1. SCOPE

This section of the Live Working Manual deals with the general principles for operating all types of distribution **System HV** alternating current switchgear within its capability and gives instruction on its operation. The assessment of operational adequacy and operational restrictions that may apply to individual types and manufactured types of switchgear is dealt with in other Energy Networks documentation.

Where *Air-Break Switch Disconnectors* are concerned, ENA Engineering Recommendation G18 shall be applied in Energy Networks. The principles contained in that Recommendation as to the marking of 6.6kV, 11kV and 33kV *Air-Break Switch Disconnectors* shall apply where those switches are installed on overhead networks, including overhead arrangements in substations.

2. ISSUE RECORD

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Issue Date	Issue No	Author	Amendment Details
July 18	6	Dave Naylor Jose Quintana John Geddes	Scope limited to **High Voltage** AC **System** Category 0 ABSDs added ABSD guidance updated to reflect revision of ENA EREC G18 Revised switchgear definitions SF_6 references changed to 'dielectric gas' Changes to reflect current switchgear population Updated voltage transformer and tap changer guidance Reference to switchgear operating hierarchy **Switching** PPE guidance added Requirement to inspect *Circuit Breaker* moving and fixed portions Extra requirements to secure *Circuit Breakers* as **Primary Earths** Phasing-out methods included, with order of preference Section 13 added.
02/05/2019	7	Dave Naylor Jason Morgan	*Fuse Switch* section 9.2.2.2 updated Section 12: requirement to print name in substation logbooks Section 13: re-worded to improve clarity Appendix 1: Table 0, cat 0 ABSD rating errors corrected

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Dave Naylor Operational Safety Engineer	Gary Evans Operational Assurance Manager	Frank Monaghan Health and Safety Director Frank Monaghan Digitally signed by Frank Monaghan Date: 2019.05.22 11:36:59 +01'00'

4. REVIEW

This is a Reference document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive.

DISTRIBUTION

This document is part of the Live Working Manual but does not have a maintained distribution list.

5. CONTENTS

6. FOREWORD

Within ground mounted substations on the Energy Networks distribution **System** there are **Switching** devices known variously as "switches", "isolating switches" or "isolators" which have been manufactured over the years to the requirements of a number of technical and/or user specifications. As a result, the many designs of this type of **Apparatus** installed on the **System** differ in their operational capability.

Also connected to the overhead **System** is a multiplicity of types of *Air-Break Switch Disconnector* that have been produced by various manufacturers and not to any National Standard. Experience has shown that this type of **Apparatus** has a good operational safety record when correctly installed. However, in the absence of any appropriate National Standard, ENA Engineering Recommendation G18 was first published in 1974 and updated in 2013.

7. RELATED DOCUMENTS

Energy Networks Association (ENA)
Engineering Recommendation: (EREC) G18 - Air-Break Switch Disconnectors: Recommendations

Scottish Power Safety Rules Specialised Procedures:
SP 5 - Opening And Closing Of High Voltage Metal Enclosed Switchgear Shutters By Hand Up To And Including 33 kV

SP Energy Networks Documents (SPEN)
EPS-01-002 Hazard and Defect Management Policy
OPSAF-04-009 Suspension of Operational Practice and Access Constraint Procedure
OPSAF-10-001 PSSI 1. High Voltage Switching
OPSAF-11-010 MSP 1.8 Recording and Reporting of High Voltage and Low Voltage Switching
OPSAF-11-016 MSP 2.5 Procedures to be Adopted when the Safety Rules (Safety Document Process and/or Safety Features) cannot be applied
OPSAF-12-003 LWM 2.1 Operation of LV System
OPSAF-12-005 LWM 2.3 Use of Approved Voltage Indicators (HV) and Capacitive Phasing-Out Devices
OPSAF-12-024 LWM 8.1 Approval of Equipment for Live Working or Testing
OPSAF-16-XXX Suspension of operational practice - various
SWG-01-001 Switchgear Post-Fault Maintenance Policy
SWG-02-007 Switchgear Assessment (6kV, 11kV & 33kV)
SWG-06-001 Approved Equipment Register - Switchgear

8. DEFINITIONS

Terms printed in bold are as defined in the ScottishPower Safety Rules (Electrical and Mechanical) 4th Edition.

Terms printed in Italics are defined in Section 9.1 of this document.

9. SWITCHGEAR TYPES AND CATEGORIES

9.1 Definitions

The following definitions shall apply for the purposes of this and other related sections of the Live Working Manual. The **Apparatus** defined may be used individually or in combination in separate or composite tanks or enclosures.

(a) *Circuit Breaker*

Mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified duration and breaking currents under

specified abnormal circuit conditions such as those of short circuit. Current may be made or broken under oil, in dielectric gas (such as SF_6), or in vacuum.

(b) *Switch Disconnector*

Switch which, in the open position, satisfies the isolating requirements specified for a disconnector and may be used as an **Isolating Device** when open and appropriately **Locked**. This type of device is capable of:
(i) carrying and making current under normal and abnormal conditions.
(ii) breaking current under normal conditions only.

