WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 132/1

Earthing Materials and 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.

Author: **Graham Brewster**

Implementation Date: **March 2021**

Approved by

Carl Ketley-Lowe

Engineering Policy Manager

Date: **22nd March 2021**

Target Staff Group	**Network Services Teams & ICPs**
Impact of Change	**Green – The change has no immediate impact on working practices or has been aligned to current working practices – Communication via a monthly update of changed policy. Team Manager discretion on how the changes are communicated to the team.**
Planned Assurance Checks	**None**

IMPLEMENTATION PLAN

Introduction

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

Main Changes

This is an existing document which has been reviewed prior to re-tendering. Some new sections have been included to reflect products being used by the business for which no specification existed. Some existing sections have been re-written to make non-brand specific.

Impact of Changes

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

Implementation Actions

All relevant staff shall be briefed on the requirements of this document by their Manager.

The document shall be uploaded onto the WPD Technical Information website (www.westernpowertechinfo.co.uk).

There are no retrospective actions associated with this Engineering Equipment Specification.

Where any difficulty is encountered in the application of this Engineering Equipment Specification, the company's Engineering Policy team should be notified, who will consider whether an application specific concession or an amendment to this document is appropriate.

Implementation Timetable

This Engineering Equipment Specification shall be implemented following being briefed and no later than 30th April 2021.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
Mar 2021	Issue of EE132/1 • Document reviewed prior to re-tendering • New Section 2 (General Requirements) added • New Section 7 (Substation Earth Bars) added • New Section 8 (Deep Earthing Systems) added • Former Section 9 (Brazed Joints) moved into Section 20 (Sundry Items) • Section 10 (Exothermic Welding) re-written to make non-brand specific – no change of overall requirements. Apliweld included as an approved product. • Section 12 (Rebar Earth Bonds/Clamps) renamed and rewritten – no change of requirements • Sections 16.2 & 16.3 re-written to make non-brand specific – no change of overall requirements. • Copper crimps & lugs added to Section 20 (Sundry Items)	Graham Brewster
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 GENERAL REQUIREMENTS

The following general requirements apply where earthing materials are supplied under a contract with WPD.

2.1 WPD Product Approval

2.1.1 WPD Approved Products

Some sections of this specification make reference to "WPD Approved Products". These are items which have either completed a formal product approval process or are tried and tested by virtue of have been satisfactorily deployed on the distribution network for an extended period of time.

Where any product offered by the supplier is not a WPD approved product then the supplier shall complete the 'WPD Product Approval Process' described in section 2.1.3 below prior to that product being deployed on the distribution network.

This prerequisite, and other requirements contained in this specification, are not intended to restrict or inhibit the introduction of new product but simply to ensure that there is a suitable investigation or exercise of care that a reasonable business would normally be expected to take before entering into a contract, and that work equipment is so constructed as to be suitable for the purpose for which it is to be used.

2.1.2 WPD Approved Product Is Not To Be Changed

No change in the product, packaging or labelling shall be made after approval has been granted without prior notice and without receipt of agreement from WPD, in writing, to the proposed change.

2.1.3 WPD Product Approval Process

The cost of WPD Product Approval shall be borne by the supplier and included in the tender costs.

The supplier shall, at the time of tender, provide the following information:

a) Drawings (where appropriate)

b) Technical Datasheets

c) Control of Substances Hazardous to Health (COSHH) Datasheets (where applicable) such as to guide WPD in the safe use, storage and disposal of the product

d) A written declaration of conformance or otherwise with relevant parts of this Engineering Equipment Specification

e) Details of where product is manufactured

f) Details of packaging and labelling

g) Details of how gross weight is to be marked packages with a gross weight over 1 kg, as will enable WPD to comply with the Health and Safety Manual handling Operation Regulations 1992

h) Details of product packaging disposal, as will enable WPD to comply with the requirements of BS EN 14001: 1996 – Environmental Management Systems

i) Details of any warranty, and what this covers

2.2 **Packaging and Labelling**

Packaging shall be non-returnable, easily disposable and where practicable bio-degradable and/or recyclable.

The packaging method must be robust, resistant to impact damage during transit and from handling equipment, and be suitable for the applied weight and load.

All timber (including wooden boxes, and pallets) if used in the packing shall be new, dry, and properly seasoned. The timber shall be natural wood. The timber and any timber treatment shall not damage the product.

If the pallets are to be stacked on one another during transit and / or storage then the load-bearing points shall be positioned above one another ensuring that the stack is both sturdy and stable and will not crush under self-weight.

Pallets must conform to the following specification:

a) Pallets must be either Euro pallets (measuring 1200mm by 800mm) or four way pallets (measuring 1200mm by 1000mm) that are in good condition and strong enough to bear the weight of the Items being delivered.

b) Components must not overhang the pallet in any direction.

c) Individual pallets must not be more than 1.5m high.

d) Maximum pallet weight must not exceed 450kg.

All labels shall be legible, indelible and must be suitable and durable for the lifetime of the package.

Each package / pallet / box must be labelled with the following details:

a) WPD E5 Code
b) Material Description
c) Manufacturer's name
d) Quantity of product contained within the package / pallet / box
e) Gross weight of package / pallet / box in kg

2.3 Delivery

There are three modes of delivery for earthing materials to WPD:

- Delivery to its central stores
- Delivery to its local depots
- Delivery direct to site

WPD will confirm the requirements for delivery at the time of tendering.

2.4 Quality assurance

The Supplier shall confirm, at the time of tendering, whether or not approval is held in accordance with a Quality Assurance Scheme accredited under ISO 9000. If not, he shall submit a statement of quality assurance procedures employed to control the quality of the product, including the performance of sub-suppliers and sub-contractors.

WPD reserves the right to make, from time to time, such inspections of the Supplier's facilities as it may deem to be reasonably necessary to ensure compliance with this Specification and any Contract of which it forms a part.

