PR-NET-OSM-014

RESPONSE TO SYSTEM FAULTS

OPERATIONAL SAFETY MANUAL - SECTION 2.4

Scottish & Southern Electricity Networks

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1 Introduction

1.1 This **Approved** procedure covers fault Switching on all **High Voltage (HV)** Distribution networks up to and including 132kV, controlled by **SSEN-D**'s Distribution Control Centres, including out of area networks and third-party networks with a control contract.

1.2 It is designed to ensure a consistent approach and swift supply restoration, whilst considering the safety of staff and the public alongside the integrity of the **System**.

1.3 There may be unusual situations that necessitate a different approach. When these arise, the **Control Engineer Shall** decide what action to take, but **Shall** follow the principles of this procedure.

2 Scope

2.1 The scope of this document applies to:

- Response to faults on the **High Voltage** Distribution System operated by **SSEN-D**
- Control and co-ordination of initial response to **High Voltage** faults to ensure the safety of persons and the restoration of electricity supplies

2.2 The scope does not apply to:

- Response to faults on the **Low Voltage System** (see PR-NET-OSM-071 Management of Faults on the Low Voltage System - Operational Safety Manual Section 10.6).
- Response to System emergencies (see PR-NET-OSM-019 Emergency Procedures - Operational Safety Manual Section 2.9).
- The scope applies to **SSEN-D** employees, contractors and other third parties involved who are engaged with responding to **High Voltage System** faults.

3 References

The documents detailed in Table 3.1 - Scottish and Southern Electricity Networks Documents, and Table 3.2 - External Documents, should be used in conjunction with this document.

Table 3.1 - Scottish and Southern Electricity Networks Documents

Reference	Title
PR-NET-OSM-006	SSEN Distribution Operational Safety Rules - Operational Safety Manual – Section 1.1
PR-NET-OSM-028	Switching Terminology and Approved Abbreviations - Operational Safety Manual - Section 4.4
PR-NET-OSM-008	System Control Procedures - Operational Safety Manual – Section 2.1
PR-NET-OSM-019	Emergency Procedures - Operational Safety Manual - Section 2.9
PR-NET-OSM-020	Manual Reclosing of Circuits Post Trip, Sequence Operation and Lockout - Operational Safety Manual – Section 2.10
PR-NET-OSM-071	Management of Neutral Faults on the Low Voltage System - Operational Safety Manual - Section 10.6
PR-NET-EPR-011	Response to Network System Emergencies
WI-NET-PAC-019	Operation of 33kV Busbar Auto-Reclose Schemes
WI-NET-OSM-002	Personal Protective Equipment and Workwear for Live Environments
N/A	SSEN SHE Handbook (Held in Safety, Health and Wellbeing SharePoint Site)

Table 3.2 - External Documents

Reference	Title
ENA SHEC06	Post Trip Reclosing of HV Electrical Distribution Circuits

4 Definitions

4.1 The words printed in bold text within this document are either headings or definitions. Definitions used within this **Approved** Procedure are defined within the list presented immediately below, or within section 2 of the **Operational Safety Rules**.

4.2 **North, East, West, South Aid Consortium (NEWSAC)**

Electricity industry agreement which governs the 'loan' of employees from Networks Operators (NOs) to other NOs during a **System** Emergency.

4.3 **Operational Safety Rules (OSR)**

The **SSEN-D** Distribution set of rules, as read with related documents and procedures, that provide generic safe systems of work on the **System** therefore ensuring the health and safety of all who are liable to be affected by any **Danger** that might arise from the **System**.

4.4 **Operator**

The **Authorised Person** permitted to carry out **Switching** on the **System**

5 General Responsibilities

5.1 All work must be done be in compliance with **SSEN-D** Safety, Health and Environmental Policy and procedures, including **OSR**.

5.2 Persons who are required to operate and undertake work on the **System**, **Shall** have a thorough understanding of the work and ensure that on-site risks are suitably assessed and that appropriate control measures are put in place before, during and immediately after all activities.

5.3 The procedures and instructions in this **Approved** procedure **Shall** only be carried out by suitably trained and authorised persons.

