme in conjunction with static var compensators.

- **System disturbance control**

Capacitor banks at 220 kV and above substations (generally 80 Mvar and above) will typically switch into service when the voltage falls below 92% of nominal and will switch out of service if the voltage rises to 111% of nominal.

Reactors at 220 kV and above substations (generally 50 Mvar and above) will typically switch into service when the voltage rises to 109% of nominal and will switch out of service if the voltage falls below 94% of nominal. Switching is time delayed and settings vary depending on location.

## 7.3. Disconnectors and Similar Equipment

The interruption capability of a disconnector is usually not defined as it is generally not a basic function of the design. An IEC standard defines one specific current switching role, which is “Bus-transfer current switching”. The voltage across the contacts also plays an important part in re-establishing the arc current at each current zero. According to IEC, a disconnector is generally able to interrupt up to 80% of the current rating provided the bus transfer voltage does not exceed 100V. However, this is reduced to only 10V in 132kV GIS. The inclusion of transformers, feeders or long bus sections in the interruption circuit creates a reasonable probability that voltages across the contacts will be significant enough to cause problems.

Due to limited capabilities, a disconnecter **shall not be used to break load** or significant charging current unless it has been identified as being suitable for the purpose. The specific conditions under which the equipment can be used for off loading or de-energising is set out in OMs.

Except for [bypass switches](#), generally disconnectors and similar switches shall be operated only after associated circuit breakers have been opened and checked OPEN. If there is no associated circuit breaker, or the circuit breaker is inoperable the disconnector shall not be opened or closed except when '[Breaking parallel](#)' unless a specific operating instruction permits its use in these circumstances. Where remote operation of a disconnector is provided, this facility shall be used.

#### **Avoiding automatic operation of associated circuit breakers**

Where inadvertent automatic closure of a circuit breaker could cause current to flow through an associated disconnector, the automatic closure of that CB should be made non-auto before operating the disconnectors. Check auto-close, auto-changeover and auto-standby arrangements.

**Note:** Transmission line auto reclose is not required to be made non-auto as protection initiation will be prevented by the circuit breaker open status.

#### **Visual checking of disconnector contact position**

Unless special alternative approved procedures apply, after operating a disconnector, visual checks shall be made by the authorised person to ensure that contacts fully OPEN or CLOSED on all three phases.

##### **7.3.1. Operation of disconnectors**

The normal field switching practice is to operate a disconnector by remote operation from a substation control panel or HMI. If the remote operation fails, it could be that the facility is unserviceable or that the conditions required for operation have not been met. (e.g. the associated circuit breaker is open and interlocking arrangements exist between the disconnector and the circuit breaker.) Problems that arise with the operation shall be referred to the Controller.

In certain cases disconnectors are not provided with facilities for remote operation. Local operation is also permissible in cases where remote operation is unserviceable. 'Ready to Operate' lamps may be provided as an aid to safe operating, an unexpected indication warns that an abnormal situation may exist.

##### **7.3.2. By-pass switches**

By-pass switches may be opened or closed only after the associated circuit breaker and its isolating disconnectors have been checked closed.

##### **7.3.3. Bus selector disconnectors**

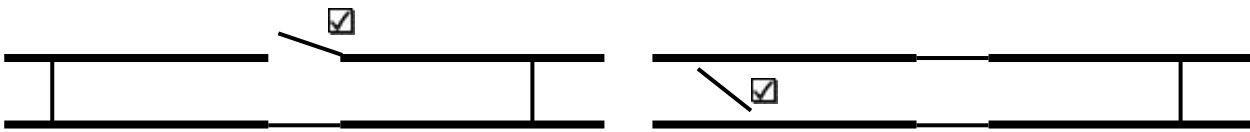
A bus selector disconnector associated with a double selection may be opened or closed with its associated circuit breaker closed, provided the conditions in '[Breaking parallel](#)' are met, and protection is designed to allow the transfer of supply between the busbars involved.

#### **Breaking parallel**

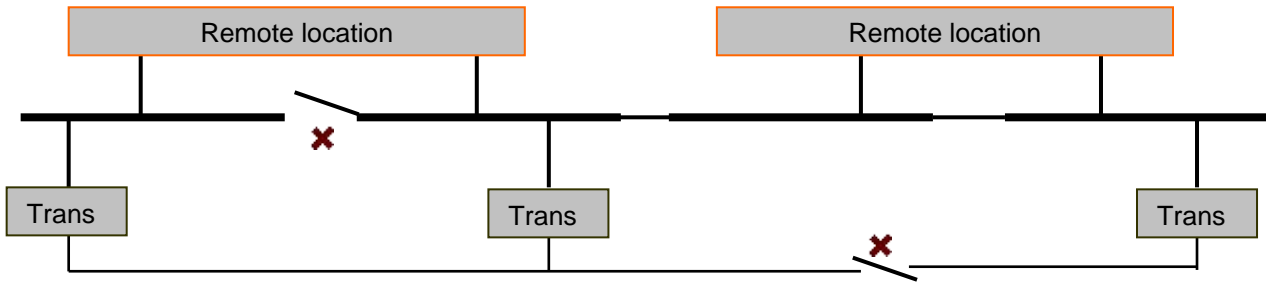
Breaking parallel means opening off one path of two or more parallel connections. Such operations shall be carried out using circuit breakers or load-breaking circuit switches whenever possible. However, a disconnector may be used to break parallel in those cases where the parallel path is effectively a short-circuit such as via busbars, bus section breakers and bus couplers **within a switchyard**. That is, the parallel path must be of low impedance through short lengths of conductor so as to ensure there will be virtually no voltage difference across the disconnector when it is opened. Examples:

**Permissible:** Double bus with circuit breaker or disconnectors: One disconnector may be opened if other paths remain closed.