The Supplier shall provide free of charge to WPD such samples as, in WPD's opinion, may be reasonably required for inspection and/or retention as quality control samples. WPD will confirm the requirements for samples at the time of tendering.

WPD reserves the right to require the Supplier to undertake such testing, at the Supplier's premises or other agreed location, as WPD may deem to be reasonably necessary to verify compliance with this Specification. These tests may involve subjecting the product to extreme operating conditions, and may include destructive tests.

WPD reserves the right to require the Supplier to repeat, from time to time, such tests as it may deem to be reasonably necessary to demonstrate continued compliance with the Specification.

The Supplier shall submit with his tender, details of how product traceability is assured.

The Supplier shall submit with his tender, a list of the tests and inspections which are to be carried out on the product prior to despatch which shall demonstrate, to the satisfaction of WPD, the absence of damage or decay and fitness for installation and service.

2.5 **Defects**

In the event that WPD notifies the supplier of a defect or other non-conformance with the earthing materials, the supplier shall carry out a diligent investigation and provide WPD with a written report explaining the root cause of the defect or non-conformance and the measures the supplier is going to take to prevent a recurrence.

The supplier shall work with WPD to decide the appropriate course of action in relation to:

- The defective or non-conforming item
- Any similar item stocked in WPD's central or local stores
- Any similar item installed on site

3.0 REQUIREMENTS FOR STRANDED COPPER CONDUCTOR

3.1 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.

3.1.1 WPD Standard Items

The following bare stranded copper conductor is used within WPD:

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

3.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

3.2 Insulated Stranded Copper Conductor

3.2.1 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.

3.2.1.1 WPD Standard Items

The following insulated stranded copper conductor is used within WPD:

35mm^2 cross section (7 x 2.50mm diameter strands)	[E5 - 41389]

3.2.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

3.2.2 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).

3.2.2.1 WPD Standard Items

The following insulated stranded copper conductor is used within WPD:

35mm^2 cross section (7 x 2.50mm diameter strands)	[E5 - 30035]

3.2.2.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

3.2.3 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 grey colour.

3.2.3.1 WPD Standard Items

The following insulated stranded copper conductor is used within WPD:

120mm^2 cross section (19 x 2.80mm diameter strands)	[E5 - 41393]

3.2.3.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

4.0 REQUIREMENTS FOR STRANDED COMPOSITE COPPER & STEEL CONDUCTOR

4.1 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.

4.1.1 WPD Standard Items

The following bare stranded copper conductor is used within WPD:

70mm^2 cross section (7 x 3.66mm diameter strands)	

4.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

5.0 REQUIREMENTS FOR BARE COPPER TAPE SYSTEMS

5.1 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.

5.1.1 WPD Standard Items

The following bare copper tapes are used within WPD:

3mm x 25mm x 25m annealed bare copper tape (25m x 0.67kg/m = 16.75kg)	[E5 - 51154]
4mm x 50mm x 15m 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]

5.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

5.2 **Tape Clips For Copper Tape**

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).

5.2.1 WPD Standard Items

The following tape clips are 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]

5.2.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

6.0 REQUIREMENTS FOR BARE ALUMINIUM TAPE SYSTEMS

6.1 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-Al99.5 (Europe)
- Al99.5 (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.

6.1.1 WPD Standard Items

The following bare aluminium tape is used within WPD:

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

6.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

6.2 Tape Clips For Aluminium Tape

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).

6.2.1 WPD Standard Items

The following tape clips are used within WPD:

Tape clips for 6 x 50mm bare aluminium tape	[E5 - 51171]

6.2.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

7.0 REQUIREMENTS FOR SUBSTATION EARTH BARS

7.1 Substation Earth Bars

Substation earth bars shall meet the requirements of BS EN 13601 (2013): Copper & Copper Alloys - Copper Rod, Bar and Wire for General Electrical Purposes. They shall have an R300 / H085 (i.e. hard) material condition and be manufactured to the following equivalent international designations:

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

Substation earth bars shall have a thickness of 6mm and a width of 50mm. The bar shall have lightly rounded edges and be tinned.

Earth bars shall be supplied mounted on stand-off insulators to the following specification:

- Compliant with BS EN 61439-1
- Insulation voltage 1kV or greater
- Dielectric strength 3.5kV or greater for 1 minute
- Insulator body manufactured from reinforced polyester
- M10 inserts complete with stainless steel studs, washers and locking nuts

Earth bars shall be supplied complete with M10 stainless steel nuts (x2), bolts (x1), washers (x1) and spring washers (x1) for each way.

Where specified, earth bars shall be supplied with a disconnectable link at each end. The disconnectable link shall be to the same specification as the earth bar.

Where specified, earth bars shall be supplied mounted on a metal base which is pre-drilled such that it is suitable for fixing to a masonry wall using screws and rawl plugs.

Substation earth bars shall be supplied in three forms:

1. 6 way earth bar for RMU subframe mounting

   The earth bar shall be in accordance with Figure 1 below, and be supplied without disconnectable links and without a base

2. 8 way earth bar for wall mounting

The earth bar shall be supplied mounted on a metal base and without disconnectable links

3. 10 way earth bar with twin disconnectable links for wall mounting

   The earth bar shall be supplied mounted on a metal base and with a disconnectable link at each end. Note that 10 way means 8 ways on the central section and 1 way on the disconnectable section at each end.

