PR-NET-OSM-065

TESTING OF HIGH VOLTAGE APPARATUS

OPERATIONAL SAFETY MANUAL – SECTION 9.1

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 Scottish and Southern Electricity Networks Distribution (**SSEN-D**) own and operate a large and complex **High Voltage System** which requires work to be undertaken on it. Following such work, it is sometimes necessary for testing to be undertaken to ensure the safety of those who work on the **System**, persons in the vicinity of the **System** and to confirm the integrity of **Apparatus** prior to energising.

1.2 This procedure describes the required tests and the manner in which they **Shall** be carried out.

1.3 Tests are described for cable circuits, switchgear, and transformers.

1.4 Whilst some **Apparatus** covered within this procedure may not currently be used with **SSEN-D** it is included to account for any future developments**.**

2 Scope

2.1 This document defines the procedures to be adopted by personnel carrying out testing of **High Voltage Apparatus**. It ensures, following the completion of an appropriate risk assessment, that testing is carried out safely, with correct equipment and PPE, and complies with relevant legislation.

2.2 The document is applicable to the following:

- All testing of **High Voltage Apparatus** that forms part of the **SSEN-D** distribution **Systems**, including **DC Systems**
- It includes Overvoltage (Pressure) Testing, operation of **High Voltage** fault location equipment (test van and portable) and phasing checks following work on the **System**
- All **SSEN-D** employees, including contract partners working for **SSEN-D,** engaged in the Testing of **High Voltage Apparatus** that form part of **SSEN-D System**.
- The testing of **High Voltage Apparatus** that does not form part of the **SSEN-D System** but is required as part of the construction or commissioning cycle, where the **High Voltage Testing** activity is not covered by the Contract Partners Safe System of Work.

2.3 Excluded from this procedure are factory tests (routine, type and special) as these are documented at the time of procurement, within the relevant specifications. In addition, the testing of **Low Voltage Apparatus** up to and including 1000V is also excluded from this procedure.

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-ENG-039	Deviations from ‘G81’ Design, Specification and Operational Documents or Approved Designs
PR-NET-OSM-006	SSEN Distribution Operational Safety Rules – Operational Safety Manual – Section 1.1
PR-NET-OSM-011	Management of Work or Testing in Substations with Exposed Live Busbars and/or Gas Insulated Apparatus - Operational Safety Manual - Section 6.2

Reference	Title
PR-NET-OSM-028	Switching Terminology and Approved Abbreviations - Operational Safety Manual - Section 4.4
PR-NET-OSM-058	Access and Work on Poles - Operational Safety Manual - Section 7.1
PR-NET-OSM-059	Access and Work on Towers and Structures - Operational Safety Manual - Section 7.2
WI-NET-CAB-400	Identification, Phase Checking and Setting to Work on 11 kV, 33 kV and 132 kV Cable Circuits
WI-NET-OSM-002	Personal Protective Equipment and Workwear for Live Environments
WI-NET-SST-119	Insulation Resistance Testing of 132-66kV Bushings
N/A	SSEN SHE Handbook (Held in Safety, Health and Wellbeing SharePoint Site)

Table 3.2 - External Documents

Reference	Title
BS EN 60076-18	BS EN 60076-18: 2012 – Power Transformers. Measurement of frequency response.

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 **High Voltage Fault Location Equipment**

Any test device used for the purpose of fault location that can produce a voltage in excess of 1000 V

4.3 **Low Voltage Fault Location Equipment**

Any test device used for the purpose of fault location that does not produce a voltage in excess of 1000V

4.4 **High Voltage Testing**

The application of any voltage in excess of 1000V to any **Apparatus** for testing purposes.

4.5 **Low Voltage Testing**

The application of any voltage not in excess of 1000V to any **Apparatus** for testing purposes.

4.6 **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**.

5 General Responsibilities

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

5.2 Persons must 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 Authorisation

6.1 Persons who are required to undertake testing of **High Voltage Apparatus Shall** hold the appropriate competence and authorisation to carry out specified duties. It **Shall** be the responsibility of the individual to ensure that any actions performed are within the bounds of their competency and authority level.

6.2 The Testing of **High Voltage Apparatus Shall** be carried out by, or under the **Personal Supervision** of, an **Authorised Person** who holds authorisation for testing at the design voltage of the **Apparatus** being tested.

E.g., Cable Sheath Testing on a 33kV cable requires an **Authorised Person** holding issue or receipt of 33kV **Sanction For Test**.

6.3 Competence and authorisation certificates **Shall** be retained personally and be made available upon request.

7 Safety Rules and Documentation

7.1 All tests described in this procedure **Shall** be carried out in accordance with the **Operational Safety Rules** and a risk assessment is to be carried out, ensuring that adequate safeguards are put in place and remain in place for the duration of the testing.

7.2 Where the **Apparatus** forms part of the **System**, **High Voltage tests Shall** only be carried out under the terms of a **Safety Document** issued by a **Senior Authorised Person**.

8 Personal Protective Equipment

8.1 Persons who are required to work or undertake testing 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.

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

8.3 When carrying out testing of **High Voltage Apparatus**, **Approved** insulating gloves **Shall** be worn by the Operator before carrying out any of the following tasks:

- Inserting test probes
- Connecting or disconnecting test equipment and test leads
- When applying or removing portable **Earthing**
- When operating **High Voltage** test equipment where reasonably practicable to do so

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

8.5 **Approved** insulating gloves **Shall** be inspected before use to ensure they are within date (where applicable) and undamaged. Where concerns exist, the gloves **Shall** be replaced before any operation is carried out.

9 General Considerations

9.1 Identification

9.1.1 **High Voltage Apparatus** on which testing is to be carried out **Shall** be readily identifiable or have fixed to it a means of identification that **Shall** remain effective throughout the course of the testing.

9.1.2 Demarcation zones **Shall** be deployed around equipment under test to ensure the safety of staff and the public.

9.2 Dangers

9.2.1 The main **Dangers** to personnel during the course of testing are electric shock, burns or physical damage arising from:

- Inadvertent or erroneous contact with **Live System Conductors**
- Inadvertent or erroneous contact with **System Conductors** that have not been properly discharged following testing
- Electrical energy and mechanical pressures and forces imposed by testing sources

9.2.2 Do not allow interruptions during an **HV** test. If it becomes essential to engage in a conversation, or undertake any other activity, then the test **Shall** be suspended, and **Earths** applied before diverting attention from the task in hand.

9.3 Overhead Line Circuits

9.3.1 It is not normally possible to carry out **High Voltage** insulation tests on overhead line circuits, because of damp and dirty insulators.

9.3.2 For the same reason, it may not be possible to carry out a **High Voltage** insulation tests on a cable circuit that is connected to an overhead line, therefore the line may have to be disconnected from the cable circuit in order to carry out a satisfactory test.

9.3.3 Care **Shall** be taken not to subject ancillary overhead line equipment such as closing coils in pole mounted reclosers, voltage transformers, pole mounted transformer bushings etc. to test voltages.

9.4 Deviations from this Procedure

9.4.1 In situations where compliance with the **OSR** and associated **Approved** procedures cannot be achieved, and/or when the **OSR** and **Approved** procedures do not cover the intended/required operational activities; the **Designated Engineer Shall** be contacted in writing.

9.4.2 Where this is required, a deviation request **Shall** be submitted to **SSEN-D** in accordance with PR-NET-ENG-039.

9.4.3 Where a deviation is required at the design stage, connection designers **Shall** follow the same procedure and submit a deviation request.

9.4.4 The **Designated Engineer Shall** provide guidance and/or dispensation in such cases.

9.4.5 **SSEN-D** can refuse, or require, an alteration to a request. It is therefore imperative that signed agreement is obtained before installation to avoid the possibility of rework or rejection of the scheme.

9.4.6 In situations of this nature, the **Designated Engineer** may provide a specific **Approved** procedure to cover the intended/required operational activity.

9.4.7 Requests for deviations which could compromise the safety of the public or **SSEN-D** staff, **Shall** be rejected.

9.5 High Voltage Test Record

9.5.1 **High Voltage** test record forms as appropriate to the asset are detailed in the References section of this **Approved** Procedure.

9.5.2 Test record forms **Shall** be completed for tests on the **SSEN-D System** and when required by customers or other organisations.

9.5.3 **SSEN-D Shall** use these forms as evidence of asset testing. Where third parties do not have a form of a comparable standard, the relevant **SSEN-D** form **Shall** be used.

9.5.4 The results of any testing carried out **Shall** be recorded on an appropriate test results form and retained by the **SSEN-D Authorised Person** (or supplied to **SSEN-D** if carried out by a third party) with a copy recorded against the **SSEN-D** asset records.

10 Methods of Testing

10.1 Insulation Resistance (IR)

10.1.1 An Insulation Resistance (IR) test, sometimes referred to as a 'Megger' test, is used to provide a quantifiable resistance value for the insulation of **Apparatus** being tested.

10.1.2 Unless otherwise stated, IR tests **Shall** be carried out at a test voltage of 5kV DC, with each test lasting 1 minute.

10.2 Overvoltage (Pressure) Testing

10.2.1 A dielectric withstand test, typically referred to as an overvoltage or pressure test, measures leakage current between the **Conductor** under test and **Earth**.