5.4 Persons **Shall** ensure that at all times during the work (or associated testing) **General Safety** arrangements are maintained and that other work areas are not adversely affected by the activities for which they are responsible.

6 Personal Protective Equipment

6.1 Persons who are required to work or undertake **Switching** duties on the **System Shall** wear suitably approved Personal Protective Equipment (PPE). Furthermore, where warning labels or signs identify the existence of a particular hazard, additional and appropriate PPE **Shall** be worn.

6.2 As a minimum, PPE **Shall** meet the requirements of WI-NET-OSM-002.

6.3 When carrying out **Switching**, **Approved** insulated gloves **Shall** be worn by the **Operator** before operating any of the following **Apparatus**:

- Test equipment, test leads, test prods

- Structure mounted equipment
- Overhead line **Apparatus**
- When applying portable **Earthing**

6.4 The insulated gloves **Shall** only be removed following the completion of the operation and when the **Operator** has moved away from the operating position.

6.5 Insulated gloves **Shall** be inspected before use to ensure they are within date and undamaged. Where concern exist, the gloves **Shall** be replaced before any operation is carried out.

7 Red Alert Conditions

7.1 A Red Alert is normally issued during (or sometimes after) a major event that significantly impacts the Distribution System (> 100 **High Voltage** faults / loss of > 20,000 customers). Under these circumstances, actions **Shall** be in accordance with the **Approved** procedures:

- PR-NET-OSM-019 Emergency Procedures - Operational Safety Manual - Section 2.9
- PR-NET-EPR-011 Response to System Emergencies

7.2 Mobilisation **Shall** involve all available **SSEN-D** resource from within the affected Licence area and may also require the transfer of staff from the other Licence areas, as well as the utilisation of all appropriate staff across **SSEN-D**, external contracting resource and a request for staff from other Distribution Network Operators via the **NEWSAC** Agreement.

7.3 Large one-off events, can fall into this category and usually involve implementing pre-written contingency plans. For these situations, typically in excess of 100 linesmen/tree cutters/managers, should be moved into the affected Licence area.

8 Pre-Switching Actions

8.1 **Control Engineers Shall** access the Outage Management System (OMS) for information and updating of incidents / calls and for NaFIRS (National Fault and Interruption Reporting Scheme) reporting in accordance with PR-NET-OSM-008 System Control Procedures - Operational Safety Manual Section 2.1.

8.2 Before carrying out any restoration **Switching** on a faulted circuit, the **Control Engineer Shall**:

- Take all practicable steps to contact anyone known to be working on or adjoining the faulty circuit
- Check that those persons are not involved and warn them to stay clear of the circuit until the fault has been identified and **Isolated**
- Check if any damage calls have been received that relate to the faulty circuit
- Check for Supervisory Control and Data Acquisition (SCADA) protection alarms or operations which provide an indication of the nature or location of the fault
- Where applicable, identify the remaining fault breaking capacity of the source circuit-breaker
- Check to see if the circuit is fitted with remote controlled switchgear and / or Fault Passage Indicators (FPIs)

- Take reasonable steps to ensure that no **Plant** or **Apparatus** is operated outside of its rating
- Establish contact with relevant Transmission Company where Transmission **Plant** is involved,

9 Fault Level Reduction

9.1 System Operating Voltages at 11kV or 6.6kV

Where the busbar fault level exceeds 150 MVA at 11kV or 100 MVA at 6.6kV, then the fault level **Shall**, where practicable, be reduced before the first reclosing attempt as follows:

- If there are no parallel circuits across the bus-section, then the bus-section circuit-breaker **Shall** be opened rather than disconnecting a transformer. This minimises the number of customers who suffer subsequent voltage dips and is the preferred option.
- If there are parallel circuits across the bus-section or the bus-section circuit-breaker has no telecontrol, then a transformer circuit-breaker **Shall** be opened. This **Shall** normally be the transformer feeding the same section of busbar as the fault in order to minimise the impact of operating two-stage busbar protection where fitted.
- If there are no telecontrol facilities available to reduce fault levels, then the first attempted reclose may be made at the normal fault level. However, before attempting any subsequent reclosures, the fault level **Shall** be reduced by manual **Switching.**

9.2 System Operating Voltages above 11kV

Any requirement for fault level reduction on **Systems** operating above 11kV, **Shall** normally be location specific and **Shall** be detailed on the Network Management and Control system, or in the appropriate records.