7.1.1 WPD Standard Items

The following substation earth bars are used within WPD:

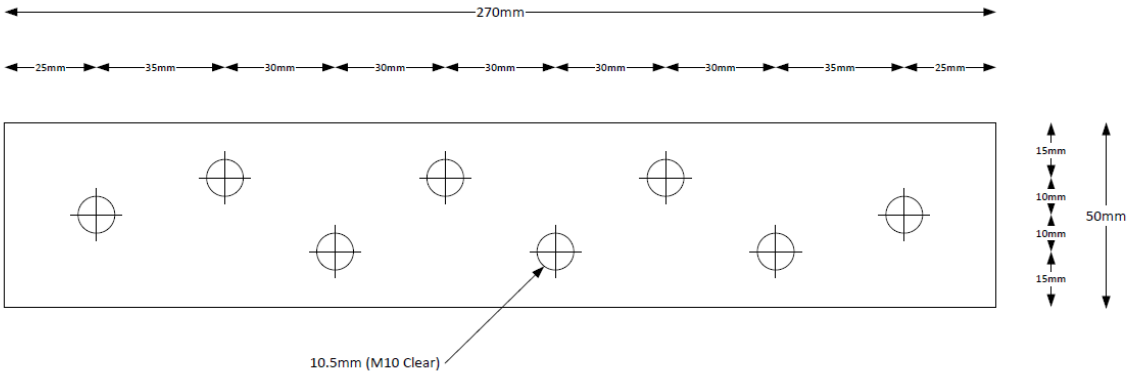
6 way earth bar for RMU subframe mounting	[E5 – XXXXX]
8 way earth bar without disconnectable link for wall mounting	[E5 – XXXXX]
10 way earth bar with twin disconnectable links for wall mounting	[E5 – XXXXX]

7.1.2 WPD Approved Products

The following substation earth bars are approved for use on the WPD distribution network.

EBC006T/SPC to Drawing No. 81 (6 way earth bar for RMU subframe mounting)	Manufacturer = A N Wallis

Figure 1: 6 way earth bar for RMU subframe mounting



8.0 REQUIREMENTS FOR DEEP EARTHING SYSTEMS

8.1 Driving Tips

The driving tip shall, in conjunction with the leading rod, incorporate a means of securely attaching a length of stranded copper conductor such that the conductor is pulled down into the soil as the driving tip and leading rod are driven into the soil.

(Note: The stranded conductor will be as per Section 3.1 above).

Driving tips shall be manufactured from hardened steel and be suitable for driving into normal and soft soils.

The driving tip shall incorporate a means of securely coupling it to the leading rod thereby enabling it to be driven into the ground.

8.1.1 WPD Standard Items

The following deep earth driving tips are used within WPD:

Driving tips suitable for 70mm^2 stranded copper conductor	[E5 - 50543]

8.1.2 WPD Approved Products

The following deep earth driving tips are approved for use on the WPD distribution network.

FS11	Manufacturer = Elpress

8.2 Leading Rods

The leading rod shall, in conjunction with the driving tip, incorporate a means of securely attaching a length of stranded copper conductor such that the conductor is pulled down into the soil as the driving tip and leading rod are driven into the soil.

(Note: The stranded conductor will be as per Section 3.1 above).

The leading rods shall be manufactured from steel and be suitable for driving into normal and soft soils.

The tip of the leading rod shall incorporate a means of coupling to the driving tip.

The base of the leading rod shall incorporate a means of coupling to an extension rod or to a driving head.

8.2.1 WPD Standard Items

The following deep earth leading rods are used within WPD:

Leading rods suitable for 70mm^2 stranded copper conductor and normal or soft soils	[E5 - 50542]

8.2.2 WPD Approved Products

The following deep earth leading rods are approved for use on the WPD distribution network.

FS21	Manufacturer = Elpress

8.3 **Extension Rods**

Extension rods shall be manufactured from steel and be suitable for driving into normal and soft soils.

The tip of the extension rod shall incorporate a means of coupling to the leading rod or other extension rod.

The base of the extension rod shall incorporate a means of coupling to another extension rod or to a driving head.

8.3.1 WPD Standard Items

The following deep earth extension rods are used within WPD:

Extension rods suitable for normal or soft soils	[E5 - 50544]

8.3.2 WPD Approved Products

The following deep earth extension rods are approved for use on the WPD distribution network.

FS31	Manufacturer = Elpress

8.4 **Driving Heads**

Driving heads protect the rod end from damage when being driven into the ground. Also known as driving caps, driving sleeves or driving studs.

Driving heads shall be manufactured from steel and incorporate a means of coupling it to a leading rod or extension rod.

8.4.1 WPD Standard Items

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

Driving head suitable for use with sledge hammers	[E5 - 50545]
Driving head suitable for use with Hilti power hammers	[E5 – XXXXX]

8.4.2 WPD Approved Products

The following deep earth driving heads are approved for use on the WPD distribution network.

FS62 (for use with sledge hammers)	Manufacturer = Elpress
FS81C (for use with Hilti power hammers)	Manufacturer = Elpress

9.0 REQUIREMENTS FOR EARTH RODS AND ASSOCIATED COUPLERS, DRIVING HEADS AND DRIVING TIPS

9.1 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.

Earth rods shall be supplied in four forms:

1. In a plain, non-extendable form
2. In a plain, extendable form, suitable for use with the couplers, driving heads and driving tips specified below

3. In customised form “A”

   A plain, non-extendable earth rod with one end of a 1m length of 70mm^2 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 free end of the stranded conductor shall be secured to the rod using a pair of cable ties.

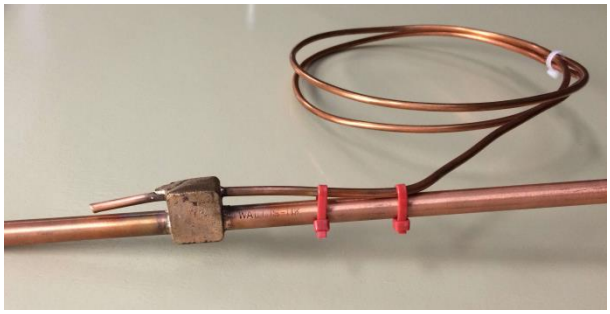
   

   The stranded conductor shall comply with the requirements of Section 3.1 above, and the exothermic welding shall comply with the requirements of Section 10.0 below.

4. In customised form “B”

   A plain, non-extendable earth rod with one end of a 1.7m length of 5mm diameter (20mm^2) annealed solid copper conductor exothermically welded to it.

   The conductor shall be attached 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.



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 10.0 below.