10.2.2 The voltage, frequency and duration of an overvoltage test will vary depending upon the **Apparatus**.

10.2.3 Overvoltage tests are potentially destructive as they apply stresses to the dielectric that are in excess of normal operating conditions. For this reason, they are not generally required after routine maintenance work, however they are required after repair work or during initial commissioning.

10.2.4 Any remaining electrical charge **Shall** be discharged to **Earth** through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage **Shall** not be interrupted as this may generate switching transients that can cause damage to the **Apparatus** or inaccurate test results.

10.3 AC Testing

10.3.1 As most insulation is intended for use on power frequency **Apparatus**, an applied test voltage at power frequency provides a more accurate test, as it reproduces electric field patterns similar to normal operating conditions.

10.3.2 The test voltage **Shall** be applied to the **Conductor** under test at a value sufficiently low to prevent any effect of over-voltages due to switching transients, this **Shall** ideally be zero. It **Shall** be raised as rapidly as is consistent with the measurement so as not to cause prolonged stressing of the **Apparatus** under test, near to the final test voltage.

10.3.3 The test voltage **Shall** then be maintained for the specified time before being rapidly decreased to zero and switched off.

10.3.4 Any remaining electrical charge **Shall** be discharged to **Earth** through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage **Shall** not be interrupted as this may generate switching transients that can cause damage to the **Apparatus** or inaccurate test results.

10.4 DC Testing

10.4.1 The advantages of DC testing are that test equipment is generally smaller and requires less power.

10.4.2 Using DC testing also mitigates the impact of capacitance in the asset under test.

10.4.3 DC tests **Shall** be carried out with the test voltage at negative polarity to accommodate electroendosmosis.

10.4.4 Any remaining electrical charge **Shall** be discharged to **Earth** through an impedance to prevent any damage being caused to the insulation due to rapid voltage discharge. The applied test voltage **Shall** not be interrupted as this may generate switching transients that can cause damage to the **Apparatus** or inaccurate test results.

10.5 Very Low Frequency Testing (VLF)

10.5.1 VLF tests **Shall** be carried out at a frequency between 0.01Hz to 0.1Hz with a square wave shape (cosine rectangular).

10.5.2 VLF testing is used as an alternative to DC testing on XLPE insulated cables, as it negates the premature ageing of the insulation due to space charge.

10.6 Frequency Response Analysis (FRA)

10.6.1 Frequency response analysis, sometimes referred to as sweep frequency response analysis (SFRA), is a comparative test used to analyse the mechanical condition of the core and winding within a transformer.

10.6.2 Changes in the mechanical condition can occur during transportation, or if the unit is subjected to significant fault current, therefore FRA testing **Shall** be carried out on all Continuous Maximum Rating (CMR) transformers and any Continuous Emergency Rating (CER) transformer operating at 33kV or above, before and after relocation, or after being subjected to fault current from an internal fault or close-up **System** fault.

10.6.3 As the test is comparative, the transformer **Shall** be disconnected from any **Conductors** prior to the test taking place. Results **Shall** be compared to original manufacturer FRA test results where available.

10.6.4 Tests **Shall** be carried out in accordance with BS EN 60076-18 – Power Transformers. Measurement of Frequency Response (as amended).

10.7 Dissipation Factor Testing.

10.7.1 Dissipation/Power Factor and Capacitance measurements are performed to investigate the condition of insulation in apparatus such as bushings, cable sealing ends and transformers. These tests are also commonly referred to as Tan Delta tests (Tan □).

10.7.2 Dissipation/Power Factor testing is carried out at **High Voltage**, normally 10kV is preferred, and across a short range of frequencies, normally from 15Hz up to 400Hz.

10.7.3 The **Apparatus** to be tested **Shall** be disconnected from any other **Conductors** prior to the test taking place.

10.7.4 Deterioration of insulation in apparatus may be considered normal in line with the age and service conditions of the equipment. All results **Shall** be considered on their own merits and further advice or action taken as necessary.

10.8 Requirements for Phase Checks.

10.8.1 When work has been carried out on the **HV System** and the possibility of the phasing being inadvertently changed exists (typically where **Conductors** or connections are broken and or disturbed), it is essential to prove by testing, or other **Approved** means, that phasing is correct.

10.8.2 To ensure that there is no risk to the operator or **Apparatus** or to the continuity of customer supplies, phase checks **Shall** be carried out before connecting customer supplies and before making a parallel on that part of the **System**.

10.8.3 Where practicable, having checked that the phasing is correct, a **System** parallel **Shall** then be made and proven on a suitably rated switching device.

10.8.4 Some of the methods used to confirm correct phasing are more hazardous than others, especially where it involves testing at **System** voltage using **Approved** voltage indicators inserted into switchgear spouts. **LV** methods of phase checking are preferred to **HV** methods, as they do not require access to **Live HV Conductors**. The method to be used **Shall** be agreed with the appropriate **Control Engineer**.

10.8.5 The methods for phase checking are detailed in WI-NET-CAB-400 The order of preference is as follows:

1. Using **Low Voltage** techniques.
2. Using **High Voltage** techniques where both **High Voltage** sources can be safely accessed.

NOTE: This includes ‘Pfisterer’ capacitive indicators.

3. Across voltage transformers connected to both sources.
4. Using **Dead** phasing checks, where no other method is possible.

11 General Requirements for High Voltage Testing

11.1 General

11.1.1 Where two or more assets are electrically connected and where reasonably practicable, they **Shall** be disconnected and tested separately. If the **Authorised Person** determines that the risks associated with disconnecting the equipment are greater than the risks associated with a reduced test value, the asset requiring the least onerous test **Shall** determine the test value.

11.1.2 The testing of an oil sample does not require the sanction of an **Authorised Person** or **Control Engineer**, or a **Sanction-for-Test** to be issued. Providing the oil test sets used have fully enclosed test electrodes electrically interlocked and are of an **Approved** type, the testing may be carried out by a suitably trained competent person to an **Approved** procedure.

11.1.3 The principles for controlling the testing of **High Voltage Apparatus**, including **Apparatus** that does not form part of the **SSEN-D System**, is shown in Figure 11.1 below.

Location	Person responsible for HV testing	HV Apparatus state	Applicable control measure
SSEN Operational Site	SSEN	Forming part of the System (OSRs applicable)	Sanction for Test
SSEN Operational Site	SSEN	De-commissioned / New / Not forming part of the System	Off Circuit Testing Certificate
Greenfield Site	SSEN	Not forming part of the System	Off Circuit Testing Certificate
SSEN Operational Site	Contract Partner / 3rd Party	Forming part of the System (OSRs applicable)	Sanction for Test
SSEN Operational Site	Contract Partner / 3rd Party	De-commissioned / New / Not forming part of the System	Contract Partners Safe System of Work*
Greenfield Site	Contract Partner / 3rd Party	Not forming part of the System	Contract Partners Safe System of Work*

* The Contract Partners Safe System of Work **Shall** adequately cover the requirements to ensure, following the completion of an appropriate risk assessment, that testing is carried out safely, with correct equipment and PPE, and complies with relevant legislation.

Figure 11.1 - Principles for controlling Testing

11.2 Preparation for Testing

11.2.1 The appropriate **Control Engineer Shall** confirm with the **Senior Authorised Person** that all other **Safety Documents** associated with the **Apparatus** to be tested have been suspended or cancelled before the **Sanction-for-Test** is issued.

11.2.2 The **Apparatus** to be tested **Shall** be **Isolated,** and where practicable, **Earthed** in preparation for testing. (For Off-System testing, refer to section 15 of this **Approved** procedure) This preparation **Shall** include:

- Attaching **Danger Notices** to all adjacent **Live Apparatus** such that the notices can be seen from all possible means of approach
- To ensure the safety of personnel and where necessary to avoid **Danger**, the visible identification of the test area and its boundaries **Shall** be set. This **Shall** be achieved by the use of an **Approved** barrier / demarcation system.
- Testing in the open terminal compound of EHV substations, where there are exposed **Live High Voltage Conductors**, **Shall** be in accordance with Section 4.4 and Section 7 of the **SSEN-D OSR** and PR-NET-OSM-011 Management of Work or Testing in Substations with Exposed Live Busbars and/or Gas Insulated Apparatus - Operational Safety Manual Section 6.2.
- Where testing is required from poles, towers or structures, reference **Shall** be made to PR-NET-OSM-058 Access and Work on Poles - Operational Safety Manual Section 7.1and / or PR-NET-OSM-059 Access and Work on Towers and Structures - Operational Safety Manual Section 7.2.
- In distribution substations or sites where access is restricted, the walls or fences may form part of the barrier. '**Live** Testing' notices **Shall** be placed conspicuously within the area, such that they **Shall** be seen by persons approaching the area. (See Section 13, Figure 13.1).
- When the testing is to be carried out within buildings, '**Live** Testing' notices **Shall** be posted on doors and other suitable positions which give access to the test area, such that they **Shall** be seen by persons approaching the area.

