

## Company Directive

### ENGINEERING EQUIPMENT SPECIFICATION 132

#### Earthing Materials & Associated Sundry Items

##### Summary

This Engineering Equipment Specification details the requirements for earthing materials and associated sundry items for use on the Western Power Distribution network.

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**Implementation Date:** July 2015

**Approved By:**



Policy Manager

**Date:**

10 July 2015

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## **IMPLEMENTATION PLAN**

### **Introduction**

This engineering equipment specification document details the requirements for earthing materials & associated sundry items.

### **Main Changes**

This is a page amendment of an existing document. The earth rod with 5mm diameter conductor exothermically welded to it was found to be vulnerable whilst in storage. A requirement to use cable ties to strap the conductor to the rod for additional support during this period has been included as we are about to undertake a re-tendering exercise.

### **Impact of Changes**

This engineering equipment specification is relevant to all staff who are involved with specifying, buying, installing or maintaining earthing systems. It is also relevant to Independent Connection Providers.

### **Implementation Actions**

Managers should inform relevant staff that this engineering equipment specification has been page amended, and brief them on the changes. There are no retrospective actions.

### **Implementation Timetable**

This page amendment shall be implemented with immediate effect.

*Page revised November 2016*

<b>DOCUMENT REVISION &amp; REVIEW TABLE</b>		
<b>Date</b>	<b>Comments</b>	<b>Author</b>
Nov 2016	Page amendment to include additional requirements for customized form "B" earth rods	Graham Brewster
Jul 2016	Page amendment to include E5 item numbers for various items	Graham Brewster
Jul 2015	Initial issue	Graham Brewster

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## **1.0 INTRODUCTION**

This Engineering Equipment Specification details the requirements for earthing materials and associated sundry items for use on the Western Power Distribution network.

Some sections make reference to “WPD Approved Products”. These products shall ordinarily be employed on the WPD network unless otherwise agreed by WPD’s Policy Section. Alternative products may be submitted to WPD’s Policy Section for approval.

## 2.0 REQUIREMENTS FOR STRANDED COPPER CONDUCTOR

### 2.1 Bare Stranded Copper Conductor

Bare stranded copper cable shall comply with the requirements of WPD Engineering Equipment Specification 85: Specification for Bare and PVC Covered Overhead Line Conductor.

The minimum strand diameter shall be 2.50mm.

#### 2.1.1 WPD Standard Items

The following bare stranded copper conductor is regularly used within WPD:

35mm <sup>2</sup> cross section (7 x 2.50mm diameter strands)	[E5 - 50025]
70mm <sup>2</sup> cross section (7 x 3.55mm diameter strands)	[E5 - 30006]
125mm <sup>2</sup> cross section (19 x 2.90mm diameter strands)	[E5 - 30008]

### 2.2 Insulated Stranded Copper Conductor For Use On LV, 6.6kV & 11kV Wood Pole Overhead Lines

Insulated stranded copper cable shall comply with the requirements of WPD Engineering Equipment Specification 73: Specification for PVC Insulated, Single Core General Purpose Cable.

The cable shall have a single core and the conductor shall be annealed copper which conforms to the requirements of BS EN 60228, Class 2. The minimum strand diameter shall be 2.50mm.

The PVC insulation shall conform to the type TI 1 compound requirements of BS 7655-3.1, be not less than the thickness value defined in BS 6004, and have a blue colour.

The PVC sheath shall conform to the type 6 material requirements of BS 7655-4.2, be not less than the thickness value defined in BS 6004, and have a grey colour.

#### 2.2.1 WPD Standard Items

The following insulated stranded copper conductor is regularly used within WPD:

35mm <sup>2</sup> cross section (7 x 2.50mm diameter strands)	[E5 - 41389]
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### 2.3 Insulated Stranded Copper Conductor For Use On Joint BT / WPD Poles On 11kV Wood Pole Overhead Lines

Insulated stranded copper cable shall comply with the requirements of BS 6485: PVC Covered Conductors For Overhead Power Lines.

The conductor shall be hard drawn copper stranded conductor which complies with the requirements of BS 7884. The minimum strand diameter shall be 2.50mm.

The PVC covering shall conform to the type TI 1 compound requirements of BS 7655-3.1, be not less than 1.6mm thick, and have a green colour (i.e. Type 16 designation).

#### 2.3.1 WPD Standard Items

The following insulated stranded copper conductor is regularly used within WPD:

35mm <sup>2</sup> cross section (7 x 2.50mm diameter strands)	[E5 - *****]
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### 2.4 Insulated Stranded Copper Conductor For Use On 25kV, 33kV, 66kV & 132kV Wood Pole Overhead Lines

Insulated stranded copper cable shall comply with the requirements of BS 7889: Electric cables – Thermosetting insulated, non-armoured cables with a voltage of 600/1000 V, for fixed installations.

The cable shall have a single core and the conductor shall be annealed copper which conforms to the requirements of BS EN 60228, Class 2. The minimum strand diameter shall be 2.50mm.

The PVC insulation shall conform to the type GP 8 compound requirements of BS 7655-3.1, be not less than the thickness value defined in BS 7889, and have a blue colour.

The PVC sheath shall conform to the type 9 material requirements of BS 7655-4.2, be not less than the thickness value defined in BS 7889, and have a black colour.

#### 2.4.1 WPD Standard Items

The following insulated stranded copper conductor is regularly used within WPD:

120mm <sup>2</sup> cross section (19 x 2.80mm diameter strands)	[E5 - *****]
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### 3.0 REQUIREMENTS FOR STRANDED COMPOSITE COPPER & STEEL CONDUCTOR

#### 3.1 Bare Stranded Composite Copper & Steel Conductor

Bare stranded composite copper & steel conductor is sometimes employed as the above ground earthing conductor on LV, 6.6kV & 11kV wood pole lines as a theft deterrent measure.

The conductor shall comprise of concentric strands in one of the following forms:

- All strands made of copper clad steel
- Outer layers made of copper clad steel which hide and protect inner layers made of copper.
- Outer layers made of galvanised steel which hide and protect inner layers made of tinned copper.