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

9.1.1 WPD Standard Items

The following earth rods are used within WPD:

Non- extendable copper bonded earth rod 12.7mm x 1.2m	[E5 - 61379]
Extendable copper bonded earth rod 12.7mm x 1.2m	[E5 - 61380]
Non-extendable copper bonded earth rod 12.7mm x 1.2m with 70mm^2 stranded copper conductor tail	[E5 - 60808]
Non-extendable copper bonded earth rod 12.7mm x 1.2m with 5mm Ø solid copper conductor tail	[E5 - 60780]

9.1.2 WPD Approved Products

Any manufacturer’s product which conforms to the specification.

9.2 **Earth Rod Driving Tips**

Earth rod driving heads are attached to the tip of the leading earth rod thereby enabling it to be driven into the ground. Also known as driving spikes.

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

9.2.1 WPD Standard Items

The following earth rod driving tips are used within WPD:

Earth rod driving tips for 12.7mm Ø copper bonded earth rod	[E5 - 61383]

9.2.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

9.3 **Earth Rod Couplers**

Earth rod couplers are used for joining extendable earth rods together and ensuring continued electrical and mechanical contact between the rods both during and after installation.

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.

9.3.1 WPD Standard Items

The following earth rod couplers are used within WPD:

Earth rod coupler for 12.7mm Ø copper bonded earth rod	[E5 - 61381]

9.3.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

9.4 **Earth Rod Driving Heads**

Earth rod driving heads protect the internal thread and top of the rod from damage when being driven into the ground. Also known as driving studs.

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

9.4.1 WPD Standard Items

The following earth rod driving heads are used within WPD:

Earth rod driving head for 12.7mm Ø copper bonded earth rod	[E5 - 61382]

9.4.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

10.0 REQUIREMENTS FOR EXOTHERMIC WELDING PRODUCTS

10.1 **Weld Material and Ignition Starter**

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

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

The weld material and ignition starter shall be supplied in the form of either a tablet and separate ignition starter, or a sealed package comprising the weld powder, starting powder and ignition strip.

10.1.1 WPD Standard Items

The standard items are dependent upon the chosen make / brand of exothermic welding system.

10.1.2 WPD Approved Products

The following welding material is approved for use on the WPD distribution network.

CADWELD Plus *(for use with CADWELD product range)*	Manufacturer = ERICO
APLIWELD T Weld Tablets APLIWELD E Starter *(for use with APLIWELD product range)*	Manufacturer = Aplicaciones Tecnolgicas

10.1.3 CADWELD & APLIWELD Standard Items

Details of the weld materials and ignition starters employed for the WPD approved products can be found in Sections 10.6 and 10.7 below.

10.2 **Moulds**

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

10.2.1 WPD Standard Items

The standard items are dependent upon the chosen make / brand of exothermic welding system.

10.2.2 WPD Approved Products

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

CADWELD Moulds *(for use with CADWELD product range)*	Manufacturer = ERICO
APLIWELD Specific Moulds *(for use with APLIWELD product range)*	Manufacturer = Aplicaciones Tecnolgicas

10.2.3 CADWELD & APLIWELD Standard Items

Details of the weld materials and ignition starters employed for the WPD approved products can be found in Sections 10.6 and 10.7 below.

10.3 **Mould Clamps**

Mould clamps shall be suitable for use with the moulds.

10.3.1 WPD Standard Items

The standard items are dependent upon the chosen make / brand of exothermic welding system.

10.3.2 WPD Approved Products

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

CADWELD Mould Clamps *(for use with CADWELD product range)*	Manufacturer = ERICO
APLIWELD Mould Clamps *(for use with APLIWELD product range)*	Manufacturer = Aplicaciones Tecnolgicas

10.3.3 CADWELD & APLIWELD Standard Items

Details of the weld materials and ignition starters employed for the WPD approved products can be found in Sections 10.6 and 10.7 below.

10.4 **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.

10.4.1 WPD Standard Items

The standard items are dependent upon the chosen make / brand of exothermic welding system.

10.4.2 WPD Approved Products

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

CADWELD Plus Control Unit *(for use with CADWELD product range)*	Manufacturer = ERICO
APLIWELD Kit E Electronic Ignition Device *(for use with APLIWELD product range)*	Manufacturer = Aplicaciones Tecnolgicas

10.4.3 CADWELD & APLIWELD Standard Items

Details of the weld materials and ignition starters employed for the WPD approved products can be found in Sections 10.6 and 10.7 below.

10.5 **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.

Hand tools and personal protective equipment should include:

- Safety glasses
- Safety gloves
- Hand Tools
- Mould cleaning brush
- Slag removal spade
- Cable cleaning brush
- Card cleaning brush
- Ceramic blanket
- Mould sealer
- Cable clamp

10.5.1 WPD Standard Items

The standard items are dependent upon the chosen make / brand of exothermic welding system.

10.5.2 WPD Approved Products

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

CADWELD Tool Kits *(for use with CADWELD product range)*	Manufacturer = ERICO
APLIWELD Tool Kits *(for use with APLIWELD product range)*	Manufacturer = Aplicaciones Tecnolgicas

10.5.3 CADWELD & APLIWELD Standard Items

Details of the weld materials and ignition starters employed for the WPD approved products can be found in Sections 10.6 and 10.7 below.

10.6 **CADWELD Reference Data**

The correct CADWELD products for each joint along with quantities required is determined using the reference selection tables below.