11.2.3 The **Senior Authorised Person Shall** issue to the suitably **Authorised Person** who is to carry out the testing:

- **A Sanction-for-Test**
- If appropriate, a **Key Safe** key
- If appropriate, an **Earthing** Schedule
- The requirements for any necessary **Additional Earths**

11.3 Testing

11.3.1 Under the terms of the **Sanction-for-Test,** the recipient is responsible for all matters of safety concerned with the test and for controlling access to, and within the test area.

11.3.2 To enable testing to be done, the **Authorised Person Shall**, if specified on the **Sanction-for-Test**, remove, replace or instruct to be removed or replaced, **Circuit Main Earths**. The **Authorised Person Shall** also (subject to being suitably authorised) operate, or instruct to be operated, **Apparatus** within the test area. A record of **Switching** operations **Shall** be maintained by the **Authorised Person** in charge of the testing in order to identify the state of the network.

11.3.3 Before testing commences, the **Authorised Person** in charge of the testing **Shall** ensure, that sufficient '**Live** Testing' notices have been fitted.

11.3.4 Where **High Voltage Testing** is to take place, the **Authorised Person** completing the testing **Shall** be accompanied by a **Competent Person**. All personnel not essential to the testing **Shall** be excluded from the test area whilst testing proceeds (except those persons receiving training).

11.3.5 If the application of a test voltage will make **Conductors** at a remote end of the circuit **Live**, the **Authorised Person Shall** safeguard the remote end so as to prevent **Danger** as follows:

- If the remote end(s) of the **Apparatus** is readily accessible from ground level, i.e., is not within a locked compartment or on a structure or tower, then the remote end **Shall** be cordoned off by the use of barriers with '**Live** Testing' notices attached and under the control and supervision of a **Competent Person** for the duration of the testing. The **Authorised Person Shall** obtain confirmation from the **Competent Person** that barriers are in position before a test voltage is applied. It is the responsibility of the **Competent Person** to ensure that no person approaches the **Apparatus** unless instructed to do so by the **Authorised Person** in charge of the testing. **Conductors Shall** be **Earthed** / discharged before being approached
- Where the remote end(s) of the **Apparatus** is inaccessible from ground level, for example near the top of a pole or terminated in totally enclosed metal clad switchgear, the **Authorised Person** may choose to apply '**Live** Testing' notices and **Safety Locks** (where possible)

11.3.6 When it is necessary to carry out testing in areas where the public have access, additional precautions **Shall** be taken to prevent persons and vehicles approaching the works. These precautions **Shall** include the use of barriers, cones and warning signs as required by the New Road and Street Works Act 1991.

11.3.7 **High Voltage** test equipment and connections **Shall** be used in the following way:

- Only **Approved** test equipment **Shall** be used
- Test equipment **Shall** be rated for the chosen application, equipped with insulated leads and appropriate protective features

- All test connections **Shall** be made using purpose designed test probes or terminations, which ensure connections are secure and cannot come adrift
- The test set **Earth** connection **Shall** be connected to the same **Earth** as the **Apparatus** to be tested
- Test connections **Shall** be made via a termination with sufficient exposed metal that a separate earthing device / discharge stick can be used to discharge the **Apparatus**
- The **Earthing** device / discharge stick **Shall** be of an **Approved** type and be independently connected to **Earth** via an insulated lead, which **Shall** be clamped to the **System Earth** using a secure clamp
- The testing process **Shall** not rely on test set internal switches or dump resistors alone to **Earth** / discharge the **Apparatus** under test

11.4 Use of Internal Test Facilities and Test Probes

Internal Test access Facilities

11.4.1 Where testing is carried out from switchgear fitted with integral test access facilities e.g., Schneider RN2c and Lucy Sabre Ring Main Units, the common **Earth** star bar **Shall** be replaced and the test access door locked on completion of testing, or when the **Sanction-for-Test** is suspended or cancelled.

11.4.2 It **Shall** not be acceptable to open an **Earth** star bar as a means of removing an **Earth** for the purpose of testing from a remote location. Under these circumstances the switch **Shall** be physically opened from **Earth** to Off. Similarly, where Portable **Circuit Main Earths** for 11kV Metal Enclosed Switchgear are used, these **Shall** be completely removed and ensure any shutters / covers are closed / replaced.

Use of Test Probes

11.4.3 Only test probes which have been maintained in accordance with an **Approved** procedure **Shall** be used. Prior to being inserted into switchgear they **Shall** be visually inspected and cleaned with a fibre free wipe.

11.4.4 Where test probes are inserted into switchgear for the purpose of testing, they **Shall** be removed on completion of testing or when the **Sanction-for-Test** is suspended or cancelled, and the test access closed and secured.

11.5 Completion of Testing

11.5.1 When testing is complete, the **Sanction-for-Test Shall** be cleared by the **Authorised Person**. Any changes to the **Earthing** arrangements from those at the time of issue of the **Sanction-for-Test Shall** be fully specified as exceptions on the **Sanction-for-Test** upon clearing the document.

11.5.2 The **Senior Authorised Person** who suspends / cancels the **Sanction-for-Test Shall** report to the appropriate **Control Engineer** these exceptions at the time of suspension / cancellation such that they can be recorded on their **Switching** schedule / Network Control System.

11.5.3 It is essential that on completion of testing, the **Senior Authorised Person** ensures that all results are documented on the appropriate **SSEN-D** Declaration of Test Results and Checks report sheet (or equivalent form if supplied by a third party).

12 Cable Testing

12.1 General

12.1.1 During installation, sheath testing **Shall** be required, prior to cable jointing work taking place.

12.1.2 Following installation and/or jointing work and before making **Live**, cables **Shall** be subjected to test voltages suitable to their type and rated voltage.

12.2 De-energised Cables

12.2.1 Where cables are de-energised for more than 24 hours, a risk assessment **Shall** be undertaken prior to them being made **Live**. This **Shall** assess the likelihood of the cable(s) having been damaged or becoming faulty during the period while they were not **Live**.

12.2.2 It is recommended that any cable which has been **Dead** for more than one month is tested before being made **Live**.

12.2.3 In any scenario, if it is thought the cables could be faulty or damaged, they **Shall** be subjected to an appropriate test, with due consideration to the cable construction and design voltage.

12.3 11kV to 132kV Paper Insulated and 11kV to 66kV Polymeric Insulated Cables

Cable installations that comprise of paper insulated cables, polymeric insulated cables or mixed types **Shall** be subject to the appropriate test voltage specified in WI-NET-CAB-400.

12.4 132kV Polymeric Insulated Cables

12.4.1 Cable installations that comprise polymeric insulated cables, in part or in whole, **Shall** be subjected to the appropriate test specified in WI-NET-CAB-400.

12.4.2 The special characteristics of polymeric insulation mean that a DC voltage test **Shall** not be used. Consequently, an AC withstand voltage test (VLF or 50Hz, as appropriate) is recommended for major new works, particularly upon completion of supply and install contracts.

12.4.3 Where testing is not reasonably practicable, the cable installation **Shall** be subjected to an off-load ‘soak’ test specified in Table 12.2.

12.5 Cable Test Connections

12.5.1 On circuits containing any belted paper insulated cable sections, connect the cable as shown in Figure 12.1. Table 12.1. Of the three tests possible, any combination of two tests will suffice.

Table 12.1 - Testing Schedule for Cables

Test Number	Connect to Negative of Test Set	Connect to Positive of Test Set
1	Cores 1 and 2	Core 3 and screen / Earth
2	Cores 1 and 3	Core 2 and screen / Earth
3	Cores 2 and 3	Core 1 and screen / Earth

Note: Disconnect any surge diverters on **Systems** rated above 11 kV before applying these test voltages. Surge diverters on 6.6kV and 11kV **Systems Shall** be disconnected only if applying voltages greater than those in Table 12.1.