Conductors employing copper clad wires shall comply with the requirements of the American Society for Testing and Materials (ASTM) specifications:

- B229-12: Standard Specification for Concentric Lay Stranded Copper and Copper Clad Steel Composite Conductors, or
- B228-11A: Standard Specification for Concentric Lay Stranded Copper Clad Steel Conductors

The minimum strand diameter shall be 2.50mm.

The conductor shall be suitable for use with standard connectors used on stranded copper conductors, including exothermic connections.

##### 3.1.1 WPD Standard Items

The following bare stranded copper conductor is regularly used within WPD:

70mm <sup>2</sup> cross section (7 x 3.66mm diameter strands)	[E5 - *****]
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## 4.0 REQUIREMENTS FOR BARE COPPER TAPE SYSTEMS

### 4.1 Bare Copper Tape

Bare copper tape shall meet the requirements of BS EN 13601 (2013): Copper & Copper Alloys - Copper Rod, Bar and Wire for General Electrical Purposes. It shall be manufactured from annealed copper to the following equivalent international designations:

- BS 1E (UK)
- C10100 (UNS - Unified Numbering System)
- CW 004A (European 'CEN')
- Cu-ETP (ISO)

Bare copper tape shall normally have an R200 / H035 (i.e. annealed) material condition. However, it is occasionally required with an R250 / H065 (i.e. half-hard) or R300 / H085 (i.e. hard) material condition, for example, lengthy unsupported horizontal runs (e.g. between 145kV surge arrester bases) where a neater appearance is required than is produced with annealed copper tape.

Bare copper tape shall have a thickness in the range 3 to 6mm and a width in the range 25 to 80mm. Widths in the range 40 to 50mm are preferred as they are compatible with the standard earth end clamps employed on portable earthing equipment designed to ENA TS 41-21. The copper tape shall have lightly rounded edges.

Copper tape shall be supplied in rolls weighing not more than 30kg, and preferably less than 25kg, and having a length which is a multiple of 5m.

All bare copper tape shall have "PROPERTY OF WESTERN POWER DISTRIBUTION" embossed along the length of the tape. The embossing shall be repeated approximately two times per linear metre and shall be applied on both of the broader sides of the tape.

#### 4.1.1 WPD Standard Items

The following bare copper tapes are commonly used within WPD:

3mm x 25mm x 50m annealed bare copper tape (25m x 0.67kg/m = 16.75kg)	[E5 - 51154]
4mm x 50mm x 25m annealed bare copper tape (15m x 1.74kg/m = 26.10kg)	[E5 - 42469]
6mm x 50mm x 10m annealed bare copper tape (10m x 2.68kg/m = 26.80kg)	[E5 - 51156]

## 4.2 Tape Clips

Bare copper tape will normally be fixed in place using the security fixings and security capping specified in section 14.3 & 14.4 below. Tape clips may occasionally be required, for example, where the security method of attachment is not reasonably practicable.

Tape clips shall:

- Be compatible with the bare copper tape specified above
- Be fixed to the support structure by mechanical means such as screws or bolts
- Not require the bare copper tape to be drilled
- Have a form such that the bare copper tape is supported off the structure it is being attached to
- Be supplied in handy sized packs (say around 20 to 50 clips in each).

Metallic tape clips shall such that there can be no deleterious effect (e.g. galvanic corrosion) on the tape or the clip resulting from their association.

Non-metallic tape clips shall be UV stabilised to prevent degradation from sunlight and non-brittle to protect against cold weather.

The clip-to-tape and clip-to-structure fixings shall be resistant to tear-off forces arising from the passage of fault current (i.e. electro-magnetic forces) or from wilful interference (i.e. metal thieves).

### 4.2.1 WPD Standard Items

The following tape clips are commonly used within WPD:

Tape clips for 3 x 25mm bare copper tape	[E5 - 61260]
Tape clips for 4 x 50mm bare copper tape	[E5 - 61261]
Tape clips for 6 x 50mm bare copper tape	[E5 - 61262]

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## 5.0 REQUIREMENTS FOR BARE ALUMINIUM TAPE SYSTEMS

### 5.1 Bare Aluminium Tape

Bare aluminium tape shall meet the requirements of BS 2898 or BS EN 755. It shall be manufactured from annealed aluminium to the following equivalent international designations:

- BS 1E (UK)
- A91350 (UNS - Unified Numbering System)
- EN AW-AI99.5 (Europe)
- AI99.5 (ISO)
- 1350 (AA - Aluminium Association)

Bare aluminium tape shall have a thickness in the range 3 to 6mm and a width in the range 25 to 80mm. Widths in the range 40 to 50mm are preferred as they are compatible with the standard earth end clamps employed on portable earthing equipment designed to ENA TS 41-21. The bare aluminium tape shall have lightly rounded edges.

Bare aluminium tape shall be supplied in rolls weighing not more than 30kg, and preferably less than 25kg, and having a length which is a multiple of 5m.

#### 5.1.1 WPD Standard Items

The following bare aluminium tape is commonly used within WPD:

6mm x 50mm x 30m bare aluminium tape (30m x 0.85kg/m = 25.50kg)	[E5 - 51161]
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### 5.2 Tape Clips

Tape clips shall:

- Be compatible with the bare aluminium tape specified above
- Be fixed to the support structure by mechanical means such as screws or bolts
- Not require the bare aluminium tape to be drilled
- Have a form such that the bare aluminium tape is supported off the structure it is being attached to
- Be supplied in handy sized packs (say around 20 to 50 clips in each).

Metallic tape clips shall such that there can be no deleterious effect (e.g. galvanic corrosion) on the tape or the clip resulting from their association.

Non-metallic tape clips shall be UV stabilised to prevent degradation from sunlight and non-brittle to protect against cold weather.

The clip-to-tape and clip-to-structure fixings shall be resistant to tear-off forces arising from the passage of fault current (i.e. electro-magnetic forces) or from wilful interference (i.e. metal thieves).

#### 5.2.1 WPD Standard Items

The following tape clips are commonly used within WPD:

Tape clips for 6 x 50mm bare aluminium tape	[E5 - 51171]
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## 6.0 REQUIREMENTS FOR EARTH RODS AND ASSOCIATED CONNECTORS, COUPLERS, DRIVING HEADS AND DRIVING TIPS

### 6.1 Earth Rods

Earth rods shall comply with the requirements within ENA Technical Specification 43-94.