(c) *Fuse Switch*

Switch disconnector in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact and may be used as an **Isolating Device** when the switch disconnector is open and appropriately **Locked**. This type of device is capable of
(i) carrying and making current under normal and abnormal conditions.
(ii) breaking current under normal conditions.
(iii) breaking current under abnormal conditions only via **Approved** fuseable links.

(d) *Disconnector*

Mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements and may be used as an **Isolating Device** when open and appropriately **Locked**. This type of device is capable of opening or closing a circuit either:
(i) when negligible current is broken or made, or
(ii) when no significant change in the voltage across the terminals of each pole of the disconnector occurs.

Disconnectors may be oil immersed, air insulated or dielectric gas insulated.

(e) *Air-Break Switch Disconnector (ABSD)*

Switch disconnector in which the contacts open and close in air at atmospheric pressure and may be used as an **Isolating Device** when open and appropriately **Locked**. This term includes devices variously described as air-break disconnectors, air-break switch disconnectors, isolating switches, line isolating switches, mast switches or air-break switches.

The making and breaking capability of these devices varies dependent on:
(i) whether they are fitted with interrupter heads
(ii) whether they are fitted with arcing horns
(iii) whether they are horizontally mounted
(iv) their **Location** on the **HV System**

Where an *Air-Break Switch Disconnector* is situated at a **Location** within its fault making duty, it shall be marked with a letter "M" (see also paragraph 9.3.2.1 below).

(f) *Transfer Earthing*

An **Approved** means of earthing using withdrawable metal enclosed switchgear:
(i) which does not require the attachment of an earthing extension **Earthing Device** and,
(ii) where a separate selector mechanism is used to select either Busbar Earth, Circuit Earth or Service position.

9.2 Ground Mounted Metal Enclosed Switchgear

9.2.1 Acceptable Types

The current types of **HV** switchgear **Approved** for purchase and connection to the distribution **System** shall be found in the **Approved** Equipment Register.

9.2.2 Operational Limitations

The ratings, operational adequacy of earlier designs and restrictions on the operation of individual manufactured types of **HV** switchgear are contained in SWG-02-007 'Switchgear Assessment (6kV, 11kV & 33kV)' and OPSAF-04-009 'Suspension of Operational Practice and Access Constraint Procedure'. General conditions on the operation of **HV** switchgear are listed below.

9.2 2.1 Dielectric gas (e.g. SF_6) or Oil *Switch Disconnectors*

(a) All **HV** independent manual dielectric gas or oil *Switch Disconnectors* and associated Earth Switches are fitted with a reverse operation delay feature either at manufacture or, for earlier designs, retrospectively. Should a unit be discovered without such a feature (either by defect or design), then it shall not be operated **Live**. The network diagram shall be annotated to this effect and EPS-01-002 'Hazard and Defect Management Policy' shall be applied.

(b) A time interval of at least 60 seconds shall be allowed to elapse between the closing of a dielectric gas or oil *Switch Disconnector* into the 'ON' or 'EARTH ON' position, and the re-opening of the device, due to the possibility of auto-reclose **Apparatus** operating and completing its **Switching** cycle.

(c) Following a fault clearance by a withdrawable oil *Circuit Breaker,* a time interval of at least 10 minutes shall be allowed to elapse before the *Circuit Breaker* is withdrawn, due to the possibility of build-up of explosive gases in busbar or circuit spouts.

(d) Earth switches fitted to dielectric gas or oil *Switch Disconnectors* are designed for fault making, and may be utilised to apply a **Primary Earth** to a circuit.

9.2.2.2 *Fuse Switch* (including *Fuse Switches* of Ring Main Units)

(a) Reverse operation delay features are not always fitted to the "ON/OFF" handles of *Fuse Switches*, as these are fitted with fast operating fuse links. The fuse links will operate in less than 0.01 seconds for faults of 18 MVA or more and actuate the trip mechanism.

(b) Access to the **HV** fuse carrier and the replacement of **HV** fuses shall be carried out with the *Fuse Switch* or ring main unit not **Live.** Following the operation of an **HV** fuse neither the *Fuse Switch* nor any associated *Switch Disconnectors* shall be operated **Live**. The switchgear shall be made not **Live** from a remote location. Following an **HV** fuse change the *Fuse Switch* shall be closed not **Live,** the area cleared of **Persons** and the public, and re-energised from a remote location.

(c) The Earth Switch associated with *Fuse Switches* shall not be operated unless fitted with a reverse operation delay feature as 9.2.2.1(a).

(d) As in 9.2.2.1(b), the 60-second delay operational restriction shall apply to the manual re-opening or tripping after closure of a *Fuse Switch* or the associated Earth Switch.

(e) Where Earth Switches are associated with the equipment listed below, they shall not be used to apply a **Primary Earth** to a circuit capable of a back feed from an alternative 11kV or 6.6kV supply source, unless the circuit can be proved not **Live** by an **Approved** testing device and a **Primary Earth** is in place between the alternative supply source and the Earth Switch. Earth

Switches on the arrangements below will only be rated to 3.15 kA short-circuit making current, hence the limitation.

(i) Earth Switch associated to some free-standing *Fuse Switches*
(ii) Earth Switch associated to all Y-type Ring Main Unit *Fuse Switches*
(iii) Earth Switch associated to some Y-type Ring Main Unit transformer *Circuit Breakers*

9.2.2.3 Dependent Manual Switchgear

The operation of dependent manual ground mounted *Switches or Circuit Breakers* shall not be carried out with the **Apparatus Live**.