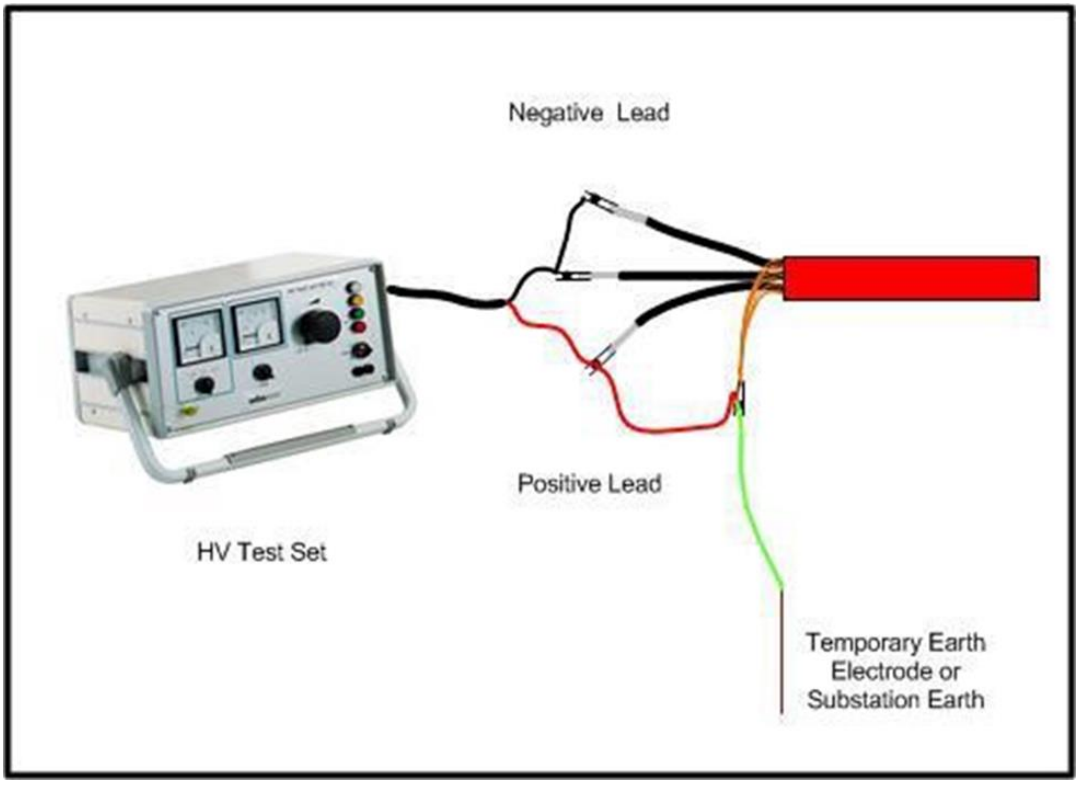

Figure 12.1 - Connections for Testing Belted Cables

12.5.2 On cable circuits that contain no belted paper insulation (e.g. all polymeric) and 33kV circuits, connect the cable as shown in Figure 12.2 and apply the specified test from Table 12.1.

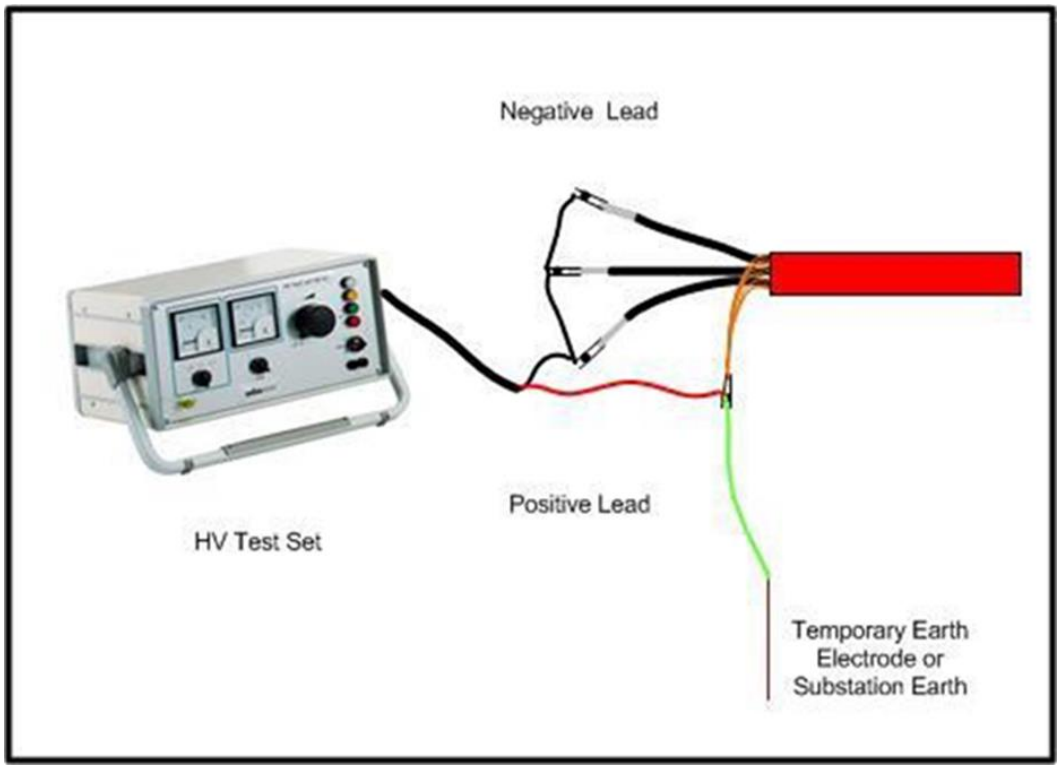

Figure 12.2 - Connections for Testing Non-Belted Cables

Note: On some older test sets it may not be possible to **Earth** the positive terminal. On these test sets the negative terminal **Shall** be **Earthed**.

12.6 Continuity Tests

12.6.1 Tests **Shall** be carried out to confirm the continuity of **Conductors** and screen-wires.

12.6.2 On three phase cables, each **Conductor Shall** be tested in turn using the screen as the return. Phase to phase continuity tests are not required.

12.6.3 For single core cables the measurement of continuity **Shall** be between the phase **Conductor** and the screen-wires of each cable.

12.6.4 On cross-bonded **Systems**, the continuity of each section **Shall** be proved prior to the cross-bonding being put in place.

12.6.5 A sheath continuity test **Shall** be carried out prior to the final sheath test, or immediately after the sheath test, but **Shall** be carried out prior to the **HV** overvoltage test.

12.6.6 The setup for the continuity test is shown in Figure 12.3. An ohm-meter **Shall** be used to record the value of continuity.

12.6.7 Where a continuity test has been carried out more than 24 hours prior to the sheath test, then it **Shall** be repeated either before or immediately after the sheath test.

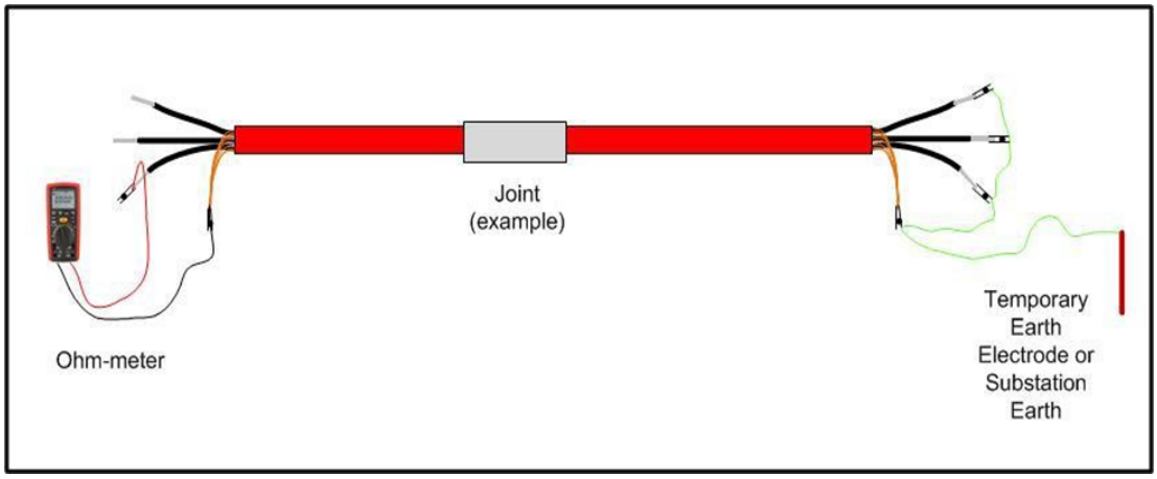

Figure 12.3 - Connections for Continuity Test

12.7 Sheath Withstand Test

12.7.1 To check that the cable sheath has not been damaged during installation, a sheath withstand test **Shall** be carried out at 5 kV for 1 minute and is required on 6.6kV, 11kV, 22kV and 33kV polymeric cables, before the cable is jointed, or, where the cable screen can be disconnected from **Earth**. The resistance reading **Shall** be greater than 10MΩ.

12.7.2 On 132kV cables, the minimum test voltage for commissioning is 10kV. This test **Shall** be carried out for 1 minute with a minimum resistance of 20MΩ. This test voltage may need to be increased where it is shown that screen to **Earth** voltages will be in excess of 10kV under fault conditions.

12.7.3 Where cables are being laid in sections, sheath tests **Shall** be carried out before jointing onto the previous section. This allows for any sheath repairs to be carried out prior to final completion.

12.7.4 A final sheath test **Shall** be carried out prior to the circuit being made **Live**, with all cables jointed through.

12.7.5 To test the sheath, connect the cable screen to the core(s), as shown in Figure 12.4, and apply the test between the cable screen/core(s) and **Earth**, using an **Approved** insulation resistance tester.

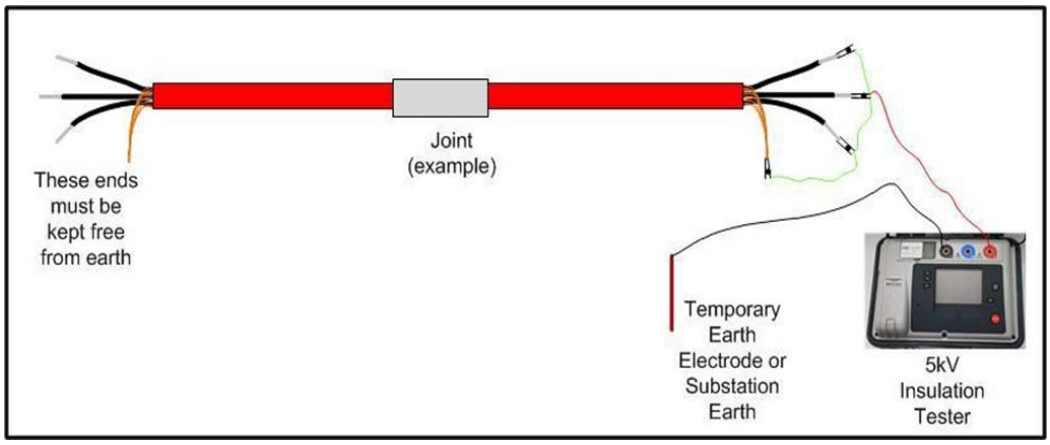

Figure 12.4 - Connections for Sheath Withstand Test

12.7.6 Failure to maintain the applied test voltage, or a resistance reading of less than 10MΩ, indicates a damaged sheath.