10 Re-energising from Source, Secondary or Pole-Mounted Circuit-Breaker

10.1 If the faulted circuit includes any section of overhead line or free-standing cable / transformer poles or structures, the **Control Engineer Shall** attempt to re-energise the circuit as shown below in Table 10.1.

Table 10.1 - Re-energising Circuit Table

Operating Voltage (kV)	Security Level	Normal Weather Conditions		Abnormal Weather Conditions, e.g. Gales / Lightning
		22:00 to 06:00	06:00 to 22:00	
6.6 11 22 33	Customer supplies affected and / or **System** at risk from loadings or next fault	After 5 minutes	After 20 minutes	Immediate (with permission from Duty Manager)
	System firm against next fault	Following inspection		
66 132	Customer supplies affected	As soon as practicable following investigation of probable cause and the agreement NMC Manager.		
	All other scenarios including **System** firm against next fault	Following inspection unless system stability issues arise		
NOTE: These time delays also apply to the first re-energisation attempt when fault sectioning on underground circuits.				

10.2 Where immediate **Switching** is permitted, the **Control Engineer Shall** still risk assess and make an informed decision based on the alarms, indications, weather conditions and any other relevant information available before re-energising.

10.3 For all other situations shown in table 9.1, prior to reclosing, the **Control Engineer Shall** confirm that no reports of accidental contact or damage have been received prior to re-energising. For out-of-area networks, the **Control Engineer Shall** also check for damage reports with the host Distribution Network Operator.

10.4 The relevant Transmission Company **Shall** be contacted prior to attempting any reclosure which may affect a Transmission network, except in an emergency.

10.5 Any restoration sequence **Shall** also have regard for **System** voltage and frequency before recovery of any significant lost load or generation.

11 Manual Closing of Circuits Post Trip

11.1 It is acceptable to manually reclose **High Voltage** circuits following operation and lockout of automatic reclosing devices, providing this does not pose an unacceptable risk of injury to the public.

11.2 The risk of injury to the public, who could be in the vicinity of any damaged or accessible **High Voltage** circuit, when the circuit is manually reclosed, needs to be balanced against the risk to the public from the ongoing supply loss.

11.3 Risk assessment of and requirements for manual reclosing of **High Voltage** circuits, following operation and lockout of automatic reclosing devices, are necessary to minimise the risk of **Danger** to the public.

11.4 Where manual closing of circuits post trip is required, reference **Shall** be made to the **Approved** Procedure PR-NET-OSM-020 Manual Reclosing of Circuits Post Trip, Sequence Operation and Lockout - Operational Safety Manual – Section 2.10.

11.5 This **Approved** procedure is intended to assist **Control Engineers** with assessing the risk of manual reclosing and what steps need to be taken before attempting manual reclosing of **High Voltage** circuits following trip, sequence operation and lockout of automatic reclosing devices. These steps are based on the common framework for manual reclosing of **High Voltage** circuits in ENA SHE Standard 06.

12 Fault Switching

12.1 No Specific Report of Network Damage

12.1.1 Where network automation is part of the **System**, this may automatically sectionalise faulted circuits based on pre-determined conditions. This will operate prior to the intervention of a **Control Engineer**. Where a sequence **Switching** scheme or remotely controlled switchgear is fitted, then **Operators Shall** be directed to appropriate locations based on the outcome of the initial **Switching** by these devices.

12.1.2 For Distribution circuits, if there is no specific report of network damage, and no automation has operated, then the Fault Action Plan (see NOTE) **Shall** be followed. This identifies the first **Switching** point that halves the circuit by customer numbers, consistent with the most effective site access.

NOTE: Fault Action Plans are circuit specific **Switching** plans held in the Outage Management System database and / or the network control system.

12.1.3 If the first **Switching** operation proves the faulted network is towards the source, then the next **Switching** operation **Shall** aim to restore the healthy network from an alternative source, where available. This should restore half the customers in the shortest possible time.