9.3 *Air-Break Switch Disconnectors*

9.3.1 Categorisation

All *Air-Break Switch Disconnectors* shall, according to making and breaking capability, be placed in one of the following three categories:

Category 0: ABSDs fitted with a mechanism other than dependent manual or dependent power, and fitted with a self-contained arc extinguishing device ('interrupter heads').

Category 1: ABSDs fitted with self-contained arc extinguishing devices ('interrupter heads').

Category 2: ABSDs fitted with any type of load-break arcing contacts (e.g.arcing horns), or with plain-break contacts.

Category 3: Other types, including dependent manual operations, with no assigned rating. Essentially, *Disconnectors*.

9.3.1.1 The identification of Category shall be in accordance with the making and breaking duties at the **Location** of the unit and in accordance with Tables 2.1, 2.2, 2.3 and 2.4 of ENA Engineering Recommendation G18 and the guidance given in that recommendation.

9.3.1.2 All A*ir-Break Switch Disconnectors* shall be marked according to Category, both on the pole or structure at the **Location**, and on the **System** diagram.

9.3.2 Marking

9.3.2.1 Symbols

The undernoted symbols shall be used for marking A*ir-Break Switch Disconnectors*:

(a)	**Categories**		**(0), (1), (2), (3)**
(b)	**Mounting**	Horizontal	**H**
		Vertical	**V**
(c)	**Making Duty Adequate**		**M**

Normal fault level at **Locations** within the making duty (MVA) shown in Tables 2.1, 2.2 and 2.3 of Engineering Recommendation G18 (attached as Appendix 1), i.e. unit able to make a circuit.

9.3.2.2 At the **Location**

At the **Location** of the *Air-Break Switch Disconnector*, Category 0, 1 and 2 units installed where the normal fault level is within the making capability as shown in Tables 2.1, 2.2 and 2.3 of ENA EREC G18, shall be fitted with a label. The label shall be marked in accordance with the appropriate combination of symbols given in Table 1 below. Category 3 units shall not be marked.

If there is a requirement to operate an *Air-Break Switch Disconnector* that is expected to be category 0, 1 or 2 but is found to be unmarked at the **Location,** discussion is required with the **Control Person**. The construction type of the *Air-Break Switch Disconnector* shall be assessed and enquiries shall be made to establish if recent work has been carried out which may have replaced a previous switch or if there is a reason labelling may have been removed. Only if it has been established that there is no doubt about the applicable category for the *Air-Break Switch Disconnector* and its serviceability, may it be operated **Live**. If there is any concern about the *Air-Break Switch Disconnector* it shall be treated as a Category 3 unit and not operated **Live**

Table 1 – On Site Marking

Category	Duty at **Location** Of Unit	
	Normal fault level within making duty	Normal fault level in excess of making duty
Category 0	C0 M	C0
Category 1	C1 M	C1
Category 2	C2 M	C2
Category 3	NOT MARKED	NOT MARKED

Application of the above procedure will lead to the marking of substation overhead A*ir-Break Switch Disconnectors* according to category, but because of short-circuit levels it will not generally be possible to mark these units as being within fault-making capability.

9.3.2.3 **System** Diagram

On the **System** diagram all A*ir-Break Switch Disconnectors* shall be marked according to Category number and making duty capability and in the case of Category 2 devices, whether the mounting is horizontal or vertical. The combination of markings shall be in accordance with Table 2 below.

Table 2 – System Diagram Marking

Category	Duty at **Location** of unit	
	Normal fault level within making duty	Normal fault level in excess of making duty
Category 0	C0 M	C0
Category 1	C1 M	C1
Category 2	C2 HM C2 VM	C2 H C2 V
Category 3	C3	C3

10. HV SWITCHGEAR OPERATION

10.1 General Notes

10.1.1 The decision as to whether or not to operate switchgear rests with the **Authorised Person** who is to carry out the operation.

10.1.2 Switchgear shall be operated in accordance with the ScottishPower Safety Rules (Electrical and Mechanical) 4th Edition, Power Systems Safety Instructions and Procedures.

10.1.3 Switchgear shall only be operated within its design rating and duty on which guidance is given in Section 9 of this document.

10.1.4 A drop in the level of the oil, the loss of gas pressure or the loss of vacuum in any unit may substantially alter the duty of which it is capable.

10.1.5 Where any gas-filled switchgear indicates a substantial loss of gas pressure, and the switchgear does not automatically operate in the event of low pressure, then no attempt shall be made to operate the switchgear **Live** until working pressure has been restored.

10.1.6 After **Apparatus** has been filled with oil, it shall not be energised, or for withdrawable **Apparatus** plugged into **Live** spouts, until adequate time has elapsed for the oil to de-aerate. Excessive aeration of the oil may alter the duty of the **Apparatus**.

10.1.7 Where **Apparatus** has had a change of insulating oil, or has had significant work carried out within the tank which may affect the insulation of the switchgear, it shall, where reasonably practicable, be energised from a remote point, provided that to achieve this no extra **Switching** will be required. For withdrawable **Apparatus**, racking into **Live** spouts is permitted prior to closing.