Earth rods shall be manufactured from copper bonded steel, have a shank diameter of 12.7mm and a nominal length of 1.2m or 1.5m.

Earth rods shall be supplied in three forms:

1. In a plain form - as described above
2. In customised form "A"

A plain earth rod (as described above) with one end of a 1m length of 70mm<sup>2</sup> stranded copper conductor exothermically welded to it. The conductor shall be at an angle of 90° to the rod, be attached 75mm below the top of the rod, and have an unobstructed length of not less than 900mm.

The stranded conductor shall comply with the requirements of Section 2 above, and the exothermic welding shall comply with the requirements of Section 6 below.

3. In customised form "B"

A plain earth rod (as described above) with one end of a 1.7m length of 5mm diameter annealed solid copper conductor exothermically welded to it.

The conductor shall be in line with the rod, be attached 75mm below the top of the rod, and have an unobstructed length of not less than 1600mm. The first 100mm of conductor immediately adjacent to the exothermic weld shall be secured to the rod using a pair of cable ties spaced at 50mm centres, as shown in the photo below.



*Page revised November 2016*

The free end of the conductor shall have a flat end designed to fit a “BNCE-3” Tyco Electronics brass end termination for copper waveform CNE conductors as shown in the photo below. The dimensions of the flat portion are 9mm wide x 35mm long.



The exothermic welding shall comply with the requirements of Section 6 below.

Guidance

*The preferred approach is to use the conductor that is supplied as part of Tyco Electronics’ Earth Electrode Kit - part number BAH-035030029.*

6.1.1 WPD Standard Items

The following earth rod couplers are commonly used within WPD:

Plain non-extensible copper bonded earth rod 12.7mm x 1.2m	[E5 - 61379]
Plain extensible copper bonded earth rod 12.7mm x 1.2m	[E5 - 61380]
Non-extensible copper bonded earth rod 12.7mm x 1.2m with 70mm <sup>2</sup> stranded copper conductor tail	[E5 - 60808]
Non-extensible copper bonded earth rod 12.7mm x 1.2m with 5mm Ø solid copper conductor tail	[E5 - 60780]

**6.2 Earth Rod Couplers**

Earth rod couplers shall comply with the requirements within ENA Technical Specification 43-94.

Couplers shall be compatible with copper bonded earth rods such that there can be no deleterious effect on the earth rod or the coupler resulting from their association.

**Page revised November 2016**

### 6.2.1 WPD Standard Items

The following earth rod couplers are commonly used within WPD:

Earth rod coupler for 12.7mm Ø copper bonded earth rod	[E5 - 61381]
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## 6.3 Earth Rod Driving Heads

Earth rod driving heads shall comply with the requirements within ENA Technical Specification 43-94.

### 6.3.1 WPD Standard Items

The following earth rod driving heads are commonly used within WPD:

Earth rod driving head for 12.7mm Ø copper bonded earth rod	[E5 - 61382]
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## 6.4 Earth Rod Driving Tips

Earth rod driving tips shall comply with the requirements within ENA Technical Specification 43-94.

### 6.4.1 WPD Standard Items

The following earth rod driving tips are commonly used within WPD:

Earth rod driving tips for 12.7mm Ø copper bonded earth rod	[E5 - 61383]
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## 7.0 REQUIREMENTS FOR EXOTHERMIC WELDING PRODUCTS

### 7.1 Welding Material

Exothermic welding material shall be suitable for joining copper to copper and copper to copper clad steel.

The welding material shall be suitable for electronic ignition using a battery powered controller and control cable.

The welding material shall be supplied in a sealed package comprising the weld powder, starting powder and ignition strip.

#### 7.1.1 WPD Approved Products

The following products are approved for use on the WPD distribution network.

"CADWELD Plus"	Manufacturer = ERICO
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#### 7.1.2 WPD Standard Items

The following CADWELD Plus welding material is regularly used within WPD:

32PLUSF20	(White colour identification)	[E5 - 61384]
45PLUSF20	(Light Blue colour identification)	[E5 - 61385]
65PLUSF20	(Dark Green colour identification)	[E5 - 61472]
90PLUSF20	(Grey colour identification)	[E5 - 61386]
115PLUSF20	(Orange colour identification)	[E5 - 61387]
150PLUSF20	(Dark Blue colour identification)	[E5 - 61388]
200PLUSF20	(Yellow colour identification)	[E5 - 61389]
250PLUSF20	(Purple colour identification)	[E5 - 61390]

### 7.2 Moulds

Moulds shall be manufactured from graphite and be suitable for re-use up to fifty times.

#### 7.2.1 WPD Approved Products

The following products are approved for use on the WPD distribution network.

"CADWELD Moulds"	Manufacturer = ERICO
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## 7.2.2 PD Standard Items

The following CADWELD moulds are regularly used within WPD:

