1. SCOPE

This document details the procedure required to ensure **Safety from the System** when earthing the conductors, at tension towers, on multiple circuit overhead lines (OHL) that have no electrical connections and are subject to induced voltages from adjacent **Live** circuits.

These circuits shall be under Grid System Operations (GSO) **Control Person** control and the final earthing shall be regarded as a **Primary Earth** for future S**afety Documents**.

2. ISSUE RECORD

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3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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4. REVIEW

This document shall be reviewed after five years or when there are technical reasons for earthing the circuits with no electrical connections in a different manner.

5. CONTENTS

6. DEFINITIONS

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

7. INTRODUCTION

There are currently four sections of multiple circuit OHLs that have no electrical connections from the Transmission **System**, are regarded as part of the **System** due to their **Location** on towers adjacent to **Live** circuits with the hazards associated with induced voltages. These circuits are listed in Appendix 1.

PSSI 4 – HV Overhead Lines, section 10 – Conductors on Multiple Circuit OHLs, requires that all conductors on a multiple circuit OHL shall be under the control of the appropriate **Control Person**. Those sections that have no electrical connection require to be effectively earthed and the earth connections considered as a **Primary Earth**. Any work on these four OHL sections shall be carried out under the application of the Safety Rules with the appropriate **Safety Document** issued with the **Consent** of a **Control Person** at GSO.

The earthing arrangements that are currently in place and the method of earthing on three of these sections of OHL are not consistent with the requirements of PSSI 4 or PSMSP 3.4 – Jumpers at a Point of Isolation, and may restrict future changes to **System** configuration and maintenance of the OHL if not brought into line with the Safety Rules and supporting documentation.

Where the earthing arrangements of other sections of OHL line that have no electrical connection do not comply with the requirements of the PSSI 4 or PSMSP 3.4, the procedure in the method statement shall be implemented to meet the standard of earthing required.

8. OPERATING STATUS

There are four sections of OHL with no electrical connections to the S**ystem** and are regarded as part of the **System**.

Of the four, there is only one OHL section associated with ZN route that complies with PSSI 4 and PSMSP 3.4, with the jumpers bolted back at both tension towers, effectively earthing the spans to earth at the point where they were electrically disconnected. These earthing arrangements are an effective permanent measure and ideally suited to the remaining three sections of OHL.

The method statement section below, describes the method for earthing the remaining three OHL sections to the standard achieved on ZN route.

Although the current earthing arrangements are different for these sections of OHL, and one of the sections is not earthed, the principles of the earthing in the method statement will be applied. With regards to the single span with no earthing, the extra precaution of earthing at the nearest suspension tower cannot be achieved but as this is a single span and **Live** circuits do not run parallel, the risks from induced voltage are greatly reduced.

9. METHOD STATEMENT

The OHL circuits to be worked on have no electrical connection to the **System** but are subject to induced voltages from adjacent **Live** circuits. The most onerous hazard is the adjacent **Live** circuit but any underlying **Live** OHL should also be considered as a potential hazard.

Taking this into consideration the following earthing procedure has been developed to provide effective earthing for the installation of a conductor jumper arrangement to bi-pass the insulators and provide a more secure and permanent earth to the circuits.

i) Where practicable switch out of service the adjacent **Live** circuit prior to applying any additional earths on the sections of OHL with no electrical connections.
ii) Using the appropriate precautions for identifying and climbing OHL circuits issue a **Permit for Work** for the application of **Drain Earths.**
iii) Where practicable apply **Drain Earths** to the conductors at the nearest tower at the other end of the span from the point of no electrical connection.
iv) At the point of no electrical connection apply **Drain Earths** from the crossarm to the conductor on the line side of the anchor clamps.
v) Where it is not reasonably practicable to apply the earth connections, as specified above, to the conductors from the crossarm, the earths may be applied using the procedure in points vi and vii below.
vi) From the crossarm of the tower apply a **Drain Earth** to the corona shield, which should potentially reduce the risk of any trapped charge.
vii) With this in place the linesmen can now use the procedure in PSSI 4, Scheme 2, section 1.3 to traverse the insulator and using an **Approved** 600mm earthing pole apply the relevant number of earths to the conductor to enable work at that location.