Note: A remote point means – a point physically remote from the switchgear to be re-energised. The re-energising operation may include operation by telecontrol from a control centre, operation from a substation control room, which is separate from the switchroom, operation from a remote substation, delayed operation, or operation by umbilical or lanyard.

10.1.8 Interlocks are safety devices, and shall not be defeated unless carried out in accordance with OPSAF-11-016 (MSP 2.5).

10.1.9 Should the mechanism jam, the corrective action required to release it shall be taken subject to the requirements of the ScottishPower Safety Rules (Electrical and Mechanical) 4th Edition.

10.1.10 When it cannot be proved locally that non-withdrawable metal enclosed switchgear is not **Live**, the integral Earth Switch must be closed before the test connection cover is opened.

10.1.11 Voltage Transformers (VTs):

(a) Withdrawable VTs shall not be withdrawn or replaced with the circuit **Live**. The preferred method for establishing a **Point of Isolation** is by removal of the **LV** fuses.

(b) For fixed VTs with an **HV Switching** device, the **Switching** device shall not be operated **Live**.

(c) For fixed VTs the method used to isolate the VT shall be by withdrawing the **LV** fuses and fixing a **Caution Notice**.

10.1.12 Tap Changers

(a) The term ‘Off Load’ tap changer shall not be used.

‘Off-Circuit’ tap changers shall only be operated with the transformer **Isolated** from the **System.** A **Limited Work Certificate** shall be issued.

(b) ‘On-load’ tap changers shall not be manually operated **Live** or by local electrical operation at the adjacent control cubicle.

10.2 Before Operation – Points to Consider

10.2.1 All switchgear operations shall be planned and carried out following the hierarchy of switching listed in OPSAF-10-001 (PSSI 1) section 10.1.

10.2.2 Suitable personal protective equipment shall be worn, including fire retardant coveralls, fastened to the ankles, wrists and neck. Appropriate safety footwear shall be worn. A safety helmet shall be worn when operating overhead **Apparatus**.

Approved class 1 rubber gloves shall be worn when operating *Air-Break Switch Disconnectors* with ground-level operating handles and when operating overhead **Apparatus** in substation outdoor compounds. Consider the use of leather protective gauntlets.

10.2.3 Take the switching schedule or *Switching and Fault Log* with you to the switchgear to be operated.

10.2.4 Make any proposed operation clear to all personnel involved at the **Location** and to the **Control Person**, who is designated as the **Person** in charge of the operation.

10.2.5 Examine the **Apparatus** for signs of distress, interference, pollution, undue noise or temperature rise or other indications, which may affect its capability.

Examination of overhead **Apparatus** shall be visual from ground level.

10.2.6 Confirm you are at the correct **Location** and identify the switch to be operated and confirm identity from the circuit labelling.

10.2.7 *Air-Break Switch Disconnectors* shall also be checked from ground level to ensure that:

- a Category label is fitted and the duty is appropriate to the operation intended,
- all operating blades are in the expected position,
- the insulators show no sign of damage,
- where a fixed metal operating handle at ground level is fitted,
    - the handle is connected to the earth mat on which the operator stands (to the extent a check is possible without excavation), and
    - an insulator is fitted in the switch operating rod, and
    - the insulator has not accidentally been shorted out and rendered ineffective by being bridged with conducting material.
    - the **HV** steelwork earth is insulated and the insulation is in sound condition,
    - the **HV** steelwork earth and the operating switch handle earth have not been accidentally shorted together by being bridged with conducting material,
    - the **HV** steelwork earth and the operator handle earth are at opposite sides of the pole,
    - there are no wire fences attached to or compromising the earth arrangements of the installation,

- the operating position is clear, the operator has good access and is able to stand directly in line with the switch-operating handle.

10.2.8 Check that the functional position of the switchgear, shutters, padlocks, interlocks and selectors are as they should be for the expected state of the **System**.

10.2.9 Before inserting any **Approved** test equipment into fixed portion spouts of withdrawable switchgear, check that all shutters to which access is not required are **Locked**.

Where practicable, inspect the *Circuit Breaker* moving portion for evidence of distress to the bushings and contacts such as burning, arcing or soot deposits.

Observing the requirements of Specialised Procedure SP 5, and wearing a minimum of light eye protection, the switchgear spouts shall be visually inspected with the aid of a torch (or equivalent) for evidence of distress such as burning, arcing or soot deposits – also consider if one or more bushings or spouts appear to be affected more than the rest.

Should either of these inspections reveal any evidence of distress – especially if one or more bushings or spouts appear to be affected more than the rest then **Switching** shall not continue. A **High Voltage** shutdown shall take place for a more thorough inspection to be completed.

10.2.10 Only **Approved Earthing Devices** shall be used for **HV** switchgear, and with the exception of *Transfer Earthing*, immediately before applying to spouts check that the shutters giving access to **Live** contacts are **Locked**. Then test the spouts concerned with an **Approved** voltage indicator in accordance with OPSAF-12-005 (LWM 2.3), the indicator itself being tested immediately before and after use.