12.1.4 Following the first restoration stage, the faulted network **Shall** be sub-divided again consistent with the most effective access and operation. This process **Shall** continue until the faulty section is identified. Where a multi-panel switchboard is installed on the network, this can sometimes be used effectively to provide more rapid fault sectionalising and supply restoration.

12.1.5 Where **Switching** has restored all but the last section of an all underground 11kV or 6.6kV circuit, then the condition of this circuit section **Shall** be proven by either:

- Re-energisation, or
- Overvoltage (pressure) test, which **Shall** be carried out as soon as practicable and certainly within 12 hours of the initial trip

12.1.6 If this test is successful, then all substations on the circuit **Shall** be patrolled in accordance with section 12 of this Approved procedure.

12.1.7 For Distribution circuits operating at a higher **System** voltage than 11kV, with little or no sectioning options, the **Control Engineer Shall** determine the next restoration action from the protection and alarm information available. This may include further complete circuit reclose attempts if the situation or weather conditions deem this to be appropriate. Reference should be made to PR-NET-OSM-020 Manual Reclosing of Circuits Post Trip, Sequence Operation and Lockout - Operational Safety Manual – Section 2.10 for guidance on manual reclosing of circuits post trip, sequence operation and lockout.

12.1.8 As **Switching** progresses, the **Control Engineer Shall** monitor the number of circuit-breaker trips / fault level to ensure the 'remaining fault breaking capacity' limits of the circuit-breaker are not exceeded. It may be necessary to energise the last few suspect sections one at a time if the circuit-breaker 'remaining capacity' will only allow one more fault clearance.

12.2 Damage or Other Incident Report Received

12.2.1 If a damage or other incident report is received and there are no reported injuries from site and the section of network involved is able to be identified, then the damaged network **Shall** be disconnected, and other supplies restored before visiting the site of damage.

12.2.2 If an associated injury report is received, then this **Shall** take priority over supply restoration.

13 Network Automation

13.1 The sequence of switchgear operations for circuits fitted with automation or remotely controllable switchgear may be determined by a Fault Passage Indicator (FPI), normally situated at the mid-point on each section of the circuit.

13.2 There are several types of FPI in use and all may be used for positive indication. However, only three-phase FPIs or circuit-breaker based protection relays (including pole-mounted circuit-breakers), which register the passage of both **Earth** and phase fault current, should be used for negative indication.

13.3 When a fault occurs on a network fitted with FPIs the following procedures **Shall** apply.

13.4 Positive mid-point FPI indication:

- The first operation **Shall** be to open the mid-point switch remotely, as the FPI indicates positively that the fault is beyond the mid-point, then the source circuit-breaker **Shall** be reclosed immediately, without the need to reduce the fault level.
- Thereafter section 11 of this **Approved** procedure **Shall** be followed.

13.5 Negative mid-point FPI indication (3 phase FPI only):

- The first operation **Shall** be to open the mid-point switch
- After checking that the alternative supply is able to supply the section of network beyond the mid-point and that the protective devices can be controlled from SCADA, the normally open point **Shall** be closed
- Thereafter section 11 of this **Approved** procedure **Shall** be followed

14 Transient / Unknown Faults

14.1 If a 132kV, circuit auto-recloses successfully and the cause is unknown, then the circuit **Shall** be patrolled by practical means (e.g. Helicopter, vehicle, foot) within 48 hours, or at the first reasonable opportunity thereafter.

14.2 In the event that the line has been patrolled recently, with no fault identified, an alternative management plan may be agreed between the relevant Control Centre and the field unit.

14.3 If a 6.6kV, 11kV or 33kV circuit-breaker has auto-reclosed successfully more than once in a rolling month and the cause is unknown, then the circuit **Shall** be patrolled.

14.4 If the patrol fails to locate the cause, then portable FPIs **Shall** be fitted at strategic points on the circuit and moved to localise the fault on any subsequent reclosures or lockouts. The **Control Engineer Shall** be informed of the position of these portable FPIs.

