1. SCOPE

This procedure details the requirements for the correct use of **Portable Primary Earths**, **Portable Drain Earths**, *Field Equipment Earths,* **LV** Portable Shorting Devices, Rack Earths and Capacitor Short-Circuiting Leads when working in substations and on overhead lines. The application, inspection and storage of **Portable Earths** is covered in OPSAF-11-009 (MSP 1.7).

2. ISSUE RECORD

This is a Reference document. The current version is held on the Energy Networks Intranet Document Library.

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Issue Date	Issue No	Author	Amendment Details
October 2005	2	Jack Neilson	New document template. Minor editorial Changes
October 2006	3 **Published to Intranet Only**	David Kilday	Inclusion of portable earths for 132kV wood poles.
Dec 2010	4	Phil Currie	Update to Logo, Issue Authority, Review & changed ESI to ENA on back page.
October 12	5	Dave Naylor Phil Currie Jason Morgan	Updated to include Rack Earths and Capacitor Short-Circuiting Leads. Explanation of the need for Field Equipment Earths

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Name David Kilday Title Senior Policy & Standards Engineer	Name Phil Currie Title Operational Compliance Manager	Name: Ewan McMillan Title: EN Health & Safety Director  Date: ..4/7/2013.....

4. REVIEW

This is a Reference document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive. The proposed revision date can be viewed in the Management Safety Procedures Document Index DOC-00-238.

5. DISTRIBUTION

This document is part of the Management Safety Procedures Manual but does not have a maintained distribution list.

6. CONTENTS

7. DEFINITIONS

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

Terms printed in italics are as defined in the Definitions document (OPSAF-11-002) of the Management Safety Procedures.

8. PORTABLE PRIMARY EARTHS

Primary Earths shall safely discharge the resultant fault current, which would flow in them if they were inadvertently energised from the ScottishPower **HV System**. To safely discharge this current, the **Primary Earths** shall be of adequate cross-section and be efficiently connected between earth and the **Isolated HV Apparatus**.

Portable Primary Earths shall have their flexible leads shrouded in clear or orange insulating material and shall be fitted with end connections of an **Approved** type appropriate to their use.

A summary of the requirements for **Portable Primary Earths** and their cross-section is given in Appendix 1.

8.1 Substations, Power Stations and Overhead Steel Tower Lines Operating at Voltages of 400kV to 132kV Inclusive

Portable Primary Earths for use in substations, on overhead steel tower lines and at Power Stations operating at voltages of 400kV to 132kV inclusive, shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 150mm^2.

8.2 Substations Operating at Voltages of 33kV and Below

Portable Primary Earths for use in indoor substations and outdoor open type substations of 33kV and below shall have a short between phases and an earth lead which shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 120mm^2.

As an alternative to the above, single phase **Portable Primary Earths** may be used which shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 120mm^2.

8.3 Overhead Wood Pole Lines Operating at a Voltage of 132kV

Portable Primary Earths for use on **HV** overhead wood pole lines operating at a voltage of 132kV shall be made up of aluminium wires, the short between phases shall be of circular cross-section giving a minimum cross-sectional area of 150mm^2. The earth lead shall have a cross-sectional area of not less than 70mm^2.

8.4 HV Overhead Wood Pole and Slim Lattice Tower Lines Operating at Voltages of 33kV and Below

Portable Primary Earths for use on **HV** overhead wood pole lines and slim lattice tower lines of voltages of 33kV and below shall be made up of aluminium wires, the short between phases shall be of circular cross-section giving a minimum cross-sectional area of 120mm^2. The earth lead shall have a cross-sectional area of not less than 50mm^2.

8.5 HV Overhead Broad Base Steel Tower Lines Operating at Voltages of 33kV and Below

Portable Primary Earths for use on **HV** broad base steel tower overhead lines of voltages of 33kV and below shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 120mm^2.