<b>Stranded Copper Conductor to Stranded Copper Conductor</b>		
SSCY2	Straight Joint - 35mm <sup>2</sup> Conductors	[E5 - 61391]
SSCY4	Straight Joint - 70mm <sup>2</sup> Conductors	[E5 - 61392]
SSCY6	Straight Joint - 120mm <sup>2</sup> Conductors	[E5 - 61393]
TACY2Y2	Equal T - 35mm <sup>2</sup> Conductors	[E5 - 61394]
TACY4Y4	Equal T - 70mm <sup>2</sup> Conductors	[E5 - 61395]
TACY6Y6	Equal T - 120mm <sup>2</sup> Conductors	[E5 - 61396]
XACY2Y2	Equal X - 35mm <sup>2</sup> Conductors	[E5 - 61397]
XACY4Y4	Equal X - 70mm <sup>2</sup> Conductors	[E5 - 61398]
XACY6Y6	Equal X - 120mm <sup>2</sup> Conductors	[E5 - 61399]
<b>Copper Tape to Copper Tape</b>		
BBCCAJ	Straight Joint on Flat - 3 x 25mm Strip / Tape	[E5 - 61400]
BBREAM	Straight Joint on Flat - 4 x 50mm Strip / Tape	[E5 - 61401]
BBDPAMPAM	Straight Joint on Flat - 6 x 50mm Strip / Tape	[E5 - 61402]
BMCCAJCAJ	Equal T on Flat - 3 x 25mm Strip / Tape	[E5 - 61403]
BMDEAMEAM	Equal T on Flat - 4 x 50mm Strip / Tape	[E5 - 61404]
BMDPAMPAM	Equal T on Flat - 6 x 50mm Strip / Tape	[E5 - 61405]
EBCCAJCAJ	Equal X on Flat - 3 x 25mm Strip / Tape	[E5 - 61406]
EBCEALEAL	Equal X on Flat - 4 x 50mm Strip / Tape	[E5 - 61407]
EBCPALPAL	Equal X on Flat - 6 x 50mm Strip / Tape	[E5 - 61408]
<b>Stranded Copper Conductor to Copper Tape</b>		
LJCCAJY4	70mm <sup>2</sup> Conductors to 3 x 25mm Strip / Tape	[E5 - 61409]
LJCEALY4	70mm <sup>2</sup> Conductors to 4 x 50mm Strip / Tape	[E5 - 61410]
LJCPALY4	70mm <sup>2</sup> Conductors to 6 x 50mm Strip / Tape	[E5 - 61411]
<b>Stranded Copper Conductor to side of Earth Rod</b>		
GYR14Y2	12.7mm Earth Rod to 35mm <sup>2</sup> Conductors	[E5 - 61412]
GYR14Y4	12.7mm Earth Rod to 70mm <sup>2</sup> Conductors	[E5 - 61413]
GYR14Y6	12.7mm Earth Rod to 120mm <sup>2</sup> Conductors	[E5 - 61414]
<b>Solid Copper Conductor to side of Earth Rod</b>		
GYR14W3	12.7mm Earth Rod to Ø5mm Conductor	[E5 - 61415]

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<b>Copper Tape to side of Earth Rod</b>		
LQE14CAJ	12.7mm Earth Rod to 3 x 25mm Strip / Tape	[E5 - 61416]
LQE14EAM	12.7mm Earth Rod to 4 x 50mm Strip / Tape	[E5 - 61417]
LQE14PAM	12.7mm Earth Rod to 6 x 50mm Strip / Tape	[E5 - 61418]

### 7.3 Mould Clamps

Mould clamps shall be suitable for use with the moulds.

#### 7.3.1 WPD Approved Products

The following products are approved for use on the WPD distribution network.

“CADWELD Handle Clamps”	Manufacturer = ERICO
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#### 7.3.2 WPD Standard Items

The following CADWELD Handle Clamps are regularly used within WPD:

L159	For Use with 76mm wide moulds (**C-*** or **E-***)	[E5 - 61419]
L160	For Use with 102mm wide moulds (**D-***)	[E5 - 61420]

### 7.4 Battery Powered Controller

Battery powered controllers shall be compatible with the ignition strip employed on the welding material. It shall include a control cable not less than 3m long such that the weld can be started from a remote position.

#### 7.4.1 WPD Approved Products

The following products are approved for use on the WPD distribution network.

“CADWELD Plus Control Unit”	Manufacturer = ERICO
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#### 7.4.2 WPD Standard Items

The following CADWELD Plus Control Units are regularly used within WPD:

PLUSCU15L	CADWELD Plus Control Unit with 4.6m control cable	[E5 - 42528]
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## 7.5 Accessories

A tool kit containing the hand tools and personal protective equipment needed for executing exothermic welds shall be provided. The kit shall be contained within a metal toolbox which shall be oversized such that it can also accommodate the battery powered controller plus control lead, a mould clamp, and a number of moulds and weld material.

### Personal Protective Equipment

Safety glasses

Safety gloves

### Hand Tools

Mould cleaning brush

Slag removal spade

Cable cleaning brush

Card cleaning brush

Ceramic blanket

Mould sealer

Cable clamp

### 7.5.1 WPD Approved Products

The following accessories are approved for executing exothermic welds on the WPD distribution network.

"CADWELD Tool Kits"	Manufacturer = ERICO
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### 7.5.2 WPD Standard Items

The following CADWELD Tool Kits are regularly used within WPD:

T396	Metal Tool Box 480mm x220mm x 220mm	[E5 - 42530]
T394	Mould Cleaning Brush	[E5 - 61422]
B136B	Slag Removal Spade	[E5 - 61423]
T314	Cable Cleaning Brush	[E5 - 61424]
T313	Card Cleaning Brush	[E5 - 61425]
T306	Ceramic blanket	[E5 - 61426]
T403	Mould Sealer	[E5 - 61427]
B265	Cable Clamp	[E5 - 61428]

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## 8.0 REQUIREMENTS FOR TRANSITION WASHERS

Transition washers shall be surface penetrating, grease protected washers manufactured from corrosion resistant copper alloy to BS2874 (grade CZ121) and designed to provide a stable corrosion resistant interface between aluminium and copper or tinned copper.

### 8.1.1 WPD Approved Products

The following transition washers are approved for use on the WPD distribution network.

Alcomet Transition Washers	Manufacturer = Alcomet
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### 8.1.2 WPD Standard Items

The following transition washers are regularly used within WPD:

TW1/3	M10 Transition Washer	[E5 - 61429]
TW1/4	M12 Transition Washer	[E5 - 61430]

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## 9.0 REQUIREMENTS FOR BRAZED JOINTS

### 9.1 Brazing Rods

Silver-Copper-Phosphorous (i.e. self-fluxing) brazing filler metal rods suitable for brazing copper to copper joints. The rods shall comply with BS EN ISO 17672 (2010): Brazing - Filler Metals and shall have a melting point above 640°C.

#### 9.1.1 WPD Approved Products

The following brazing rods are approved for use on the WPD distribution network.

Sil-Fos	Manufacturer = Johnson Matthey Metal Jointing
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#### 9.1.2 WPD Standard Items

The following Sil-fos products are regularly used within WPD:

Brazing Rods	[E5 - 61431]
Foil	[E5 - 61432]

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## 10.0 REQUIREMENTS FOR REBAR BONDING SYSTEMS

### 10.1 Rebar Bonding System

Rebar is to be bonded to the substation earthing system in order to control touch voltages. It shall be bonded at a single point and, as a consequence, is not reasonably likely to carry fault current.