14.5 On every occasion that an all underground circuit trips and is re-energised without any cause being found, the connected substations, **Switching** stations and cable compounds **Shall** be visited as soon as practicable in daylight to check that the busbars, cable boxes and exposed cables show no sign of distress.

15 Busbar Faults

There are differences in busbar protection arrangements between the South and the North Licence areas relevant to this section.

15.1 South Licence Area

15.1.1 Most grid sites with open 33kV busbars are fitted with an auto-reclose scheme which will attempt to re-energise the site following a busbar fault. The operation of these schemes is covered by the **Approved** Procedure for Operation of 33kV Busbar Auto-Reclose Schemes.

15.1.2 Section 14.4 of this **Approved** procedure applies where this type of scheme is not installed or following partial restoration by this type of scheme.

15.1.3 Most primary sites are fitted with protection which only disconnects the affected section of busbar for a busbar fault or for an un-cleared feeder fault.

15.2 North Licence Areas

Most grid and primary sites are fitted with protection which only disconnects the affected section of busbar for a busbar fault or for an un-cleared feeder fault.

15.3 Situations Where Busbars Shall Not Be Remotely Energised

15.3.1 Busbars **Shall** not be remotely re-energised in the following situations, until a site inspection has been carried out:

- Those associated with a Transmission System or 132kV Networks operated by SEPD.
- Where the busbars and associated **Apparatus** are all indoors or enclosed (unless there is sufficient information available to indicate protection / Plant maloperation (see section 15.4 part 2)
- Where a positive report of fire or disruptive failure from the site has been received
- Where staff are known to be working on site but attempts to contact them have been unsuccessful
- Where an automatic **Switching** scheme has already restored supply to all customers affected and there is no immediate threat to the integrity of the **System**
- Where, under section 15.4 of this **Approved** procedure, the attempt to open an outgoing circuit by telecontrol fails, thus indicating a ‘stuck’ circuit-breaker

15.3.2 In all other circumstances, following an assessment of fault alarms and operations, section 15.4 of this **Approved** procedure **Shall** apply.

15.4 Situations Where Busbars May Be Remotely Energised

Part 1 – Outdoor (air insulated) busbars

15.4.1 Where all or part of the busbars have become de-energised and the load affected is within the rating of a single transformer or incoming circuit, then an attempt **Shall** be made to re-energise the affected busbars immediately via a single transformer feed or incoming circuit.

15.4.2 If this is successful then, where practicable, no further **Switching Shall** be carried out pending an immediate inspection.

15.4.3 If the load exceeds the rating of a single transformer or incoming circuit, then:

1. The busbars **Shall** be split and/or potential load **Shall** be disconnected as necessary
2. An attempt **Shall** be made to re-energise each section of busbars in turn
3. Only the minimum amount of **Apparatus** to restore supplies **Shall** be energised until the site has been inspected

15.4.4 If an attempt to remotely re-energise the whole busbar has failed, or where an automatic **Switching** scheme has already restored one section of busbars then:

1. Any remaining busbar **Shall** be split
2. All outgoing circuits fitted with telecontrol **Shall** be opened
3. An attempt **Shall** be made to re-energise each remaining section of busbar, but only using a transformer or incoming circuit not previously used to attempt re-energisation, until the faulty section has been identified
4. Only the minimum amount of **Apparatus** to restore supplies **Shall** be energised until the site has been inspected

15.4.5 If the attempts to restore supplies via the busbars are unsuccessful, remote **Switching Shall** be used to restore supplies from alternative sources, while staff travel to site.

Part 2 - Indoor and enclosed outdoor busbars

15.4.6 Indoor or enclosed outdoor busbars **Shall** not be re-energised until they have been inspected on site (including the integrity of the gas insulation in GIS Switchgear), unless there are positive indications that protection and / or **Plant** has mal-operated.

15.4.7 Where an FPI or other protection alarm(s) indicate a mal-operation and the suspect **Apparatus** can be disconnected from the affected busbar by telecontrol, then one re-energisation attempt may be made.

16 High Voltage Overhead Network Fuse Replacement

16.1 During major weather-related events, e.g. lightning storms, the **High Voltage System** up to and including 33kV lines with distributed transformers, can experience multiple **High Voltage** fuse failures with no permanent damage. In these circumstances, it is permissible for the **Control Engineer** to issue an instruction for 'Delegated Fuse Replacement', to replace all fuses that have operated 'as found'.