**Not Permissible:** Single bus with circuit breaker or disconnectors: One disconnector may not be opened as parallel paths through lines and transformers are of high impedance.



## 7.4. Earthing

Except in an emergency, earthing shall only be carried out as a step in a High Voltage Preparation and Restoration Instruction (HVPRI) or with the approval of the Controller. Unless special alternative approved procedures apply, earthing shall be carried out before work starts, immediately after the conductors have been isolated and proved de-energised.

### *Work on or near an earthing switch*

If portable earths are to be applied to allow work on an earthing switch, the earthing switch should still be closed before application of the portable earths.

### *Work on a wave trap or series reactor*

This apparatus has sufficiently large impedance to make earthing ineffective through the equipment. Earthing shall be applied on the side of the wave trap where work is to be carried out and on both sides if work is on the wave trap itself.

### *Dissipation of charge on a cable*

Sufficient time must be allowed between the de-energising of the cable and the application of the earths to permit any trapped charge on the cable to be dissipated. Discharge time will vary from negligible, where cables are connected to magnetic VTs (on all phases) or power transformers at the time of de-energising, up to several hours when there is no connected equipment or where there are only CVTs.

### *Transmission line earthed for work in a substation*

In cases where work takes place just inside the perimeter of the switchyard, field earths may need to be applied on a transmission line to provide earthing for the work. The line shall first be earthed at all points of supply as for normal field work before field earths are applied, typically at the first structure outside an electrical station.

#### 7.4.1. Proving de-energised

Only approved devices shall be used to prove de-energised. Guidelines for operation, use, maintenance and storage of proving de-energised equipment is set out in '[Proving HV Conductors De-energised](#)'.

#### **7.4.2. Portable earths**

Guidelines for operation, use, maintenance and storage of portable earthing equipment is set out in ['Portable Earthing of HV Conductors'](#). Portable earths shall be applied and removed in sets of three. Allowable exceptions are the earthing of neutrals or star points or DC and where apparatus is connected to one phase only of a three phase supply. Portable earths shall be placed so that they will not interfere with the work and so that they will not be accidentally disturbed by the work.

### **7.5. Fault Earth Switches**

Fault Earth Switches (FES) have been installed in some locations on the 132kV system to provide back up for primary protection schemes. When actuated they apply a permanent, solid, single-phase earth connection to the 132kV conductors so that the distance protection at the remote end of the circuit will see the fault and trip the remote end circuit breaker.

#### **7.5.1. Operating requirements for fault earth switches**

Fault earth switches in service are OPEN. However, they must be capable of being actuated by protection and automatically closed, therefore whilst set and ready to operate on in service equipment, no part of a fault earth switch is to be locked.

#### **7.5.2. Post fault checks**

Before re-energising any circuit on which a fault earth switch is installed (possibly at a remote substation) it is important to establish that each fault earth switch is open. A visual inspection at site is usually required due to the lack of remote indications of fault earth switch condition. FESs are not designed for frequent operation, and can be damaged during the resetting process if the winding handle is overwound.

## 8. Change history

Revision no	Approved by	Amendment
0	Lionel Smyth, EGM/Network Services & Operations	<ul style="list-style-type: none"> <li>Replaces documents 'Operating Requirements – General' GD SR G2 005; and</li> <li>'Operating Requirements – Local Safety Precautions' GD SR G2 007.</li> </ul>
1	Neil Smith, GM/System Operations	<ul style="list-style-type: none"> <li>Attachment 1 – deleted</li> <li>References updated</li> </ul>
2	Neil Smith, GM/System Operations	<ul style="list-style-type: none"> <li>Section numbering corrected</li> </ul>
3	K McCall, Manager Health, Safety & Environment	<ul style="list-style-type: none"> <li>Revised accountability for this procedure</li> <li>Added section- <ul style="list-style-type: none"> <li>Identification of persons carrying out HVPRI</li> <li>HV Capacitor earthing</li> </ul> </li> <li>Deleted sections – <ul style="list-style-type: none"> <li>Logging requirements when carrying out a PRI</li> <li>Attachment of labels and tags</li> </ul> </li> </ul>
4	M Gatt EGM Field Services	<p>All significant new additions and alterations from Revision 3 have been highlighted in this version by a vertical sidebar. Editorial changes have not been highlighted.</p> <p>The following has also been altered:</p> <ul style="list-style-type: none"> <li>Added section – “General operating principles”</li> <li>Supersedes 'Operation and Earthing of System Equipment'</li> </ul>
5	Ken McCall, Manager/Health, Safety and Environment	<p>All significant new additions and alterations from Revision 4 have been highlighted in this version by a vertical sidebar. Editorial changes have not been highlighted.</p> <p>The following has also been altered:</p> <p>Section 3.2.5.3 - methods for isolation of VT secondaries aligned with other similar sections of the document.</p>

## 9. Implementation

This procedure is to be implemented in conjunction with TransGrid's Power System Safety Rules. It will be available as a resource, published on the Wire.

## 10. 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:

- Requesting regular feedback on the effectiveness of procedures and work instructions. Appropriate feedback tools include focus groups and online assessments;
- Where a change has occurred in our processes; and
- Recommendations arising from incidents.

## 11. Attachments

Nil