*Note: The Linesman should find a safe and suitable location on the insulators to apply the earths; they should not be in contact with the conductor until the appropriate **Drain Earths** have been applied to the conductors.*

viii) Once there is satisfactory earthing at both **Locations** of electrical disconnection the adjacent circuit can be returned to service.
ix) The circuit with no electrical connections to the **System** is now in an appropriate state to implement a more robust earthing system i.e. a shortened set of jumpers bolted back to the tower steelwork.
x) After the appropriate connections have been made to the conductor and the tower steelwork the portable **Drain Earths** can be removed and the tower can be regarded as permanently earthed.
xi) This will then leave the conductors earthed back to the tower in accordance with PSMSP 3.4.

10. GUIDANCE ON THE COMPLETION OF THE SAFETY DOCUMENT

The *Earthing Party* will receive a **Permit for Work** to apply **Drain Earth**s on towers as specified by the **Senior Authorised Person** and they shall be applied as directed through the use of an **Earthing Schedule**. There will be a subsequent **Permit for Work** issued after the **Drain Earths** where applied to enable the jumper works to be installed. Guidance is given below on the completion of the **Permit for Work** for the application of the **Drain Earths**.

Section 1(i) and 1(ii) of the **Permit for Work** will be completed in accordance with PSMSP 4.6 and guidance on the identification of the circuits with no electrical connections can be found in Appendix 1.

Section 1(iii) of the **Permit for Work** records the work to be done, an example would be Apply **Drain Earths** in accordance with **Earthing Schedule** (include number). The **Earthing Schedule** number will be the next in sequence on the schedule pad or allocated a number as per OPSAF-11-31.

Section 2(i) of the **Permit for Work** will record the points of no electrical connection to the **System** and the points of earthing, where applicable.

Section 2(ii) of the **Permit for Work**, Further precautions to be taken during the course of work to avoid system derived hazards, shall note the adjacent circuit(s) that will be de-energised to allow the work to proceed.

Note: As the adjacent circuit is to be switched out, and not isolated and earthed, this can be completed as an additional precaution and enhance **System** security by reducing the time of the outage. If the adjacent circuit is to be switched out in advance and remain switched out until the cancellation of the **Safety Document**, then this should be included in Section 2(i).

The remaining sections of the **Permit for Work** shall be completed as appropriate

When the earthing requirements have been met; as stated on the **Earthing Schedule**; the **Permit for Work** will be cancelled. The circuits de-energised for induction purposes may be returned to service and a **Permit for Work** can be issued for the work involving the permanent jumper arrangement.

11. CIRCUIT OUTAGE REQUIREMENTS

From the line diagram in Appendix 2 depicting the network configuration at Neilston, the following outages are required to enable the implementation of a more appropriate earthing system.

11.1 OHL Section XF1A – XF2

An outage is required on the Neilston/Windyhill (275 kV) circuit; this is due to it running parallel to the section of OHL with no electrical connection.

11.2 OHL Section XF1 – XF6

An outage is required on the Hunterston/Inverkip (400 kV) No.2 circuit, this is required to enable safe access to the crossarms on tower XF 6 and the circuit will be Isolated and Earthed.

The Neilston/Windyhill (275 kV) circuit will be required to be switched out due to it being the parallel circuit.

11.3 OHL Section XX2 – XX49

An outage is required on the Easterhouse/Newarthill (275 kV) circuit due to it being a parallel circuit.

There is no diagram depicted for XX route, the circuit with no electrical connection runs parallel to the Easterhouse/Newarthill Circuit and both circuits are on a twin circuit tower.

12. EARTHING REQUIREMENTS

Below is the earthing required at each tower for the implementation of the revised earthing arrangements. This shall only be implemented once the above circuits have been switched out of service.