Rebar shall be connected to the substation earthing system via insulated stranded copper cable of 70mm<sup>2</sup> cross sectional area.

One end of the cable shall be attached to the rebar via a “U” bolt clamp manufactured from high strength copper alloy and designed to provide a high quality low resistance connection between the cable and the rebar.

The other end of the cable shall be welded to an earth point which is to be cast onto the surface of the concrete foundation. The earth point shall be suitable for connecting to the earthing system via 3mm x 25mm copper tape / strip or 70mm<sup>2</sup> stranded copper cable. The earth point shall be designed to provide a high quality low resistance connection between the insulated stranded cable and the earthing system.

#### 10.1.1 WPD Standard Items

The following rebar earthing gear is regularly used within WPD:

FURSE PC115FU	Two hole earth point complete with pre-welded 500mm long tail of 70mm <sup>2</sup> insulated stranded copper cable plus front plate suitable for connection of 3mm x 25mm tape / strip or 70mm <sup>2</sup> stranded copper cable.	[E5 - 61263]
FURSE CR700	Rod to cable clamp (type GUV) suitable for rebar up to 16mm diameter and cable up to 95mm <sup>2</sup> . For use in conjunction with PC115FU.	[E5 - 61264]

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## 11.0 REQUIREMENTS FOR FLEXIBLE BRAIDS (EARTHING STRAPS)

### 11.1 Flexible Tinned Copper Braids

Flexible tinned copper braids shall have a flat design and be complete with a tinned copper pressed ferrule (palm) termination on each end, which is pre-drilled / punched with an M10 clear hole. The copper wire shall have a diameter not less than 0.15mm.

The braids shall have a working temperature up to 105°C and have a good resistance to vibration and fatigue.

The copper shall comply with the requirements of BS EN 13602 (2002): Copper & Copper Alloys - Drawn, Round Copper Wire for the Manufacture of Electrical Conductors. The braids and pressed ferrules shall be manufactured from annealed copper to the following equivalent international designations:

- BS 1E (UK)
- C10100 (UNS - Unified Numbering System)
- CW 004A (European 'CEN')
- Cu-ETP (ISO)

#### 11.1.1 WPD Standard Items

The following flexible tinned copper braids are regularly used within WPD:

35mm <sup>2</sup> cross section, 500mm minimum length	[E5 - 61265]
50mm <sup>2</sup> cross section, 500mm minimum length	[E5 - 61266]
70mm <sup>2</sup> cross section, 500mm minimum length	[E5 - 61267]

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## 12.0 REQUIREMENTS FOR INSULATED FENCE PANEL SYSTEMS

The WPD preferred approach is to use conventional galvanised steel palisade fence panels mounted on insulated bushings rather than utilise non-conducting fence panels.

### 12.1 Fence Insulators

Fence insulators shall have a rated voltage of 500V, a one minute power frequency withstand voltage of 3.6kV (rms), and a 1.2/50µs impulse withstand voltage of 65kV (peak).

The insulator shall have a nominal height of 60mm and a nominal creepage of 100mm.

The insulator shall be able to withstand a cantilever force of 2kN and a tensile force of 1.2kN.

#### 12.1.1 WPD Approved Products

The following fence insulators are approved for use on the WPD distribution network.

Isoelectric epoxy resin post insulators	Supplier = Mosdorfer Ltd
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#### 12.1.2 WPD Standard Items

The following "Isoelectric" post insulators are regularly used within WPD:

R951018	500V/3600V epoxy resin post insulator	[E5 - 61279]
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## 13.0 REQUIREMENTS FOR EQUAL POTENTIAL GRATINGS