Note that for all joints a battery powered controller (PLUSCU15L) and the following accessory tools are also required:

- T396 Metal Tool Box 480mm x220mm x 220mm
- T394 Mould Cleaning Brush
- B136B Slag Removal Spade
- T314 Cable Cleaning Brush
- T313 Card Cleaning Brush
- T306 Ceramic blanket
- T403 Mould Sealer
- B265 Cable Clamp

10.6.1 Joints - Stranded Copper Conductor to Stranded Copper Conductor

Description	**Weld Material & Starter**	**Mould**	**Mould Clamp**
Straight Joint - 35mm^2 Conductors	32PLUSF20 (White)	SSCY2	L159
Straight Joint - 70mm^2 Conductors	65PLUSF20 (Dark Green)	SSCY4	L160
Straight Joint - 120mm^2 Conductors	115PLUSF20 (Orange)	SSCY6	L160
Equal T - 35mm^2 Conductors	45PLUSF20 (Light Blue)	TACY2Y2	L160
Equal T - 70mm^2 Conductors	90PLUSF20 (Grey)	TACY4Y4	L160
Equal T - 120mm^2 Conductors	150PLUSF20 (Dark Blue)	TACY6Y6	L160
Equal X - 35mm^2 Conductors	65PLUSF20 (Dark Green)	XACY2Y2	L160
Equal X - 70mm^2 Conductors	115PLUSF20 (Orange)	XACY4Y4	L160
Equal X - 120mm^2 Conductors	200PLUSF20 (Yellow)	XACY6Y6	L160

10.6.2 Joints - Copper Tape to Copper Tape

Description	Weld Material & Starter	Mould	Mould Clamp
Straight Joint on Flat - 3 x 25mm Strip / Tape	90PLUSF20 (Grey)	BBCCAJ	L160
Straight Joint on Flat - 4 x 50mm Strip / Tape	200PLUSF20 (Yellow)	BBREAM	L160
Straight Joint on Flat - 6 x 50mm Strip / Tape	250PLUSF20 (Purple)	BBDPAMPAM	L159
Equal T on Flat - 3 x 25mm Strip / Tape	90PLUSF20 (Grey)	BMCCAJCAJ	L160
Equal T on Flat - 4 x 50mm Strip / Tape	250PLUSF20 (Purple)	BMDEAMEAM	L159
Equal T on Flat - 6 x 50mm Strip / Tape	250PLUSF20 (Purple)	BMDPAMPAM	L159
Equal X on Flat - 3 x 25mm Strip / Tape	115PLUSF20 (Orange)	EBCCAJCAJ	L160
Equal X on Flat - 4 x 50mm Strip / Tape	150PLUSF20 (Dark Blue)	EBCEALEAL	L160
Equal X on Flat - 6 x 50mm Strip / Tape	250PLUSF20 (Purple)	EBCPALPAL	L160

10.6.3 Joints - Stranded Copper Conductor to Copper Tape

Description	Weld Material & Starter	Mould	Mould Clamp
70mm^2 Conductors to 3 x 25mm Strip / Tape	90PLUSF20 (Grey)	LJCCAJY4	L160
70mm^2 Conductors to 4 x 50mm Strip / Tape	90PLUSF20 (Grey)	LJCEALY4	L160
70mm^2 Conductors to 6 x 50mm Strip / Tape	90PLUSF20 (Grey)	LJCPALY4	L160

10.6.4 Joints - Stranded Copper Conductor to side of Earth Rod

Description	Weld Material & Starter	Mould	Mould Clamp
12.7mm Earth Rod to 35mm^2 Conductors	90PLUSF20 (Grey)	GYR14Y2	L160
12.7mm Earth Rod to 70mm^2 Conductors	115PLUSF20 (Orange)	GYR14Y4	L160
12.7mm Earth Rod to 120mm^2 Conductors	150PLUSF20 (Dark Blue)	GYR14Y6	L160

10.6.5 Joints - Solid Copper Conductor to side of Earth Rod

Description	Weld Material & Starter	Mould	Mould Clamp
12.7mm Earth Rod to Ø5mm Conductor	90PLUSF20 (Grey)	GYR14W3	L160

10.6.6 Joints - Copper Tape to side of Earth Rod

Description	Weld Material & Starter	Mould	Mould Clamp
12.7mm Earth Rod to 3 x 25mm Strip / Tape		LQE14CAJ	L160
12.7mm Earth Rod to 4 x 50mm Strip / Tape		LQE14EAM	L160
12.7mm Earth Rod to 6 x 50mm Strip / Tape		LQE14PAM	L160

10.7 **APLIWELD Reference Data**

The correct APLIWELD products for each joint along with quantities required is determined using the reference selection tables below.

Note that for all joints a battery powered controller (AT-0100N) and an accessory tool kit (AT-069N) is also required.

10.7.1 Joints - Stranded Copper Conductor to Stranded Copper Conductor

Description	**Weld Material**	**Starter**	**Mould**	**Mould Clamp**
Straight Joint - 35mm^2 Conductors	AT-020N (1 tablet)	AT-010N (1 starter)	C35/C35/LV	AT-049N
Straight Joint - 70mm^2 Conductors	AT-020N (1½ tablets)	AT-010N (1 starter)	C70/C70/LV	AT-049N
Straight Joint - 120mm^2 Conductors	AT-020N (2 tablets)	AT-010N (1 starter)	C120/C120/LV	AT-049N
Equal T - 35mm^2 Conductors	AT-020N (1½ tablets)	AT-010N (1 starter)	C35/C35/TH	AT-049N
Equal T - 70mm^2 Conductors	AT-020N (2 tablets)	AT-010N (1 starter)	C70/C70/TH	AT-049N
Equal T - 120mm^2 Conductors	AT-020N (3 tablets)	AT-010N (1 starter)	C120/C120/TH	AT-049N
Equal X - 35mm^2 Conductors	AT-020N (2 tablets)	AT-010N (1 starter)	C35/C35/XH	AT-049N
Equal X - 70mm^2 Conductors	AT-020N (2½ tablets)	AT-010N (1 starter)	C70/C70/XH	AT-049N
Equal X - 120mm^2 Conductors	AT-020N (4 tablets)	AT-010N (1 starter)	C120/C120/XH	AT-049N