10.2.11 Check the indication on all protection relays associated with the switchgear. Any adjustment to the setting shall only be carried out with the agreement of the **Control Person**. The adjustment shall be recorded by the **Control Person** and the operator in accordance with OPSAF-11-010 (MSP 1.8).

10.2.12 Check the loading, where reasonably practicable. If this exceeds the rating of the unit, the operation must be transferred to a suitable alternative switch. Category 3 *Air-Break Switch Disconnectors* in substations may be used to energise (or de-energise) short sections of busbar and connections when negligible current is established (or interrupted) only.

10.2.13 Check if there are Operational Restrictions or SOPs on the switchgear concerned.

10.2.14 Ensure that the remote / local selector switch is correctly positioned, where the switch to be operated can be remotely or automatically controlled.

10.2.15 Ensure that all of the switchgear operational features are in their correct position before any operation is started.

10.2.16 Where required, inspect insulated operating rods before use to ensure they are in good condition, with valid test and inspection labelling. Use the appropriate head for the rods. Protect the integrity of the insulation by keeping the rods dry.

10.2.17 Remove padlocks to allow only one operation at a time. Other padlocks shall remain locked in position until their removal is required.

10.2.18 Consider which automatic *Circuit Breaker* would provide back-up protection should the operation result in a fault on the **System**.

10.2.19 Plan what to do if the operation resulted in a fault in the local **Apparatus**, including your escape route.

10.2.20 Consider all aspects of the proposed operation, including the further action to be taken if, say, the operation resulted in loss of supply.

10.2.21 Order all other persons out of the potential **Danger** zone(s) before operating or energising **Apparatus**.

10.2.22 Immediately before carrying out the **Switching** action, pause and consider whether or not it is the correct action before proceeding.

10.3 During Operation – Points to be Considered

10.3.1 Carry out operations only on receipt of a **Switching** instruction from the **Control Person**, unless in an emergency, i.e. **Danger** to life or limb.

10.3.2 Give undivided attention to the operation being carried out.

10.3.3 Suspend operations immediately if any **Apparatus** or **System** abnormalities are identified, and consult with the **Control Person** before proceeding.

10.3.4 Use remote operating facilities where provided. Observe the hierarchy of switching in OPSAF-10-001 (PSSI 1) section10.1.

10.3.5 Use the reverse operation delay handle for all operations. Where there is no delay feature, the operation shall not be carried out **Live** without reference to the **Control Person**.

10.3.6 Where practicable, when frame-earth busbar protection is incorporated, the circuit shall be **Earthed** via the substation earth bar, and the busbar shall be **Earthed** via the switchgear earth bar.

10.3.7 Consideration shall be given to inhibiting busbar protection temporarily if there is a possibility of the work in progress causing the inadvertent tripping of other circuits. The **Control Person** shall be notified.

10.3.8 Ensure that earth leads, or other metallic objects, do not short out frame-earth busbar protection.

10.3.9 When operating an *Air-Break Switch Disconnector,* place yourself in a steady stance and make a firm positive movement, throwing your weight onto the handle. Once commenced, the operation must be carried through to completion. No change or reversal of action shall take place until at least 60 seconds after the completion of the initial operation.

10.4 After Operation – Points to be Considered

10.4.1 If the **Apparatus** shows signs of distress, such as emission of smoke, oil or flame, unusual noise or an undue temperature rise, do not attempt to operate but evacuate the area immediately and notify the **Control Person** with a view to remote isolation and subsequent examination.

10.4.2 After operation, always allow time for the **System** to return to normal before taking further action. At least 60 seconds must elapse before further operation.

10.4.3 Even in an emergency, do not reopen any item of switchgear with the exception of *Circuit Breaker*s, until at least 60 seconds after closing.

10.4.4 After an operation on fault, further operation without internal examination will depend on the type of **Apparatus**. The number of reclosures allowed will be in accordance with Switchgear Post-Fault Maintenance Policy, SWG-01-001.

10.4.5 After operation of an *Air-Break Switch Disconnector*, visually check from ground-level that all blades are in the expected closed or open position.

10.4.6 After opening an *Air-Break Switch Disconnector*, confirm that each pole of the switch has opened completely and that the appropriate clearance distance for the voltage level has been established - at both the disconnector terminals and the interrupter heads - before using it as a **Point of Isolation**.

10.4.7 After operating a hook stick *Air-Break Switch Disconnector* check that it has latched into the completed position by pulling on the other side of the operating arm to ensure it does not move.

10.4.8 After inserting **HV** pole mounted fuses, links or sectionalisers carefully pull down on the top to ensure it has latched properly.

10.4.9 Following a fault clearance by a withdrawable oil *Circuit Breaker,* a time limit of at least 10 minutes must elapse before the *Circuit Breaker* is withdrawn**.**

10.4.10 When withdrawing switchgear from its fixed portion, note any mechanical stiffness. Unreasonable force must be avoided to prevent damage.

Inspect the *Circuit Breaker* moving portion for evidence of distress to the bushings and contacts such as burning, arcing or soot deposits.

10.4.11 Following isolation and / or withdrawal of an item of **Apparatus**, lock off the shutters giving access to **Live** contacts immediately, whatever the work or testing to be carried out.

10.4.12 An Earth Switch or a *Circuit Breaker* forming a **Primary Earth** shall where practicable be **Locked** in the "closed" position.