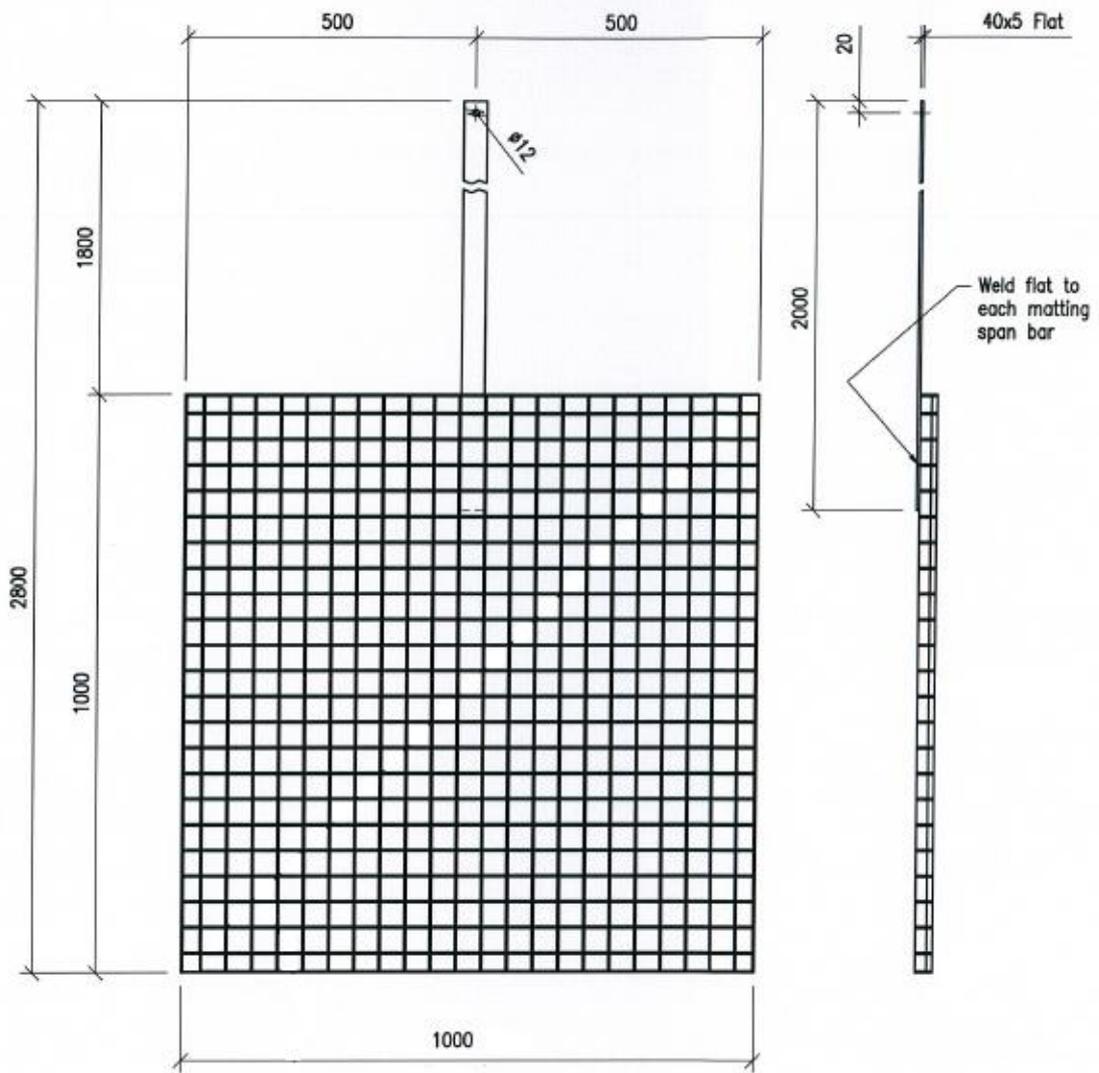
### 13.1 Gratings

Equal potential gratings shall have the following specifications:

- Manufactured from steel which has been hot dipped galvanised in accordance with BS EN ISO 1461 (2009)
- Overall dimensions 1000mm x 1000mm x 30mm
- Pressure welded mesh comprising of 30mm x 3mm load bars at 44mm centres and 10mm x 2mm serrated transverse bars at 44mm centres
- Edged on all four sides with 30mm x 3mm flat bar
- Each edge bar to have five slotted bolt holes 11mm diameter x 28mm long

The grating shall be supplied in two forms:

- a) In a standard form for use within substations - as described above
- b) In a modified form for use with pole mounted switchgear - as described above but with a 40mm x 5mm x 2000mm steel strip welded perpendicular to the centre of one of the sides with a 200mm overlap / 1800mm projection. The steel strip shall have a 12mm diameter hole drilled 20mm from the end remote from the grating. The hot dipped galvanised finish shall be applied after the steel strip has been welded in place. See diagram below for further details.



### 13.1.1 WPD Standard Items

The following equal potential gratings are regularly used within WPD:

Plain 1m x 1m grating	[E5 - 50547]
1m x 1m grating with 40mm x 5mm x 2000mm tail	[E5 - 42035]

## 13.2 Sundry Items

The following sundry items are required:

- Epoxy resin concrete fixing system
- Post hole concrete mix
- Grating fixing spike
- Grating hook bolt
- Switch contact grease
- Stainless steel bolt M10 x 25mm (pack of 100)
- Stainless steel nut M10
- Stainless steel washer M10
- Stainless steel spring washer M10

### 13.2.1 WPD Standard Items

The following sundry items are regularly used within WPD:

Epoxy resin concrete fixing system	[E5 - ****]
Post hole concrete mix	[E5 - ****]
Grating fixing spike	[E5 - 50548]
Grating hook bolt	[E5 - 51212]
Switch contact grease	[E5 - 33619]
Stainless steel bolt M10 x 25mm (pack of 100)	[E5 - 51911]
Stainless steel nut M10	[E5 - 51912]
Stainless steel washer M10	[E5 - 51913]
Stainless steel spring washer M10	[E5 - 51914]

## 14.0 REQUIREMENTS FOR THEFT PREVENTION MEASURES

Earthing conductor theft can be discouraged by suitable measures which impede the pulling of earth conductors off structures or out of the ground.

Below ground theft prevention measures include laying paving slabs over the earth conductors at periodic intervals, or encasing the earth conductor in conductive concrete.

Above ground theft prevention measures include:

- Security fixing copper and aluminium tape to brick or concrete structures
- Security capping copper and aluminium tape on brick or concrete structures
- Camouflage painting earthing conductors
- Use of forensic traceable liquids

### 14.1 Paving Slabs

Paving slabs shall be 600mm x 600mm x 50mm pressed concrete slabs in a natural colour manufactured to BS EN 1339 (2003): Concrete paving flags – Requirements and test methods.

Paving slabs shall be placed centrally over the earth electrode prior to backfilling, commencing 3m away from any earth rod attached to the earthing conductor and spaced at 3m intervals thereafter.

### 14.2 Conductive Concrete

Conductive concrete shall comply with BS EN 62561-7 (2012): Lightning protection system components – Requirements for earth enhancing compounds.

#### 14.2.1 WPD Approved Products

The following conductive concrete is approved for use on the WPD distribution network.

“Marconite”	Manufacturer = James Durrans & Sons Ltd	[E5 - 61280]
“Conducrete”	Manufacturer = SAE Inc / FM Sudafix Ltd	[E5 - *****]

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### 14.3 Security Capping

A stainless or galvanised steel capping system used in conjunction with security pins to cover and guard earth tape as an anti-theft measure. The system shall include straight lengths of capping, bespoke covers for earth tape joints (tees, right angles, crosses and straight) and square tinned copper washers for making an earth connection between the tape and the capping. The capping shall have a low profile in order to avoid being a tripping hazard.

#### 14.3.1 WPD Approved Products

The following security capping systems are approved for use on the WPD distribution network.

"Guardian" Cover Guard	Supplier = Alcomet Ltd
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#### 14.3.2 WPD Standard Items

The following "Guardian" capping products are regularly used within WPD:

GSG50C	Capping wide – 1.1m length (for earth tapes up to 50mm)	[E5 - 61269]
GJC50S	Cover for straight joints (for earth tape up to 50mm wide)	[E5 - 61270]
GJC50A	Cover for right angle joints (for earth tape up to 50mm wide)	[E5 - 61271]
GJC50T	Cover for tee (T) joints (for earth tape up to 50mm wide)	[E5 - 61272]
GJC50C	Cover for cross (X) joints (for earth tape up to 50mm wide)	[E5 - 61273]
GCW50	Tinned copper washer (for earth tape up to 50mm wide)	[E5 - 61274]

### 14.4 Security Fixings

#### 14.4.1 Security Pin

A wedge anchor type security pin manufactured from corrosion resistant stainless steel used for mechanically securing earth tape and security capping to concrete or brick structures. The pin shall:

- Have a diameter of 6mm
- Have a length within the range 40-45mm
- Have a low expansion force making it suitable for use close to the edge of the brick or concrete structure (say 50mm from the edge)

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- Be able to withstand aggressive attack e.g. the head shall be able to withstand being chiselled or ground off
- Be sold in handy sized packs (say around 25 to 50 pins in each)

An alternative security pin with a length within the range 70-75mm is also required for use on decayed concrete surfaces.

