PR-NET-OSM-103

HIGH VOLTAGE DIRECT CURRENT SYSTEMS - GENERIC OPERATING PRINCIPLES

OPERATIONAL SAFETY MANUAL - SECTION 16.1

Scottish & Southern Electricity Networks

	Name	Title
Author	N/A	Distribution SHE Team
Checked by	Peter Vujanic	Head of SHE Distribution
Approved by	Richard Gough	Designated Engineer

CONTENTS

1 Introduction

1.1 This **Approved** Procedure is currently included in the Distribution Operational Safety Manual for information purposes, where future developments may require **SSEN-D** interaction with **HVDC Systems** of **SSEN-T**.

1.2 This **Approved** Procedure sets out the generic requirements for the safe management of **High Voltage** Direct Current (**HVDC**) Converter Systems and **HVDC** Switching sites which may be encountered by **SSEN-D** staff.

1.3 There are specific **Approved** Procedure in place for each **HVDC** Converter Station and **HVDC** Switching sites owned and operated by **SSEN**. These **Approved** Procedures contain specific / unique information relating to the respective substation site. They are available in the **SSEN-T** Operational Safety Manual.

1.4 In addition to the site-specific **Approved** Procedures, a set of Engineering Documents are in place for each **HVDC** Converter Station and **HVDC** switching site. These are created in conjunction with the manufacturer of the assets and include detailed asset information (inspection, operation, maintenance, etc) which operational persons **Shall** reference when accessing, operating, testing and working on the respective **HVDC** assets.

1.5 This **Approved** Procedure **Shall** be used in conjunction with the **SSEN-T Operational Safety Rules** and the respective specific **HVDC** Converter Station site and/or **HVDC Switching**-site **Approved** Procedure and related Engineering Documents

1.6 Whilst this document specifically deals with **SSEN-D's** interaction with **SSEN-T HVDC** sites its principles may be applied to other third party owned **HVDC** sites where the third parties **Operational Safety Rules** and **Approved** procedures allow.

2 Scope

2.1 This document relates to requirements for management of operation and control on all of **HVDC** Converter Stations and **HVDC** Switching sites but is subordinate to the relevant operators **Operational Safety Rules** and **Approved** procedures.

2.2 It applies to all persons employed by or working on behalf of **SSEN-D** in their interaction with **HVDC** Converter Stations and **HVDC** switching-sites.

3 References

The documents detailed in Table 3.1 - Scottish and Southern Electricity Networks 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-502	High Voltage Direct Current (HVDC) Systems – Blackhillock Converter Station - Operational Safety Manual – Section 16.2 **(Trans Document)**
PR-NET-OSM-503	High Voltage Direct Current Systems – Spittal Converter Station - Operational Safety Manual – Section 16.3 **(Trans Document)**
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)

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 **SSEN-T OSR**.

4.2 **HVDC**

High Voltage Direct Current

4.3 **Operational Safety Rules (OSR)**

The **SSEN-T** 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 **SSEN-T Authorisation Officer**

A Person authorised in writing by the **SSEN-T Designated Engineer** to assess, award and remove, as necessary, operational authorisations required under the **Operational Safety Rules** to access, operate, test, control and work on the electrical **Systems** owned and operated by **SSEN-T**.

5 General Responsibilities

Control Engineers Shall be responsible for control of all operations within their **HV System** control zone to ensure that:

- All operations **Shall** be carried out safely in accordance with the **Operational Safety Rules** and relevant **Approved** Procedures
- The **System Shall**, where practicable, be operated to maximise security of supply, avoid overloading and maintain voltages within statutory limits
- Customer supplies **Shall**, where reasonably practicable, be restored as quickly as possible post-fault
- Compliance with all requirements for statutory and internal reporting of incidents

6 Authorisation

6.1 Persons without written **SSEN-T** operational authorisation for **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** receive **Personal Supervision** in accordance with the requirements of the **Operational Safety Rules** if they are required to access, operate, test, control or work in **HVDC** Converter Stations or **HVDC Switching**-sites.

6.2 Operational authorisation associated with **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** not be awarded to a Person without a robust business needs case being concluded in accordance with **SSEN-T**'s **Approved** Procedure for operational authorisations. This is required to ensure that all operational authorisations associated with **HVDC** Converter Stations and **HVDC Switching**-sites are optimised and therefore proven as being absolutely required. This requirement is essential to help safeguard **HVDC** Converter Station and **HVDC Switching**-site assets and persons.

6.3 Only Persons with existing experience and operational authorisation regarding the same asset type and voltage, **Shall** be considered for operational authorisation for a **HVDC** Converter Station and/or **HVDC Switching**-site, i.e. same voltage and equivalent substation environments.