10.7.2 Joints - Copper Tape to Copper Tape

Description	Weld Material	Starter	Mould	Mould Clamp
Straight Joint on Flat - 3 x 25mm Tape	AT-020N (1½ tablets)	AT-010N (1 starter)	P253/P253/LV	AT-049N
Straight Joint on Flat - 4 x 50mm Tape	AT-020N (3½ tablets)	AT-010N (1 starter)	P405/P405/LV	AT-049N
Straight Joint on Flat - 6 x 50mm Tape	AT-021N (3 tablets)	AT-010N (1 starter)	P605/P605/LV	AT-050N
Equal T on Flat - 3 x 25mm Tape	AT-020N (1½ tablets)	AT-010N (1 starter)	P253/P253/TH	AT-049N
Equal T on Flat - 4 x 50mm Tape	AT-020N (3½ tablets)	AT-010N (1 starter)	P405/P405/TH	AT-049N
Equal T on Flat - 6 x 50mm Tape	AT-021N (3 tablets)	AT-010N (1 starter)	P605/P605/TH	AT-050N
Equal X on Flat - 3 x 25mm Tape	AT-020N (1½ tablets)	AT-010N (1 starter)	P253/P253/XS	AT-049N
Equal X on Flat - 4 x 50mm Tape	AT-020N (3½ tablets)	AT-010N (1 starter)	P405/P405/XS	AT-049N
Equal X on Flat - 6 x 50mm Tape	AT-021N (3 tablets)	AT-010N (1 starter)	P605/P605/XS	AT-050N

10.7.3 Joints - Stranded Copper Conductor to Copper Tape

Description	Weld Material	Starter	Mould	Mould Clamp
70mm^2 Conductors to 3 x 25mm Strip / Tape	AT-020N (2 tablets)	AT-010N (1 starter)	P253/C70/TH	AT-049N
70mm^2 Conductors to 4 x 50mm Strip / Tape				
70mm^2 Conductors to 6 x 50mm Strip / Tape				

10.7.4 Joints - Stranded Copper Conductor to side of Earth Rod

Description	Weld Material	Starter	Mould	Mould Clamp
12.7mm Earth Rod to 35mm^2 Conductors	AT-020N (2 tablets)	AT-010N (1 starter)	C35/T14/TV	AT-049N
12.7mm Earth Rod to 70mm^2 Conductors	AT-020N (2½ tablets)	AT-010N (1 starter)	C70/T14/TV	AT-049N
12.7mm Earth Rod to 120mm^2 Conductors				

10.7.5 Joints - Solid Copper Conductor to side of Earth Rod

Description	Weld Material	Starter	Mould	Mould Clamp
12.7mm Earth Rod to Ø5mm Conductor				

10.7.6 Joints - Copper Tape to side of Earth Rod

Description	Weld Material	Starter	Mould	Mould Clamp
12.7mm Earth Rod to 3 x 25mm Strip / Tape	AT-020N (2½ tablets)	AT-010N (1 starter)	P253/T14/TV	AT-049N
12.7mm Earth Rod to 4 x 50mm Strip / Tape				
12.7mm Earth Rod to 6 x 50mm Strip / Tape				

11.0 REQUIREMENTS FOR COPPER-TO-ALUMINIUM 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.

11.1.1 WPD Standard Items

The following transition washers are used within WPD:

M10 Transition Washer	[E5 - 61429]
M12 Transition Washer	[E5 - 61430]

11.1.2 WPD Approved Products

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

Alcomet Transition Washers TW1/3 (M10) & TW1/4 (M12)	Manufacturer = Alcomet

12.0 REQUIREMENTS FOR REBAR EARTH BONDS / CLAMPS

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

12.1 'Internal' Rebar Earth Bonds / Clamps

An 'internal' rebar earth bond / clamp is incorporated within a cast concrete floor slab and provides an electrical connection between the rebar and the substation earthing system. It consists of a mechanical 'U' bolt clamp connected to the rebar, an earth point positioned on the external surface of the slab, and an insulated stranded copper cable connection between the two.

The 'U' bolt clamp and earth point shall be manufactured from high strength copper alloy and comply with the requirements of BS EN 50164-1, Classification H (heavy duty).

The 'U' bolt clamp shall be designed to provide a high quality low resistance connection between the insulated stranded cable and the rebar. It shall be suitable for rebar diameters in the range 10-16mm.

The earth point shall be designed to provide a high quality low resistance connection between the insulated stranded cable and the substation earthing system. It shall be suitable for earthing system connections made using 3mm x 25mm copper tape or 70mm^2 stranded copper cable.

The insulated stranded copper cable shall have a 70mm^2 cross sectional area and shall comply with the requirements of Section 3.2.1 above.

12.1.1 WPD Standard Items

The following 'internal' rebar earth bonds / clamps are used within WPD:

Two-hole earth point complete with pre-welded 500mm long tail of 70mm^2 insulated stranded copper cable. For use in conjunction with the rod-to-cable clamp below.	[E5 - 61263]
'U' bolt rod clamp. For use in conjunction with the two hole earth point above.	[E5 - 61264]

12.1.2 WPD Approved Products

The following 'internal' rebar earth bonds / clamps are approved for use on the WPD distribution network:

Two-hole earth point PC115-FU 'U' bolt rod clamp type GUV CR700	Manufacturer = ABB Furse

12.2 **'External' Rebar Earth Bonds / Clamps**

An 'external' rebar earth bond / clamp provides an electrical connection between rebar protruding outside the cast concrete slab and the substation earthing system. It consists of a mechanical 'U' bolt clamp connected to the rebar.

The 'U' bolt clamp shall be manufactured from high strength copper alloy and comply with the requirements of BS EN 50164-1, Classification H (heavy duty).

The 'U' bolt clamp shall be designed to provide a high quality low resistance connection between bare stranded copper cable and the rebar. It shall be suitable for rebar diameters in the range 10-16mm and stranded copper cable with a 70mm^2 cross sectional area.