When an earth is applied via a *Circuit Breaker*, as well as locking the mechanism to prevent manual tripping, other means shall be used to ensure that electrical tripping of the *Circuit Breaker* is prevented once the earth has been applied. If it is necessary to remove the *Circuit Breaker* tripping fuses, the **Control Person** shall be notified.

10.4.13 Following restoration of a withdrawable *Circuit Breaker* to the service position and when the secondary contacts have been broken, an operational check, subject to the exclusions below, shall be completed in order to prove the integrity of the auxiliary contacts and circuits. This operational check shall be completed by either, using the 'Trip Circuit Healthy' test facility, or by closing the *Circuit Breaker,* then tripping the *Circuit Breaker* with an element of a tripping relay or with a remote operation switch; then reclosing the *Circuit Breaker* for normal service.

Operational checks are required for:

- Primary Substations.
- Routine major and minor servicing.
- Work which may have affected the operation of the auxiliary contacts such as *Circuit Breaker* change, mechanism adjustments, protection relay repairs, secondary wiring alterations, etc.

Exclusions:

Operational checks are not required on the secondary 11/6.6kV networks under the following conditions:

- Routine network fault restoration process.
- Routine *Circuit Breaker* post-fault maintenance.
- Routine work affecting the network associated with the *Circuit Breaker*, e.g. cable deviations, secondary substation loop-in, adjacent substation maintenance etc.

11. METHODS FOR PHASING OUT ON COMPLETION OF WORK ON THE HV SYSTEM

This section defines the different acceptable techniques to carry out phasing checks on completion of work on the **HV System**. The use of Voltage Presence Indication Systems (VPIS) or Voltage Detection Systems (VDS) shall, where reasonably practicable, be employed. Where the use of VPIS or VDS is not reasonably practicable, consideration shall be given to the other methods described in this section.

In order of preference, the established selection of phasing out techniques is as follows:

1	Voltage Presence Indication Systems (VPIS) / Voltage Detection Systems (VDS)				
2	Phasing out at **Low Voltage**	or	Dead phase comparison under a **Sanction for Test**	or	**HV** phasing checks on overhead line/open busbar **Live** conductors
3	**HV** phasing checks on **Live** switchgear spouts				

The use of **Approved HV** voltage indicators on **Live** switchgear spouts shall only be employed where it can be demonstrated that all other techniques listed above are not reasonably practicable. When a planned **Switching** schedule is being prepared and the intention is to phase out at switchgear spouts, a short explanation shall be included in the schedule step confirming that the order of preference has been considered.

Description of the different methods available and further details on the considerations to be given when selecting the most adequate technique are provided in the sub-sections below.

11.1 Voltage Presence Indication Systems (VPIS) / Voltage Detection Systems (VDS)

Modern fixed pattern **HV** switchgear is generally supplied with Voltage Presence Indication Systems (VPIS) or Voltage Detection Systems (VDS) built into the equipment offering a method of **HV** phase checking based on capacitive coupled systems. Where a commissioned VPIS or VDS test access point is available on the **Apparatus** when phasing out is required, this shall be the preferred method. An **Approved** phase comparator shall be used in accordance with the manufacturer's instructions. The list of **Approved** instruments is provided in OPSAF-12-024 (LWM 8.1).

In the event that the **Apparatus** on which phasing out is required is not equipped with an integral VPIS or VDS test facility, but it is reasonably practicable to rearrange the **HV** network to allow phase checking at another substation fitted with VPIS or VDS test facility, this shall be the method adopted. The number of **HV** or **LV** switching operations required and the presence of tele-control capabilities shall be considered when making this judgement.

11.2 Phasing out at Low Voltage

Where a known **Low Voltage** reference is available either from the **LV** network (e.g. **LV** back-feed into a transformer cabinet/pillar) or at the secondary outputs of other equipment (e.g. known voltage transformer supply), this can be used for comparison against the **LV** supplies fed through the **HV Apparatus** to be tested in order to establish phasing. The number of switching operations required to establish a means of phasing out at **Low Voltage** shall be taken into account when this method is being considered. Refer to OPSAF-12-003 (LWM 2.1).

11.3 Dead phase comparison under a Sanction for Test

In cable circuits and some overhead line circuits, the phase relationship can be established by means of testing continuity of each individual conductor from each end of the circuit section to the other end(s) (under a **Sanction for Test**). This method is only acceptable in those cases where the **Apparatus** at each circuit end is already electrically connected and phasing can be clearly identified before and after any work is carried out on the circuit that may affect the phasing arrangement. This alternative may not be possible in fault scenarios where significant damage has been caused to the cable and as a consequence, no complete phase identification is possible, or where many transformers need to be disconnected.

Where this phasing out technique is employed, the assistance of a second **Authorised Person** is required to verify phasing (typically referred to as witness check). Where reasonably practicable, the same **Senior Authorised Person** and assisting **Person** shall carry out the phasing comparison before and after the work. If this is not possible, the information shall be adequately transferred between **Senior Authorised Persons** and recorded as required in the relevant **Safety Document**.

A requirement to insert test prods into oil-filled switchgear, or the unavailability of a suitable second **Person** shall be taken into account when this method is being considered.