6.4 Examples of applicability for **HVDC** operational authorisation:

- Existing **Competent Persons** with operational authorisation to access to 275 kV and 400 kV substations containing exposed **Live High Voltage Conductors** may be nominated for training and authorisation to access **HVDC** Converter Stations and **HVDC Switching**-sites providing a business case is proven.
- Existing **Competent Persons** with operational authorisation restricted to access 11 kV, 33 kV and 132 kV substations only, **Shall** not be considered for training and operational authorisation to access **HVDC** Converter Stations or **HVDC Switching**-sites.
- Existing **Competent Persons** with operational authorisation to receive **Safety Documents** for work in 275 kV and 400 kV substations containing exposed **Live High Voltage Conductors** may be nominated for training and authorisation to access **HVDC** Converter Stations and/or **HVDC Switching**-sites providing a business case is proven.
- Existing **Competent Persons** with operational authorisation restricted to receive **Safety Documents** in 11 kV, 33 kV and 132 kV substations only, **Shall** not be considered for training and operational authorisation to access **HVDC** Converter Stations or **HVDC Switching**-sites.
- Existing **Authorised Persons** with operational authorisation to operate in 275 kV and 400 kV substations containing exposed **Live High Voltage Conductors** may be nominated for training and authorisation to access **HVDC** Converter Stations and **HVDC Switching**-sites providing a business case is proven.
- Existing **Authorised Persons** with operational authorisation restricted to operate in 11 kV, 33 kV and 132 kV substations only, **Shall** not be considered for training and operational authorisation for **HVDC** Converter Stations and/or **HVDC Switching**-sites.
- Existing **Senior Authorised Persons** with operational authorisation to control work and testing in 275 kV and 400 kV substations containing exposed **Live High Voltage Conductors** may be nominated for training and authorisation to access **HVDC** Converter Stations and **HVDC Switching**-sites providing a business case is proven.
- Existing **Senior Authorised Persons** with operational authorisation restricted to control work and testing in 11 kV, 33 kV and 132 kV substations only, **Shall** not be considered for training and operational authorisation for **HVDC** Converter Stations and/or **HVDC Switching**-sites.
- Existing **Control Engineers** with operational authorisation to control Transmission **Systems** may be nominated for training and operational authorisation to control **HVDC Systems**.
- Existing **Control Engineers** with operational authorisation restricted to control **Distribution Systems** only cannot be considered for training and operational authorisation to control **HVDC Systems**.

7 Personal Protective Equipment

7.1 Persons who are required to work or carry out work on or near the **HVDC 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.

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

8 Training

8.1 Specific training on **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** be provided before a Person is allowed to access, operate, test, control or work in a **HVDC** Converter Station.

8.2 Specific training is a pre-requisite requirement which Persons **Shall** achieve before they are assessed for operational authorisation associated with **HVDC** Converter Stations and **HVDC Switching**-sites.

8.3 Training **Shall** educate Persons on **HVDC** systems and technology and provide an understanding of the operating arrangements **SSEN-T** has put in place for **HVDC** Converter Stations and **HVDC Switching**-sites.

9 Dangers in HVDC Converter Stations and HVDC switching-sites

The list below includes known potential **Dangers** associated with **HVDC** Converter Stations and **HVDC Switching**-sites. This list may not be exhaustive and, as such, it should be used in conjunction with planning and pre-work risks assessments.

- Stored, impressed or induced electrical energy
- Stored mechanical energy
- Automated systems
- Remotely operated systems
- Moving and rotating parts
- Exposure to Laser Light Energy
- Proximity to strong Electric and/or Magnetic fields
- Pressurised systems
- Adjoining areas with dissimilar environmental/ atmospheric pressures
- Hazardous materials
- Proximity to extreme temperatures
- Physical agents such as noise and vibration
- Legionella
- Access to roof of buildings due to presence of potentially dangerous ancillary systems
- Compressed gases

10 Access to HVDC Converter Stations and HVDC switching-sites

Access to **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** be completed in accordance with the SSEN-T **Operational Safety Rules** and associated **Approved** Procedures. In addition, all operational Persons **Shall** comply with the requirement listed below:

- The Control Centre for the **HVDC** Converter Station or **HVDC** Switching site **Shall** be notified immediately before the site is accessed, using the general site login process.

Typically, this includes the use of an App, accessed via an electronic device, although a contact number is provided for contingencies.