12.2.1 WPD Standard Items

The following 'external' rebar earth bonds / clamps are used within WPD:

'U' bolt rod clamp.	[E5 - 61264]

12.2.2 WPD Approved Products

The following 'internal' rebar earth bonds / clamps are approved for use on the WPD distribution network:

'U' bolt rod clamp type GUV CR700	Manufacturer = ABB Furse

13.0 REQUIREMENTS FOR FLEXIBLE BRAIDS (EARTHING STRAPS)

13.1 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)

13.1.1 WPD Standard Items

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

35mm^2 cross section, 500mm minimum length	[E5 - 61265]
50mm^2 cross section, 500mm minimum length	[E5 - 61266]
70mm^2 cross section, 500mm minimum length	[E5 - 61267]

13.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

14.0 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.

14.1 Fence Insulators

Fence insulators shall be suitable for outdoor use and have the following attributes:

- Rated voltage: Not less than 500V
- One minute power frequency withstand voltage: Not less than 3.6kV (rms)
- A 1.2/50µs impulse withstand voltage: Not less than 65kV (peak)
- Creepage distance: Not less than 85mm

The insulator shall have a nominal height of 60mm and be able to withstand a cantilever force of not less than 2kN and a tensile force of not less than 1.2kN.

14.1.1 WPD Standard Items

The following fence insulators are used within WPD:

Fence Insulator	[E5 - XXXXX]

14.1.2 WPD Approved Products

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

Isoelectric epoxy resin post insulators 500V/3600V, Reference R951018	Supplier = Mosdorfer Ltd

15.0 REQUIREMENTS FOR EQUAL POTENTIAL GRATINGS

15.1 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 Figure 2 below for further details.

15.1.1 WPD Standard Items

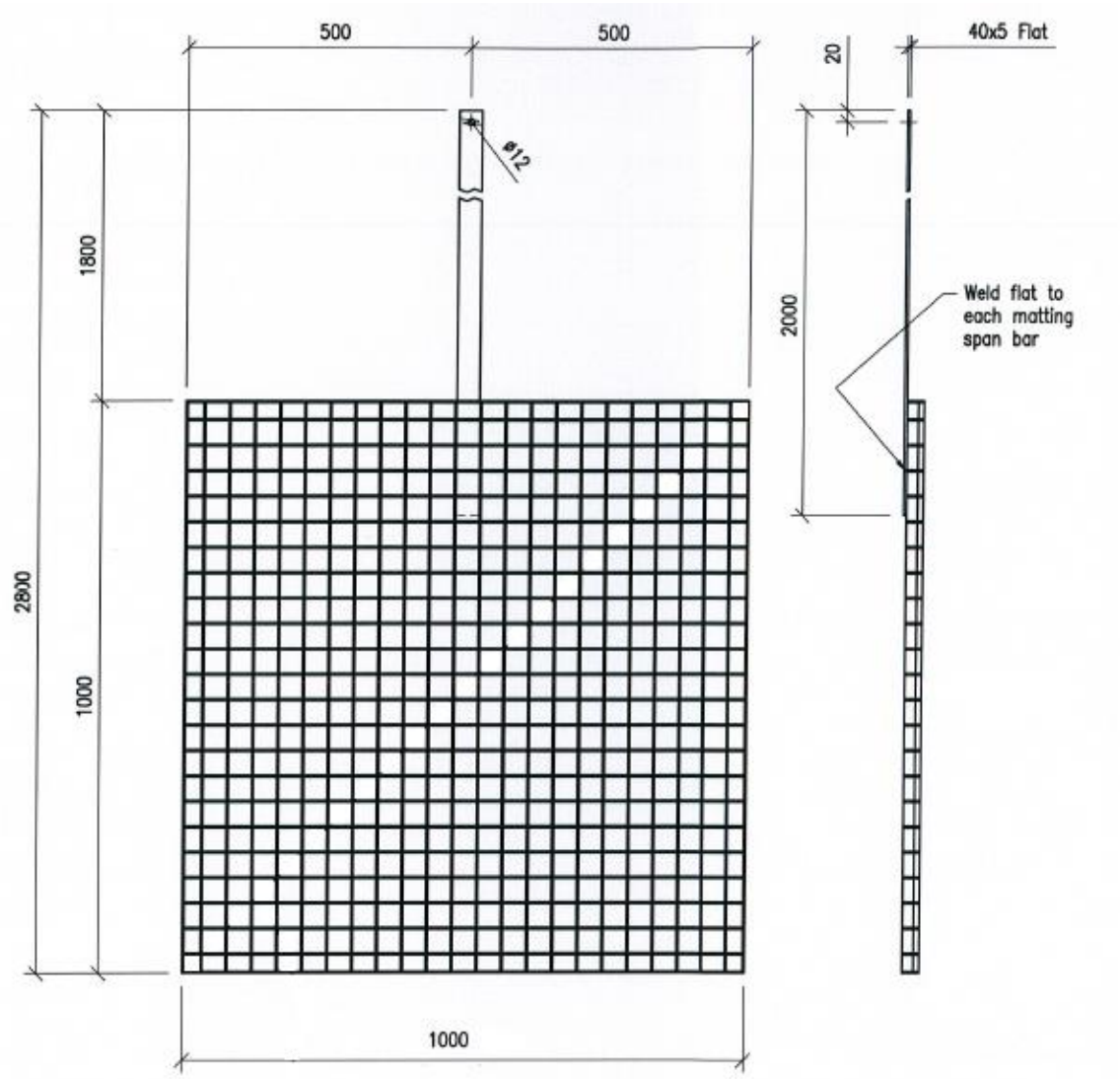
The following equal potential gratings are used within WPD:

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

15.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

Figure 2: Equal potential grating in modified form for use with pole mounted switchgear



15.2 **Grating Fixings**

The following grating fixings 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

15.2.1 WPD Standard Items

The following grating fixings are 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]

15.2.2 WPD Approved Products

Any manufacturer’s product which conforms to the specification.

16.0 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

16.1 **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.

16.1.1 WPD Standard Items

None.

16.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

16.2 **Security Capping**

A stainless or galvanised steel capping system used in conjunction with security pins to cover 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 be suitable for covering earth tape of the following dimensions: 25x3mm, 50x4mm & 50x6mm.