#### 14.4.2 Security Bolt

A wedge anchor type security bolt manufactured from corrosion resistant stainless steel used for securing bespoke covers for earth tape joints (see 1.4.3 above) to concrete or brick structures. The bolt shall be supplied complete with a security nut, which shall be removable using a purpose made tool. This will allow the bespoke covers for earth tape joints to be removed in order to facilitate testing of the joint, whilst also providing a high security fixing. The removable bolt shall:

- Have a diameter of 6mm
- Have a length within the range 40-45mm\*
- Have a low expansion force making it suitable for use close to the edge of the brick or concrete structure (say 50mm from the edge)
- Have a uniquely shaped security nut removable only through the use of a compatible tool
- Be sold in handy sized packs (say around 25 to 50 bolts in each).

#### 14.4.3 WPD Approved Products

The following security pins are approved for use on the WPD distribution network.

"Guardian" Security Pins	Supplier = Alcomet Ltd
"Guardian" Security Nuts & Bolts	Supplier = Alcomet Ltd
"Safemet" Security Pins	Supplier = Earthmet Ltd

#### 14.4.4 WPD Standard Items

The following security pins are regularly used within WPD:

GSP01C	Guardian Security Pin – Standard length	[E5 - 42620]
GSP03C	Guardian Security Pin – Extra Long	[E5 - 42621]
SAPIN01	Safemet A4 Security Pin	[E5 - *****]

The following security bolts are regularly used within WPD:

GSP02C	Guardian Security Bolt With Removable Nut	[E5 - 61275]
GRN06	Guardian Removable Security Nut	[E5 - 61276]
GDS06	Guardian Socket for Removable Security Nut	[E5 - 61277]

#### 14.5 Camouflage Paint

A brush applied, quality, self-priming, micaceous iron oxide coating in matt grey colour which is used to disguise copper earth tape as painted steel. The paint shall have excellent adhesion to copper and aluminium, be able to be applied in low temperatures, and be resistant to UV ageing.

##### 14.5.1 WPD Approved Products

The following forensic traceable liquids are approved for use on the WPD distribution network.

Silver Grey Paint	Manufacturer = Various	[E5 - 51165]
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#### 14.6 Security Marking Products

Security marking products shall be proprietary forensic taggants or asset marking systems that can be applied to earthing conductors in order to deter theft and potentially to identify culprits for prosecution.

The taggant or marking system shall be applied in liquid form and be non-hazardous, long lasting, and contain a unique identifier that is invisible to the naked eye. The identifier shall be a “code” that is registered to an address or location or company. The product shall be supplied along with deterrent stickers and signage.

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#### 14.6.1 WPD Approved Products

Security marking systems shall not be employed on the WPD distribution network without the sanction of the Company Security Manager.

The following forensic traceable liquids are approved for use on the WPD distribution network.

"Smartwater" Forensic Taggant #	Manufacturer = Smartwater Technology Ltd	[E5 - *****]
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# Smartwater is currently approved / licenced for use in the WPD East Midlands & WPD West Midlands areas only.

## 15.0 REQUIREMENTS FOR GROUND AMENDING MATERIAL

Ground amending material shall be employed around buried earth electrode where the native soil is particularly hostile to copper or where there are difficulties achieving good contact between the electrode and earth (for example, gravelly soils or where the electrode is installed in an augered hole).

### 15.1 Imported Soil

Imported soil shall be a cohesive sub-soil which is pH neutral and is free of organic matter and contaminants such as asbestos, oil and other harmful, toxic, carcinogenic or corrosive substances. Imported soil shall be supplied in product size 0/10 (i.e. 10mm to dust) and grading classification G<sub>c</sub> 85/5.

Imported soil shall enclose the earth electrode to a compacted depth of not less than 250mm.

### 15.2 Ground Enhancing Material

Ground enhancing material shall comply with BS EN 62561-7 (2012): Lightning protection system components – Requirements for earth enhancing compounds.

The material shall enclose the earth electrode in order to increase its effective radius, thereby reducing the overall earth electrode resistance.

#### 15.2.1 WPD Approved Products

The following ground enhancing materials are approved for use on the WPD distribution network.

“Bentonite”	Manufacturer = Various e.g. A N Wallis Ltd	[E5 - *****]
“Marconite”	Manufacturer = James Durrans & Sons Ltd	[E5 - 61280]
“Conducrete”	Manufacturer = SAE Inc / FM Sudafix Ltd	[E5 - *****]

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## **16.0 REQUIREMENTS FOR GROUND SURFACE COVERINGS**

The open surface areas of substations shall be covered with high resistivity material. The requirements have been included within this Engineering Equipment Specification because the ground surface covering is an integral part of the substation earth system.

### **16.1 Limestone Aggregate**

Limestone aggregate shall be to BS EN 13043. It shall be supplied as a coarse natural aggregate in product size 14/20 (i.e. 20mm single-sized) and grading classification  $G_c$  85/20. It shall be free from recycled material and other deleterious matter (e.g. metallic compositions, organic material, contaminants).

Limestone aggregate shall be laid on top of a granular sub base to a depth of 150mm when laid direct or 75mm where laid on top of a geotextile membrane.

### **16.2 Granite Aggregate**

Granite aggregate shall be to BS EN 13043. It shall be supplied as a coarse natural aggregate in product size 14/20 (i.e. 20mm single-sized) and grading classification  $G_c$  85/20. It shall be free from recycled material and other deleterious matter (e.g. metallic compositions, organic material, contaminants).

Granite aggregate shall be laid on top of a granular sub base to a depth of 150mm when laid direct or 75mm where laid on top of a geotextile membrane.