12.1 OHL Section XF1A – XF2

This section of OHL is a single span with back-to-back tension towers, which does not facilitate the application of earths directly to the conductors from the crossarms. Therefore the first point of earthing would be to the corona shields at both tension towers XF1A and XF2. After this point has been completed, the procedure describe for applying earths in section 8 of traversing the insulators to a suitable point to apply the earths etc. should be utilised.

12.2 OHL Section XF1 – XF6

This section of OHL is currently earthed at the point of entry into the substation, at one of the points of where the electrical connection has been removed. The second point where the electrical connection has been removed is on tension tower XF6; earths shall be first applied at the suspension tower XF5 from the crossarm to the conductors. There will be a requirement to apply **Drain Earths** to the **Isolated** and **Earthed** Hunterston/Inverkip No.2 circuit jumpers while working on the crossarms of XF6. The earthing of the section with no electrical connections at XF6 will require the earthing procedure in section 8 to be implemented i.e. traversing the insulators to apply earths etc.

12.3 OHL Section XX2 – XX49

This section of OHL is **Earthed** at both suspension towers a span away from the points of no electrical connection. The first point associated with the earthing should be to check the integrity of the earths at XX3 and XX48, should these be satisfactory the earthing procedure in section 8 should be utilised to earth at the tension tower i.e. first earth applied to the corona shield and then subsequently traverse the insulators etc.

13. APPENDIX 1 – OHL SECTIONS CURRENT STATUS

Below is the information on the sections of OHL where the electrical connections have been removed and the earthing arrangements of these OHL sections that are part of the S**ystem**.

13.1 OHL Section XF1A – XF2

XF1A – XF2: 2 towers (single span) 275 kV.
Circuit Colour Yellow, no circuit I.D. on XF2.

Points of no electrical connection:

Electrical connections removed from Neilston 275kv substation at tower XF1A by the removal of jumpers and downleads.

Electrical connections removed from Hunterston/Inverkip No.2 Circuit by the removal of jumpers at XF6 and XF 2.

Earthing: None currently applied.

13.2 OHL Section XF1 – XF6

XF1 – XF6: 7 towers (six spans) 400kv.
Circuit Colour Red/White/Green, no circuit I.D. on XF 6.

Points of no electrical connection:

Electrical connections removed from Neilston 400 kV substation by the removal of busbars within the compound. These could be connected to the Neilston / Hunterston circuit and Transformers SGT3A & SGT3B.

Line VT secondary supplies **Isolated** and Safety **Locked**, was the Inverkip line VTs.

Electrical connections removed from Hunterston/Inverkip No.2 Circuit by the removal of jumpers at XF6.

Earthing: 2 sets per phase of **Portable Primary Earths** applied to the busbars connected to the OHL, (this is the only point currently **Earthed**).

13.3 OHL Section ZN 85 – ZN 90

ZN 85 – ZN 90: 6 towers (five spans) 400 kV.
Circuit Colours Yellow, no circuit I.D. on ZN 85.

Points of no electrical connection:

Electrical connections removed from Hunterston/Inverkip No.2 Circuit by the removal of jumpers at ZN 85.

Electrical connections removed from Neilston/Hunterston Circuit by the removal of jumpers and span of conductor.

Earthing: Jumpers bolted back to crossarms at towers ZN 85 and ZN 90 providing **Primary Earths**.

13.4 OHL Section XX2 – XX49

XX2 – XX49: Easterhouse to Newarthill 275 kV.
Circuit Colours Red/Blue.

Points of no electrical connection:

Electrical connections removed from Easterhouse Substation, by the removal of Jumpers, downleads and the removal of conductor, to XX2.

Electrical connections removed from Newarthill Substation by the removal of jumpers and downleads at tower XX49.

Earthing: 3 sets of **Drain Earths** applied at towers XX3 and XX48 providing **Primary Earth** equivalence, this equates to 18 earths per tower.

1 set of **Drain earths** applied at towers XX37, XX38 and XX39. There is one earth per sub conductor (twin conductor per phase); this equates to 6 earths at each tower.

Appendix 2 - Conductor and Earthing Arrangements at Neilston Substation