- The **Control Engineer** for the **HVDC** Converter Station or **HVDC** switching-site **Shall** be notified, without undue delay, when persons leave **HVDC** Converter Stations or **HVDC Switching**-sites
- A log of Persons accessing **HVDC** Converter Stations and **HVDC** Switching sites **Shall** be maintained. This log **Shall** be referenced when operating the **HVDC System** to help avoid **Danger**, i.e. operations that have the potential to cause **Persons** on site harm, **Shall** not be completed unless the **Control Engineer** has confirmed all **Persons** are situated in a safe place
- Specific access requirements for **HVDC** Converter Stations and **HVDC Switching**-sites might be included within the **Approved** Procedure and / or **Approved** site-specific Engineering Documents for the respective Converter Station or **Switching**-site. Operational Persons **Shall** comply with any such site-specific requirements. Operational Persons have the responsibility to check the documentation available to them and determine whether additional access requirements are in place
- Normally, the access requirements to the outside areas at an **SSEN-T HVDC** Converter Station or **HVDC Switching**-site will be the same as the arrangements covering other Transmission substations. It should however be noted that requirements to access inside areas (buildings) at all **HVDC** Converter Stations and **HVDC Switching**-sites will likely be specific to each respective Converter Station or **Switching**-site
- All access at height within **HVDC** Converter Stations and **HVDC Switching**-sites (including access to the roof of buildings) **Shall** be planned and coordinated using the site-specific **Approved** Procedures and Engineering Documents. Specific hazards exist in many areas in **HVDC** Converter Stations and **HVDC Switching**-sites and therefore it is essential that access and work at height, and all known hazards and **Dangers**, are considered in the work planning process

11 Work and/or Testing in HVDC Converter Stations and HVDC switching-sites

11.1 All work and/or testing of **Apparatus** in **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** be effectively controlled by a **Senior Authorised Person** in conjunction with the **Control Engineer** for the **HVDC** Converter Station or **HVDC Switching**-site.

11.2 Verbal instructions to complete work or testing in an **HVDC** Converter Station or **HVDC Switching**-site are deemed to be unsuitable if not accompanied by the issue of a **Safety Document** (where applicable) or an agreed Risk Assessment and Method Statement for the activity.

11.3 When work or testing is to be carried out on **High Voltage Apparatus**, the **Senior Authorised Person** controlling the work or testing **Shall** issue a **Safety Document** in accordance with **OSR** 4.1.1, detailing the work and/or testing to be completed.

11.4 Where the **Senior Authorised Person** has agreed a Risk Assessment and Method Statement prior to work being carried out on the ancillary systems of an **HVDC** Converter Station or and **HVDC Switching**-site, such as air handling or refrigeration systems, and a **Permit to Work** or **Sanction for Test** is not applicable, a **Safety Document** need not be issued, but a Senior **Authorised Person Shall** maintain control of the work taking place.

11.5 Work associated with “building services”, such as internal office or meeting room lighting systems, in unrestricted or non-operational areas of an **HVDC** Converter Station or **HVDC Switching**-site **Shall** be carried out by a **Competent Person** working under their craft

competencies. In these situations, a **Safety Document** need not be issued, but a **Senior Authorised Person Shall** maintain control of the work and agree a Risk Assessment and Method Statement prior to the work taking place. In the case of a shared access or crawl space being accessed that could allow inadvertent entry to a restricted or operational area, the work **Shall** not take place until a **Safety Document** is issued by a **Senior Authorised Person.**

11.6 Overvoltage testing in **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** be completed in accordance with the site-specific Engineering Documents and therefore the manufacturers recommendations.

12 System Operations at HVDC Converter Stations and HVDC switching-sites

12.1 All **High Voltage System** 'field operations' at **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** be instructed by a **Control Engineer** operating in the **SSEN-T** Central Control Room. **Approved** Procedures which allow the transfer of control responsibilities from the **Control Engineer** to a **Senior Authorised Person** operating 'in the field' do not apply to the **HVDC** Converter Stations, **HVDC** Switching sites and Systems, e.g. Network Operating Procedure (NOP) 2, 3 and 4 are not to be utilised.

12.2 Some **HVDC** Converter Stations and **HVDC Switching**-sites utilise a single instruction sequence switching command, issued via the Transmission Control Centre telecontrol system, to run down, discharge and earth the **HVDC System** and associated **Apparatus**. In situations where the sequence **Switching** operation fails, the **Control Engineer** may instruct a **Senior Authorised Person** to carry out individual local operation of the equipment from the control interface on site. In such situations, the **Senior Authorised Person** on site **Shall** confirm those switches that have not operated as part of the sequence with the **Control Engineer** and receive instructions to carry out **Switching** operations for each switch to be operated. Any instructions given by the **Control Engineer**, and received by the **Senior Authorised Person** on site, **Shall** be carried out in accordance with **SSEN-T OSR**.

13 Approach to Live High Voltage Conductors

13.1 The **Safety Distances** and **Working and Access Clearances** detailed within the **SSEN-T Operational Safety Rules apply** to **HVDC** Converter Stations.