12.7.7 Sheath faults **Shall** be located, repaired and the cable retested, repeating the testing process if further sheath faults are detected.

Test Results

12.7.8 An acceptable result is deemed to be when, at the prescribed test voltage and duration, the leakage current is an average of 0.5mA and a maximum of 1mA and is, ideally, steady.

12.7.9 A test leakage current that fluctuates by several mA may be indicative of a faulty circuit. In such cases the test duration **Shall** be extended up to 30 minutes, during which time the test current fluctuation may be as shown in Table 12.2.

12.7.10 In all cases, the result **Shall** be discussed with the **Control Engineer** and agreement reached on the next course of action.

Table 12.2 - Test Current Fluctuations

	Type of Current Fluctuation	Action to be discussed with the Control Engineer
a	Diminish to a normal steady state for the test conditions	Decide to restore the circuit to normal load carrying service
b	Continue the same level of fluctuation	Decide to energise the circuit from the System but not carrying load (on soak)
c	Leakage current increases but not sufficient to trip the test set	Decide to energise the circuit from the System but not carrying load (on soak)
d	Leakage current increase to a level that trips the test set	Fault location and repair Shall be required

12.7.11 Routine sheath tests **Shall** be carried out in accordance with WI-NET-CAB-400.

12.8 Insulated Sheathed Cables on Fluid Filled Cables and Single Cross Bonded Systems

12.8.1 On insulated sheathed cable **Systems**, the voltage tests between the sheath and **Earth** are:

- New Cable Installation: 10kV DC for 1 minute
- Routine Maintenance Test: 5kV DC for 1 minute

12.8.2 For Silicon Carbide Sheath Voltage Limiters (132kV Systems), the test voltages are shown in Table 12.3.

Table 12.3 - Silicon Carbide Sheath Voltage Limiter Test

S.V.L No	Applied Voltage (DC)	Commissioning Test Current Limit @ 20°C	Maintenance Test Current Limit @ 20°C
8	70 V	1 mA – 16 mA	0.5 mA – 50 mA
16	140 V	1 mA – 16 mA	0.5 mA – 50 mA
28	210 V	1 mA – 16 mA	0.5 mA – 50 mA

12.8.3 For Zinc Oxide Sheath Voltage Limiters, a DC test voltage **Shall** be adjusted to give a test current of 10mA. If the ambient temperature is different from 20°C, the recorded voltage **Shall** be decreased by 0.1% for every 1°C above 20°C, or increased by 0.1% for every 1°C below 20°C. The corrected values **Shall** be within the range below:

- Commissioning Test: Rated voltage +20% to +45%
- Maintenance Test: Rated voltage +17% to +45%

12.8.4 The test equipment used **Shall** be capable of supplying 10mA at 6kV.

12.9 Submarine Cables

12.9.1 When testing is to be carried out on off-shore cables, **SSEN**s contracted service provider **Shall** develop a written method statement and risk assessment for the works.

12.9.2 A subsequent and specifically related written safe system of work **Shall** be established in accordance with the **OSR** and the contracted service providers engineering work instructions and procedures.

12.9.3 The contracted service provider **Shall** provide a procedure for the identification and proving Dead of the cable to be worked on. The **SSEN-D Senior Authorised Person Shall** confirm that the procedure adequately covers the requirements of **OSR** 4.1.1 and **OSR** 5.9.2. and issue a **Sanction-for-Test** to allow cable identification and proving **Dead**, in accordance with the contracted service providers procedure only.

12.9.4 **OSR** 5.9.2. requires the **Senior Authorised Person** to identify and prove **Dead** at the point of work. In circumstances where it is not reasonably practicable for the **Senior Authorised Person** to be present at the point of work, e.g. on the seabed or at sea, the contracted service providers safe system of work **Shall** include methods of identification and proving **Dead** to the satisfaction of the **Senior Authorised Person** issuing the **Safety Document**, or referred to the **Designated Engineer** for guidance (as per Section 9.9.4).

12.9.5 Prior to the manipulation of the cable on the sea bed, the contracted service provider's procedure **Shall** positively identify the cable to be cut and capped and/or lifted onto the vessel intact. This identification **Shall** use a combination of:

- cable records
- GPS data
- injected signal
- Remotely Operated Vehicle (ROV) or visual confirmation by diving personnel

12.9.6 Where the identified cable is to be cut and capped on the seabed, the cutting operation and proving **Dead Shall** be carried out by remote operation with all persons positioned safe by distance.

12.9.7 Where the cable is to be lifted onto the vessel intact, the contracted service providers **Shall** prove the identified cable **Dead** in accordance with the specific safe system of work and to the satisfaction of the **Senior Authorised Person** issuing the **Safety Document**.

12.9.8 Once the **SSEN-D Senior Authorised Person** is satisfied that the cable meets the requirements of **OSR** 4.1.1, and it has been identified and proved **Dead** at the point of work, a **Safety Document Shall** be issued in conjunction with the **Control Engineer**.

12.9.9 The preferred arrangement for the issue and receipt of a **Safety Document** is face to face between the **Senior Authorised Person** and the recipient. Where the recipient of the **Safety Document** is remote from the **Senior Authorised Person** issuing the **Safety Document**, e.g., recipient is at sea and the **Senior Authorised Person** is on-shore, arrangements **Shall** be made to ensure compliance with **OSR** 4.6.2. This **Shall** include provision for the recipient of the **Safety Document** to physically sign a copy of the **Safety Document** and retain it in his possession for the duration of the work.

12.9.10 Once the recipient of the **Safety Document** has signed the receipt section, a copy **Shall** be returned to the **Senior Authorised Person** issuing the **Safety Document**.

12.9.11 On completion of the work / testing or for other reasons listed in **OSR** 4.6.3, the recipient **Shall** comply with **OSR** 4.6.3. (b) and return their copy of the **Safety Document** to the **Senior Authorised Person**, having duly signed the clearance section.

13 Switchgear Testing

13.1 General

13.1.1 Before making new switchgear **Live**, or following maintenance, repairs or modifications to existing switchgear, which may have affected the integrity of the insulation, the switchgear **Shall** be tested.

13.1.2 When testing across open contacts, the side not subjected to the test voltage **Shall** be connected to **Earth**.

13.1.3 If there is a requirement to test vacuum interrupters, to avoid any hazards associated with the potential presence of X-rays, no personnel **Shall** approach within 3 metres of the vacuum interrupter which is subjected to the test voltage.

13.1.4 Where practicable, voltage transformers (VTs) connected to switchgear **Shall** be **Isolated** prior to testing and tested separately.

13.1.5 When preparing the restoration, or restoration part of the **Switching** programme, consideration **Shall** be given to the location of the test.

13.1.6 Where reasonably practicable, testing **Shall** take place from the switch or circuit breaker that will be used to make the **System Live**. Ideally, an indoor location and, if possible, one that does not require the insertion of test probes into an oil filled switch due to the increased risk of introducing contaminants into the oil. Consideration **Shall** be made in the risk assessment whether a second person is required.

13.1.7 If the test has to take place from an outdoor location, a tarpaulin or other suitable weather protection **Shall** be available and if necessary erected. This **Shall** be secure and not interfere with insertion of any test probes, or the testing itself.

13.2 Secondary Distribution Switchgear

13.2.1 In this procedure, secondary distribution switchgear is taken to mean **HV** switchgear rated up to 11kV, but not forming part of a main extensible **HV** switchboard in a primary substation.

13.2.2 After new switchgear is in its final position, but before connecting it to the **System**, insulation tests **Shall** be carried out on secondary distribution switchgear with a 1kV insulation tester in accordance with Table 13.1.

Table 13.1 - Insulation Testing Secondary Distribution Switchgear

1 kV Insulation Tests for Secondary Distribution Switchgear		
1	With the switch closed, test between all phases	L1 – L2 L1 – L3 L2 – L3
2	With the switch closed, test between each and **Earth**.	L1 – E L2 – E L3 – E
3	With the switch open, test each phase across the open switch contacts.	L1 – L1 L2 – L2 L3 – L3

13.2.3 An insulation resistance level of 100MΩ or more is acceptable; less is not. If the switchgear is not separately tested before connection to the **System**, then the tests applied to the associated cable **Shall** suffice.

13.3 HV Testing Notes for Secondary Distribution Substations

13.3.1 '**Danger**' and 'Testing in Progress' notices **Shall** be prominently affixed around and outside the test area and on the **Apparatus** under test, to ensure persons in the vicinity of the test are aware of the hazard.