9. PORTABLE DRAIN EARTHS

Drain Earths shall be of adequate cross-sectional area and be efficiently connected between earth and the **Isolated HV Apparatus** so as to discharge safely the resultant current due to any induced voltage, impressed voltage or inadvertent back-feed.

Portable Drain Earths shall have their flexible leads shrouded in blue insulating material or have a blue label inscribed '**Drain Earth**' affixed at the earth end and shall be fitted with end connections of an **Approved** type appropriate to their use.

A summary of the requirements for **Portable Drain Earths** and their cross-section is given in Appendix 1.

9.1 Substations and Power Stations Operating at Voltages of 400kV to 132kV Inclusive

Portable Drain Earths for use in substations, and at Power Stations operating at voltages of 400kV to 132kV inclusive, shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 150mm^2.

9.2 Overhead Steel Tower Lines Operating at Voltages of 400kV to 132kV Inclusive

Portable Drain Earths for use on overhead steel tower lines operating at voltages of 400kV to 132kV inclusive shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

9.2.1 *Bridging Earths*

Bridging Earths for use on overhead lines shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

9.2.2 *Earthing Bridle*

Earthing Bridles for use on overhead lines shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

9.2.3 *Trailing Earths*

Trailing Earths for use on overhead lines shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

9.3 Overhead Wood Pole Lines Operating at a Voltages of 11kV to 132kV Inclusive

Portable Drain Earths for use on **HV** overhead wood pole lines operating at voltages of 11kV to 132kV inclusive shall be made up of aluminium wires, the short between phases shall be of circular cross-section giving a minimum cross-sectional area of 50mm^2. The earth lead shall have a cross-sectional area of not less than 50mm^2.

9.4 Substations Operating at Voltages of 33kV and Below

Portable Drain Earths for use in substations operating at voltages of 33kV and below shall have a short between phases and an earth lead which shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

As an alternative to the above, single phase **Portable Drain Earths** may be used which shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

10. FIELD EQUIPMENT EARTHS

Field Equipment Earths are used to bond temporary structures, mechanical plant or vehicles and other items of field equipment to the mass of earth or the local earth system to avoid **Danger** from rise in earth potential, step/touch potentials, induced or impressed voltages. Many permanent installations are designed with separation between earth systems to avoid step and touch potentials, e.g. substation mats and perimeter fences. It is important to avoid **Danger** from reducing this separation when using *Field Equipment Earths*.

Field Equipment Earths shall have a label inscribed *'Field Equipment Earth*' affixed at the earth end and shall be fitted with end connections of an **Approved** type appropriate to their use.

10.1 400, 275 and 132kV Substations and Power Stations

Field Equipment Earths for use in substations operating at voltages of 400kV to 132kV inclusive, and in all Power Stations, shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 150mm^2.

10.2 Substations Operating at 33kV and Below

Field Equipment Earths for use in substations operating at voltages of 33kV and below shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 120mm^2.

10.3 Overhead Lines All Voltages

Field Equipment Earths for use during overhead line work shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2.

11. LV PORTABLE SHORTING DEVICES

Approved LV Portable Shorting Devices shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2, shrouded in clear or orange insulating material and fitted with end connections of an **Approved** type for either bare wire lines or ABC, as appropriate. They shall be designed to withstand 7.5 kA for 1 second.

12. RACK EARTHS

Approved Rack Earths are fixed or portable **Earthing Devices** provided for the purpose of earthing and/or short-circuiting Capacitor Units or groups and the Capacitor Rack or frame supporting them. The term Rack Earth includes Frame Earths. Requirements for their use are laid out in PSSI 11 (OPSAF-10-011) and MSP 2.12 (OPSAF-11-064).

Approved Rack Earths shall be of circular cross-section made up of aluminium wires giving a minimum cross-sectional area of 50mm^2 and shall be fitted with end connections of a type appropriate to their use. They shall have their flexible leads shrouded in clear insulating material and have a label inscribed 'Rack Earth' affixed.