13.2 Some **HVDC Systems** operate at 425kV AC and 320kV (per pole) DC. In such cases the **OSR** requirements for 400kV **Shall** be used.

13.3 In accordance with **OSR** 4.4.4; a **SSEN-T Senior Authorised Person** can establish **Working and Access Clearances** in **HVDC** Converter Stations and **HVDC Switching**-sites different to those detailed within Appendix D of the **OSR**, providing compliance with **OSR** 4.4.4 is achieved and **Safety Distances** are maintained.

13.4 Considering the distances involved with some **HVDC Plant** and **Apparatus** situated inside buildings; it is possible that **Senior Authorised Persons** will need to consider reduced **Working and Access Clearances** when considering working and/or access methods. If there is a risk that **Safety Distances** will be compromised; work and/or access under reduced **Working and Access Clearances Shall** not progress.

14 Areas within HVDC Converter Stations Containing Laser Technology

14.1 All areas within **HVDC** Converter Stations containing Lasers **Shall** have signage conspicuously posted at all entrance doors to the area and at the position of the specific **Plant** and/or **Apparatus** containing Laser technology.

14.2 Signage warning of lasers **Shall** identify the class and specific control measure (e.g. personal eye protection) requirements of each respective Laser technology present on site.

15 Movement of Vehicles and Long Objects within HVDC Converter Stations and HVDC switching-sites

15.1 The **Operational Safety Rules** set out specific requirements for the movement of vehicles and long objects in substations containing **Live High Voltage Conductors**.

15.2 When considering **HVDC** Converter Stations and **HVDC Switching**-sites, these **SSEN-T OSR** requirements for the movement of vehicles and long objects apply to all areas, i.e., external areas and internal areas within buildings.

16 Interlocked Areas within HVDC Converter Stations

16.1 Access to some areas in **HVDC** Converter Stations will be restricted by interlocks that may be connected to **System Plant** and **Apparatus**, e.g. access doors to areas may be interlocked with **System** isolators and associated **Earth** switches.

16.2 It is important that operational **Persons** familiarise themselves with the interlocking arrangements at all **HVDC** Converter Station sites they are authorised to access.

16.3 Considering the functionality of **HVDC** Converter Station interlocking systems; when operating it is essential that Control Engineers and **Authorised Persons** work effectively together to visually confirm the actual physical status of electrical switches (circuit breakers, isolators, **Earth** switches, etc) after they have been operated in a manner which allows access to interlocked areas. This positive confirmation is needed to confirm each respective switch has operated correctly and the ancillary system indications provided to the **Control Engineer** are accurate with the actual visually confirmed status of each switch.

16.4 Until a **Safety Document** is issued to allow access; no **Person Shall** access the interlocked areas within a **HVDC** Converter Station unless they have been specifically instructed to by the **Control Engineer** for the **HVDC System**. Usually this will be restricted to an **Authorised Person** operating under the instruction of the **Control Engineer** to complete or confirm **System Switching** operations.

17 Electric and Magnetic Fields

17.1 Certain items of **Plant** and **Apparatus** within **HVDC** Converter Stations and **HVDC Switching**-sites may emit electric and magnetic fields when **Live. HVDC** Converter Stations and **HVDC** switching-sites are designed so that harmful exposure to electric and magnetic fields is managed by appropriate positioning and guarding of the associated **Plant** and **Apparatus**.

17.2 Areas in **HVDC** Converter Stations and **HVDC** switching-sites containing **Plant** and Equipment known to emit potentially harmful electric and magnetic fields **Shall** have notices

fixed at entrance doors and other conspicuous positions to warn and remind persons of the hazard and potential danger.

17.3 Persons with a metallic medical implants or ferrite metallic jewellery can be more susceptible to injury caused by proximity to electric and/or magnetic fields.

17.4 All work completed within **HVDC** Converter Stations and **HVDC Switching**-sites **Shall** take account for the potential **Dangers** from electric and magnetic fields and ensure that appropriate control measures are used to help prevent harm.

18 Dispensation from Transmission Operational Safety Rules and Approved Procedures

18.1 In situations where compliance with the **SSEN-T Operational Safety Rules** and associated **Approved** Procedures cannot be achieved, and/or when the **SSEN-T OSR** and **Approved** Procedures do not cover the intended/ needed operational activities; the **Designated Engineer Shall** be contacted in writing.

18.2 The **SSEN-T Designated Engineer** will provide guidance and/or dispensation in such cases.

18.3 In situations of this nature, the **SSEN-T Designated Engineer** may provide a specific **Approved** Procedure to cover the intended/ needed operational activity.

19 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01	New Distribution only version document created for the OSM	PR-NET-OSM-501	1.00	Richard Gough
02				