The capping shall have a low profile in order to avoid being a tripping hazard.

16.2.1 WPD Standard Items

The following security capping is used within WPD:

Capping, 1.1m length, used for earth tape up to 50x6mm	[E5 - 61269]
Removable cover for straight joints on earth tape up to 50x6mm	[E5 - 61270]
Removable cover for right angle joints on earth tape up to 50x6mm	[E5 - 61271]
Removable cover for tee (T) joints on earth tape up to 50x6mm	[E5 - 61272]
Removable cover for cross (X) joints on earth tape up to 50x6mm	[E5 - 61273]
Tinned copper washer	[E5 - 61274]

16.2.2 WPD Approved Products

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

"Guardian" Cover Guard Range • GCG50C capping • GJC50S cover for straight joints • GJC50A cover for right angle joints • GJC50T cover for tee joints • GJC50C cover for cross joints • GCW50 tinned washer	Supplier = Alcomet Ltd

16.3 **Security Capping Fixings**

16.3.1 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)
- 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.

16.3.1.1 WPD Standard Items

The following security pins are used within WPD:

Security Pin – Standard length	[E5 - 42620]
Security Pin – Extra Long	[E5 - 42621]

16.3.1.2 WPD Approved Products

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

"Guardian" Security Pins • GSP01C – standard length • GSP03C – extra long	Supplier = Alcomet Ltd
"Safemet" Security Pins • SAPIN01	Supplier = Earthmet Ltd

16.3.2 Security Bolt

A wedge anchor type security bolt manufactured from corrosion resistant stainless steel used for securing removable covers on security capping (see 16.2 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)

16.3.2.1 WPD Standard Items

The following security bolts are used within WPD:

Security Bolt With Removable Nut	[E5 - 61275]
Removable Security Nut	[E5 - 61276]
Socket for Removable Security Nut	[E5 - 61277]

16.3.2.2 WPD Approved Products

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

"Guardian" Security Nuts & Bolts • GSP02C security bolt & nut • GRN06 security nut • GDS06 socket for security nut	Supplier = Alcomet Ltd

16.4 **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.

16.4.1 WPD Standard Items

Silver Grey Paint	[E5 - 51165]

16.4.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

16.5 **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.

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

16.5.1 WPD Standard Items

None.

16.5.2 WPD Approved Products

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

Smartwater	Manufacturer = Smartwater Technology Ltd

Smartwater is currently approved / licenced for use in the WPD East Midlands & WPD West Midlands areas only.

17.0 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).

17.1 **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_c 85/5.

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

17.1.1 WPD Standard Items

None.

17.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

17.2 **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.

17.2.1 WPD Standard Items

None.

17.2.2 WPD Approved Products

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

“Bentonite”	Manufacturer = A N Wallis Ltd
“Marconite”	Manufacturer = James Durrans & Sons Ltd
“Conducrete”	Manufacturer = SAE Inc / FM Sudafix Ltd

18.0 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.

18.1 **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.

18.1.1 WPD Standard Items

None.

18.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

18.2 **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.

18.2.1 WPD Standard Items

None

18.2.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

18.3 **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.

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.
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 70mm.

18.3.1 WPD Standard Items

None

18.3.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

18.4 **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_c 75/9.

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

18.4.1 WPD Standard Items

None.

18.4.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

18.5 **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.

18.5.1 WPD Standard Items

None.

18.5.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

19.0 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

19.1.1 WPD Standard Items

None.

19.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

20.0 REQUIREMENTS FOR SUNDRY ITEMS

The following sundry items may be required:

20.1 **Copper Lugs**

Copper, crimping lugs suitable for 70mm^2 stranded copper conductor with single M12 clear hole.

The copper lugs shall meet the requirements of BS EN 13600 (2013): Copper & Copper Alloys – Seamless Copper Tubes for Electrical Purposes. It shall be manufactured from copper to the following equivalent international designations:

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

Copper lugs shall have an R200 / H035 (i.e. annealed) material condition.

20.1.1 WPD Standard Items

Copper lug, 70mm^2, 1 x M12	[E5 - 30289]

20.1.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

20.2 **Copper 'C' Sleeve Connectors**

Copper, 'C' sleeve connectors suitable for joining 2 x 70mm^2 stranded copper conductors.

The 'C' sleeve connectors shall meet the requirements of BS EN 13605 (2013): Copper & Copper Alloys - Copper Profiles and Profiled Wire for General Electrical Purposes. It shall be manufactured from copper to the following equivalent international designations:

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

Copper ‘C’ sleeve connectors shall have an R200 / H035 (i.e. annealed) material condition.

20.2.1 WPD Standard Items

C Sleeve Connectors, Cu, 70mm^2-70mm^2	[E5 - 30265]

20.2.2 WPD Approved Products

Any manufacturer’s product which conforms to the specification.

20.3 **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.

20.3.1 WPD Standard Items

Cold galvanising spray	[E5 - 33578]

20.3.2 WPD Approved Products

Any manufacturer’s product which conforms to the specification.

20.4 **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

20.4.1 WPD Standard Items

1in x 10ft cable guard	[E5 - 30408]

20.4.2 WPD Approved Products

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

"Cable Guard - 1in x 10ft"	Manufacturer = Polypipe Civils

20.5 **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

20.5.1 WPD Standard Items

Sheath Repair Tape	[E5 - 40232]

20.5.2 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

20.6 **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

20.6.1 WPD Standard Items

Anti-seize compound	[E5 - 61278]

20.6.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

20.7 **Brazing Rods and Foils**

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

20.7.1 WPD Standard Items

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

20.7.2 WPD Approved Products

Any manufacturer's product which conforms to the specification.

APPENDIX A

SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 132 dated July 2015 which has now been withdrawn.

APPENDIX B

RECORD OF COMMENT DURING CONSULTATION

Comments received during consultation.

APPENDIX C

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 D

KEY WORDS

Earthing; Earth; Material; Tape; Rod; Bar; Joint; Grating; Fence; Insulator.