16.2 This instruction **Shall** be issued on a circuit basis directly to suitably authorised staff by the **Control Engineer**.

16.3 The 'Delegated Fuse Replacement' instruction **Shall** be issued as a standard **Switching** instruction, which **Shall** be logged by the recipient, and on completion of work or shift **Shall** be confirmed back to **Control Engineer** as complete.

16.4 Individual fuse replacement **Shall** only be attempted after the network protected by the fuse has been inspected and no obvious damage identified. Where inspection is not reasonably practicable, e.g., a long inaccessible spur, then a check **Shall** be made to ensure that there have been no 'damage calls' and that there has been a suitable delay, as required by section 10 of this **Approved** procedure.

16.5 All fuse replacements **Shall** be recorded on a standard **Switching** log with 'instructed' and 'carried out' times.

16.6 The completed field **Switching** log details **Shall** be relayed back to the Distribution Control Centre as soon as practicable after the delegated instruction is confirmed back to the **Control Engineer** as complete.

17 Disconnecting Known Live Faults

17.1 When **Switching** to disconnect known faults where the circuit / **Apparatus** remains **Live**, the minimum number of customers **Shall** be interrupted for the shortest possible time, but without risk to the **Operator**.

17.2 The following methods of achieving this **Shall** be utilised:

- Use of a ground-mounted or pole-mounted circuit-breaker
- Use of overhead line switch provided the fault is remote from the switch pole and stable (i.e., a Broken Jumper)
- **Live**-line disconnection of faulty / suspect **Apparatus** after the circuit has been made Dead and hot stick **Live**-line techniques are used on the **Dead** connections to disconnect the **Apparatus** before re-energising

18 Removing Debris from Overhead Lines

18.1 Removing debris such as trees, balloons, and ice from 11kV and below overhead line **Conductors** carries a risk of clashing Conductors, breaking **Conductors** and/or electric shock.

18.2 The following principles **Shall** be followed to avoid these risks:

- Where the item can be removed entirely using insulated rods/tools and there is no risk of breaking or clashing bare **Conductors**, then this may be done with the circuit **Live**
- If removing the item carries a risk of clashing bare **Conductors**, but no risk of breaking a **Conductor**, and the item can be removed with insulated rods/tools, e.g., removing ice accretion from a large **Conductor**, or to remove a sapling, then this **Shall** be done with the relevant section of circuit de-energised
- Where insulated rods/tools cannot be used and / or there is a risk of breaking **Conductors**, then the section of circuit **Shall** be Isolated and **Earthed**, and a **Permit-to-Work** issued
- Where the item is being removed with the line de-energised, but the circuit has not tripped on fault, then it **Shall** be verified that the line is **Dead** by the use of **Approved** testing equipment or checking supplies at a local transformer

19 Manual Closing of Circuits Post Trip

19.1 It is acceptable to manually reclose **High Voltage** circuits following operation and lockout of automatic

19.2 The risk of injury to the public, who could be in the vicinity of any damaged or accessible **High Voltage** circuit, when the circuit is manually reclosed, needs to be balanced against the risk to the public from the ongoing supply loss.

19.3 Risk assessment of and requirements for manual reclosing of **High Voltage** circuits, following operation and lockout of automatic reclosing devices, are necessary to minimise the risk of **Danger** to the public.

19.4 Where manual closing of circuits post trip is required, reference **Shall** be made to the **Approved** Procedure PR-NET-OSM-020 Manual Reclosing of Circuits Post Trip, Sequence Operation and Lockout - Operational Safety Manual – Section 2.10.

19.5 This **Approved** procedure is intended to assist **Control Engineers** with assessing the risk of manual reclosing and what steps need to be taken before attempting manual reclosing of **High Voltage** circuits following trip, sequence operation and lockout of automatic reclosing devices. These steps are based on the common framework for manual reclosing of **High Voltage** circuits in ENA SHE Standard 06.

20 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01	New document created	TBC	1.00	Richard Gough
02				