11.4 HV Phasing checks on overhead line/open busbar Live conductors

Phasing out on overhead line sections or open busbars may be carried out by means of checking across the overhead line/open busbar **Live** conductors using an **Approved** voltage indicator, preferably of the capacitive type. Refer to the guidance in OPSAF-12-005 (LWM 2.3). The list of **Approved** instruments is provided in OPSAF-12-024 (LWM 8.1).

11.5 HV Phasing checks on Live switchgear spouts

Where none of the previously described methods are reasonably practicable, checking across the **Live** busbar and feeder spouts using an **Approved** voltage indicator is permitted. Refer to the guidance in OPSAF-12-005 (LWM 2.3). The list of **Approved** instruments is provided in OPSAF-12-024 (LWM 8.1).

11.6 Back-energisation of transformers

Transformers shall not be back-energised with the aim of conducting phase checks on the higher voltage side. This practice could lead to an inadequate level of protection or protection mal-operation, and will leave the back-energised section un-earthed in the case of DY transformers, which may not be in compliance with ESQC regulations.

11.7 Network energisation without prior phasing confirmation

On non-interconnected networks (radial circuits), it is not necessary to carry out **HV** phase checking on completion of work. However, correct phase rotation on the **LV** network shall be confirmed where required (e.g. 3 phase **LV** customers) and it may be necessary to confirm the **LV** network is correctly in phase with inter-connecting parts of the **System**.

On interconnected networks, in circumstances where it has not been possible, by any means, to identify and confirm phasing after carrying out work, the network may be energised providing that:

- An appropriate Senior Manager shall give written formal consent to the **Senior Authorised Person** carrying out the work
- By prior **Switching** of the network, the **Control Person** shall limit the **System** disruption that would occur if the **System** was to be out of phase.
- Protection settings shall be adjusted with the aim of reducing the *Circuit Breaker* tripping time to a minimum.

12. SUBSTATION LOGBOOKS

12.1 Logbooks

12.1.1 Grid Substations

Substation logbooks shall be provided at all Grid Substations; either a hard backed book or loose-leaf sheets in a suitable binder. They shall be kept prominently displayed, preferably close to the telephone.

12.1.2 Primary Substations

Substation logbooks shall be provided at all primary substations and shall be of size A4; either a hard backed book or loose-leaf sheets in a suitable binder. They shall be kept prominently displayed, preferably close to the telephone.

12.1.3 Secondary Substations

Substation logbooks need not be provided at outdoor secondary substations, as it is impracticable to do so.

12.2 Use of Substation Logbooks

Where a substation logbook is provided it shall be used in the following manner.

(a) Entries shall be made in continuous chronological order.

(b) All **Persons** visiting or entering the substation shall record the date, time, printed name and purpose (i.e. Switchgear maintenance, routine inspection etc.) of their visit.

(c) **Switching** carried out in substations shall be recorded in accordance with OPSAF-10-001 (PSSI 1) and OPSAF-11-010 (MSP 1.8). A detailed record of **Switching** operations does not need to be replicated in the substation logbook, however the purpose of the **Switching** shall be recorded in sufficient detail e.g. “Switching to schedule S3443 for maintenance at XXX” .

(d) Details of any abnormal conditions and remedial actions taken shall be recorded, e.g. switches found open, relays flagged, tap changer out of step, building defects, dangerous situations, etc. As appropriate, such conditions shall also be reported to the **Control Person** or in accordance with EPS-01-002 ‘Hazard and Defect Management Policy’.

13. USE OF INSULATED DEVICES INSIDE SAFETY DISTANCE

Approved insulated rods may be used from ground level and placed inside the **Safety Distance** of overhead conductors for purposes such as **Switching**, measuring conductor height or separation to adjacent objects, or the removal of debris / accumulations of snow/ice.

These may be undertaken by **Authorised Persons** holding an appropriate category that involves the use of insulated rods – e.g. OP for overhead **HV Apparatus**, DE or appropriate WL or other specific category. The rods shall be inspected before use to confirm they are in good condition and that they carry a valid inspection and electrical test label.

Note that the preferred method for height measurement is to use an optical or sonic range-finder type measuring device.

14. APPENDIX 1 – *AIR-BREAK SWITCH DISCONNECTOR* RATING TABLES

TABLE 0 – AIR-BREAK SWITCH DISCONNECTORS: MAKING AND BREAKING DUTY
CATEGORY 0 – FITTED WITH A MECHANISM OTHER THAN DEPENDENT MANUAL OR DEPENDENT POWER AND FITTED WITH A SELF-CONTAINED ARC EXTINGUISHING DEVICE

SYSTEM VOLTAGE kV	RATED NORMAL CURRENT Amps	RATED SHORT-CIRCUIT WITHSTAND CURRENT kA	MAKING DUTY MVA / kA (kA peak)	BREAKING DUTY			
				LOAD CURRENT Amps	CIRCULATING CURRENT Amps	TRANSFORMER MAGNETISING CURRENT (Equivalent Connected) MVA	CABLE CHARGING CURRENT Amps (Equivalent Length in kilometres)
6.6	400	12.5	110/10 (25)	400	400	5	7 (50km Solid)
11	400	12.5	190/10 (25)	400	400	7.5	10 (30km Solid)
20-22	400	12.5	120/3 (7.5)	400	400	15	16 (12km Solid)
33	400	12.5	180/3 (7.5)	400	400	24	20 (8km Solid)

Notes

(a) For special application e.g. for switching networks involving long lengths of cable to supply embedded generation e.g. wind turbines, use the following ratings for cable-charging breaking current: 11kV – 25A, 22kV - 40A, 33kV – 50A.