### **16.3 Asphalt Concrete (Bitumen Macadam)**

Asphalt concrete shall be to BS EN 13108-1 (2006): Bituminous Mixtures - Material Specifications – Asphalt Concrete.

Asphalt concrete shall be transported, laid, compacted in accordance with BS EN 594987 (2010): Asphalt for roads and other paved areas – Specification for transport, laying, compaction and type testing protocols.

Asphalt concrete shall be laid on a granular sub base.

### 16.3.1 Surface Course

The surface course shall be made from AC 6 Dense Surf 160/220 to Table B15 of PD 6691 (2007): Guidance on the use of BS EN 13108. The minimum PSV of coarse aggregate shall be 50.

The surface course shall be laid to a compacted depth of 30mm.

### 16.3.2 Binder Course

The binder course shall be made from AC 20 Dense Bin 160/220 recipe mix to Table B11 of PD 6691 (2007): Guidance on the use of BS EN 13108.

The binder course shall be laid to a compacted depth appropriate for the design load, but shall be a minimum of 60mm.

## 16.4 Granular Sub-Base

Granular sub-base shall be a crushed natural aggregate to BS EN 13285 (2010): Unbound Mixtures – Specification. Granular sub-base shall be supplied in product size 0/32 (i.e. 32mm to dust) and grading classification G<sub>c</sub> 75/9.

The granular sub-base shall be laid to a compacted depth of 200mm.

## 16.5 Geotextile Membranes

Geotextile membranes shall prevent the intermixing of granular materials with soil. They shall have a non-woven design which is engineered to provide high tensile strength and high puncture resistance. Geotextile membranes shall have low pore size in order to prevent soil infiltration whilst providing high permeability to water. It shall be UV stabilised to prevent degradation from sunlight, be resistant to soil acids and alkalis, and be impervious to fungi or rot.

Geotextile membrane shall be supplied in rolls 4.5m wide and 100m long.

## 17.0 REQUIREMENTS FOR DIELECTRIC PROTECTIVE COATING SYSTEMS

Dielectric protective coating systems are required to improve the touch potential on earthed metalwork. The coating system shall:

- Have a withstand voltage in excess of 40kV/mm
- Be paintable by spray, brush, or roller application and be air drying
- Be suitable for indoor and outdoor use
- Adhere well to metal surfaces
- Be UV resilient to prevent degradation from sunlight
- Be resistant to abrasion and impact
- Be resistant to moisture, oils, paints and other chemicals

### 17.1.1 WPD Approved Products

The following dielectric protective coating systems are approved for use on the WPD distribution network.

"Voltsafe"	Manufacturer = CCS Network Ltd	[E5 - *****]
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## 18.0 REQUIREMENTS FOR SUNDRY ITEMS

The following sundry items may be required:

### 18.1 Cold Galvanising Spray Paint

Cold galvanising spray paint is required to repair the surface of galvanised components that have been damaged due to welding, drilling, cutting or other mechanical operations.

Cold galvanising spray paint shall:

- Be fast drying
- Be suitable for indoor and outdoor use
- Adhere well to metal surfaces
- Contain at least 90% zinc in the dry film
- Be durable

The paint shall comply with BS EN ISO 12944-5: Paint and varnishes: Corrosion protection of steel structures by protective paint systems: Protective paint systems.

#### 18.1.1 WPD Approved Products

The following cold galvanising spray paints are approved for use on the WPD distribution network.

"Cold Galvanising Spray"	Manufacturer = Rocol	[E5 - 33578]
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### 18.2 Cable Guards For Wood Pole Lines

Cable guards are required in order to protect earth cables attached to wood pole overhead lines.

Cable guards shall:

- Be manufactured from PVC
- Be UV stabilised to prevent degradation from sunlight
- Be non-brittle to protect against cold weather
- Have a diameter of 25mm
- Be supplied in 3000mm lengths
- Have fixing holes pre-drilled

### 18.2.1 WPD Approved Products

The following cable guards are approved for use on the WPD distribution network.

"Cable Guard - 1in x 10ft"	Manufacturer = Polypipe Civils	[E5 - 30408]
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### 18.3 Insulation Repair Tape

Insulation repair tape is required in order to repair the PVC or PVC/PVC covering on insulated stranded copper conductors where it has been removed for earth testing purposes.

Insulation repair tape shall:

- Have two layers, with the inner one having good adhesion and sealing properties, and the outer one having good mechanical and electrical properties
- Have a withstand voltage in excess of 40kV/mm
- Be cold applied
- Be UV stabilised to prevent degradation from sunlight
- Be resistant to abrasion and impact
- Be resistant to moisture, oils, paints and other chemicals

### 18.3.1 WPD Approved Products

The following insulation repair tapes are approved for use on the WPD distribution network.

"Rulle 2 Sheath Repair Tape"	Manufacturer = ABB Kabeldon	[E5 - 40232]
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### 18.4 Copper-Based Anti-Seize Paste

Copper-based anti-seize paste is required in order to prevent corrosion when fixing bare copper tape direct to galvanised steel support structures. Anti-seize pastes establish a barrier between mating surfaces.

Copper-based anti-seize paste shall:

- Be composed of a non-melting thickener and a copper solid lubricant
- Have excellent high temperature performance
- Strongly adhere to all metals
- Have excellent separating properties and be resistant to abrasion
- Be insoluble in water

#### 18.4.1 WPD Approved Products

The following copper-based anti-seize pastes are approved for use on the WPD distribution network.

"Anti-Seize Compound"	Manufacturer = Rocol	[E5 - 61278]
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## **APPENDIX A**

### **SUPERSEDED DOCUMENTATION**

None.

## **APPENDIX B**

### **ANCILLARY DOCUMENTATION**

EE SPEC 89 Fixed Earthing Systems for Major Substations

ST: TP21B Design and Installation of Fixed Earthing Systems - Major Substations

ST: TP21C Equal Potential Gratings for Structure Mounted Switchgear at Primary Network Substations

ST: TP21D 11kV, 6.6kV and LV Earthing

ST: TP21L Fixed Earthing Systems - Construction Techniques – Jointing

## **APPENDIX C**

### **KEYWORDS**

Earthing; Tape; Strip; Rods, Joints; Gratings; Fence; Insulator.