A summary of the requirements for Rack Earths and their cross-section is given in Appendix 1.

13. CAPACITOR SHORT-CIRCUITING LEADS

Approved Short-Circuiting Leads are used for short-circuiting an individual Capacitor Unit. Requirements for their use are laid out in PSSI 11 (OPSAF-10-011) and MSP 2.12 (OPSAF-11-064). There are no requirements relating to colour or labelling of Short-Circuiting Leads.

There are two types of **Approved** short-circuiting lead:

i) Clip-on leads shall be of circular cross-section made of aluminium wires giving a minimum cross-section of 16mm^2 with crocodile clips at each end for application by hand.

ii) Bolt-on leads shall be of circular cross-section made of aluminium wires giving a minimum cross-section of 50mm^2 with crimped lugs at each end.

14. APPENDIX 1 – SUMMARY OF THE REQUIREMENTS FOR PORTABLE EARTHING AND SHORTING LEADS

Type of Earthing or Shorting Lead	Where Used	Aluminium Conductor (Minimum CSA)	Identification	Cross-section Copper Equiv. in ins.	Cross-section Copper Equiv. in mm.
Portable Primary Earths	Power Stations and 400, 275 and 132kV Substations.	150 mm^2	Clear or Orange	0.14 in^2	92.33 mm^2
	Substations up to 33kV.	120 mm^2 between phases 120 mm^2 to earth		0.12 in^2 0.12 in^2	73.86 mm^2 73.86 mm^2
	Overhead Broad Base Tower Lines up to 33kV.	120 mm^2		0.12 in^2	73.86 mm^2
	400, 275 and 132kV Overhead Steel Tower Lines.	150 mm^2		0.14 in^2	92.33 mm^2
	132kV Overhead Wood Pole Lines.	150 mm^2 between phases 70 mm^2 to earth		0.14 in^2 0.07 in^2	92.33 mm^2 44.00 mm^2
	Overhead Wood Pole Lines and Slim Lattice Tower Lines up to 33kV.	120 mm^2 between phases 50 mm^2 to earth		0.12 in^2 0.05 in^2	73.86 mm^2 30.78 mm^2
Portable Drain Earths	Power Stations and 400, 275 and 132kV Substations.	150 mm^2	Blue or Labelled '**Drain Earth**'	0.14 in^2	92.33 mm^2
	400, 275, 132 and 33kV Broad Base Tower Overhead Lines.	50 mm^2		0.05 in^2	30.78 mm^2
	Overhead Wood Pole Lines up to 132kV and Slim Lattice Tower Overhead Lines and Substations up to 33kV.	50 mm^2 between phases 50 mm^2 to earth		0.05 in^2 0.05 in^2	30.78 mm^2 30.78 mm^2
Field Equipment Earths	Power Stations and 400, 275 and 132kV Substations.	150 mm^2	Labelled '*Field Equipment Earth*'	0.14 in^2	92.33 mm^2
	All Overhead Lines.	50 mm^2		0.05 in^2	30.78 mm^2
	Substations up to 33kV.	120 mm^2		0.12 in^2	73.86 mm^2
LV Portable Shorting/ **Earthing Devices**	**Low Voltage** overhead lines up to 400V.	50 mm^2	Clear or Orange	0.05 in^2	30.78 mm^2
Rack Earths	Capacitor Units and Capacitor Rack or frames	50 mm^2	Clear and labelled 'Rack Earth'	0.05 in^2	30.78 mm^2
Capacitor Short-Circuit Leads	Clip-on short-circuiting lead for temporary use	16 mm^2	n/a	0.02 in^2	10.00 mm^2
	Bolt-on short-circuiting lead for permanent use	50 mm^2	n/a	0.05 in^2	30.78 mm^2

Note: ENA Standard 41-21 makes reference to Portable Earthing Equipment for Open Type **HV Apparatus**.
ENA Standard 43-81 makes reference to Portable Earthing Equipment for **HV** Overhead lines up to and including 66kV.