TABLE 1 – AIR-BREAK SWITCH DISCONNECTORS: MAKING AND BREAKING DUTY
CATEGORY 1 – FITTED WITH SELF-CONTAINED ARC EXTINGUISHING DEVICES (INTERRUPTER HEADS)

SYSTEM VOLTAGE kV	MAKING DUTY MVA / kA (kA peak)	BREAKING DUTY			
		LOAD CURRENT Amps	CIRCULATING CURRENT Amps	TRANSFORMER MAGNETISING CURRENT (Equivalent Connected MVA)	CABLE CHARGING CURRENT Amps (Equivalent Length in kilometres)
6.6	36 / 3 (7.5 peak)	400	400	5	7 (50km Solid Cable)
11	60 / 3 (7.5 peak)	400	400	7.5	10 (30km Solid Cable)
20-22	120 / 3 (7.5 peak)	400	400	15	16 (12km Solid Cable)
33	180 / 3 (7.5 peak)	400	400	24	{20 (8km Solid Cable) {15 (5.5km Oil Filled Cable)

Notes

(a) The breaking ratings are based on units with a manufacturer's rating of 400 Amps up to 33kV. For units having other prescribed manufacturers ratings the range of breaking duties should be amended pro-rata (e.g. for a unit rated at 600 Amps the breaking duties may be increased by 50%). The current making duty is unaffected.

(b) The making and breaking ratings quoted above are independent of mounting arrangements.

(c) For 66kV units the making and breaking ratings are only for double head arrangements.

(d) The magnetising current breaking capability is based on the total installed MVA. (Nameplate rating – natural cooling).

(e) The capability for breaking cable charging current is based on a copper conductor cable size of 185 sq.mm at 6.6kV and 11kV, and on 300 sq.mm at 20-22kV, and 33kV.

(f) There is no practical limit on the length of overhead line the charging current of which may be interrupted.

TABLE 2 – AIR-BREAK SWITCH DISCONNECTORS: MAKING AND BREAKING DUTY
CATEGORY 2 – FITTED WITH ANY TYPE OF ARCING HORNS OR PLAIN BREAK CONTACTS

SYSTEM VOLTAGE kV	MAKING DUTY MVA / kA (kA peak)	BREAKING DUTY			
		LOAD CURRENT Amps	CIRCULATING CURRENT Amps	TRANSFORMER MAGNETISING CURRENT Equivalent Connected MVA	CABLE CHARGING CURRENT Amps (Equivalent Length in kilometres)
6.6	36 / 3 (7.5 peak)	33	Full Load	1.4	5 (2.0km Solid Cable)
11	60 / 3 (7.5 peak)	20	Rating	1.4	5 (1.3km Solid Cable)
20-22	120 / 3 (7.5 peak)	17	or	1.8	5 (0.7km Solid Cable)
33	180 / 3 (7.5 peak)	10	300 Amps whichever is less	2	{5 (0.4km Solid Cable) {5 (0.3km Oil Filled Cable)

Notes

(a) The above breaking ratings are for units which are mounted horizontally above or below the line. For vertically mounted units the breaking duty should be reduced by 50%.

(b) The magnetising current breaking capability is based on the total installed MVA (nameplate rating – natural cooling).

(c) The capability for breaking cable charging current is based on a copper conductor cable size of 185 sq.mm at 6.6kV and 11kV, and on 300 sq.mm at 20-22kV, and 33kV.

(d) There is no practical limit on the length of overhead line the charging current of which may be interrupted.

TABLE 3 – AIR-BREAK ISOLATING SWITCHES: MAKING AND BREAKING DUTY
CATEGORY 3 – OTHER TYPES (DISCONNECTORS)

SYSTEM VOLTAGE kV	MAKING DUTY MVA / kA (kA peak)	BREAKING DUTY			
		LOAD CURRENT Amps	CIRCULATING CURRENT Amps	TRANSFORMER MAGNETISING CURRENT Equivalent Connected MVA	CABLE CHARGING CURRENT Amps (Equivalent Length in Kilometres)
All Voltages	"Negligible current"*	"Negligible current"*	"Where no significant change in voltage across the terminals of each pole will result from the operation"	"Negligible current"*	"Negligible current"*

Notes

Equipment in this Category has no making or breaking rating beyond the duties specified in IEC 62271-102, these *Disconnectors* will always be interlocked. Such equipment will include:

(a) units which are not ganged,

(b) units which the Engineering Services Director (or his designate) decides should be included in this category because of deficiencies in design or installation, or where environmental factors or operational history are abnormal.

Disconnectors when in the open position and suitably **Locked** provide sufficient isolation distance to be used as a **Point of Isolation.**

* A current not exceeding 0.5A is considered to be Negligible Current. Negligible current refers to the charging current of bushings, busbars and *Circuit Breakers*.