13.3.2 The test area **Shall** be guarded or fenced with barriers and/or rope if there is no security fence around the **Apparatus**, or if the test area is part of a larger site where others may be working.

13.3.3 If testing to an open end of cable, suitable precautions **Shall** be taken to protect the remote end from public access, and a **Competent Person Shall** be posted at this position. An example is shown in Figure 13.1.

13.3.4 Only **Senior Authorised Persons** or a person under their **Personal Supervision**, are permitted inside the test area for the purposes of earthing the cable(s) and making connections, at other times access **Shall** not permitted in the test area.

13.3.5 The test equipment **Shall** be placed on a flat surface in such a position that during testing, no part of the operator approaches within the appropriate working and access clearance as defined in the **OSR**.

13.3.6 **Approved** insulating gloves **Shall** be worn when connecting or disconnecting the **HV** test leads.

13.3.7 The test **Earth** lead **Shall** be connected to a clean (unpainted) part of the substation **Earth**, as near as possible to the **Apparatus** under test.

13.3.8 The test leads **Shall** be securely attached to the test probes/terminals and routed to avoid becoming a tripping hazard.

13.3.9 A resistive discharge **Earth** probe **Shall** be connected and available in an accessible position that does not infringe the appropriate working and access clearances.

13.3.10 In windy conditions ensure the test access cover cannot be blown onto the test probes.

13.3.11 With the **Circuit Main Earth** removed, the test voltage **Shall** be gradually to the required value. The cable charging current will be seen on the ammeter.

NOTE: When the test voltage is reached, there should be negligible leakage current.

13.3.12 When a satisfactory test has been completed and the test set switched off, reapply the **Circuit Main Earths** and change the leads as necessary. Where a local **Circuit Main Earth** is not available (i.e., when testing a cable via test probes in a circuit breaker housing or via test terminals on distribution switchgear), take precautions shown in 13.3.13.

13.3.13 The capacitive characteristic of cables causes them to hold relatively **High Voltage** charges after an energising source has been removed, e.g., after they have been subject to a **HV** testing supply. This residual voltage charge can, in certain circumstances, be high enough to cause death by electrocution. It can occur between phases, and between phases and **Earth**. It can be reduced to at or about zero, and the **Danger** removed, by applying a short-circuit between phases or between phases and **Earth**. However, if the short-circuit is only applied for a short duration and then removed, it is possible the residual voltage charge may partially recover, and the **Danger** reappear. To deal with these **Dangers**, obey the following rules during **HV** testing:

- Immediately after a cable has been subjected to an **HV** DC test, and before making any other contact, use the 'earth dump' facility found on most **HV** test sets to make an initial short-circuit to **Earth**. Then apply a separate earthing probe immediately before making any other contact with the **HV** test terminals
- In addition to the above safety **Earthing** procedures, **Approved** insulating gloves **Shall** always be worn before touching any **HV** cable or associated terminals/clamps that have been subject to an **HV** DC test

13.3.14 When using a test van in a public location, appropriate arrangements **Shall** be taken to protect the public from the **dangers** of the **HV** test leads. Use fencing, ducting, and **Danger Notices** as necessary.

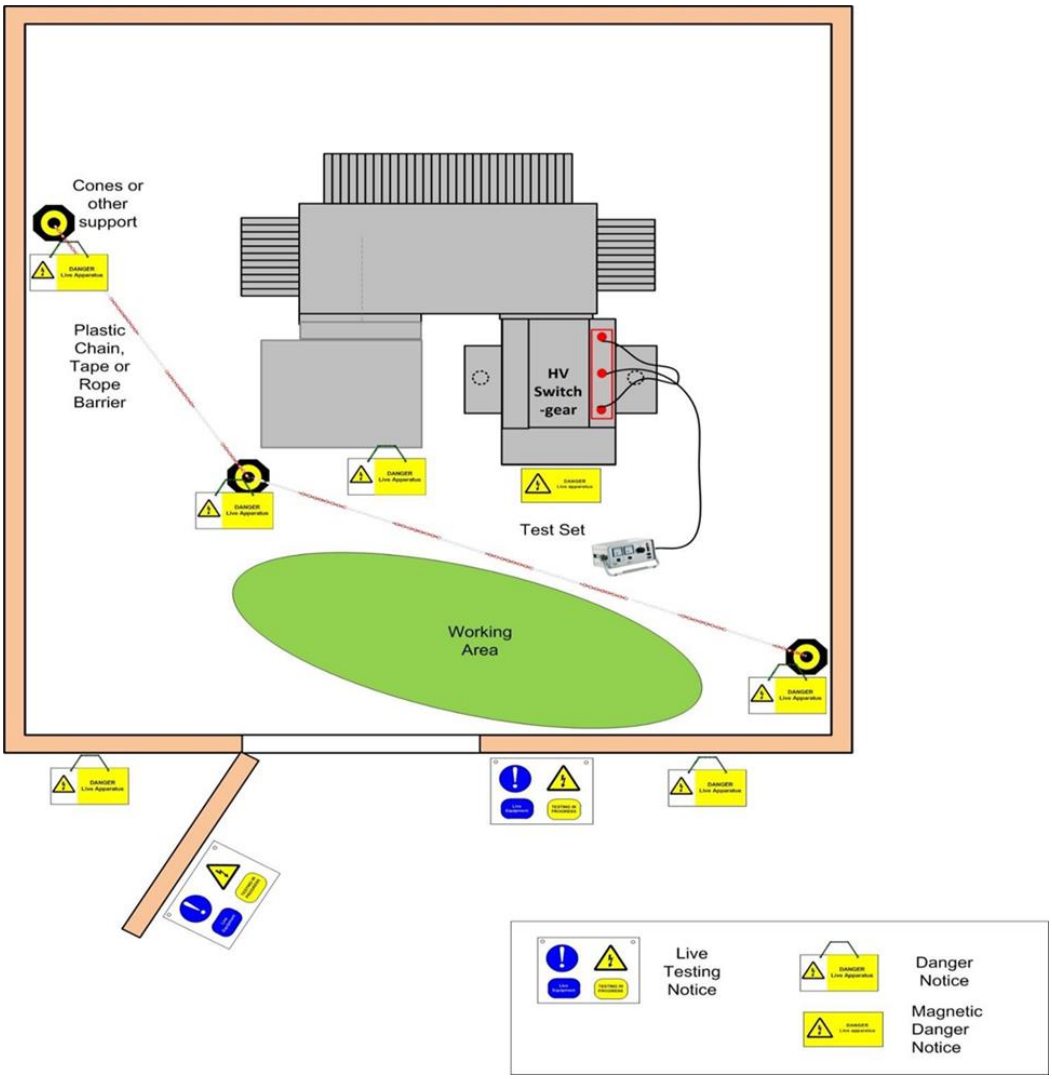

Figure 13.1 - Example of an HV Testing Layout in an 11kV Distribution Substation

13.4 Primary Distribution Switchgear

13.4.1 In the context of this procedure, primary switchgear includes any 11kV or 6.6kV multi-panel switchboard such as that installed in a typical 33/11kV or 33/6.6kV substation.

13.4.2 It is preferred to test the insulation resistance of primary switchgear with alternating current (AC) but if this is not reasonably practicable, direct current (DC) may be used.

13.4.3 Tests **Shall** be carried out on site, preferably after the switch has been installed in its final position either before, or after, the switch has been connected to the **System**.

13.4.4 Tests **Shall** be in accordance with Table 13.2, at the voltage and duration set out in Table 13.3.

Table 13.2 - Insulation Testing Primary Distribution Switchgear

Voltage Tests for Primary Distribution Switchgear	
1	With the switch closed, test between all phases, and between each phase and earth.
2	With the switch open, test each phase across the open switch contacts.

Table 13.3 - Insulation Testing Voltages and Duration for Primary Distribution Switchgear

System Voltage (kV)	Test Voltage	
	AC 1 min (kV	DC 5 min (kV)
6.6	20	11
11	28	18
22	50	23
33	70	45
66 and above	As per manufacturer specification	

13.4.5 Primary distribution switchgear **Shall** normally be tested with the cables connected.

Note: Care **Shall** be taken not to subject ancillary equipment such as closing coils in pole mounted reclosers, voltage transformers, etc. to **HV** tests.

13.5 Tests on Switchgear after Routine Maintenance or Examination after Fault

13.5.1 Routine post maintenance or inspection testing of 11kV & 33kV switchgear **Shall** not be carried out unless subject to one of the exceptions below:

- The maintained **Plant** cannot be made **Live** remotely
- The **Plant** maintained is the moving portion(s) only of circuit breakers when insulation tests **Shall** be carried out as part of the maintenance process
- There are special reasons when a test **Shall** be necessary (work has been carried out other than of a maintenance nature)
- The **Plant** is located in a very high-risk area e.g., chemical refinery, crowded shopping area, high rise building, school, etc

13.5.2 For the exceptions listed above, and any other situation where the test cannot be carried out due to the design of the equipment and with the agreement of the **Control Engineer** the undernoted test **Shall** be undertaken:

- The switchgear **Shall** successfully withstand a 1kV DC insulation test for one minute between phases and **Earth** before being made **Live**. If the insulation resistance between phases and **Earth** is less than 100MΩ, the cause **Shall** be established, and remedial action taken before the equipment is made **Live**.

If the test is successful, the **Apparatus Shall**, where reasonably practicable, be made **Live** remotely.

13.6 Approved Procedure for Tests Carried out During Statistical Sampling of High-Volume Distribution Switchgear

13.6.1 The **OSR** require that testing of **HV Apparatus** is carried out under a **Sanction-for-Test**.

13.6.2 The following **Approved** procedure is only applicable to the testing of small, insulated component items such as drive links, barriers and fuse carriages when carried out as part of Statistical Sampling of **HV** switchgear and does not require a **Sanction-for-Test,** however the remainder of the **OSR Shall** apply:

- **Danger Notices Shall** be posted and all persons in the vicinity of testing **Shall** be advised prior to the start and at the end of each test
- The 5kV insulation tester, and the component item under test, **Shall** not be left unattended whilst the test voltage is applied
- **Circuit Main Earths** stated on the **Permit-to-Work Shall** not be removed during tests

13.6.3 This procedure is not applicable to capacitive items liable to retain an electric charge following testing, such as lengths of cable.

13.7 Pole Mounted Reclosers

13.7.1 Immediately before the recloser is connected to the circuit, a 1kV DC insulation test **Shall** be carried out in addition to continuity resistance tests via the main connections as follows:

- With recloser OPEN, test across each phase (Test result greater than 100MΩ)
- With recloser CLOSED test across each phase (Test result at 0Ω)
- With recloser CLOSED, test between each phase (Test result greater than 100MΩ)
- With recloser CLOSED, test between individual phases and **Earth** (Test result greater than 100MΩ)

13.7.2 If the recloser fails any of these tests the cause **Shall** be established and remedial action taken before it is made **Live.**

13.8 132 kV Porcelain Terminal Bushings

All 132kV porcelain bushings **Shall** be tested in accordance with WI-NET-SST-119.

14 Transformers Testing

14.1 Distribution Transformers

NOTE: There is no requirement to disconnect the **LV** surge arrester when carrying out these tests.

14.1.1 The insulation resistance of distribution transformers **Shall** be tested using a 1kV insulation tester.

14.1.2 The testing **Shall** be carried out on-site, preferable after the transformer has been installed into its final position and before it has been connected to the **System**, as described below:

1. Connect the **LV** winding to **Earth** and to the tank, then test between the **HV** winding and **Earth** (see Figure 14.1). Remove the connection between the **Earth**/tank and the **LV** winding and connect the **HV** winding to the **Earth** and tank. Repeat the test, now between the **LV** winding and **Earth**.
2. Test between the **HV** winding and the **LV** winding
3. If the insulation resistance between the **HV** and **LV** winding or winding and **Earth** is less than 100MΩ the cause **Shall** be established, and remedial action taken before the equipment is made **Live**.

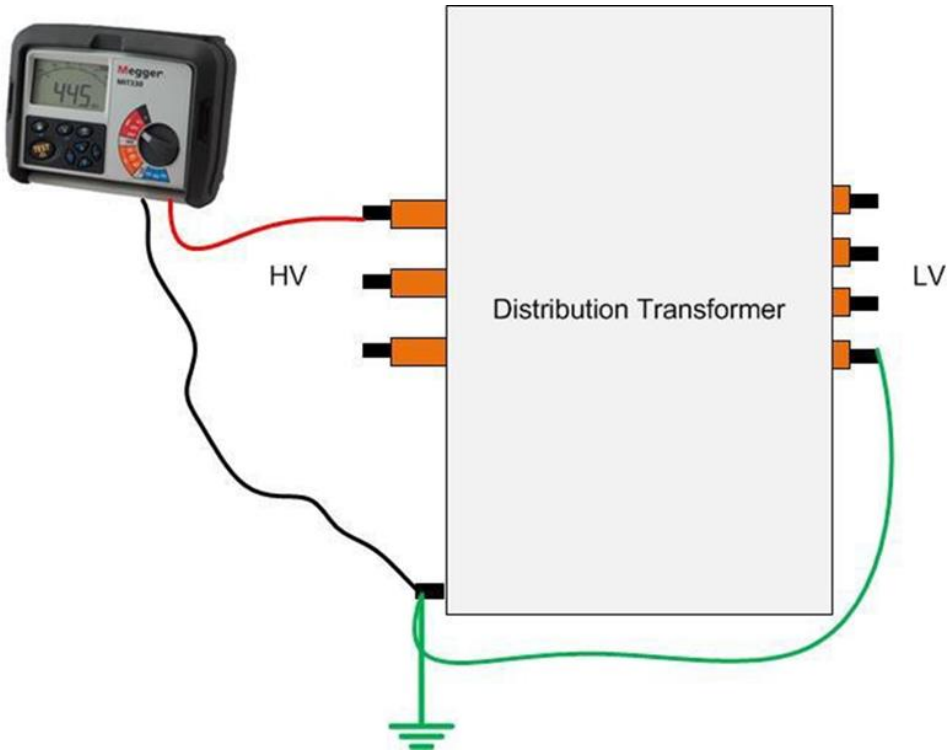

Figure 14.1 - Distribution Transformer Test Connection

14.2 Continuity Tests

14.2.1 Using a 1kV DC resistance tester (megger type):

- Check the continuity of the **HV** winding between all phases
- Check the continuity of the **LV** winding between all phases and neutral

14.2.2 A low and equal resistance continuity reading **Shall** be obtained between each phase on the **HV** winding.

14.2.3 Similarly, on the **LV** winding, low and equal resistance continuity readings **Shall** be obtained between phases and between each phase and **Earth**.

14.2.4 Unequal and/or high values may indicate an open or partial open circuit on the winding.

14.3 Primary Transformers

14.3.1 Where possible, **System** transformers **Shall** be tested with AC voltage, in accordance with Table 14.1using the test voltage appropriate to the winding voltage. If this is not reasonably practicable, DC voltages may be used.

14.3.2 Testing is to be carried out as described for distribution transformers in Section 14.1.

Table 14.1 - Insulation Testing Voltages and Duration for Primary Transformers

System Voltage (kV)	Test Voltage	
	AC 1 min (kV	DC 5 min (kV)
6.6	11	11
11	17	18
22	34	23
33	50	45
66	95	50

14.4 Grid and Supergrid Transformers

14.4.1 Overvoltage testing is not practicable on transformers at 132kV and above.

Insulation Tests

14.4.2 Using a 5kV DC insulation test:

- Measure the insulation resistance of each transformer winding with respect to **Earth** (the transformer tank)
- Measure the insulation resistance between the **HV** and **LV** and tertiary windings
- Measure the insulation resistance between the core and **Earth** (tank)
- Measure the insulation resistance between the frame and **Earth** (tank)

14.4.3 If the insulation resistance is less than 100MΩ, the cause **Shall** be established, and remedial action taken before the transformer is commissioned.

14.4.4 All Grid and Supergrid transformers **Shall** be made **Live** remotely from the **System** and left "on-soak" for a period recommended by the equipment manufacturer or a minimum of 24 hours prior to any load being applied.

14.5 Tests on Transformers after Routine Maintenance or Examination after Fault

Routine post maintenance or inspection testing of transformers **Shall** not be carried out unless subject to one of the exceptions below:

- The maintained **Plant** cannot be made **Live** remotely
- There are special reasons when a test will be required (i.e., work has been carried out other than of a maintenance nature)
- The **Plant** items are located in a very high-risk area e.g., chemical refinery, crowded shopping area, high rise building, school, etc

14.6 Ancillary Transformers (CTs, VTs, etc.)

14.6.1 All other ancillary transformers are to be tested with a 1kV DC insulation tester.

14.6.2 Apply the test voltage to the winding under test with the remaining windings, frame and tank of the transformer all connected to **Earth**, as described for distribution transformers in Section 14.1.

14.6.3 The insulation resistance **Shall** not be less than 100MΩ.

15 Off-System Testing

15.1.1 When **High Voltage Testing** is required on **Apparatus** that is not connected to the **System**, where practicable all requirements of this procedure and the **OSR Shall** be followed to prevent **Danger.**

15.1.2 Off-**System** testing **Shall** include **High Voltage Testing** in workshops.

15.1.3 For all Off-**System High Voltage Testing**, an Off-**System** Testing Certificate **Shall** be issued by the **Senior Authorised Person** to the person carrying out the testing. See Appendix A for example.

15.1.4 Prior to issuing the Off-**System** Testing Certificate, the **Senior Authorised Person Shall** ensure that all **Working Parties** engaged in the area specified on the Off-**System** Testing Certificate, or working on **Apparatus** connected to the **Apparatus** that is to be tested, have suspended work and taken suitable and sufficient precautions to prevent **Danger** during

testing. The person in charge of the **Working Party Shall** sign the **Working Party** log on the rear of the certificate.

15.1.5 Where applicable, staged schematic drawings **Shall** be used to show connections between **Apparatus** that is not connected to the **System**.

15.1.6 Off-**System** Test Certificates **Shall** have a unique identification number printed on them. If no number is printed, the following elements **Shall** be used to generate a unique identification number for each certificate:

- Initials of issuing **Authorised Person**
- Job number
- Date in the format ddmmyy
- Issue number
- The resulting unique identifier will have these elements hyphenated

AA-J24682-010120-1

15.1.7 When testing is complete, any **Earths** stated on the certificate **Shall** be replaced where applicable and the Off-**System** Testing Certificate **Shall** be cleared by the person carrying out the testing.

15.1.8 The application and removal of **Earths Shall** be logged on the rear of the certificate. This is not required for temporary **Earths** used in relation to discharging test voltages.

15.1.9 Once cleared, the Off-**System** Testing Certificate **Shall** be cancelled by the **Senior Authorised Person**, who **Shall** then inform all **Working Parties** that testing is complete, and all work may resume. Where applicable, the **Senior Authorised Person Shall** prove **Conductors Dead** using an **Approved** voltage testing device. The person in charge of the **Working Party Shall** sign the **Working Party** log on the rear of the certificate.

15.1.10 To mitigate the risk of an inadvertent/ undesirable **System** event, all persons intending to complete **High Voltage** Off-**System** testing **Shall** in advance of the testing notify the **Distribution Control Engineer** to make clear their intentions for the testing.

15.1.11 Off-**System** Testing Certificates **Shall** be retained in line with **SSEN-D Approved** procedures.

15.1.12 Off-**System** Test Certificates **Shall** not be used for testing any **Apparatus** connected to the **System**. Should **Apparatus** be connected to the **System**, the requirements of the **OSR** and this **Approved** procedure **Shall** be followed.

16 Operation of High Voltage Fault Location Equipment

- All persons operating **HV** fault location equipment on **SSEN-D Apparatus Shall** be adequately trained and assessed as being competent.
- Only **Approved** equipment which has been maintained in accordance with an **Approved** procedure **Shall** be used.

16.1 Test Van Operator

16.1.1 Only **Senior Authorised Persons**, who have received training for the use of the **Approved** test vans, are permitted to operate the **HV** fault location equipment installed in the test van.

16.1.2 The **Senior Authorised Person Shall** carry out a full risk assessment and take full responsibility for all aspects of Safety when using the test van.

16.1.3 A **Sanction-for-Test Shall** be issued before **HV** fault location equipment can be connected to the **System**.

16.2 Test Van Attendant

During the course of fault location, it may become necessary for the **Senior Authorised Person** to leave the test van for periods of time, for example, to carry out fault position identification. This is permissible provided that the following has been complied with:

- The test van **Shall** be attended at all times
- The attendant **Shall** be a **Competent Person** and is adequately trained to safely switch off all **HV** fault location equipment within the test van in the case of an emergency. This **Shall** preferably be by the operation of a single emergency stop switch
- **The attendant and the Senior Authorised Person Shall** be able to communicate with each other when required. This can be achieved via a mobile phone or portable radios of the 'walkie talkie' type

16.3 Test Van Training

16.3.1 Training of staff in the operation of the **Approved** test vans **Shall**, where reasonably practicable, be carried out by the manufacturers of the test equipment fitted in the van.

16.3.2 Staff who are required to operate the test van, **Shall** have 'on job' experience by shadowing a **Senior Authorised Person test** van operator, prior to the formal training.

16.3.3 Attendants **Shall** be trained to switch off the test equipment in cases of emergency, by a **Senior Authorised Person** test van operator.

16.4 Operating Portable High Voltage Fault Location Equipment.

16.4.1 Only a **Senior Authorised Person** trained in the use of such equipment **Shall** operate portable **HV** fault location equipment.

16.4.2 Portable equipment requires a higher level of attendance, as there are fewer built in safety devices than the equipment contained in a test van. It is therefore a requirement that at least an **Authorised Person**, specifically trained in the use of the equipment / or how to switch it off in case of an emergency, acts as an attendant.

16.4.3 The **Senior Authorised Person Shall** carry out a full risk assessment and take full responsibility for all aspects of Safety when using portable **HV** fault location equipment.

16.4.4 A **Sanction-for-Test Shall** be issued before portable **HV** fault location equipment can be connected to the **System**.

16.5 Guides for Fault Location and Log Books

16.5.1 The test van **Shall** have suitable, easy to follow guidelines, which detail basic tests and appropriate instruments available.

16.5.2 Instruction books for all the **Approved** equipment in the test van and a list of trained test van operators and attendants **Shall** be available within the van.

16.5.3 Each test van **Shall** have a log book that is kept with the van. Details and results of all fault locations **Shall** be recorded and kept for reference.

17 Routine Testing of High Voltage Test Equipment

17.1 General

17.1.1 All **HV** test equipment, potential indicators and phasing out devices **Shall** be tested on a routine basis for an adequate level of insulation to establish the integrity of the insulation and the functionality of the unit to its original specification and to ensure it continues to operate safely.

17.1.2 All equipment **Shall** be checked before and after use on its general condition and cleaned where required with an **Approved** polymer cleaning solution.

17.1.3 Approved **HV** test equipment **Shall** be maintained in accordance with the manufacturer's instructions, unless other approved policies are in place. An example of the testing requirements for the equipment listed below is shown in Table 17.1.

Table 17.1 - Routine Test Frequency for HV Test Equipment

Equipment	Test Period (Years)
Portable **High Voltage** test sets up to 25kv DC (Baur PGK25)	1
Baur Syscompact 2000M HV Fault Location sets	1
Westminster Potential indicators	2
High voltage detectors (capacitive types, HVI, Pfisterer)	2
Phasing out device – Fameca TAG 5000	2
Phasing out device – Metrohm **Live** line tester	2
Portable **High Voltage** test van equipment	1

17.2 Routine Checks

17.2.1 Before and after use all equipment **Shall** be checked to ensure it has been maintained in a safe condition and is within its next test due date.

17.2.2 **HV** test sets all types:

- General condition of all plugs, sockets and connectors
- **HV** leads clean and free from defects
- All switches and interlocks working correctly
- Discharge rods in good condition, clean and free from defects
- If defects are found which would influence the safe operation of the unit, it **Shall** not be used

17.2.3 Potential indicators, detectors and phasing devices:

- General condition, clean and checking for cracks and defects in the insulation
- If required, clean with the **Approved** polymer cleaning kit for **HV** instruments
- Confirm operation of unit as existing procedures
- If defects are found, they **Shall** be quarantined, and not used until repaired or replaced by an **Approved** provider.

17.3 Routine Testing

17.3.1 A Certificate of Test is to be produced for each unit tested.

17.3.2 All units that have passed the tests set out in this section **Shall** have a label attached to the device with the serial number of the unit and the next test due date. These details **Shall** be recorded in the Instrument register, which is the responsibility of each works unit.

17.3.3 The test schedules **Shall** record the detail of the tests carried out. These **Shall** include:

- Description of the equipment with serial number
- Details of each test applied
- Tolerance of test
- Correct indication of the equipment
- Record test results such as voltage and current and if the equipment has Passed or Failed.

17.3.4 The testing **Shall** be carried out by an accredited test house with the facilities to perform **HV** AC and DC testing.

17.3.5 All test schedules **Shall** be approved by **SSEN-D**.

18 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01	New document created.	NA	1.00	Richard Gough
02	Minor revisions made to improve clarity for users.	PR-NET-OSM-065 (Rev1.00)	1.01	Richard Gough
03	Minor revisions made to improve clarity for users.	PR-NET-OSM-065 (Rev1.01)	1.02	Richard Gough
04				

Appendix A Off System Testing Certificate

Table A.1

Scottish & Southern Electricity Networks **OFF-SYSTEM TESTING CERTIFICATE**	
Issued By:	Certificate Number:
Issued To:	Designation:

ISSUE

Location of testing to be carried out:	
Apparatus to be tested: *Where applicable attach a schematic diagram showing any connections between apparatus	
Earths applied:	
Description of testing to be carried out:	
Signed:	Time: Date:

RECEIPT

I accept responsibility for the testing described on this Off-System Testing Certificate and for taking all precautions necessary during testing, to prevent Danger.	
Signed:	Time: Date

CLEARANCE

All persons involved with testing have been withdrawn and warned that it is no longer safe to carry out testing on the Apparatus detailed on this Off-System Testing Certificate, and all Earths have been replaced. All Testing is ***Complete / *Incomplete** All Gear, Tools & Test Equipment has been ***Removed / *Not Removed** The operational state of the Apparatus is the same as at the time of issue of this Off-System Testing Certificate apart from the Exceptions noted below (if none, state "none"):	
Signed:	Time: Date

CANCELLATION

All Working Parties affected by the testing have been informed that testing is now complete and work may resume. Where necessary, Apparatus has been proved Dead prior to work resuming.	
Signed:	Time: Date

WORKING PARTY LOG

I, as the person in charge of the Working Party, have been briefed by the Authorised Person as to the state of the Apparatus being worked upon.					
Name	Signed	Equipment is NOT Safe to work on		Equipment is safe to work on	
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:
		Date:	Time:	Date:	Time:

EARTHING LOG

Position of Earth	Applied	Removed	Applied	Removed	Applied
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time:
	Date: Time:	Date: Time:	Date: Time:	Date: Time:	Date: Time: