WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales
Gwasanaethu Canolbarth a De Orllewin Lloegr a Chymru

Company Directive

STANDARD TECHNIQUE: CA6A/6

Relating to the Installation of Underground Cables

Policy Summary

This technique forms the approved installation procedure for all underground cables, which are installed within Western Power Distribution with the exception of pressure-assisted cables at 33kV, 66kV and 132kV cables.

Author:	**Richard Summers**
Implementation Date:	**January 2019**
Approved by	Bell
	Policy Manager
Date:	24 January 2019

IMPLEMENTATION PLAN

Introduction

This technique forms the approved installation procedure for all underground cables, which are installed within Western Power Distribution with the exception of pressure-assisted cables at 33kV, 66kV and 132kV cables.

Main Changes

This document has been updated to include:-

- Reference to duct colour added to section 3.7
- Reference to ground settlement added to section 4.1
- References to SURF amended to WPD Telecoms

Impact of Changes

No major change

Implementation Actions

Team managers to disseminate the information to their respective staff.

No formal training will be required.

Implementation Timetable

This Standard Technique can be implemented with immediate effect.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
January 2019	• Reference to duct colour added to section 3.7 • Reference to ground settlement added to section 4.1 • References to SURF amended to WPD Telecoms	Richard Summers
February 2018	• 33kV joint bay drawing changed to reflect the Lovink 33kV joint system (drawing 3.7.3, page 33) • Recommendation that kerb lines are installed before cables are laid on new developments (Section 4.1)	Richard Summers
January 2017	• Double 132kV circuits shown along with risk assessment that needs to be carried out, this risk assessment shall be saved in the health and safety file. • Drawings for single and double 132kV circuits including WPD Telecoms duct and joint bays. • Clarification on bedding and blinding of cable ducts in stone dust. • Removal of internal beads in all forms of jointing of SDR 11 HDD ducts. • Guidance on cleating of cables. • Guidance on the running of 70mm² HDC with other cable circuits and the need to comply with EE 89. • Number of WPD Telecoms ducts reduced to one. • Addition of Gorilla duct tape to hold single core cables in trefoil.	Peter White
July 2013	• Multiple circuits for 33kV shown	Peter White

UNDERGROUND CABLE INSTALLATION

CONTENTS

UNDERGROUND CABLE INSTALLATION

1.0 INTRODUCTION

1.1 This document has been produced for all staff engaged in the installation of cables. It must be noted that the scope of this document **does not** cover the installation of pressure-assisted 33kV, 66kV and 132kV cables, as they are supplied and installed by the cable manufacturer concerned or some other selected installer.

1.2 It is the responsibility of all staff engaged in underground cable installation to comply with appropriate legislation. The legal framework for health and safety at work is set down in a variety of legislation - Acts of Parliament, and Statutory Regulations. A range of guidance providing information on recognised good practice supports the legal requirements. This guidance is in the form of Approved Codes of Practice (issued by the Health and Safety Commission) and guidance notes, booklets and leaflets (issued by the Health and Safety Executive, trade organisations, professional institutions etc.). There are also British and International Standards.

1.3 The principle legislation, guidance etc. relevant to underground cable installations is as follows: -

- Health and Safety at Work Act 1974
- Electricity, Safety, Quality and Continuity Regulations 2002
- Electricity at Work Regulations 1989
- Control of Pollution Act 1990
- Controlled Waste Regulations 1991
- New Roads and Streetworks Act 1991 (NRSWA)
- Traffic Management Act 2004
- Management of Health and Safety at Work Regulations 1992
- Workplace (Health, Safety, and Welfare) Regulations 1992
- Provision and Use of Work Equipment Regulations 1992
- Manual Handling Regulations 1992
- Construction (Design and Management) Regulations 2015
- WPD Distribution Safety Rules
- HSG 47 Avoiding Danger from Underground Services.
- NJUG Publications - Volume 1 “NJUG Guidelines on the Positioning and Colour Coding of Underground Utilities’ Apparatus “
- NJUG Publications - Volume 4 "NJUG Guidelines for the Planning, Installation and Maintenance of Utility Apparatus in Proximity to Trees"
- HSG 66 “Protection of Workers and the General Public during the Development of Contaminated Land”

2.0 PREPARATION

Before any work is carried out, the following items must have been completed and copies of relevant documents are available at the site of the works: -

2.1 Accurate plans showing all apparatus (WPD's and other utilities or service providers) in vicinity of work site.

2.2 Plan of proposed new cable route.

2.3 Easements/landowners notified.

2.4 Highway authorities and statutory undertakers notified sufficiently in advance to meet NRSWA requirements.

2.5 Correct signing & guarding implemented as per ST: HS14D.

3.0 EXCAVATION

3.1 Trial Holes

Unless it is known from co-ordination drawings that the route is relatively clear of obstructions, trial holes shall be taken at proposed joint locations and at such other positions along the route as is necessary to ascertain the practical positioning of the cable.

Trial holes should generally be at right angles to the run of cables and at least 150mm deeper than the proposed trench.

Surface covers belonging to other utilities may give a guide to the location of their equipment.

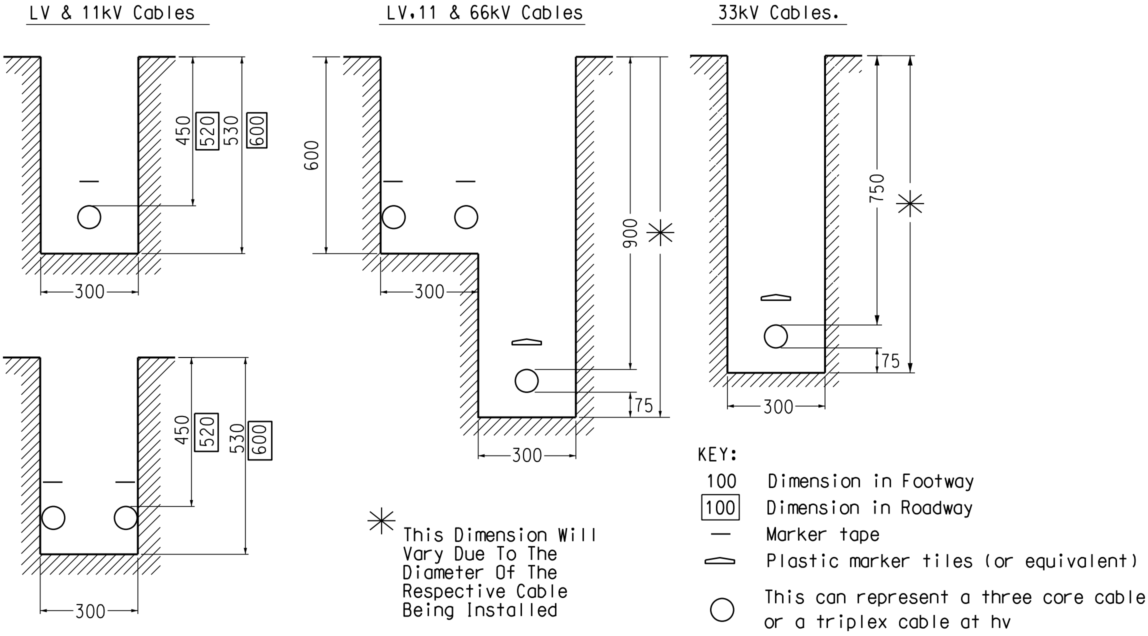
3.2 Excavation and Waste

Refer to figures 3.2a, 3.2b & 3.2c and table 3.2 for details of specific trench dimensions. If it is necessary to lay WPD Telecoms fibre ducts in the same trench as the WPD mains cables, refer to drawings G 4064.33, G4064.66 and G4065 for dimensions and layout.

The actual width of trench depends on the following factors: -

- Type and size of cable being laid.
- Number of cables being laid in same trench.
- If low and high voltage cables being laid in same trench, the effect on the cable ratings must be considered.
- Whether ducts are being used.

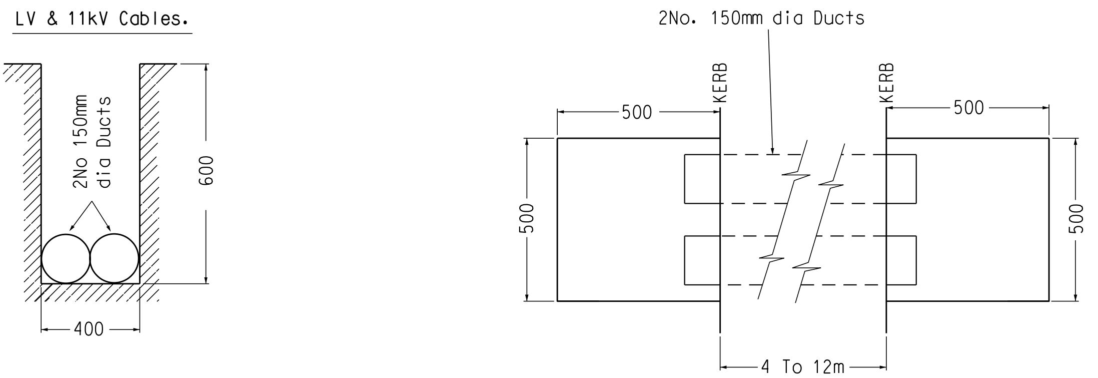
FOOTWAYS & ROADWAYS



Notes:

1. Marker tape to be laid 75mm above LV & 11kV Cables.
2. Plastic marker tiles (or equivalent) to be laid 75mm above 33 66 & 132kV Cables.

ROAD CROSSINGS.



The crossing is to include laying 2No. 150mm dia ducts (provided by WPD), a 500x500mm opening in the footpath each side of the road, removing and reinstating kerb edges as necessary and complete reinstatement on completion of works.

Rev No	Drawn	Chk'd	App'd	Date	Revision
7	RJB			07/11	TEXT ADDED

ORIGINAL ISSUE		DATE
Drawn	R.J.B.	11.97
Checked		
Approved		
SCALE	N.T.S.	

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Design Department.
Avonbank,Feeder Road,Bristol BS2 0TB
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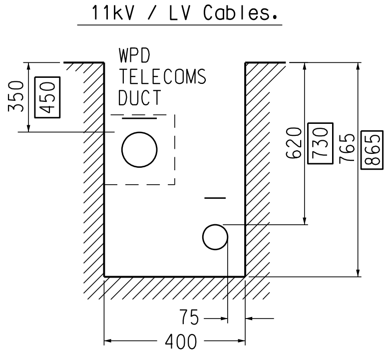
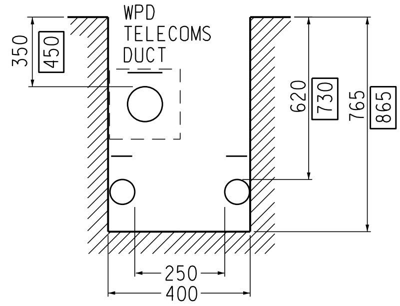
Title LV.11,33 AND 66kV ARRANGEMENT AND DIMENSIONS OF TRENCHES FOR CABLES.

Drg. No.	Rev No
3.2a	7

FOOTWAYS & ROADWAYS





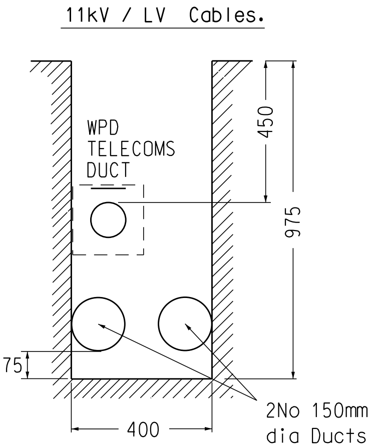
KEY:

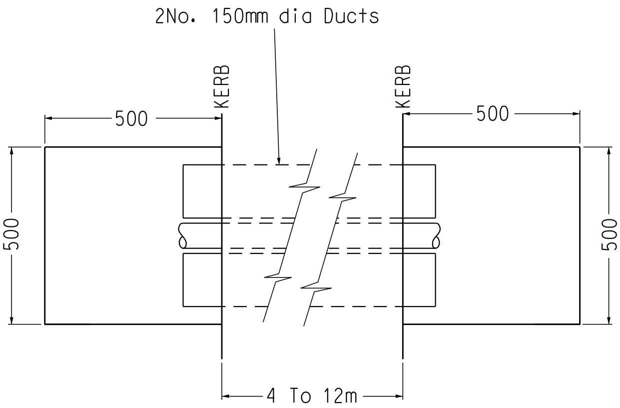
100	Dimension in Footway
$\boxed{100}$	Dimension in Roadway
—	Marker tape
⌒	Plastic marker tiles (or equivalent)

Notes:

1. Marker tape to be laid 75mm above LV & 11kV Cables.
2. WPD Telecoms duct to be surrounded by 75mm of soft fill in all directions
3. Dimensions Are Shown For 300mm² Cables

ROAD CROSSINGS.





WPD Telecoms duct to be surrounded by 75mm of soft fill in all directions

The crossing is to include laying 2No. 150mm dia ducts (provided by WPD plc), a 500x500mm opening in the footpath each side of the road, removing and reinstating kerb edges as necessary and complete reinstatement on completion of works.

Rev No	Drawn	Chk'd	App'd	Date	Revision
12	RJB			01/19	SURF RENAMED WPD TELECOMS

ORIGINAL ISSUE		DATE
Drawn	R.J.B.	05.00
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SCALE	N.T.S.	

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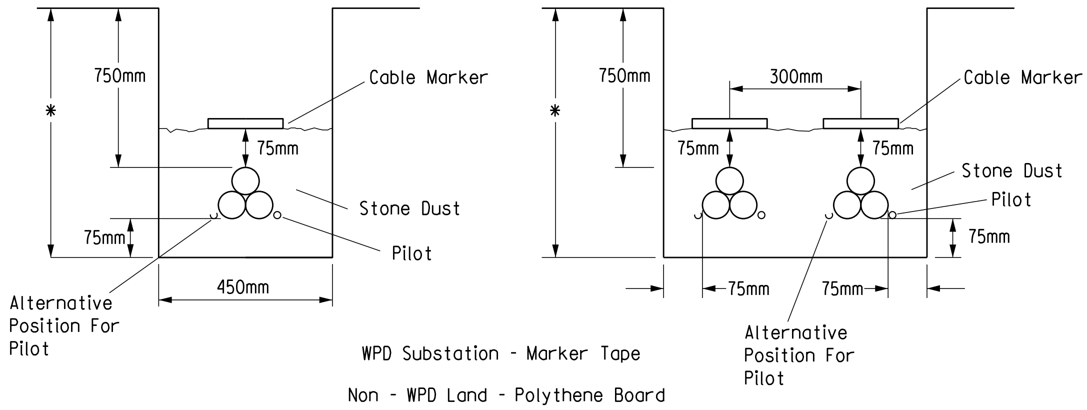
Title	Drg. No.	Rev No
LAYING OF WPD TELECOMS DUCT WITHIN LV / 11kV TRENCH	G4065	12

33kV 1xCCT

33kV 2xCCT's



WPD Substation - Marker Tape

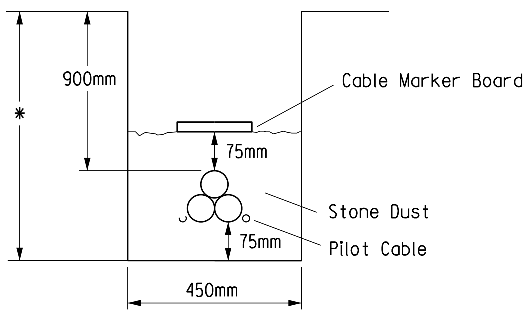
Non - WPD Land - Polythene Board

75mm Cover To Marker Tape

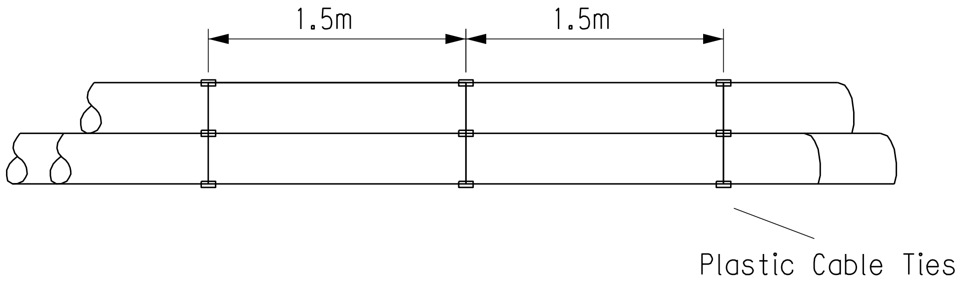
75mm 3mm To Dust,Limestone Or Granite Fine Stone Dust Bedding & Blinding

66/132kV

* This Dimension Will Vary Due To The Diameter Of The Respective Cable Being Installed



Note :- Pilot Cable Should Be Laid For 50% Of The Total Route Length
On The Right Hand Side Of The Circuit
& For The Remaing 50% On The Left Hand Side Of The Circuit



33,66 & 132kV Cables Laid In Trefoil & Cable Tied At 1.5m Intervals
(1m At Bends)

Rev No	Drawn	Chk'd	App'd	Date	Revision
8	RJB			01/15	ALTERNATIVE PILOT NOTE ADDED

ORIGINAL ISSUE		DATE
Drawn	R.J.B.	11.97
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Approved		
SCALE	N.T.S.	

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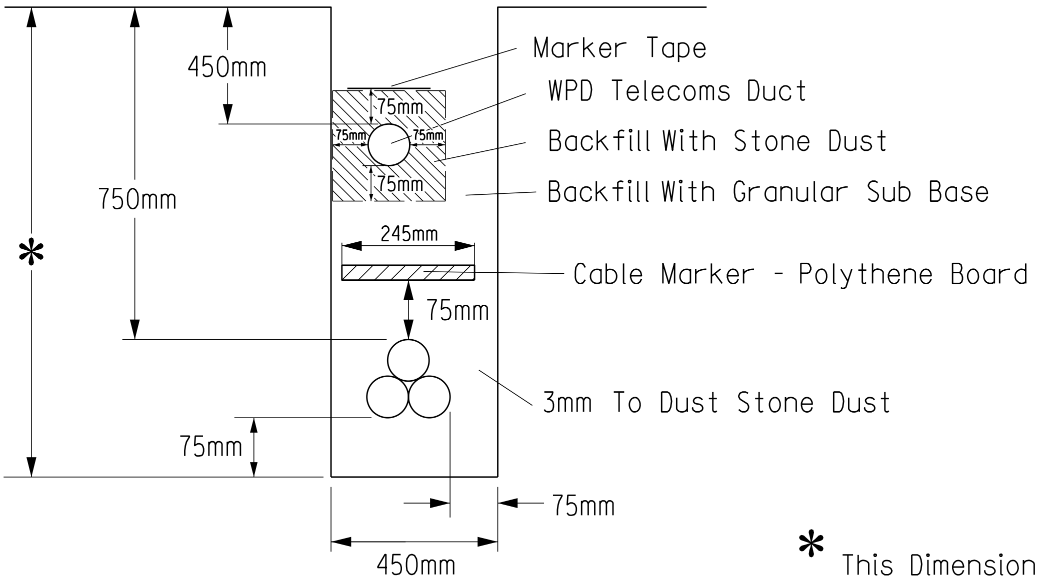
Title	Drg. No.	Rev No
33,66 & 132kV 3 x SINGLE CORE POLYMERIC CABLES	3.2b	8

SINGLE CIRCUIT

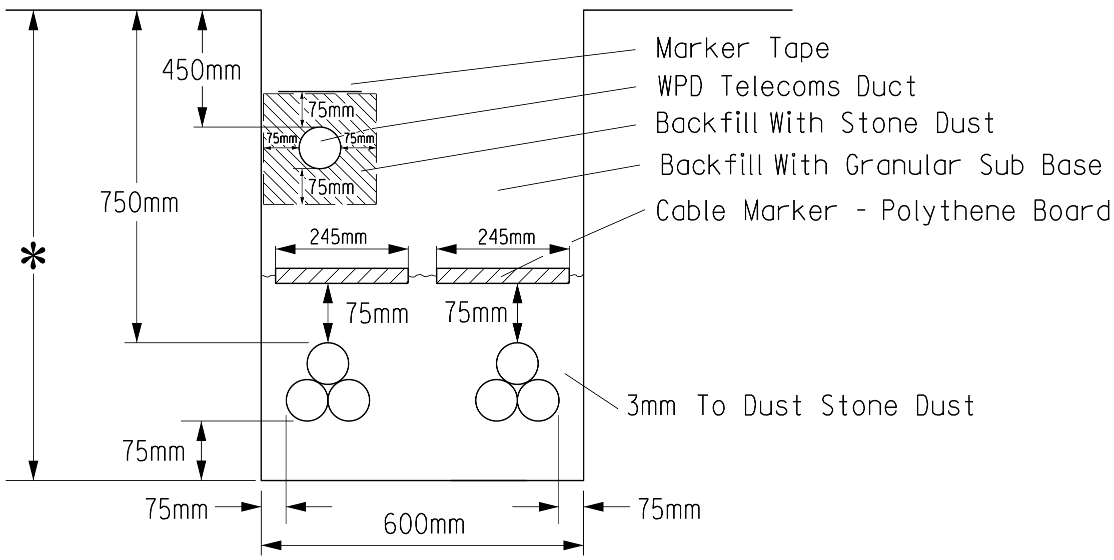


75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

* This Dimension Will Vary Due To The Diameter Of The Respective Cable Being Installed

DUAL CIRCUIT



75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

Rev No	Drawn	Chk'd	App'd	Date	Revision
11	RJB			01/19	SURF RENAMED WPD TELECOMS

ORIGINAL ISSUE		DATE
Drawn	R.J.B.	05.00
Checked	P.W.	
Approved		
SCALE	N.T.S.	

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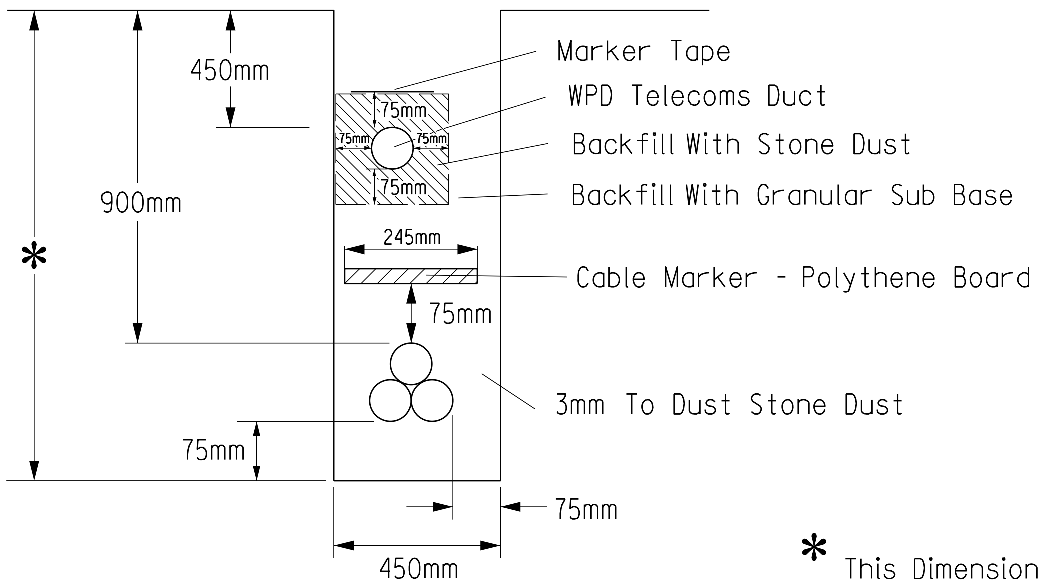
Title	Drg. No.	Rev No
LAYING OF WPD TELECOMS DUCT WITHIN 33kV TRENCH	G4064.33	11

SINGLE CIRCUIT

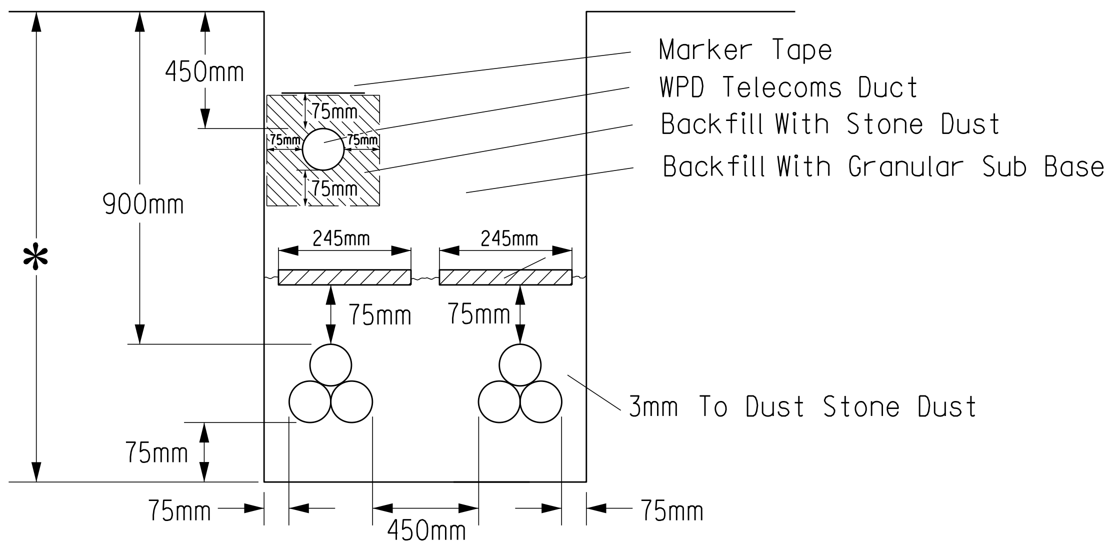


75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

* This Dimension Will Vary Due To The Diameter Of The Respective Cable Being Installed

DUAL CIRCUIT



75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

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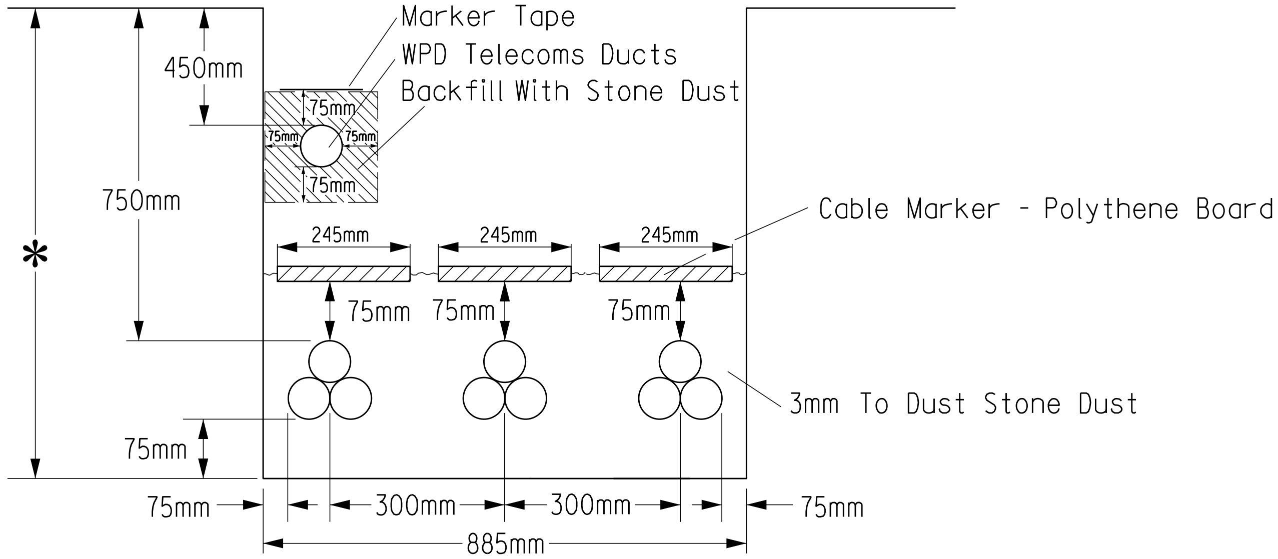
12	RJB			01/19	SURF RENAMED WPD TELECOMS

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	R.J.B.	05.00			
Checked	P.W.				
Approved			Title: LAYING OF WPD TELECOMS DUCT WITHIN 66kV TRENCH CABLES LAID IN TREFOIL	Drg. No. G4064.66	Rev No 12
SCALE	N.T.S.				

TRIPLE CIRCUIT

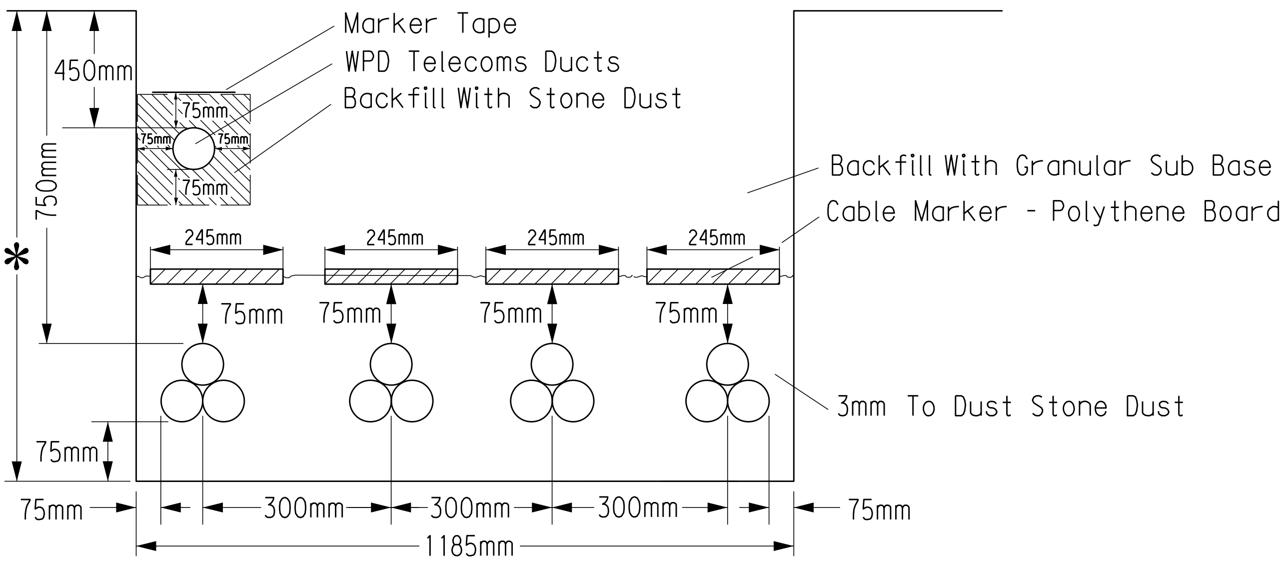


75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

* This Dimension Will Vary Due To The Diameter Of The Respective Cable Being Installed

QUAD CIRCUIT



75mm Cover To Marker Tape

75mm Fine Stone Dust Bedding

Rev No	Drawn	Chk'd	App'd	Date	Revision
2	RJB			01/19	SURF RENAMED WPD TELECOMS

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Drawn	RJB	07/13			
Checked	PW		Title LAYING OF WPD TELECOMS DUCT WITHIN 33kV TRENCH	Drg. No. G4064.33A	Rev No 2
Approved					
SCALE	N.T.S.				

- If mechanical means are being used in order to excavate the trench in order to install a single cable, then the width can be as narrow as 150mm.
- The trench width must also allow for mechanical compaction.

Trenches should: -

(a) Have lines, levels, and contours to suit continuous pulling of cable by winch.

(b) Be as straight as possible. Where bends are unavoidable the trench should allow the cable to be installed at not less than its minimum-bending radius using cable rollers.

(c) Be to the approved dimensions and normally have vertical sides which should have a side support system (e.g. timbering), should the ground be soft or loose.

(d) Have a firm and smooth contoured base.

(e) Be excavated with such precautions as are necessary to prevent damage to the highway or ground surface from a slip or breaking away of the sides of the trench. Cutting by machine (e.g. road saw, chain excavator or planer) is preferred.

(f) Be excavated so that all railways, tramways, walls, roads, sewers, drains, pipes, cables, structures, places, shall be secure against risk of subsidence or damage, and shall be carried out to meet the requirements of the authorities concerned.

(g) Where they pass from a footway to a roadway or at other positions where a change of level is necessary, have a base that rises or falls gradually.

(h) Be cleared of water by pumping to prevent the risk of the trench collapsing and hazard to the general public, especially trespassing children. In locations where flooding can occur, measures shall be taken to divert rainwater away from the trench (e.g. use of sandbags).

(i) Have provisions made during their excavation to cater for access of persons and vehicles to property of places alongside the route.

(j) In concrete surfaces be cut through the concrete as per the HAUC Specification for the Reinstatement of Openings in Highways.

(k) Where short lengths of ducts are installed, have a hole dug below the front of the leading edge of duct-run so that anything that could be dragged into the duct during cable pulling will fall into the hole instead.

(l) If ground conditions in open terrain could lead to collapse of the trench wall, the trench can be excavated with sloping sides. With machine excavation, a standard 'V' shaped ditching bucket may be used.

Other works and properties, such as decorative walls and lawns, shall be safeguarded against damage from excavated material by using some form of sheeting. When machines are being used for excavation and the location of other plant is known, the plant should be uncovered by hand excavation to reduce the possibility of damage. If the excavation is likely to reduce the stability of any part of any structure, work shall not be commenced unless adequate precautions are taken to prevent the structure from collapse or deterioration. Flooding, or vibration from heavy traffic can cause collapse of trench sides and subsidence of adjacent structures. A trench side support system or shoring shall be used to avoid this.

See ST: HS14B/3 Excavation and Shoring.

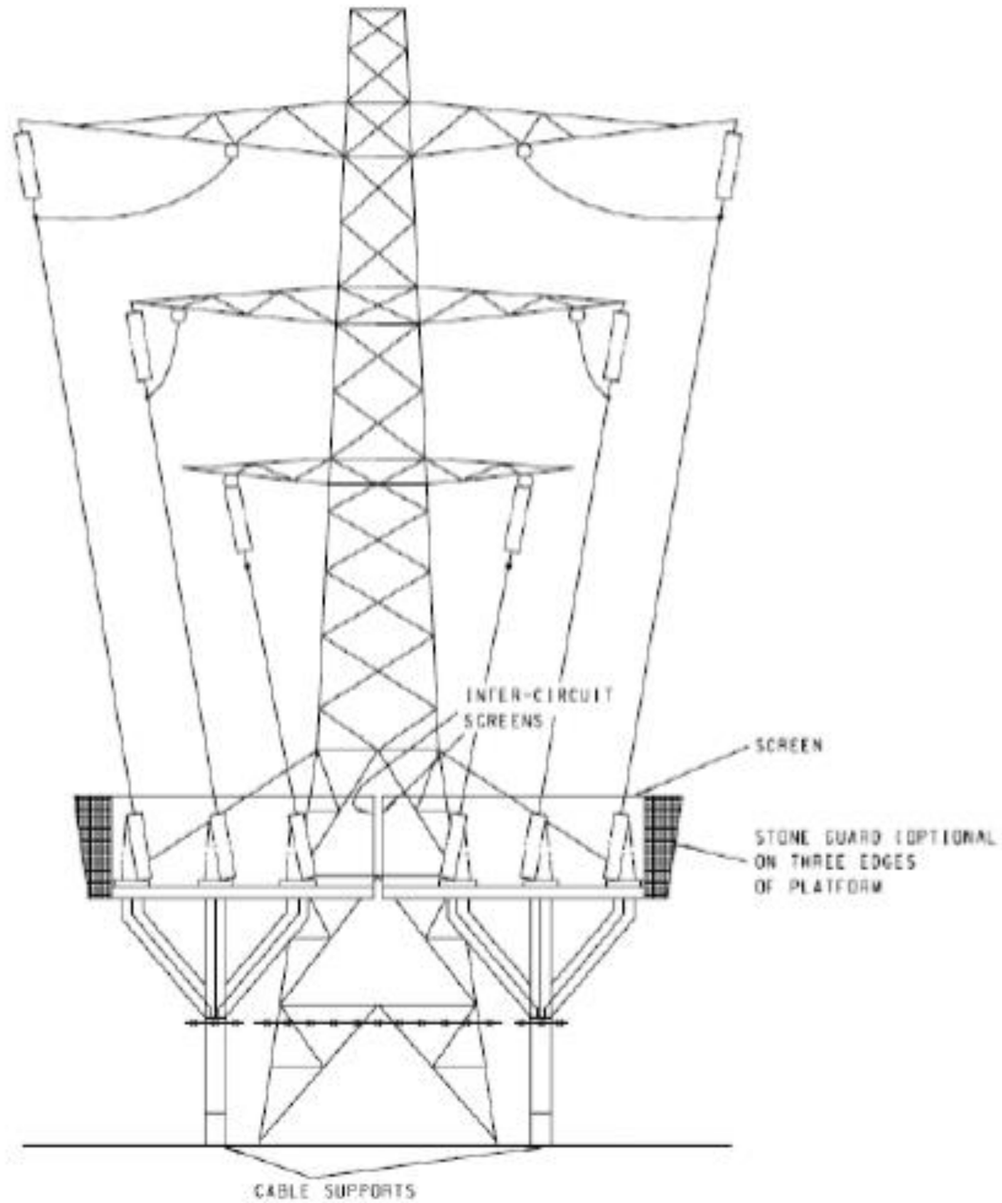
3.3 General 132kV Underground Cable Information

Typically 132kV circuits either start from overhead line terminal positions like an L4(M) DT sealing end platform, see overleaf for sketch, or L7(C) DT sealing end platform or from a substation on a three single phase 132kV sealing end structures, see drawing 3.3 for more information. With the sealing end platforms it is best to use individual cable ladders for the three phases as this eliminates the minimum bending radius problems of large cross sectional area (CSA) cables on the trident design cable ladders. The cables are to be cleated to the cable ladders or structures using Ellis Patent Atlas two bolt cleats of commensurate size for the respective cable. See below.

Ellis Patent Atlas two bolt cable cleat.

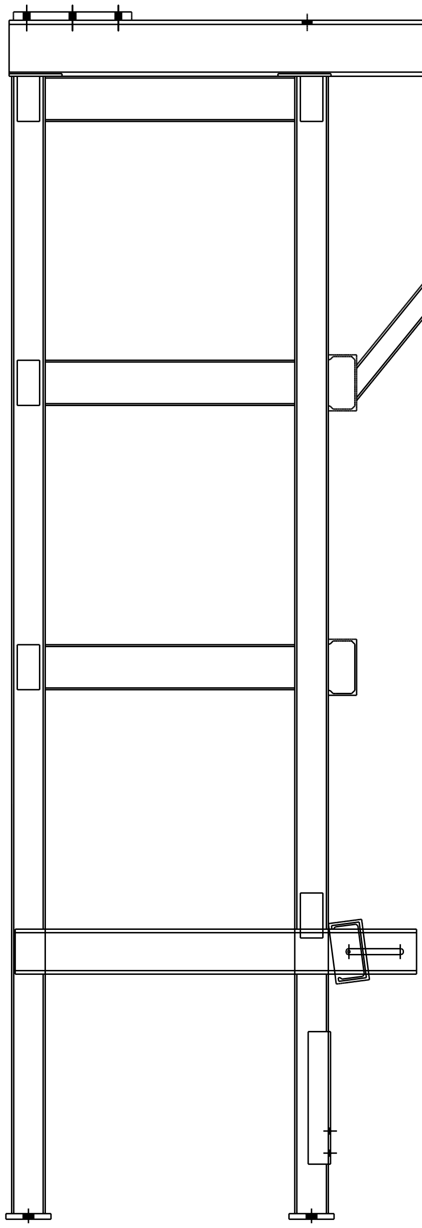
Bonding leads for 132kV circuits are 240mm² with the construction being plain or concentric, all earthing and bonding of 132kV circuits shall comply with ENA ER C55/5 where the maximum induced voltage shall **NOT exceed 65V**.

It should be noted that if WPD Telecoms ducts are to be run with 132kV circuits across agricultural land then the ducts shall have 1000mm cover and there shall be a minimum clearance between the WPD Telecoms ducts and the 132kV circuits of 150mm.



L4 (M) DT tower complete with sealing end platforms showing the trident style cable ladders.
These ladders will have minimum bending radius issues with large CSA cables.

All dimensions in mm



For Complete GA / ED Drawing Refer To

\\AVODCS01\EDS\S WALES\Subs\S\Structures and Steelwork Standard Drawings\SAS0540

Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	RJB	09/16			
Checked			Title	Drg. No.	Rev No
Approved			132kV SINGLE PHASE SEALING END STRUCTURE	3.3	
SCALE	N.T.S.				

3.3.1 132kV Single Circuit cable Trench

A single 132kV circuit in its own trench is the preferred option of installing 132kV circuits to a BSP or other location as this method of installation minimises the risk of losing supply to the BSP or the overhead line, when compared to two 132kV underground circuits in the same trench, as the double circuit in a single trench configuration presents a high probability of hitting both circuits simultaneously with e.g. a Horizontal Directional Drill (HDD), mechanical digger or other common mode failure mechanism. The typical trench width for a single circuit is given in drawing 3.7.1 and the typical joint bay is shown in drawings 3.7.1.1, 3.7.1.2, 3.7.1.3 and 3.7.1.4.

If two circuits are to be run along the same route then the preferred option is to have the centre to centre spacing of the two circuits set at 2500mm this provides thermal independence of the circuits and also means a smaller cross sectional area cable can be used as there will be no derating effects.

3.3.2 132kV Double circuit cable trench

The option of installing a two 132kV underground circuits into a single trench is available but requires a risk assessment to be carried out with final sign off by the requisite senior management, this risk assessment and sign off shall be kept in the Health and Safety file for the particular underground cable project so that the information can be reviewed at any time in the future if necessary.

This section aims to provide guidance on the management of dual 132kV circuits in the same trench and recognizes the potential for increased network risk due to the creation of a single point of failure and provides the guidance on assessing the level of risk and identifying appropriate mitigation.

Distribution Managers and Major Projects Managers will have the following responsibilities for all cases of where double 132kV circuits are laid in a single cable trench for which they are responsible and which fall within their operational areas: -

- The Identification and recording of the locations of all double 132kV circuits trenches within their respective areas.
- For each double 132kV circuit cable trench they shall identify and record the following details: -

    - The number and cable rating of circuits contained within the trench.

    - The number of Customers supplied by those circuits.

    - Details of any Critical Customers and /or Interdependent Critical Infrastructure supplied by those circuits e.g. Hospitals, Significant Food Manufactures or Processes and Water/Oil/Gas/Sewage etc.

- The recoverable demand / Customer numbers e.g. where 85% of connected Customers are recoverable in switching time, this may result in a Low Risk classification even though large numbers of customers are initially affected.

- The Criticality of the asset within the wider network.

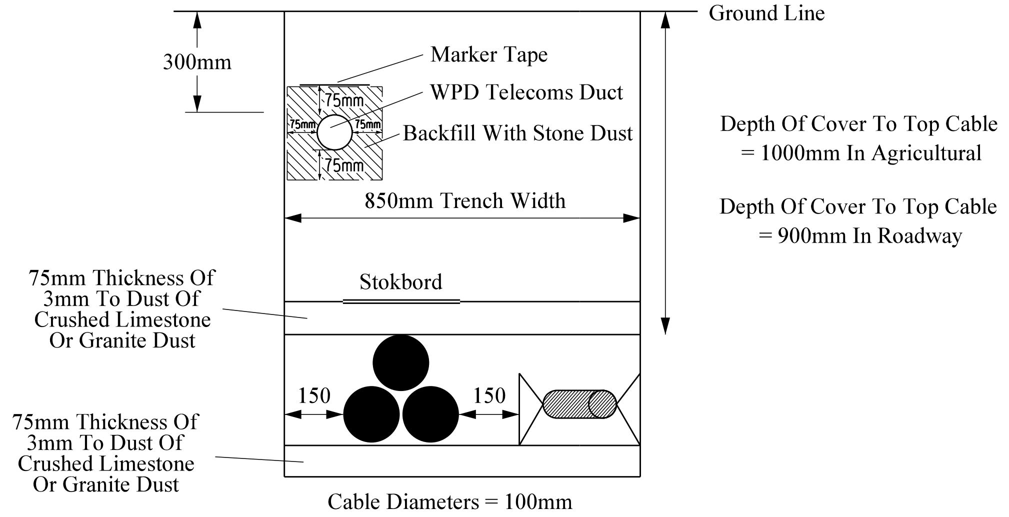
- The completion of an appropriate Risk Assessment for each asset. (See Risk score sheet for double 132kV circuits in a single trench.)

- Recording and retaining the unmitigated risk score (High/Medium/Low) irrespective of any mitigating actions taken.

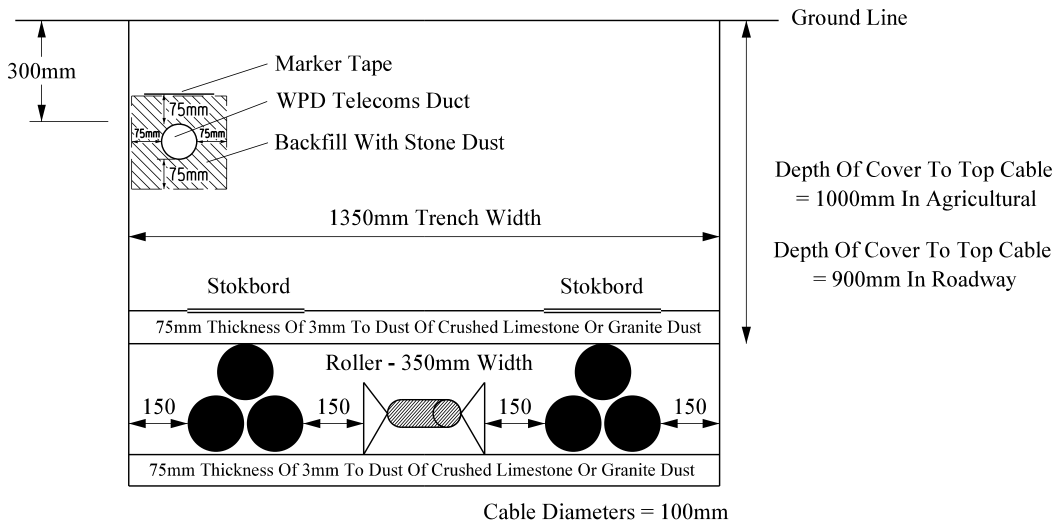
For this ST “risk” is the product of the likelihood and the consequence of both circuits being damaged, and the loss of supply to all customers. When assessing the likelihood consideration will be given to the route, surrounding land usage, is there an ability to back feed the substation etc. When assessing the consequences, consideration should be given to loss of multiple circuits e.g. loss of supplies to customers, the available supply restoration options and the potential costs.

To aid in this assessment please refer to Appendix A clause **A.3.3.1 Impact Measurement** and clause **A.3.3.2 Actions arising from Risk Prioritisation** for the methodology to be used.

All dimensions in mm



Single Circuit 132kV Trench Dimensions



Double Circuit 132kV Trench Dimensions

Note:- If Fibre Optic Is Laid In Agricultural Land
Then Fibre duct Shell Be At 1000mm Cover
& Minimum 150mm Separation From 132kV Circuit

Rev No	Drawn	Chk'd	App'd	Date	Revision
2	RJB			01/19	SURF RENAMED WPD TELECOMS

ORIGINAL ISSUE	DATE
Drawn RJB	10/16
Checked	
Approved	
SCALE N.T.S.	

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Design Department.
Avonbank,Feeder Road,Bristol BS2 0TB
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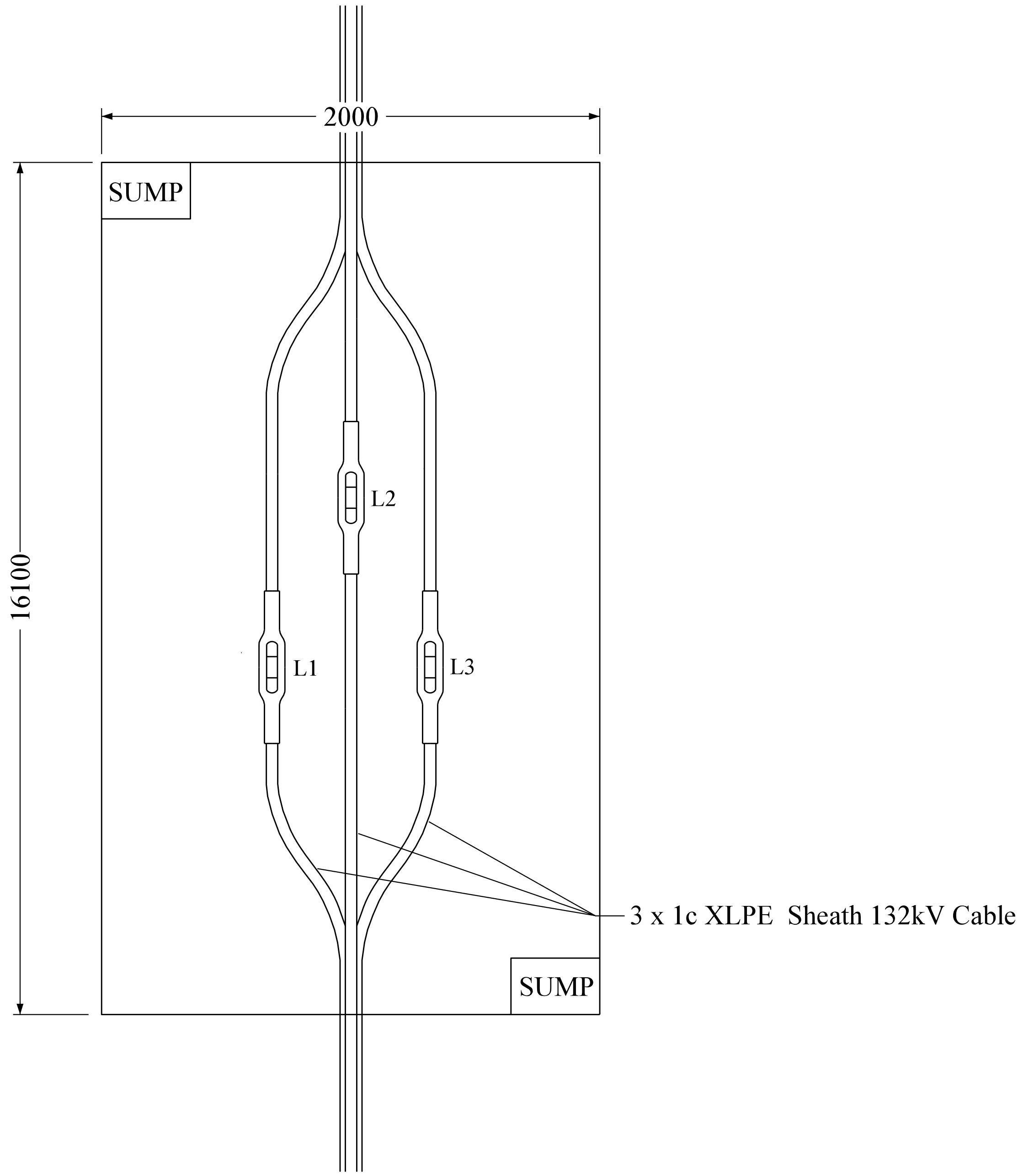
Title	Drg. No.	Rev No
132kV TRENCH WIDTHS	3.7.1	2

Note :-

1 All Dimensions Are In mm

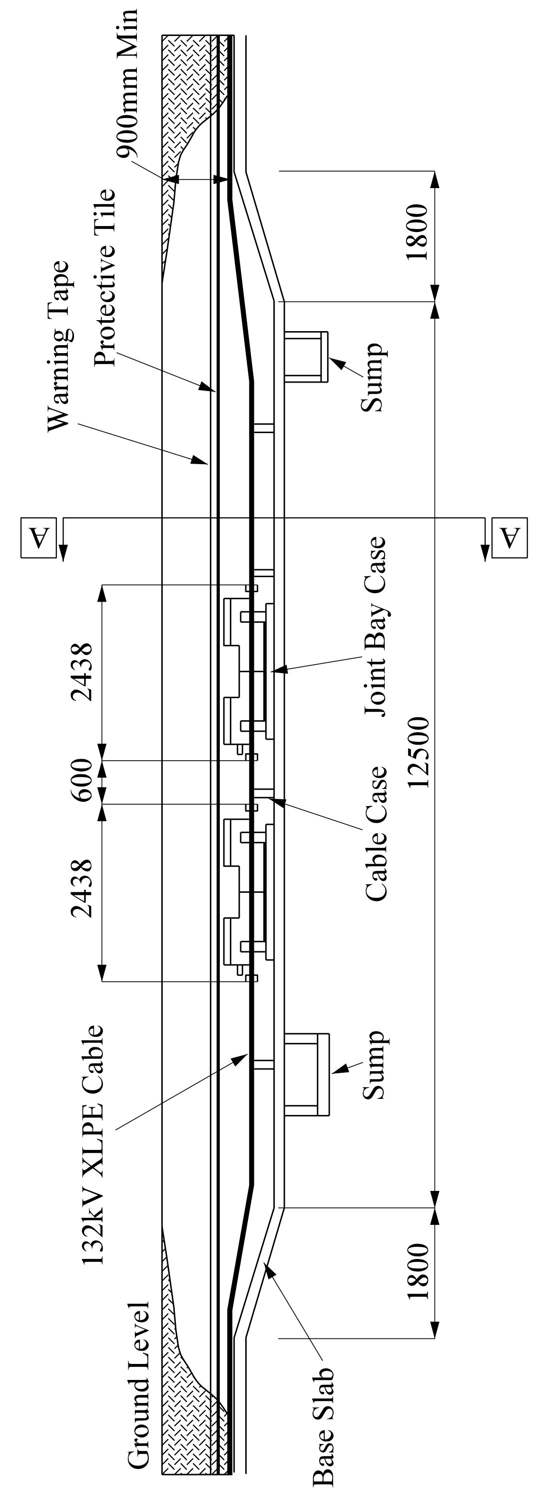
2 Sandbag Support To Be Used As Shown In WPD ST:CA6A For Details



Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	RJB	10/16			
Checked			Title	Drg. No.	Rev No
Approved			132kV JOINT BAY LAYOUT	3.7.1.1	
SCALE	N.T.S.				

All dimensions in mm



TYPICAL SECTION VIEW OF JOINT BAY

Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE	DATE
Drawn RJB	10/16
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Design Department.
Avonbank,Feeder Road,Bristol BS2 0TB
Tel: 0117 933 2000 Fax: 0117 933 2001.

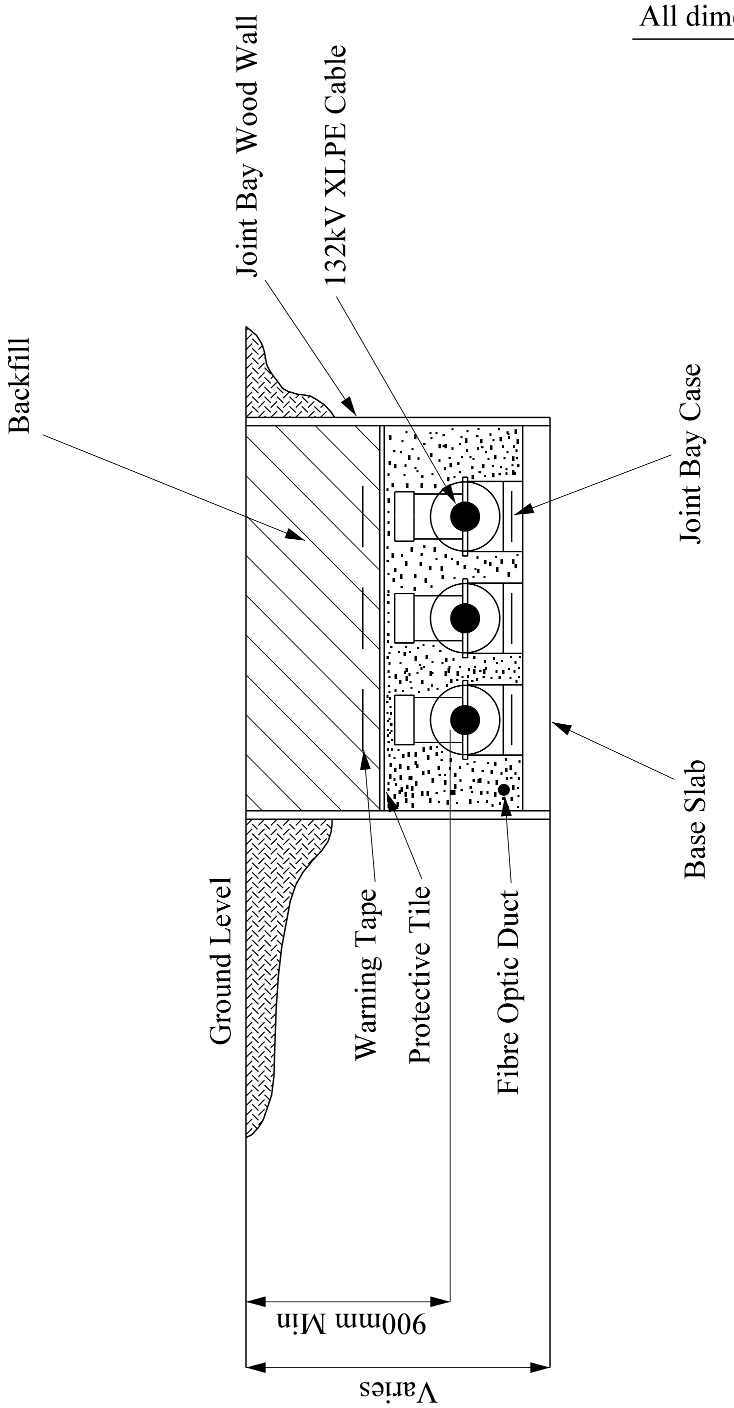
WESTERN POWER DISTRIBUTION

Title: 132kV JOINT BAY LAYOUT

Drg. No. 3.7.1.2

Rev No

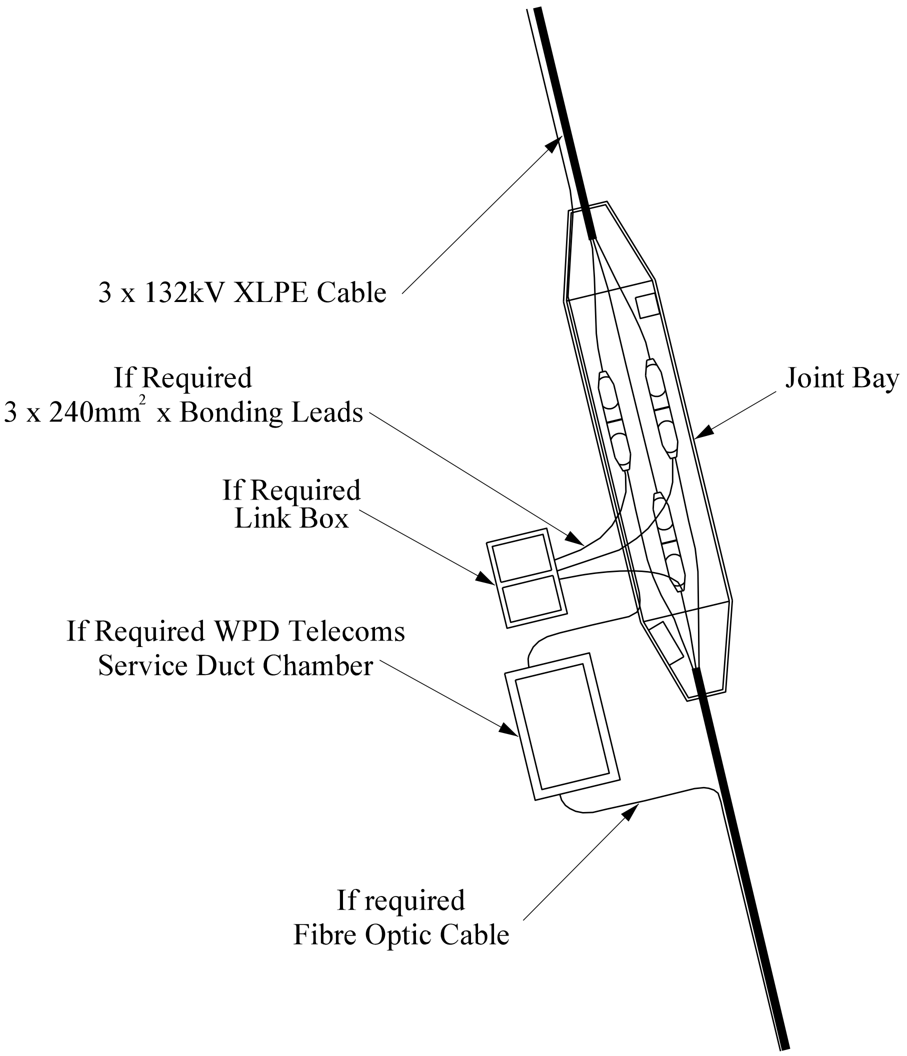
All dimensions in mm



Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	RJB	10/16			
Checked			Title CROSS SECTION OF TYPICAL SINGLE CIRCUIT 132kV JOINT BAY LAYOUT	Drg. No. 3.7.1.3	Rev No
Approved					
SCALE	N.T.S.				

All dimensions in mm



Rev No	Drawn	Chk'd	App'd	Date	Revision
1	RJB			01/19	SURF RENAMED WPD TELECOMS

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank, Feeder Road, Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	RJB	10/16			
Checked			Title	Drg. No.	Rev No
Approved			PLAN VIEW OF TYPICAL SINGLE CIRCUIT 132kV JOINT BAY LAYOUT	3.7.1.4	1
SCALE	N.T.S.				

TABLE 3.2 - NORMAL TRENCH DIMENSIONS - Three-Core Cable or Triplex.

Cable Type	Location	Trench Depth	Trench Width Single Cable	Min Cover Over Cable	Trench Width Two Cables
LV & Services	Pavement or private land	530mm	300mm	450mm	300mm
LV & Services	Roadway (ducts)	600mm	300mm	520mm	300mm
11kV (PICAS)	Pavement or private land	530mm	300mm	450mm	300mm
11kV (PICAS)	Roadway (ducts)	600mm	300mm	520mm	400mm
11kV (Triplex EPR or XLPE)	Pavement or private land	530mm	300mm	450mm	300mm
11kV (Triplex EPR or XLPE)	Roadway (ducts)	600mm	300mm	520mm	400mm
33kV H or HSL Solid Type Cable	all locations	900mm	300mm	750mm	600mm

- **Single Underground Circuit using Single Core Cables (Laid in Trefoil)**

Cable Type	Locations	Trench Depth	Trench Width	Min Cover over Cable
132kV EPR or XLPE laid in trefoil	all locations	1098mm	850mm	900mm
66kV EPR or XLPE laid in Trefoil	all locations	1098mm	450mm	900mm
66kV EPR or XLPE laid with 2D Flat Spacing (630mm² or larger c.s.a only)	all locations	Depends on diameter of cable but approximately 1050mm	550mm	900mm
33kV EPR or XLPE laid in trefoil	all locations	900mm	450mm	750mm
11kV (Single core EPR) laid in trefoil	Pavement or private land	530mm	300mm	450mm
11kV (Single core EPR) laid in trefoil	Roadway (ducts)	600mm	300mm	520mm

It is permissible to increase the trench depth for short lengths to avoid obstructions and overcome local engineering difficulties.

When installing cables in **agricultural land**, it is necessary that the cable be laid at sufficient depth to allow for deep ploughing and cultivation. The recommended depths, to the top of the cable, as agreed with the National Farmers' Union are as follows:

All LV & 11kV cables - 1000mm depth
All 33kV cables - 1000mm depth
All 66kV cables - 1000mm depth
All 132kV cables - 1000mm depth

3.3 Abnormal Trench Depths, Shuttering, and Unstable Ground

Shuttering with timber or other suitable material must be provided where it is necessary to prevent danger from trench side collapse or falls of rock or other material from the side of the ground adjacent to the trench.

This requirement must be carefully considered where a person could be trapped or buried or struck by material from any height. The Construction (Health, Safety, and Welfare) Regulations 1996 can be referred to for further guidance.

Where excavations deeper than normal are to be dug, reference should also be made to ST: HS 14B – Excavation and Shoring, and BS 6031 (2009), which is the Code of Practice for Earthworks. This deals with the dangers of water draining into a deep excavation and also with the importance of having knowledge of the types of ground being excavated.

All excavation works shall be risk assessed prior to starting work in order to determine whether appropriate shoring is required. As a guide excavations in excess of 1.2m deep shall be classified as 'deep excavations' by the ST: HS 14B and NRSWA, and, as such, the relevant highway authority shall be notified of the special condition.

In ground where subsidence is likely, the cable should be bedded in crushed limestone or crushed granite dust with a pronounced snake, from one side of the cable trench to the other side of the cable trench, to allow for settlement. Damage may be caused to a cable termination by movement of the cable due to ground subsidence, and an anchor should be fitted to the cable with a loop provided to ensure that the minimum of stress is applied to the accessory.

3.4 Coordinated Trenching

Coordinated trenching involves excavating one trench of suitable size to accommodate all the mains to be laid by the various utilities (water, gas, BT etc.). The advantages are cheaper trenching, minimum disturbance to the public, and a lower likelihood of any undertaker damaging another's plant.

It is essential that early consultation takes place and full liaison between all interested parties is imperative for the full benefits to be assured.

3.5 Positioning of Utilities' Apparatus in Pavement

Figure 3.5, overleaf, shows the NJUG agreed standard positioning of utilities' apparatus in a 2m wide new pavement and this shall normally be followed.

If these clearances to other utilities' plant cannot be achieved refer back to the relevant utility for guidance.

The clearances to WPD cables should also allow for subsequent access and jointing.

Table 3.5.1, overleaf, details how other utilities' plant can be identified underground.

TABLE 1 – Recommended Colour Coding of Underground Utilities Apparatus

All depths are from the surface level to the crown of the apparatus

Utility	Duct	Pipe	Cable	Marker Systems	Recommended Minimum Depths	
					Footway/Verge	Carriageway
Electricity HV (High Voltage)	Black or red duct or tile	N/A	Red or black	Yellow with black and red legend or concrete tiles	450-1200mm	750-1200mm
Electricity LV (Low Voltage)	Black or red duct or tile	N/A	Black or red	Yellow with black legend	450mm	600mm
Gas	Yellow	*** See row below	N/A	Black legend on PE pipes every linear metre.	600mm footway 750mm verge	750mm
	*** **PE** - up to 2 bar - yellow or yellow with brown stripes (removable skin revealing white or black core pipe). - between 2 to 7 bar -orange. **Steel pipes** may have yellow wrap or black tar coating or no coating. **Ductile Iron** may have plastic wrapping **Asbestos & Pit / Spun Cast Iron** – No distinguishable colour					
Water non Potable & Grey Water	N/A	Black with green stripes	N/A	N/A	600 – 750mm	600 – 750mm
Water - Firefighting	N/A	Black with red stripes or bands	N/A	N/A	600 – 750mm	600 – 750mm
Oil / fuel pipelines	N/A	Black	N/A	Various surface markers Marker tape or tiles above red concrete	900mm *All work within 3 metres of oil fuel pipelines, must receive prior approval*	900mm *All work within 3 metres of oil fuel pipelines must receive prior approval*
Sewerage	Black	No distinguishing colour / material (eg: Ductile Iron may be red; PVC may be brown)	N/A	N/A	Variable	Variable
Telecomms	Grey, white, green, Black, purple	N/A	Black or light grey	Various	250 – 350mm	450 - 600mm
Water	Blue or Grey	Blue polymer or blue or uncoated Iron / GRP. Blue polymer with brown stripe (removable skin revealing white or black pipe)	N/A	Blue or Blue/black	750mm	750mm minimum
Water pipes for special purposes (e.g. contaminated ground)	N/A	Blue polymer with brown stripes (non-removable skin)	N/A	Blue or blue/black	750mm	750mm minimum

TABLE 3.5.1 - COLOURS OF DUCTS, PIPES, CABLES & MARKER TAPES

TABLE 2 – Recommended Colour Coding of Other Underground Apparatus
All depths are from the surface level to the crown of the apparatus

Asset Owner	Duct	Pipe	Cable	Marker Systems	Recommended Minimum Depths	
					Footway	Carriageway
Highway Authority Services At the time of publication the following were current examples of known highway authority apparatus colour coding						
Street Lighting						
England and Wales	Black or orange* ** Consult electricity company first*	N/A	Black	Yellow with black legend	450mm	600mm
Scotland	Purple	N/A	Purple	Yellow with black legend or purple	450mm	450mm
Northern Ireland	Orange	N/A	Black or Orange	Various	450mm	450mm
Other						
Traffic Control	Orange		Orange	Yellow with black legend		
Street Furniture	Black	N/A	Black	Yellow with black legend	450mm	600mm
Telecoms	Purple/orange	N/A	Black	Various		
Motorways and Trunk Roads						
England and Wales						
Communications	Purple	N/A	grey	Yellow with black legend	450mm	
Communications Power	Purple	N/A	black	Yellow with black legend		
Road Lighting	Orange	N/A	Black	Yellow with black legend		
Scotland						
Communications	Black or grey	N/A	Black	Yellow with black legend		
Road Lighting	Purple	N/A	Purple	Yellow with black legend		

TABLE 3.5.1 Continued - COLOURS OF DUCTS, PIPES, CABLES & MARKER TAPES

3.6 Use of Trench Plates

Only fibreglass type trench plates (such as Technotrak 'Safety Cross' or Parker 'Defiance Trench Cover') will be used within WPD. For ease of ordering, these items have been set up on the E 5 system.

Trench plate use is restricted to footway excavations only where access to properties is to be maintained.

Trench plates must be used in conjunction with appropriate signing and guarding. Trench plates shall not be left on site in isolation.

A trench plate must be firmly fixed to the adjacent surfaces, preferably by using pins at the corners. The plate must fit flush to the existing footway and any edge trips will be ramped with temporary tarmac.

A risk assessment will be completed on every occasion a trench plate is used.

Trench plates shall not be used to defer permanent reinstatement.

FIGURE 1 - Recommended Positioning of Utility Apparatus in a 2 metre Footway

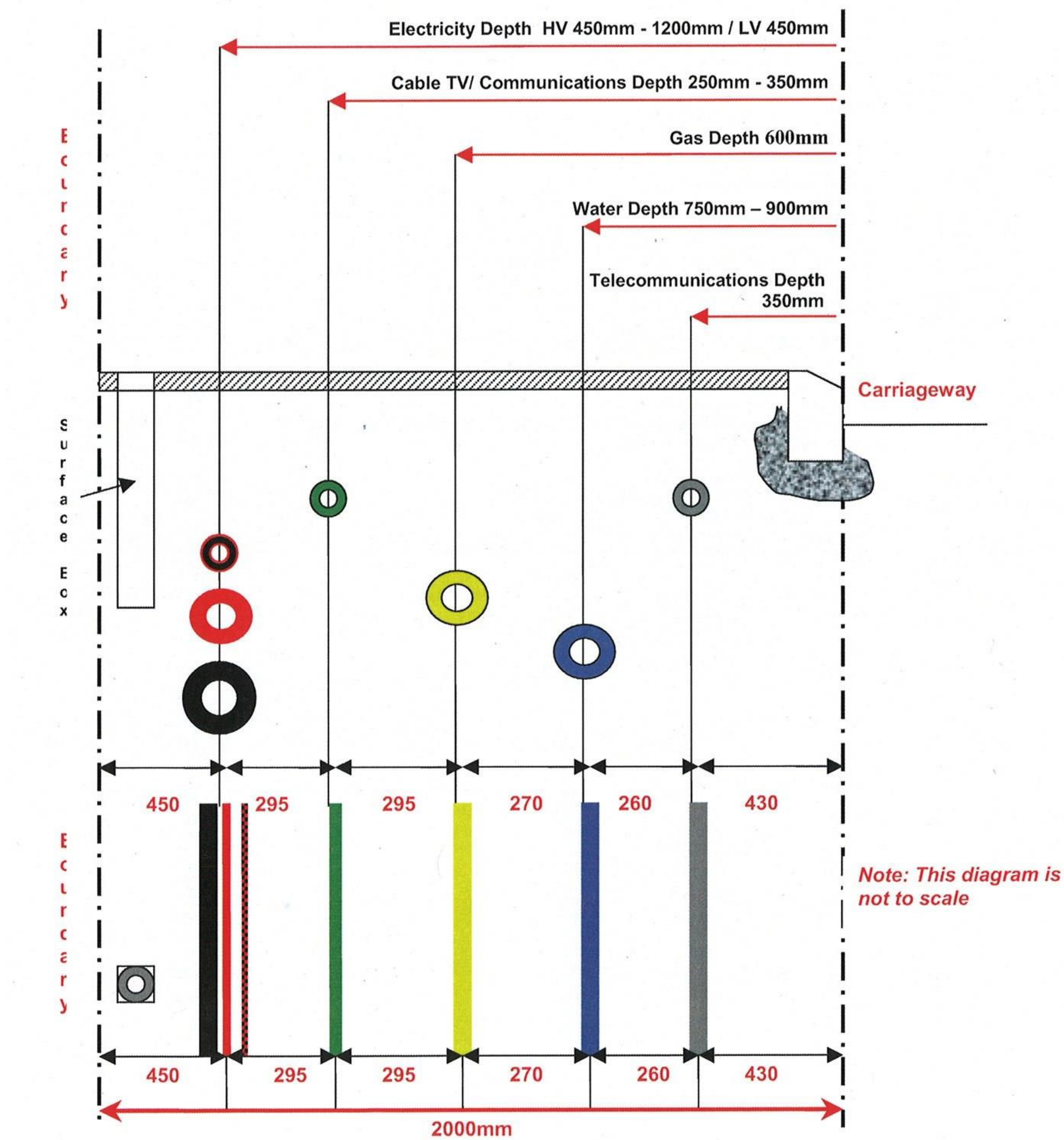


FIG 3.5 - TYPICAL CROSS-SECTION OF TRENCH SHOWING RELATIVE POSITION OF MAINS

3.7 Pipes and Ducts

Where pipes and ducts are to be installed in the cable trench they should be kept as straight as possible and shall be bedded and blinded by 75mm, this shall cover the trench width, of crushed limestone or granite 3mm to dust.

Rigiduct shall be used for LV and 11kV circuits, and "Emtelle" smooth walled uPVC type to BS EN50086-2-4: 1994 shall be used on 33, 66, 132 and 275kV circuits. All ducts shall be **BLACK**.

In theory, any length of pipe or duct will adversely affect the rating of a cable, but in practice it is generally accepted that pipes or ducts up to 15m long may be used without derating. Two or more such sections may also be used without derating; provided that no more than 30m are ducted in a total cable length of 250m and that there is a minimum separation of 10m between any two ducted sections.

The rating of the cable section can be restored if the ducts are bentonited after the cables have been installed. To ensure the thermal equivalence to the direct buried parts of the route, the ducts shall be completely filled with a bentonite-sand-cement mixture.

The filling medium shall be prepared by adding 20 parts of sand and 8 parts of cements, by weight, to 100 parts of a 10:1 water/bentonite mixture.

Note: The bentonite forms a gel, which is stabilized by the cement, and the addition of sand increases the load-bearing properties of the mixture. Should it be necessary to remove this mixture, it may be flushed out of the ducts by using high-pressure water jets.

Ducts, which are filled with a bentonite mixture, shall be installed wherever possible in a concrete surround but if not, any joints in the duct run must be effectively sealed with an approved duct seal. At the duct ends, the gap around the cable must be effectively sealed to prevent migration of the bentonite mixture and preserve its moisture content under service conditions.

In general duct lengths of up to 100m can be filled where a standard 150mm nominal bore duct is installed.

When installing duct banks, the ducts shall then be smooth walled with a 75mm radial separation of concrete between ducts. Special care should be taken to seal the joints to stop wet concrete seeping into the ducts. It must be noted that any metallic object shall not be used to maintain separation between ducts, as eddy currents will be induced if single core cables are employed in the ducts.

In long sections, synthetic fibre drawcord should be introduced as the pipes are laid.

Ducts or pipes should normally cross-established roads at right angles but it may facilitate cable laying in new developments to install them diagonally.

3.8 **Joint Hole Dimensions**

Drawing G 4016 A gives the dimensions and layout for all standard joint holes used in WPD.

3.9 **Preparation of 66 and 33kV Joint Holes**

As 66 and 33kV joints are basically flexible it is necessary to support the joints on concrete slabs. Drawing 3.7.2, 3.7.2.A and 3.7.3 shows the recommended joint bay layout. The length of slabbing will be dependant upon the particular joint involved, (e.g. for trifurcating joints a length of 6 slabs should be used).

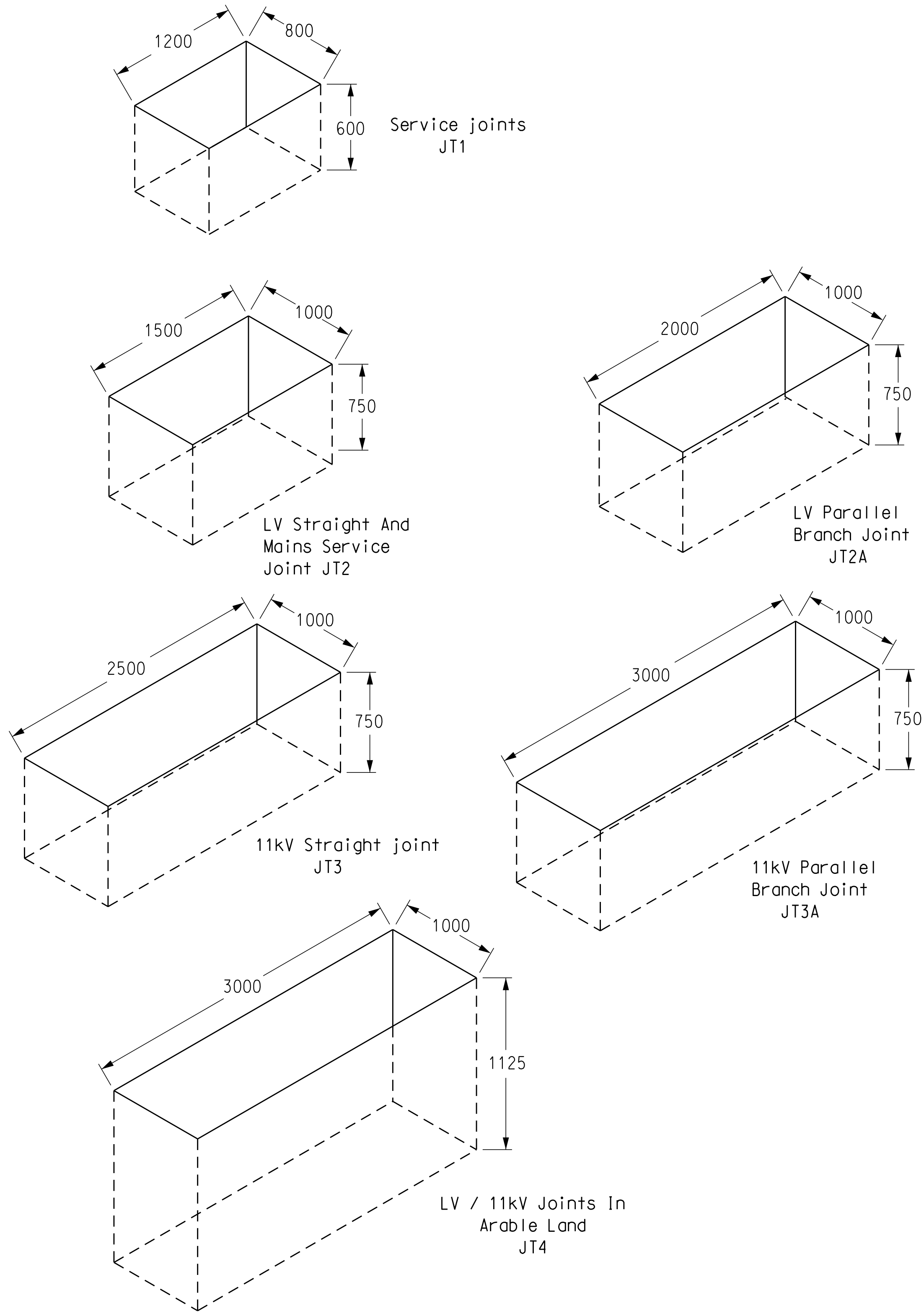
Three-slab width allows one slab each side of the joint as a working platform and these outer slabs may be recovered once jointing is complete.

A granular sub-base will allow easy levelling of the slabs in addition this will also assist with drainage of the working area if the area is wet. Sand bags beyond the ends of the joint should support the cables, and be left in position once jointing is complete.

3.10 **Installation of Cross Bonding Link Boxes on 66 & 132kV Flat Spaced Circuits**

When installing 66kV or 132kV single core cables of conductor sizes of 630mm^2 or larger then it becomes economical to consider laying the circuit in flat spaced configuration where the spacing between the individual conductors can be D, 2D, 3D or 4D spacing where D is the diameter of an individual core, this will give the circuit a slightly higher current rating but this will be offset by the increased cost of the cross bonding link boxes. The design of the cross bonding system shall comply with Electricity Network Association Engineering Recommendation C55/4, refer to the Company Cable Engineer in Avonbank. When the link boxes are installed in the ground the length of the bonding leads which connect the joints to the link boxes **must not** exceed 8m.

This means that if the circuit is laid in the carriageway then the cross bonding link boxes can be installed in the sidewalk; this will allow future maintenance on the link boxes without having to get a lane closure. See drawing 3.10



Rev No	Drawn	Chk'd	App'd	Date	Revision
5	RJB			02/18	JOINT TEXT CHANGED

ORIGINAL ISSUE		DATE
Drawn		
Checked		
Approved		
SCALE	N.T.S.	

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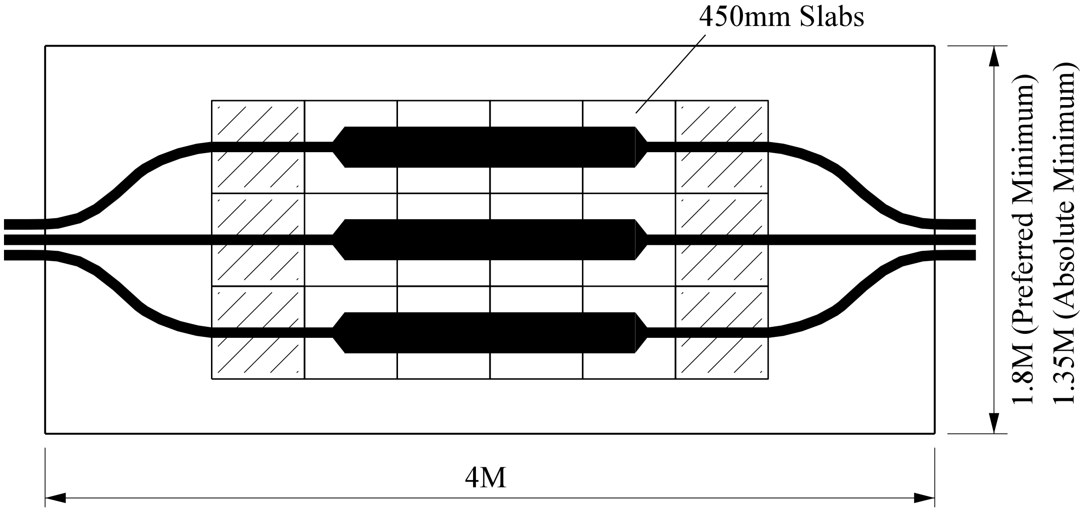
Design Department.
Avonbank, Feeder Road, Bristol BS2 0TB
Tel: 0117 933 2000 Fax: 0117 933 2001.

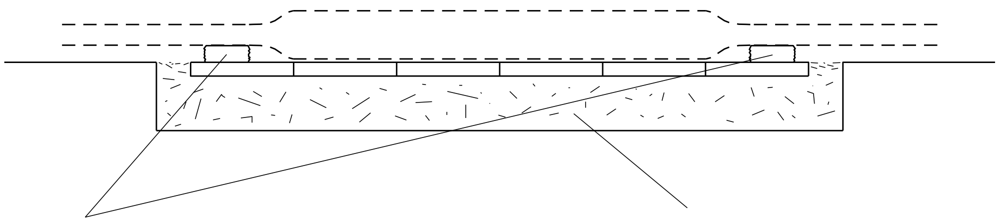
WESTERN POWER DISTRIBUTION

Title: STANDARD JOINT HOLES

Drg. No.: G4016 / A

Rev No: 5





Note shoring requirements

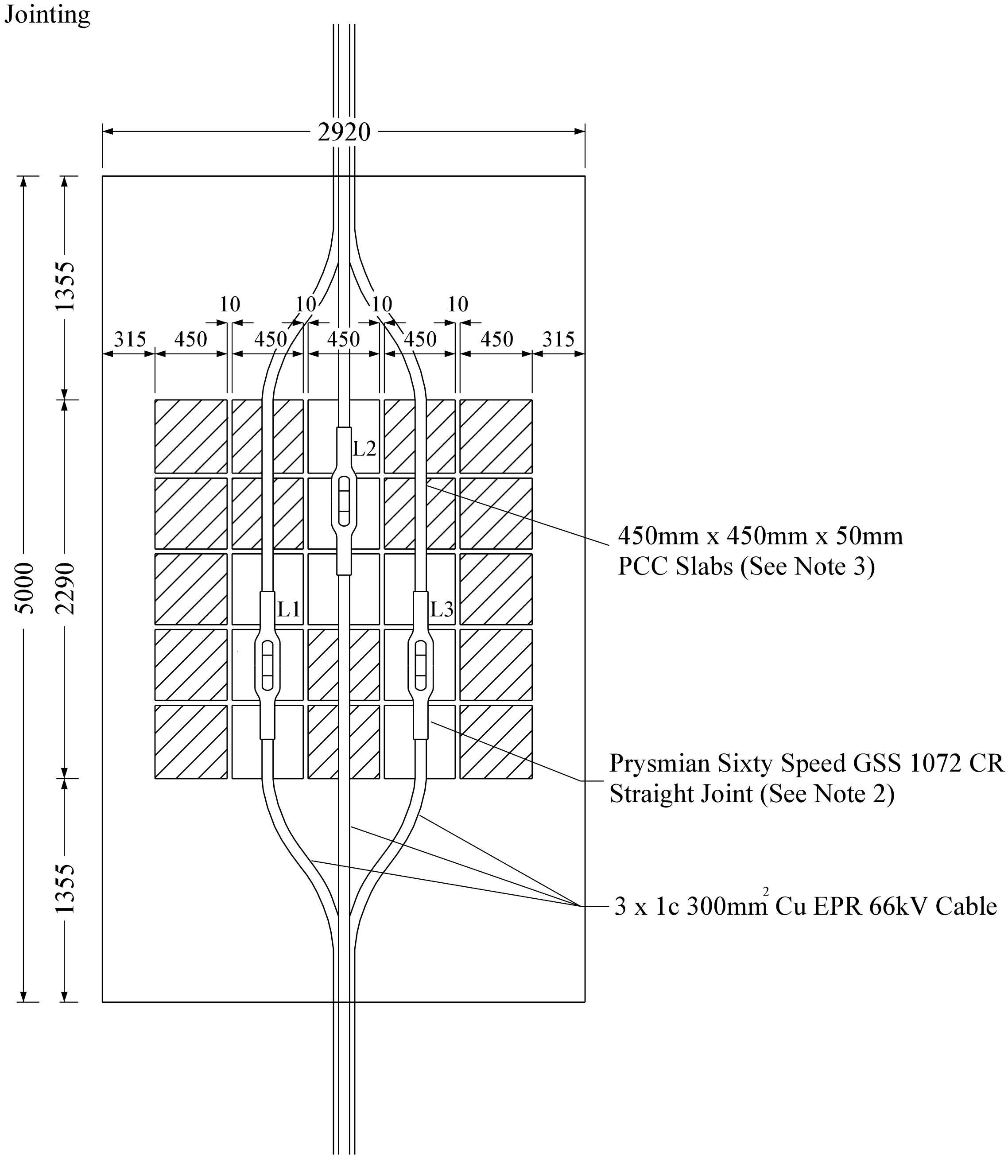
for deep excavations

5	RJB			02/18	DRAWING CHANGED
Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	R.J.B.	03.97			
Checked			Title JOINT BAY BASE FOR 33kV JOINTS	Drg. No. 3.7.3	Rev No 5
Approved					
SCALE	N.T.S.				

Note :-

1 All Dimensions Are In mm
2 Sandbag Support To Be Used As Shown In WPD Technical Standard CA6A/3 (Page 22) For Details
3 Hatched Slabs May Be Removed Upon Completion Of Jointing



Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE	DATE	
Drawn RJB	10/16	
Checked		
Approved		
SCALE N.T.S.		

WESTERN POWER DISTRIBUTION
Design Department.
Avonbank, Feeder Road, Bristol BS2 0TB
Tel: 0117 933 2000 Fax: 0117 933 2001.

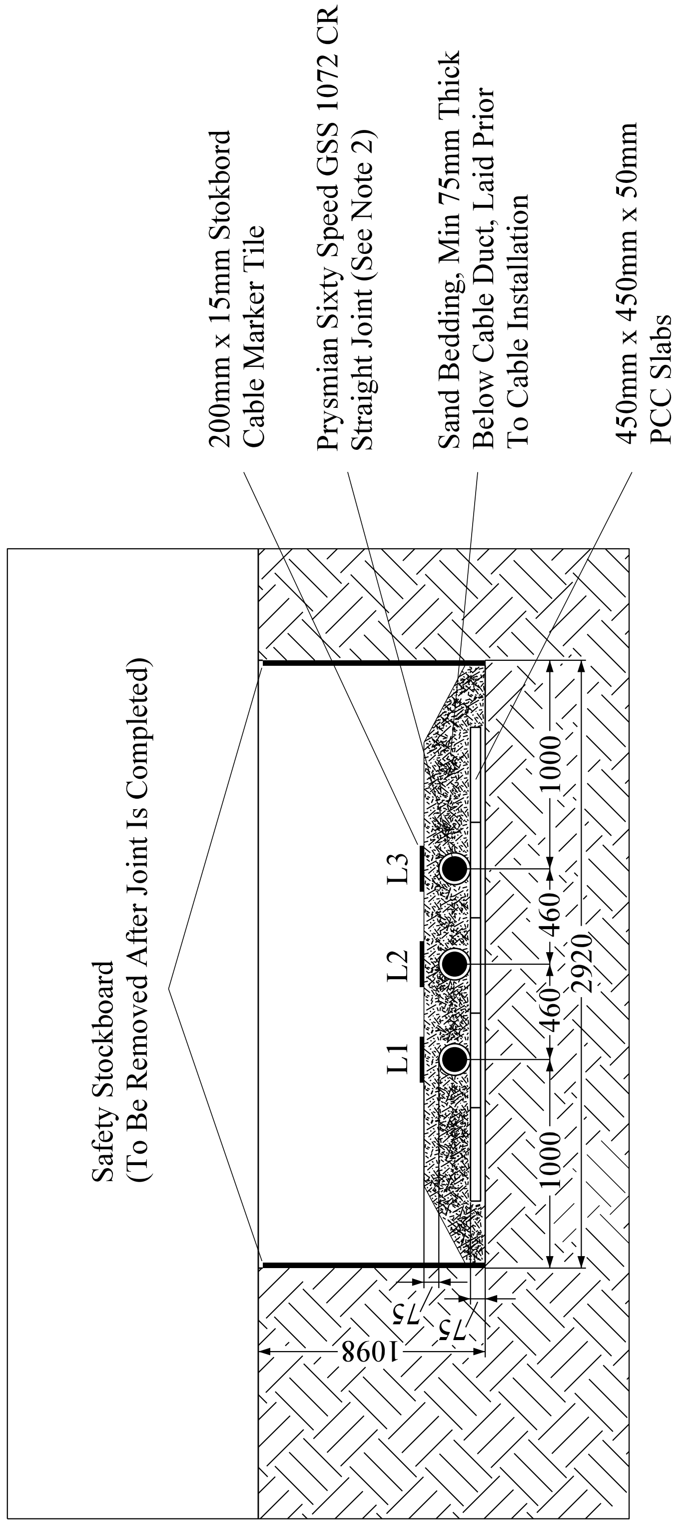
WESTERN POWER DISTRIBUTION

Title: TYPICAL 66kV JOINT BAY LAYOUT

Drg. No. 3.7.2

Rev No

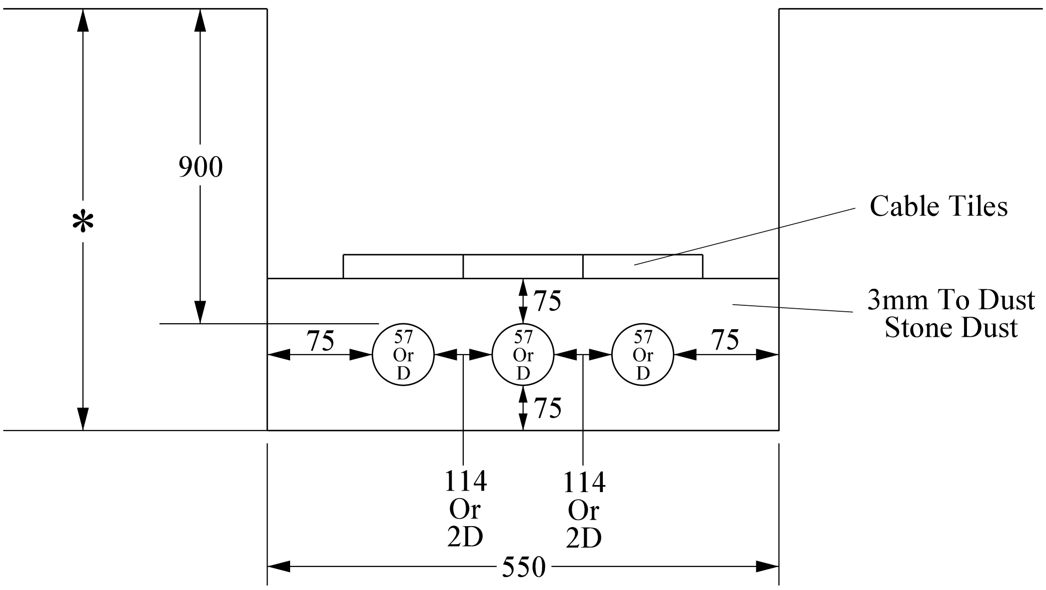
Note :-
1 All Dimensions Are In mm
2 Sandbag Support To Be Used As Shown In WPD Technical Standard CA6A/3 (Page 22) For Details



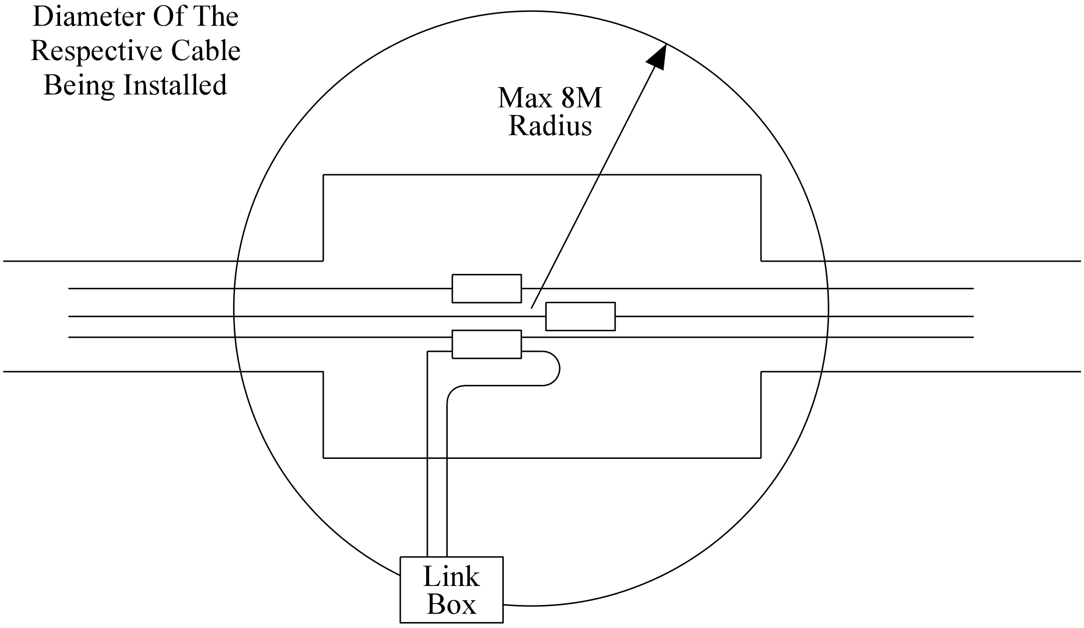
Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE	DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn RJB	10/16			
Checked		Title	Drg. No.	Rev No
Approved		TYPICAL 66kV JOINT BAY CROSS SECTION	3.7.2A	
SCALE N.T.S.				

All dimensions in mm



* This Dimension Will Vary Due To The Diameter Of The Respective Cable Being Installed



Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE	DATE
Drawn RJB	07/11
Checked	
Approved	
SCALE N.T.S.	

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Design Department.
Avonbank, Feeder Road, Bristol BS2 0TB
Tel: 0117 933 2000 Fax: 0117 933 2001.

WESTERN POWER DISTRIBUTION

Title
66kV 3 x SINGLE CORE EPR OR XLPE CABLES LAID WITH 2D FLAT SPACING

Drg. No. 3.10

Rev No

3.11 **Landfill Tax**

POL: EN 3, ST: EN 3A and ST: EN 3B sets out the regime for the disposal of material excavated from sites. It defines inert and active waste and the composition of mixed loads for the purposes of the interpretation of the HM Customs and Excise Landfill Tax Levy.

Inactive or general waste incurs the lower rate of tax and is tightly defined. For WPD purposes, materials such as rocks, soils, and concrete fall into this category. Active waste includes plastics, tins, bitumen, paper and wood and the higher tax rate applies. It is very important, therefore, that a mixed load is not corrupted with unacceptable items of active waste such as compound tins, bits of cable, wood shuttering etc. It is worth noting that the tax does make allowances for small quantities of bitumen material including tarmac or asphalt in a load of soil dug up for Utilities' street works. This qualifies at the lower tax rate if these incidental amounts of active waste are considered to be no pollution risk.

3.12 **Contaminated Ground**

Often the local knowledge of a site is the single most important aspect when assessing the risks of carrying out an excavation. In order to assess the risks attached to the laying of cables in development land, the developers should notify WPD of the land being contaminated and provide details of the contamination. If the ground to be excavated is known to contain a high percentage of ash or peat, or is contaminated with industrial waste or organic acids, then ST: HS 12J “Precautions to be taken when working on contaminated land” should be referred to. It defines contaminated material, the nature of its possible occurrence on WPD sites, and the safe handling and personal protective measures to be employed by employees and appointed contractors when carrying out excavation in the vicinity of such material.

3.13 **Bridge Crossings**

The method of crossing and work involved should be agreed with the relevant Bridge Authority who may opt to supervise the installation to ensure that the bridge fabric and abutments are not damaged.

All cables shall be sinusoidally snaked prior to the approach of an abutment, to allow for expansion and contraction of the bridge structure.

In the case of 33, 66 and 132kV cables, they shall also be cleated to the abutment.

It may be necessary to install cables in pipes or on trays fixed to the external fabric of the bridge. Cleating should be avoided particularly on structures subject to vibration. In situations where vibration occurs, then advice should be sought from the Company Cable Engineer.

Where it is not practicable to obtain normal burying depths, consideration should be given to laying the cables in ducts, which in turn may have to be protected by concrete and/or steel plates. Alternatively, chases may be formed under the footpath and suitably protected from the possibility of vehicles mounting the footpath.

3.14 Substations and Buildings

The Distribution Safety Rules apply to work on or near WPD's system and apparatus, and apply to WPD employees and contractors alike.

All work in substation buildings and compounds must comply with the Distribution Safety Rules, the appropriate sections of the Factories Acts, the Electricity (Factories Act) Special Regulations and the Electricity Supply Regulations. No person shall enter a substation without authority.

Where long objects or large machines have to be used, a Senior Authorised Person must give permission and the work must be directly supervised by an Authorised Person.

For safety and operational reasons, substations should not be used as stores, mess rooms, or for shelter.

3.14.1 Work in Buildings, including Indoor Substations

In buildings protected by CO_2 fire fighting installation the automatic operating mechanism must be rendered inoperative before any work is done in the building.

Sensitive equipment is often installed in buildings and special care must be taken to keep vibration to a minimum when working in the vicinity of such equipment. Guidance on cleating is given in section 4.3.

Cable entry positions must be sealed to keep out vermin and stop water and gas entering the building.

3.15 Earth Wires

For all aspects of earthing, then the suite of documents in ST: TP21B, ST: TP21D and ST: TP21E, Engineering Specification EE89/2 shall be referred to for guidance. Further guidance can be found in

\\avodcs01\eds\Engineering Design Manual\Connection Guides\33kV Connection Guide\33kV Indoor Connection Guide - version 18.docx

And

L:\CIC\G81 + WPD Appendices

The laying of earth electrode close and parallel to hessian served power cables, multicore cables, or bare metal pipes, is to be avoided. This is to reduce the risk of them being punctured due to high currents or voltage transients on the electrode. It is particularly important to ensure that insulation is applied to such cables at positions where a long earth electrode terminates. Ideally, the end of the electrode should be bent away from the cable or pipe, to increase the separation at this point, in addition to the insulation.

Electrode must be at laid at least 300mm away from hessian served power cables and bare metal pipes and 150mm away from plastic sheathed cables. Where a crossing is necessary, PVC tape or a split plastic duct shall be applied around the cable or pipe for 0.5m either side of a position where the cable or pipe crosses an earth electrode, or for the distance over which the 0.3m separation cannot be maintained.

When laying a 70mm² HDC earth conductor in the same trench as a LV, 11kV, 33kV, 66kV, 132kV, Pilot, Scada or Multicore cables the 70mm² HDC needs to be in intimate contact with the native soil of the cable trench, in addition damage to power cables or multicore cables due to high voltage transients or thermal effects of earth fault current on/in the 70mm² HDC earth electrode shall be prevented by adequate separation. *In the absence of other information, it shall be assumed that 150mm separation between the 70mm² HDC and the insulated power circuit or other cables meets this requirement.*

3.16 Excavation Work near Other Cables

Where work is being carried out near our underground cables special care is required. The person in charge of the site of work shall be warned of the dangers and advised of the route and depth of the mains, which may be affected. Copies of the WPD booklet "Avoiding danger from underground electricity cables" shall be sent to all contractors who work near WPD circuits. Further information can be obtained from the Health & Safety Executive Guidance booklet HS (G) 47 entitled "Avoiding danger from underground services".

3.17 Laying Cables near Trees

Tree roots keep a tree healthy and upright. Most roots are found in the top 600mm of soil and often grow out further than the tree’s height. The majority of these roots are very fine; even close to a tree few will be thicker than a pencil. Most street tree roots grow under the footway but may also extend under the carriageway. If roots are damaged the tree may suffer irreversible harm and eventually die.

Protecting Roots - Do’s and Don’ts

There are three designated zones around a tree each of which has its own criteria for working practices.

The Prohibited Zone

Don't excavate within this zone.

Don't use any form of mechanical plant within this zone

Don't store materials, plant or equipment within this zone.

Don't move plant or vehicles within this zone.

Don't lean materials against, or chain plant to, the trunk.

Do contact the local authority tree officer or owner of the tree if excavation within this zone is unavoidable.

Do protect any exposed roots uncovered within this zone with dry sacking.

Do backfill with a suitable inert granular and top soil material mix as soon as possible on completion of works.

Do notify the local authority tree officer or the tree's owner of any damage.

The Precautionary Zone

Don't excavate with machinery. Where excavation is unavoidable within this zone excavate only by hand or use trenchless techniques.

Don't cut roots over 25mm in diameter, unless advice has been sought from the local authority tree officer.

Don't repeatedly move / use heavy mechanical plant except on hard standing.

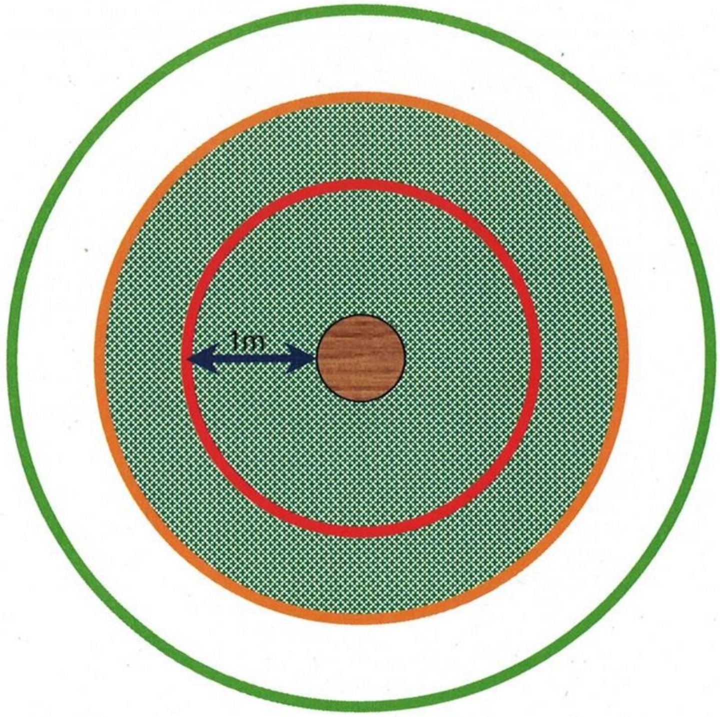
Don't store spoil or building material, including chemicals and fuels, within this zone.

Do prune roots which have to be removed using a sharp tool (e.g. secateurs or handsaw). Make a clean cut and leave as small a wound as possible.

Do backfill the trench with an inert granular material and top soil mix. Compact the backfill with care around the retained roots. On non highway sites backfill only with excavated soil.

Do protect any exposed roots with dry sacking ensuring this is removed before backfilling.

Do notify the local authority tree officer or the tree's owner of any damage.



TREE PROTECTION ZONE

Key to Diagram

Trunk of Tree

Spread of canopy or branches

PROHIBITED ZONE – 1m from trunk. Excavations of any kind must not be undertaken within this zone unless full consultation with Local Authority Tree Officer is undertaken. Materials, plant and spoil must not be stored within this zone.

PRECAUTIONARY ZONE – 4 x tree circumference. Where excavations must be undertaken within this zone the use of mechanical excavation plant should be prohibited. Precautions should be undertaken to protect any exposed roots. Materials, plant and spoil should not be stored within this zone. Consult with Local Authority Tree Officer if in any doubt.

PERMITTED ZONE – outside of precautionary zone. Excavation works may be undertaken within this zone however caution must be applied and the use of mechanical plant limited. Any exposed roots should be protected.

3.18 Tree Planting Restrictions near Underground Cables

Early consultation with WPD should take place before any tree work, including planting, is undertaken to ascertain the position of existing apparatus. When planning new tree planting, there should be liaison with the WPD, local authority and landowner so that the risks trees may pose to utility apparatus in the future are minimised.

3.18.1 It has been established that root growth of some trees is a definite hazard to all types of LV, 11kV, 33kV, 66kV and 132kV underground cable circuits, therefore before any tree planting is carried out on an underground cable easement, written approval must be obtained from Western Power Distribution (WPD). Any approval granted by WPD to plant trees on the easement must be subject to WPD retaining the right to remove, at any time in the future, all trees which in the opinion of WPD Engineer might become a danger to the underground cables. See drawing 3.18.1.

3.18.2 The written consent to plant trees will state what area may be planted and also the type of tree.

3.18.3 The only hardwood plants, which can be planted directly across the underground cable circuit, are hedge plants such as Quickthorn, Blackthorn, Holly, etc. and these should only be planted where a hedge is necessary either for screening purposes or to indicate a field boundary.

3.18.4 Poplar and Willow trees should not be planted within 10.0m of the underground circuit.

3.18.5 The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6.0m of the underground cable circuit: Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Maple, Oak, and Sycamore. Apple and Pear trees also come into this category. These trees may only be planted as individual specimens or a single row in an area between 6.0m and 10.0m of any underground cable circuit. Dense mass planting may only be carried out at distances greater than 10.0m from any underground cable circuit.

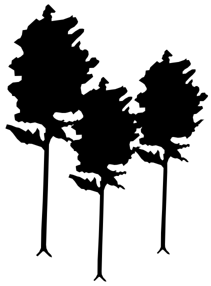
3.18.6 Raspberries, Gooseberries, Red and Blackcurrants may be planted on the easement but a 4.0m strip (2.0m each side of the underground cable circuit) must be left clear at all times.

3.18.7 Root barriers can only be used with dwarf stock only. If these are to be used please notify WPD with type and details of root barrier, and final growth and root size.

3.18.8 In cases where screening is required, the following are shallow rooting and may be planted close to any underground cable circuit: -

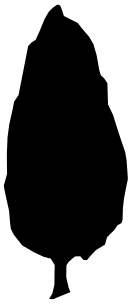
Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry and most ornamental flowering shrubs.

3.18.9 Christmas trees (Picea Abies) may be planted within 3.0m of any underground cable circuit. However, permission is given on the strict understanding that the Christmas trees are clear felled at intervals not exceeding seven years.



Large growing species of:
Poplars and Willows

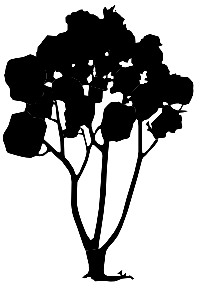
10.0m



Large Conifers and Deciduous Forest Trees

Scots Pine	Horse Chestnut	Apple
Black Pine	Sweet Chestnut	Pear
Cedar	London Plane	Plum
Larch	Hornbeam	Cherry
Ash	Lime Alder	
Beech	Elm	
Sycamore	Oak	

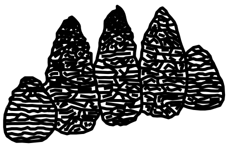
6.0m



Dwarf Stock Fruit Trees

Amenity Trees	Ornamental Trees
Field Maple	Mountain Ash
Wild Cherry	Whitebeam
Crab Apple	Cockspur Thorn
Cobnut	False Acacia
Birch	Lawsons Cypress
Elder	

3.0m



Shrub Planting

Bushes	Fruit
Holly	Gooseberries
Laurel	Raspberries
Privet	Currants
Rhododendron	Roses
Christmas Trees	

1.5m

Hedgeplants and Groundcovers

Hedgeplants only where necessary over WPD cable circuit,road and field crossings etc.

Ground Cover: Hawthorn Blackthorn Heathers Snowberry Berberis Cotoneaster

Distance From WPD Cable Circuit

Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE
Drawn	RJB	03/10
Checked		
Approved		
SCALE	N.T.S.	

WESTERN POWER DISTRIBUTION
Design Department.
Avonbank,Feeder Road,Bristol BS2 0TB
Tel: 0117 933 2000 Fax: 0117 933 2001.

WESTERN POWER DISTRIBUTION

Title	Drg. No.	Rev No
PLANTING DISTANCE FROM CABLES	3.18.1	

3.18.10 In situations where trees and bushes are already established over or near the underground cable circuit, contact will be made with you by WPD to decide on a future course of action.

3.19 Railways

Access to, or work within the Network Rail infrastructure and level crossings poses special safety hazards to staff, contractors, railway users and the general public. Consequently there are rigorous control measures in place, primarily set out in: -

(a) Energy Networks Association Engineering Recommendation G56/1-1996 "Arrangements for access by ENA Member Company staff to Railtrack infrastructure".

(b) Department for Transport - Code of Practice for Coordination of Street Works and Works for Road Purposes and Related Matters, third edition August 2009 – See Appendix C on Works at or near Level Crossings.

Compliance with these requirements is mandatory, and further information should be sought from WPD Policy Document POL: GE14 and WPD Standard Technique ST: GE14A and ST: GE14B.

It is also worth noting that when trenching under a railway bridge, there is a need to establish the position and details of the foundations plus a need to contact Network Rail to gain written clearance from them that the proposed cable route will not impinge on their existing structure.

3.20 Motorways

Motorways are classified as 'protected' in the New Roads and Streetworks Act (1991). WPD do not have any statutory rights in respect of motorways and the consent of the Ministry responsible for motorways must be obtained before WPD circuits can cross over or under motorways.

It is highly unlikely that any surface excavation will be allowed on motorways after they have been opened to traffic. Underground crossings may only be allowed if guided boring techniques are employed. It is therefore extremely important that provision be made during the construction of motorways for cable crossings, if these are foreseen.

3.21 Trenchless Technology

Trenchless technology can be a useful technique for installing cables where open excavation may prove uneconomical or difficult. Many different systems can be employed which are dependant on site/ground conditions. The varying techniques, which may be employed, include: -

- Impact mole boring
- Push rodding
- Impact pipe ramming
- Auger boring
- Rock boring
- Guided boring (Horizontal Directional Drilling - HDD)

Advantages include the fact that fewer openings are required, these being limited to the launch and receiving pits, and points where other existing services cross the intended route. Careful planning is essential in determining the route with its launch and receive pits and in accurately locating the points at which existing underground mains and services cross the route. If necessary, trial holes must be excavated at crossing points to ensure that no damage results from the passage of the mole.

The duct used in HDD work shall be appropriately sized SDR 11 duct marked with Danger Electric Cable, all joints of the SDR 11duct SHALL have the internal bead removed regardless of whether the joint was fusion butt welded or electro fusion coupled. If this bead is not removed the likelihood is there will be sheath damage to the cable/s installed into the duct. All HDD work shall comply with specification EE 53.

4.0 LAYING CABLE

4.1 Preparation

On new developments cables would not normally be laid until the kerb lines are in situ. This will help ensure that cables are laid to the correct depth and position.

Cables shall not be laid in areas impacted by settlement until the ground has been stabilized.

4.1.1 Precautions in Cold Weather

Cables with PVC or paper insulation or PVC oversheaths (e.g. service and wavecon cables) should take place only when both cable and ambient temperature have been at or above freezing point 0°C for the previous 24 hours as the cold will damage the insulation and or oversheath. Polymeric (EPR and XLPE) cables with MDPE oversheaths can be damaged if they are installed when the cable temperatures are below -10°C. In very cold weather, special measures must be taken to ensure that the cables are at a temperature above freezing point when being laid.

Under such circumstances cables shall be stored indoors, preferably in a heated building, to 'thaw out' for 24 hours before laying. The cable should then be delivered to site on a sheeted trailer and installed as quickly as possible.

If the drum has already reached a temperature below freezing, the use of a hot air blower, possibly of the propane type is recommended. Localised overheating must be avoided.

Cables stored at temperatures, which are below that recommended for installation should not be subject to any mechanical stress including shocks, impact, bending or torsion.

4.1.2 Cable Drums - Handling and Positioning

When handling drums, suitable precautions should be taken to avoid damage to the cable and injury to people. Due regard should be paid to the mass of the drum, the method and direction of rolling and the method of lifting.

It is preferable for ease of handling and safety to move drums by special cable drum trailers and whenever possible the cable should be laid direct from these. In certain cases it may be possible to lay cable from a drum trailer whilst it is being towed alongside the trench, thus giving a considerable saving in time and effort. For more guidance refer to section 4.2.3.2**.**

The drum mounting position, if stationary, will be influenced by the following:

- **Accessibility** - Good access to where the cable drum is to be mounted.
- **Gradient** - On sloping ground, cables should be pulled downhill.
- **Bends** - The drum should be mounted at the end of the trench nearest the bends. The force required to pull cable is less near to the drum, and therefore, the side forces and friction on the bends will also be less.
- **Ducts** - To minimise the disturbance to ducts and the resulting possibility of damage to the cables, the drum should be at the end of the trench farthest from the ducts.
- **Jointing** - Consecutive lengths of cable should be laid 'A' end to 'Z' end to ensure correct rotation of the cores when jointing.

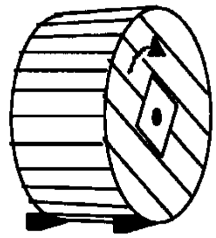
Generally, more than one of the above factors will be present and a compromise will be necessary. When bends and ducts are adjacent the guidance given for bends applies.

When rolling drums, it should be over short distances only and the drum rotation should always be according to the arrow marked on the drum flange. This will ensure that any slack cable is worked to the outer end. Failure to take this precaution may result in slack cable collecting at the hub of the drum causing damage.

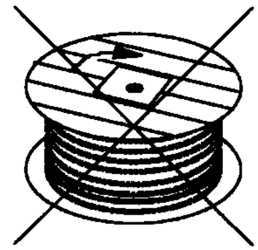
If it is necessary to alter the course on which the drum is being rolled, a drum-slewing bar should be used, as shown in figure 4.1.2. Pipes or other make-do equipment should not be used for this purpose, as they are unsuitable and dangerous.

The cable drum shall never be left unchecked, in case it rolls either by accident or vandalism.

Cable drums should be transported with the drum axis horizontal and any drum movement should be avoided.



Keep the drum standing upright. using wedges in the heels of the flanges



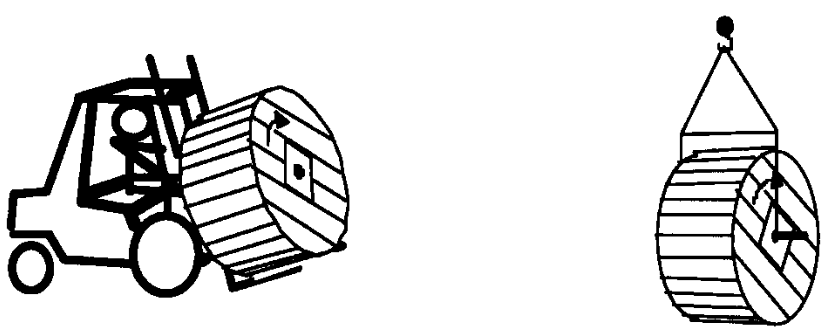
Not recommended

The cable drum must be so arranged that the cable be pulled off the top of the drum. If battens are fitted and the end of the cable cannot be seen, the drum should be set up so that it will rotate during cable laying in the opposite direction to the 'rolling' arrow.

Cable ends should be firmly attached to the drum during transport and storage to prevent damage to the cable.

Care should be taken to avoid damage to the cables caused by nails or staples used in drum manufacture or when applying battens.

For loading and unloading of cable drums, suitable lifting and hoisting equipment should be used. A drum should not be dropped.



Drums may be lifted either by crane or fork-lift truck

4.1.3 Winch Positioning

Normally, the cable will be pulled direct from the drum trailer but in its absence, drum jacks and spindles should be used. A 2.1m long by 75mm outside diameter 5000kg SWL high tensile seamless steel tubular drum spindle with 2 x 5000kg ratchet type cable drum jacks with timber bases and cups to take up to 100mm spindles will support cable drums holding up to 250m of the largest standard sizes of LV, HV and EHV cables.

Cable drum jacks should be mounted on a firm level base. If the ground is uneven, a foundation should be provided by using stout timber solidly packed. Timber packing may also be necessary to prevent settling of the jacks by spreading the weight if the ground is soft. It may be necessary to locate the drum in the roadway away from the trench and in this case the drum should then be offset by not more than 30 degrees to the line of the trench. For safety, the drum should not be mounted closer than 1m to trench excavations of normal depth.

The drum should be raised to just clear the ground and the drum spindle levelled to prevent the drum moving to one end. The level of the drum should be checked by a plumb bob against the drum side or by placing a spirit level on the drum spindle. When using a spirit level with heavy cable drums, readings should be taken at each end to compensate for deflection of the loaded spindle.

The spindle should be greased and a check made for smooth rotation of the drum.

Drum battens and steel bands if fitted may then be removed. For safety, all nails should be withdrawn from the battens and drum rim immediately and the battens stacked neatly.

The winch to be used may be of the platform mounted, trailer mounted, or vehicle mounted type.

The winch should be positioned at the end of the cable trench and securely anchored. It is important to note that where a boom is used, the main anchorage against the pull must be at the lower end of the boom. The anchorage should be obtained by cross bracings recessed into the sides of the trench.

4.1.4 **Cable Bedding**

The bed of the cable trench shall be free from water, stones, and pieces of rock that may cause damage to the cable. Loose stones in the trench sides that may be dislodged during the cable pull, shall be removed.

Crushed limestone dust 3mm to dust, or crushed granite, 3mm to dust, shall be imported and should be laid to provide a suitable bedding for the cable or duct. Once the cable or duct has been laid onto the bedding a further layer of crushed limestone dust or crushed granite dust shall be applied, this shall be for a depth of 75mm above the cable or duct.

4.1.5 **Cable Rollers - Positioning**

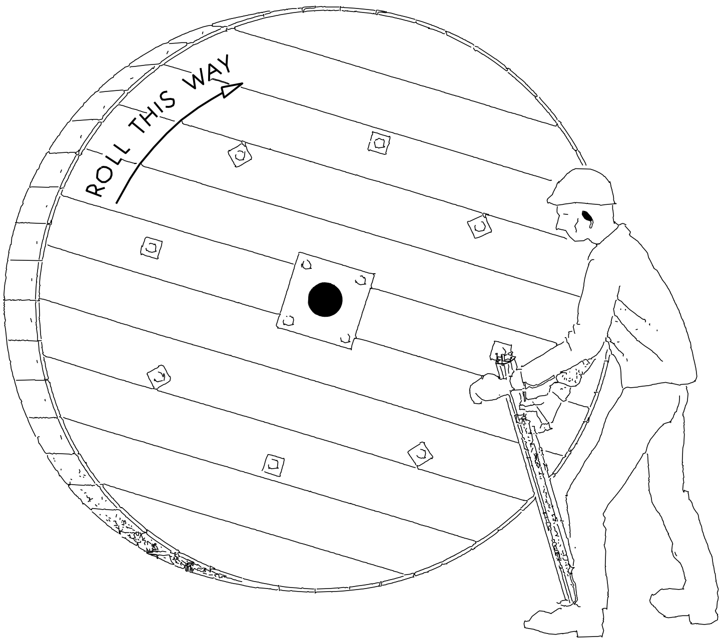
The rollers are necessary to avoid abrasion of the cable by keeping it clear of the ground and to reduce friction during pulling. The types of roller generally available are depicted in figure 4.1.5a. The ramps built into the straight and corner cable rollers allow the cable end to ride over without being lifted. These rollers are, therefore, suitable for either winch or hand pulling. The arrangement of cable rollers will depend upon which of these methods is used.

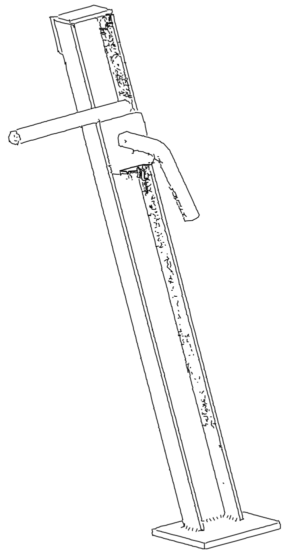
A typical arrangement of rollers in a trench is shown in figure **4.1.5b**.

The straight rollers should be no more than 2m apart. Too great a spacing between rollers will allow excessive sag in the cable and 'rowing' will result whenever the pull is released and then taken up again. This is particularly wasteful of effort during hand pulling. Special attention should be paid to the position of rollers in the trench at points where a change of direction is made.

The positioning of the rollers should be such that the cable is not bent around too sharp a radius. Refer to table 4.1.5 for details of minimum bending radius for cables.

Drum slewing bar intercepts nut at end of one
of the tie bars and ,asthe drum is rolling ,it
lifts one side of the drum and alters the direction.





2	RJB			06.03	REDRAW ON CAD
Rev No	Drawn	Chk'd	App'd	Date	Revision

ORIGINAL ISSUE		DATE	WESTERN POWER DISTRIBUTION Design Department. Avonbank,Feeder Road,Bristol BS2 0TB Tel: 0117 933 2000 Fax: 0117 933 2001.	WESTERN POWER DISTRIBUTION	
Drawn	RJB				
Checked			Title	Drg. No.	Rev No
Approved					
SCALE	N.T.S.		USE OF THE DRUM SLEWING BAR	4.1.2.	2

TABLE 4.1.5 - MINIMUM BENDING RADII OF WPD STANDARD CABLES

LV SERVICE CABLES		
Type of Cable	SINGLE CORE (mm)	THREE CORE (mm)
4 mm^2 CONC	75	-
16 mm^2 CONC	100	200
25 mm^2 CONC	125	200
25 mm^2 HYBRID	125	200
35 mm^2 HYBRID	125	250
4 mm^2 SPLIT	100	-
16 mm^2 SPLIT	125	-
25 mm^2 SPLIT	150	-
35 mm^2 SPLIT HYBRID	-	250

LV MAINS		
Type of Cable	**SINGLE CORE (mm)**	**THREE CORE (mm)**
3 Core Wavecon		
3 Core 95 mm^2 WAVECON	-	550
3 Core 185 mm^2 WAVECON	-	700
3 Core 300 mm^2 WAVECON	-	850
4 Core Wavecon		
4 Core 95 mm^2 WAVECON	-	600
4 Core 185 mm^2 WAVECON	-	800
4 Core 300 mm^2 WAVECON	-	1000

LV ARMOURED	
Type of Cable	**SINGLE CORE (mm)**
480 mm^2 SOLIDAL	350
600 mm^2 SOLIDAL	400
740 mm^2 SOLIDAL	400
960 mm^2 SOLIDAL	450

11kV Cables		
Type of Cable	**SINGLE CORE (mm)**	**THREE CORE (mm)**
95 mm^2 PICAS	-	600
185 mm^2 PICAS	-	750
300 mm^2 PICAS	-	900
500 mm^2 PILC Cu	650	-
630 mm^2 PILC Cu	750	-
630mm^2 Cu. Single core EPR	1000	-
300mm^2 Cu. Single core EPR	800	-
95mm^2 Al. Single core EPR	600	-
95mm^2 Al. Triplex EPR	-	600
185 mm^2 Al. Triplex EPR		650
300 mm^2 Al. Triplex EPR		750

33 kV Cables		
Type of Cable	**SINGLE CORE (mm)**	**THREE CORE (mm)**
185 mm^2 EPR	940	-
240 mm^2 EPR	980	-
400 mm^2 EPR	1100	-
630 mm^2 EPR	1200	-
800mm^2 EPR	1300	
185 mm^2 'H' type Cu	-	1400
240mm^2 ‘H’ type Cu.	-	1500

66 kV Cables		
Type of Cable	**SINGLE CORE (mm)**	**THREE CORE (mm)**
185 mm^2 EPR or XLPE	1300	-
300 mm^2 EPR or XLPE	1300	-
400 mm^2 EPR or XLPE	1400	-
630 mm^2 EPR or XLPE	1500	-
1000 mm^2 EPR or XLPE	1700	-

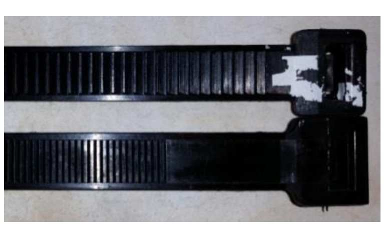
A rope should be used to check that the corner assemblies have a smooth curvature, are free of protrusions and will allow the cable to rise smoothly on to the main area without bearing on the leading edge.

Where cable has to pass through ducts the rollers must be so arranged that the cable enters in a straight line and does not bear against the duct wall. For this reason the rollers should be placed so that their surface throws the cable at least 10mm off the duct interior wall.

These points are particularly important where a bend in the cable precedes entry to the duct and then some additional standoff may be necessary to allow for movement of the roller assembly under thrust.

Removable split bell mouths can be inserted into the leading edge of pipe or ducts to facilitate cable entry and prevent damage to the cable oversheath.

Where three single core 33kV or 66kV cables are to be pulled in trefoil into a single suitable sized smooth walled uPVC duct, precautions shall be taken to prevent the cables from going into a flat space configuration in the duct. Prior to the installation in the duct two complete turns of Gorilla gaffer or duct tape shall be placed at 1.5m intervals along the cable length. Where the cables are to cable tied to cable racking it should be noted that careful selection of the 13mm cable tie is required, the cable tie needs to have small serrations as this allows the cable tie to be pulled up tight on to the cores. The bottom cable tie in the photograph is the preferred type.



4.1.5.1 **Winch Pulling**

Dynamometers should be fitted to all winches so as the maximum pulling tension of the cables is not exceeded on installation. A digital print out should also be obtained at the end of each completed cable pull to prove the cable was not over tensioned during installation. If the cable pull appears to be difficult it is advisable to use a caterpillar cable pusher, which is installed at the start of the cable run. This caterpillar is used in conjunction with the winch, when used in this fashion this will greatly reduce pulling tensions on the cable.

The winch cable will always take a direct line between angle positions and may also tend to lift up or bear down hard according to the contour of the trench. The position and level of the rollers must, therefore, be carefully arranged to prevent the taut winch rope, or cable damaging or being damaged by pipes crossing the trench. An inverted skid plate attached to screw jacks wedged across the trench will guide the cable and winch rope under obstructions.

To facilitate the pulling of cables around bends in the trench, curved steel plates or special curved corner roller assemblies should be set up against the wall of the trench to minimise the additional strain due to change of direction. To counteract sideways thrust, packing should be used to stabilise the corner assemblies.

Crowbars or single rollers **should not** be used on their sides at bends as they can cause flattening or bird caging of the triplex cable during installation.

Where pulling is difficult lubrication will ease cables round bends and through ducts. For safety, the lubricant must be applied by stick or brush and not by hand. A mixture of common household powdered detergent and powdered graphite mixed in equal proportions with water to form a paste is recommended for this, as it is 'non-sticky' and loose stones are unlikely to adhere to the cable.

Grease should not be used as the lubricant as grit will adhere to it.

When two cables are to be laid side by side, a double line of rollers should be placed in the trench at bends and duct entrance positions so that the second cable can be pulled as soon as the first cable has been taken off the straight line rollers and while the men are still in position.

4.1.5.2 **Hand Pulling**

Cable rollers should be arranged as for winch pulling but some relaxation of the measures to counter thrusts at corners may be possible. On straight sections of the trench the rollers should be placed centrally to allow a man to stand astride the cable when pulling.

4.2 **Cable Pulling**

Cable should always be pulled to provide a 1.2m overlap for jointing purposes. Where cable is cut to length the end **must be** sealed to prevent moisture ingress.

4.2.1 **Cable Attachments**

When using Triplex cable it helps to prevent the unwinding of the cable if 13mm wide cable ties (E 5 No. 35370) are placed on the leading 5m to 7m of cable, prior to the cable being laid. If this cable is then to be pulled into ducts the cable ties should be taped over with Scotch 88 tape to prevent the cable ties snagging on the ducts. All short lengths of triplex should be cable tied to prevent the cable unwinding, prior to the laying of the short length of cable.

4.2.1.1 **Attachment of Cable Stocking to Cable**

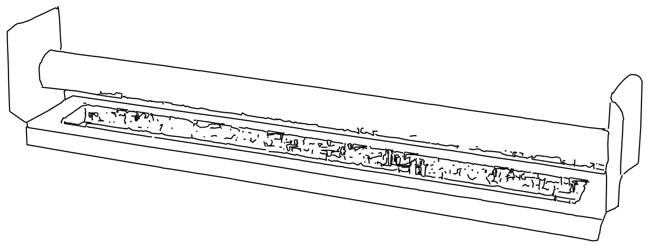
The approved method of attachment of the cable pulling rope to the cable is by cable stocking or three in one swivel head. There are wide ranges of sizes available from many different manufacturers. The stockings distribute the pull and avoid damage; care must be taken to ensure that the stocking fits over the oversheath of the cable. In the case of Triplex cable individual stockings should be applied to all three cores and these in turn should be attaches to the swivel on the pulling bond. In all cases the stocking should be pushed fully on to the cable and should be secured at the end with binding wire as shown in figure 4.2.1.1. The cable stocking will also have a SWL equivalent to the maximum pulling tension of the cable. After the end of the cable has been freed from the drum the cable stocking should be fitted.

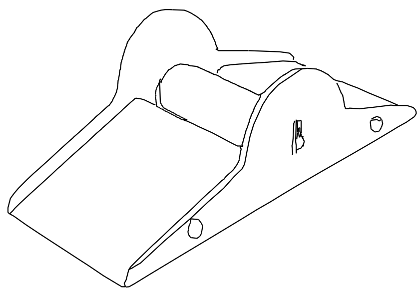
Table 4.2.1 gives guidance on maximum pulling tensions and diameters of cables most commonly used in WPD.

TABLE 4.2.1 - MAXIMUM STOCKING PULLING TENSIONS & OVERALL DIAMETERS

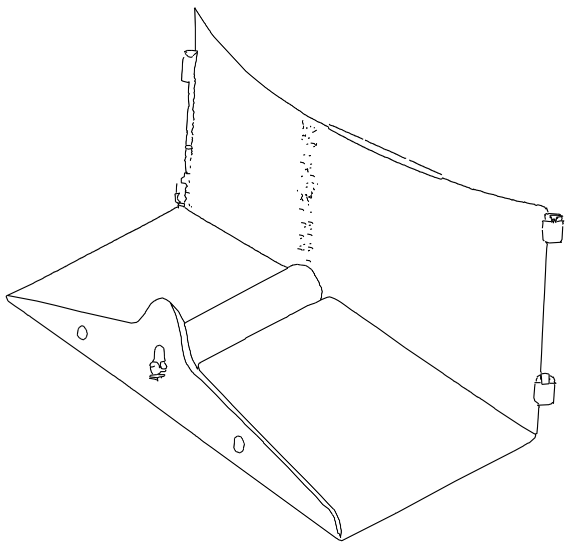
Cable voltage	Cable type	Nominal overall diameter (mm)	Pulling tension safe limit (N)
66kV	185 mm^2 EPR	54	6185N
66kV	300 mm^2 EPR	57	6300N
66kV	400 mm^2 EPR	60	6400N
66kV	630 mm^2 EPR	65	6630N
66kV	1000 mm^2 EPR	76	61000N
33kV	185 mm^2 EPR	47	6627N
33kV	300 mm^2 EPR	49	7203N
33kV	400 mm^2 EPR	55	9075N
33kV	630 mm^2 EPR	60	10800N
33kV	800mm^2 EPR	65	12675N
33kV	240mm^2'H' type Cu.	75	16875N
33kV	185 mm^2 'H' type Cu	70	14700N
11kV	95 mm^2 PICAS	50	6800N
11kV	185 mm^2 PICAS	61	11163N
11kV	300 mm^2 PICAS	73	15987N
11kV	400 mm^2 PICAS Cu.	81	19683N
11kV	500 mm^2 PILC	43	5547N
11kV	630 mm^2 PILC	47	6627N
11kV	630 mm^2 EPR	48	6912N
11kV	95 mm^2 EPR Triplex	28	2352N
11kV	185 mm^2 EPR Triplex	33	3267N
11kV	300 mm^2 EPR Triplex	37	4107N
LV	3 Core 95 mm^2 WCON	35	3675N
LV	3 Core 185 mm^2 WCON	46	6348N
LV	3 Core 300 mm^2 WCON	55	9075
LV	4 Core 95 mm^2 WCON	40	4800N
LV	4 Core 185 mm^2 WCON	54	8748N
LV	4 Core 300 mm^2 WCON	64	12288N

Leading Roller





'Straight' Cable Roller



'Corner' Cable Roller

Rev No	Drawn	Chk'd	App'd	Date	Revision
1	RJB			04.00	NEW BORDER ADDED

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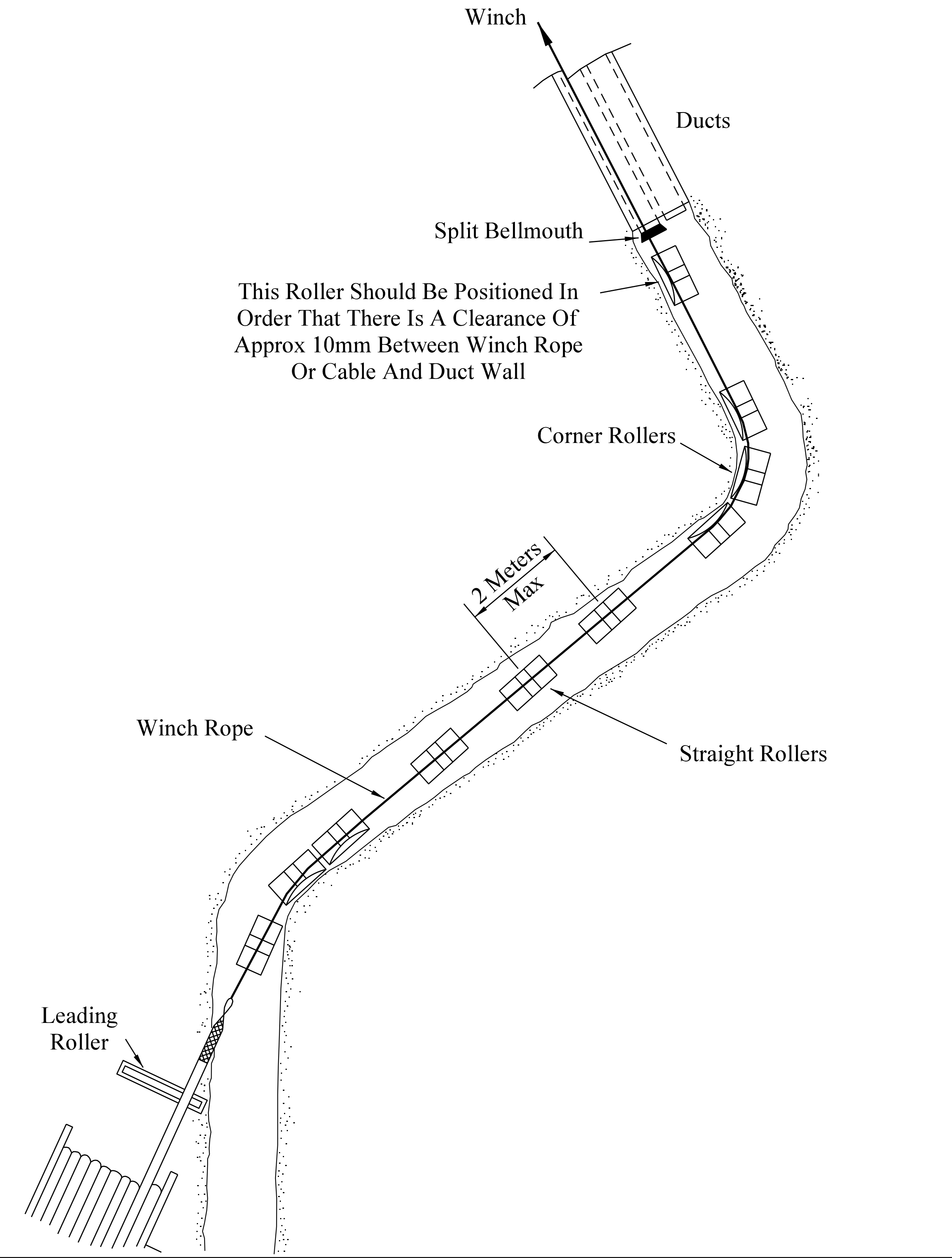
Drawn	RJB	11.97			
Checked			Title	Drg. No.	Rev No
Approved					
SCALE	N.T.S.		CABLE ROLLERS	4.1.5.a	1



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2	RJB			06.03	REDRAW ON CAD

ORIGINAL ISSUE		DATE
Drawn	RJB	11.97
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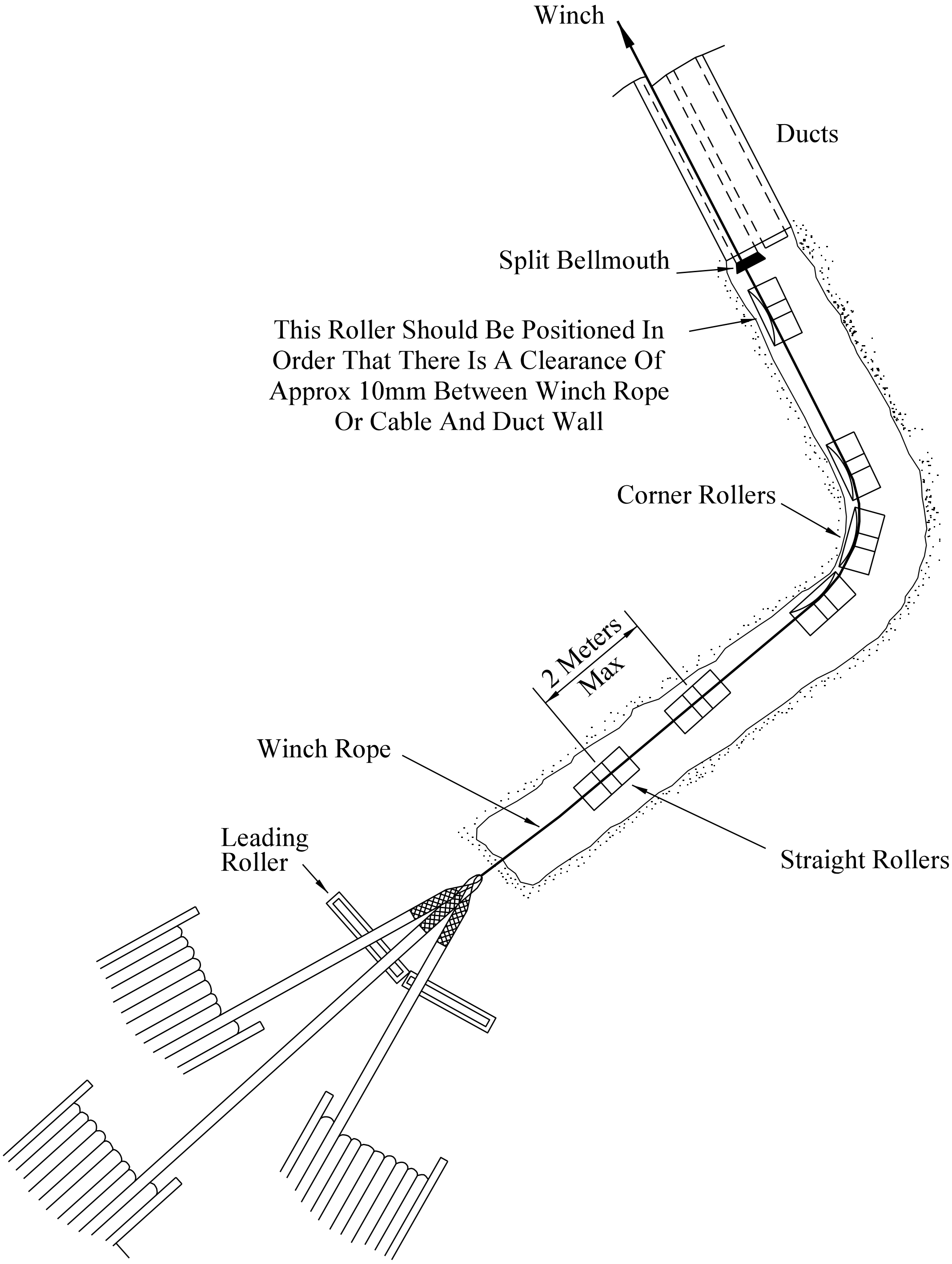
Title: TYPICAL ARRANGEMENT OF ROLLERS IN A CABLE TRENCH

Drg. No.	Rev No
4.1.5.b	2



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Drawn	RJB	08/12			
Checked			Title: TYPICAL ARRANGEMENT FOR THREE SINGLE CORE CABLES IN TO A SINGLE DUCT	Drg. No.	Rev No
Approved				4.1.5.c	
SCALE	N.T.S.				

4.2.1.2 Attachment of Pulling Rope to Cable Stocking

When pulling by winch, a clevis-ended swivel must be fitted between the rope and the thimble of the cable stocking. The swivel, as shown in figure 4.2.1.1, is streamlined and complete with clevis fittings for rope and stocking. It shall also have a SWL, which will at least match the maximum pulling tension associated with the cable to be installed.

The swivel allows the rope to turn freely. Without a swivel a twisting strain will result under load, and should there be a sudden release of this, the whip-back on a steel rope will be dangerous and in many cases cause kinking.

4.2.2 Rope Bonds

The preferred rope bond used is steel wire rope, but this is not suitable for hand pulling as it is springy, too small in diameter to grip, and broken strands may lead to injury.

When pulling by hand, either natural or synthetic fibre rope may be used but care must be taken to ensure the SWL of the rope is not a limitation when pulling cables to the recommended maximum tensions.

4.2.2.1 Steel Wire Rope

For winches, steel wire rope is preferred to fibre rope as its smaller size allows a compact arrangement of winch and take up spool, and there is little deterioration if the rope is properly maintained. Gloves must always be worn when handling wire ropes.

Tapered Talurit compressed ferrules should be specified for the thimble end to avoid a shoulder that could catch up on ducts or rollers.

To prevent the possibility of kinking and disturbance of the lay, ropes should be paid out without slack and in a straight line.

After use and before storage, the wire rope should be wire brushed, examined and lubricated with wire rope dressing.

4.2.3 Methods

Winch pulling or the laying of cable direct from a moving cable drum trailer is to be preferred to hand pulling purely because it is less arduous and fewer people are required.

Nevertheless for short lengths of cable, hand pulling may be expedient. Whichever method is used all men should wear protective gloves and footwear throughout the pulling/handling operations.

4.2.3.1 **Winch Pulling**

The winch operating procedures outlined in these sections are suitable for most types of winch at present available, although some variation in procedure may be required for a particular type of winch.

Winches should be fitted with a digital dynamometer arrangement to ensure the maximum pulling tension of the cable being installed is not exceeded. A print of the pulling tensions should be provided at the end of each completed cable pull.

The number of men required is dependant on the winch type and size, and the nature of the job.

Figure 4.2.3.1 depicts a typical example of the location and duties of men on winch cable pulling.

The person-in-charge should ensure that all personnel employed on cable winching are familiar with the signalling procedures employed. Each signal should be positive and distinct.

Portable radio may be helpful on schemes where hand signals cannot easily be used.

At any time, any man in the team is at liberty to give the emergency stop signal should personal danger or serious circumstances arise.

4.2.3.2 **Laying Cable from a Moving Drum Trailer**

Laying the cable directly into or beside the trench from a drum trailer whilst it is being towed along slowly can make considerable saving in time and effort. This method can only be used if there is unobstructed access beside the trench and if there were no pipes or services crossing the trench under which the cable would have to be laid. It is ideally suited to coordinated mains laying in a common trench.

When laying direct into a trench, the end of the cable should be fed off the drum and laid in position in the trench. The drum trailer should then be towed slowly alongside the trench. Three or four men must initially hold back the cable and then progressively ease it over the edge and onto the trench bed.

If the trench edge is not firm enough to allow a vehicle to be driven reasonably close to it, the cable can be fed from the drum trailer on to the ground beside the trench. The cable end is pulled from the trailer and placed in its final position in the trench. The remainder of the cable is then laid from the moving drum trailer directly on to the ground beside the trench. Subsequently the cable is manhandled on to the trench bed, starting from the point where the end of the cable is already in the trench.

This method is not recommended for 33kV cable or the larger sizes of 11kV EPR cable, i.e. 300mm² single core EPR and 630mm² single core EPR, as it is heavier, and stiffer to control and bend.

4.2.3.3 **Pulling in by Hand**

When it is necessary to pull in by hand, the men should be spaced clear of each other along the pulling rope. As the cable is pulled into the trench the men should move back from the rope on to the cable.

To avoid dangers from trapping, men should not be positioned on corners, or on the drum side of the cable rollers for pulling cable. The cable itself should be handled with cable slings thereby avoiding the possibility pinching fingers between cable rollers and the cable, and enabling men to pull with a straight back.

Care should be taken at bends to congregate men on the approach side so as to relieve friction on the bend.

The supervisor should ensure good control of the cable and unified pulling efforts either by using a whistle or other means with which the staff are familiar. Similarly, cessation of pull should follow a clear signal.

It must also be seen to that any undue slack does not accumulate on the drum, by employing somebody to apply braking, via the drum flanges, when necessary.

Where a cable is drawn through a road-crossing duct, pulling in should be stopped when the cable end is near the duct mouth and the pulling in rope attached to a pilot rope or wire, which has been previously drawn into the duct. The cable end should then be eased into the duct mouth and pulling continued.

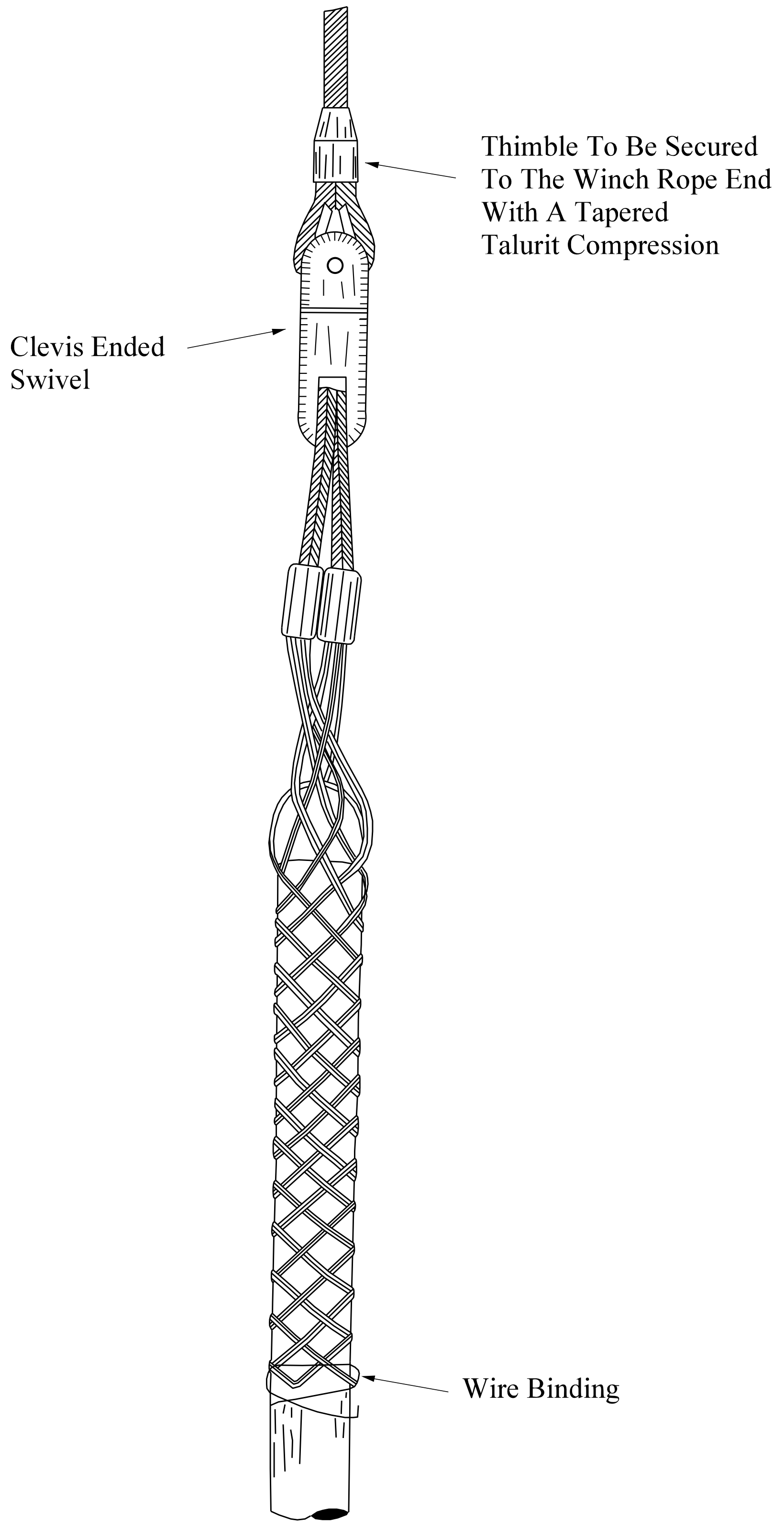
4.2.3.4 **Bond Pulling**

The general principle of bond pulling is as shown in figure 4.2.3.4.

A steel wire bond, which shall be at least twice the cable section length, is run out through the whole length of the trench over cable rollers positioned in the trench in the line, which the cable is to follow.

The cable shall be tied to the bond at no greater than 2m intervals along its entire length. Where large diameter cables are to be installed, or the cables are to be installed on a steep incline or down a shaft, the number of ties is to be increased.

At each change of direction the ties shall be released and the cable taken round the bend using a series of vertical skid plates and horizontal rollers, the bond wire passing through a snatch block. The cable shall be re-attached to the bond immediately after the change of direction. The nose of the cable shall be guided over the corner rollers ensuring that a positive tension is maintained on the nose of the cable to prevent the build up a slack at the bend.



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1	RJB			06.03	REDRAW ON CAD

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Drawn	RJB	11.97
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SCALE	N.T.S.	

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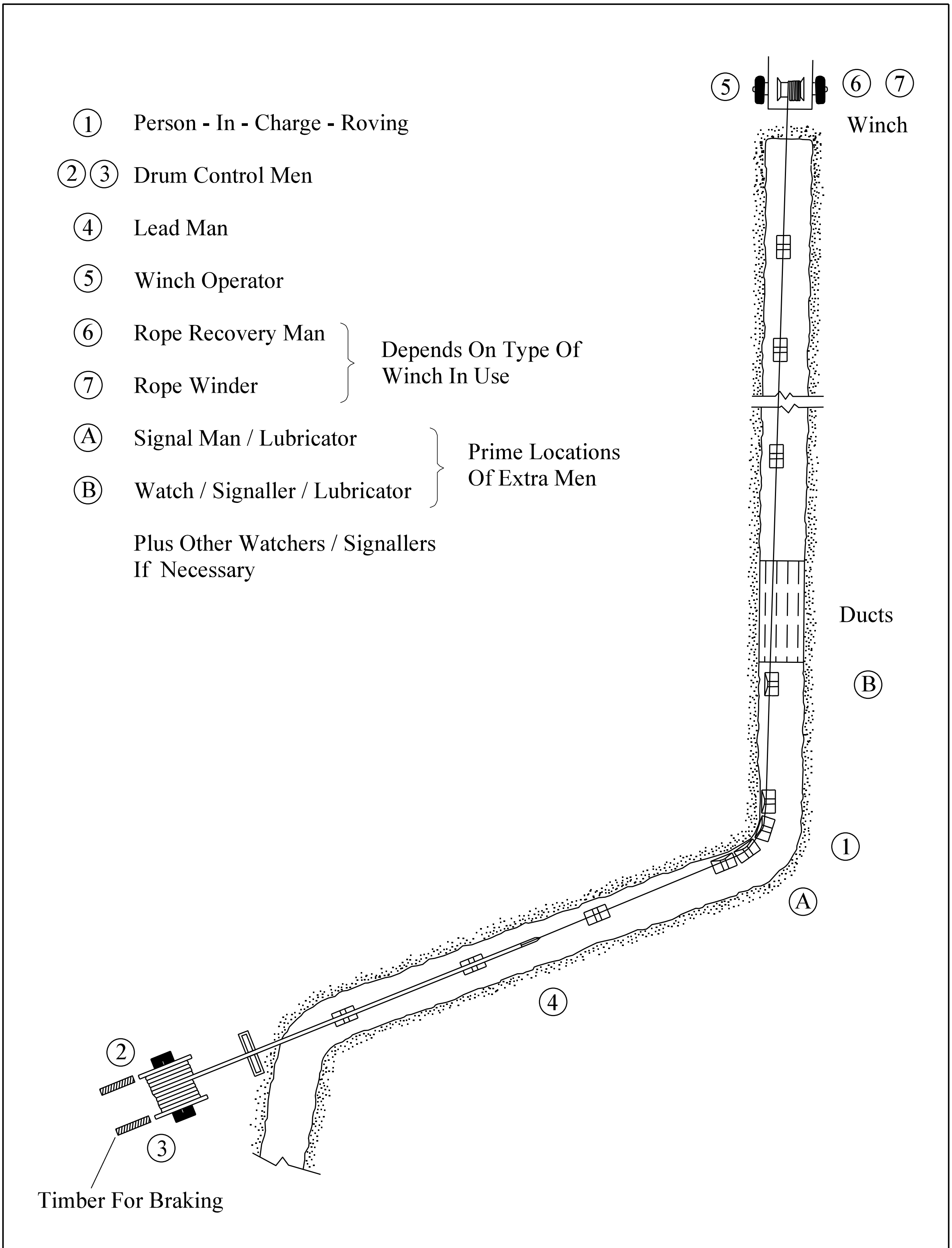
Title
ATTACHMENT OF CABLE STOCKING TO
CABLE PULLING ROPE

Drg. No.	Rev No
4.2.1.1	2



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3	RJB			06.03	REDRAW ON CAD

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Drawn	RJB	11.97
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Title	Drg. No.	Rev No
LOCATION AND DUTIES OF MEN ENGAGED ON WINCH CABLE PULLING (TYPICAL EXAMPLE)	4.2.3.1.	3

Although this procedure is rather labour intensive, it has the overwhelming advantage that there is no tension applied to the nose of the cable as it is distributed along the length and the risk of stretching one or more of the cable components is minimal.

4.2.4 Flaking and Coiling Cable

As it is not always possible to lay the complete length of cable directly into the trench due to obstructions, limited choice of drum mounting position, or the need to excavate and backfill part of the trench quickly and as a result it may be necessary to coil the remainder of the cable or flake it off the drum.

At all stages of these operations, care must be taken not to twist the cable or bend it too sharply.

In the coiling method, few men are required as the cable has already been pulled off the drum and the coils have merely to be handled individually into position, where they require little space.

The flaking method requires more labour as the cable has to be pulled off the drum and handled in figures of eight which are larger than coils and require more space.

4.2.4.1 Coiling Cable

Where the whole of the required cable can be taken off the drum in the initial pull but only part of this is laid directly in the trench, the surplus can be coiled to a suitable position in the manner shown in figure 4.2.4 a. The cable should be subsequently rolled out by a similar method. The coil diameter should not fall below the minimum-bending radius of the cable.

4.2.4.2 Flaking Cable

Where all the required cable cannot be taken from the drum during the initial pull (i.e. if the drum has to be mounted part way along the cable route) the cable can then be laid in the trench up to the drum position and the remainder then flaked off the drum and laid on the ground in the form of a figure of eight as shown in figure 4.2.4 b.

4.2.5 Pulling Single Core 66kV, 33kV EPR and Single Core 11kV EPR Cable

The single cores should be laid in trefoil in trenches with dimensions as detailed in table 3.2 and figure 3.2b.

It is important that the trench is sufficiently wide to accommodate operatives who should tie the three cores together at 1.5m intervals with 13mm wide plastic cable ties E 5 No 35370 (1m at bends). When installing three single core cables, the method to be adopted depends on site conditions. In most cases it may prove easier to pull each of the cores out individually and then tie them together in the trench. If the cables are to be laid in a green-field site, it may prove preferable to pull the three cores simultaneously from three drums and then tie them together as they enter the trench.

When installing any voltage level of three single cores cables into a single duct then all three cores shall be pulled together and every two metres two complete turns of Gorilla duct tape E 5 number 60928 shall be applied to the cables prior to entering the ducts, thus keeping the cables in trefoil.

4.3 Cleating

When it is necessary to install metal-sheathed cables on supports, the spacing of these is an important factor.

Single core cables are to be cleated every 1.5m using Ellis patent cleats with an Ellis patent strap in between every cleat.

The thermal expansion of 3 core cables is approximately 100mm in 250m over the normal operating temperature range. Cleats if erected too closely together may produce sheath fractures over a period due to localised flexing caused by expansion and contraction with change in temperature.

Hooks or cleats should provide an axial length of support of not less than 0.6 times the diameter of the cable and the corners should be radiused 5mm to prevent sharp indentations or damage to the cable.

4.3.1 Horizontal Straight Runs

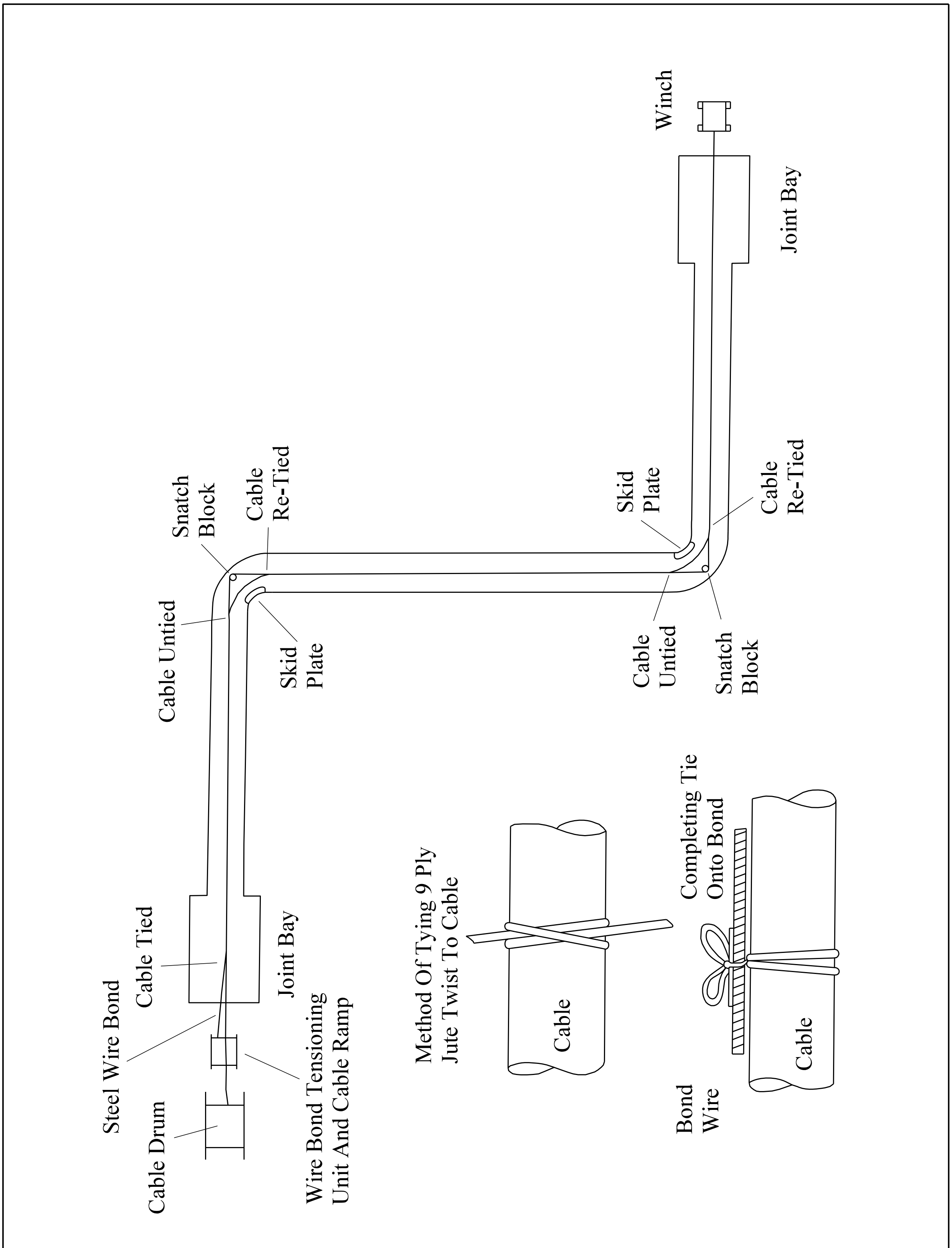
Cables should be installed with sag in order to reduce the amount of flexing of the sheath and 2% of the recommended span is suitable.

Normally, sagging should be carried out on each span about 2 spans behind the last support in which the cable has been laid. It may be necessary to hold down each span while the next one is sagged and a straight edge with a projection at the middle equal to the required sag will be useful.

Supports, which grip the cable, are required only where a tendency to move has to be restrained, such as joints, vertical runs, or slopes.

4.3.2 Horizontal Bends

Spacing of cleats on horizontal bends should be similar to that on straight horizontal runs. If the distance between cleats is increased, horizontal supports should be provided on the bends to allow lateral movement of the cable during expansion.



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Approved					
SCALE	N.T.S.		METHOD OF BOND PULLING	4.2.3.4.	2

4.3.3 Cable Runs other than Horizontal and Straight

When it is necessary to install metal-sheathed cables on supports, the spacing of these is an important factor.

Single core cables laid in touching trefoil are to be cleated every 1.5m using Ellis patent Atlas two bolt cleats with an Ellis patent strap in between every cleat.

The thermal expansion of 3 core cables is approximately 100mm in 250m over the normal operating temperature range. Cleats if erected too closely together may produce sheath fractures over a period due to localised flexing caused by expansion and contraction with change in temperature.

Hooks or cleats should provide an axial length of support of not less than 0.6 times the diameter of the cable and the corners should be radiused 5mm to prevent sharp indentations or damage to the cable.

4.3.1 Horizontal Straight Runs

Cable systems need to be adequately fixed to a surface to prevent problems with expansion and contraction during service, and to contain the cables in the event of a short-circuit which creates high electro-dynamic loads between the phases, which would create uncontrollable damage to the cable and surroun ding area without the necessary fixings. It is important to design a cable support system which provides the necessary clamping force to withstand the forces generated in service and short-circuit conditions.

Cables should be installed with sag in order to reduce the amount of flexing of the sheath and 2% of the recommended span is suitable.

Aluminium conductors	Support spacing	
Diameter of cable (mm)	**Horizontal (mm)**	**Vertical (mm)**
15-20	1200	550
20-40	2000	600
40-60	3000	900
>60	4000	1300

Copper conductors	Support spacing	
Diameter of cable (mm)	**Horizontal (mm)**	**Vertical (mm)**
15-20	400	550
20-40	450	600
40-60	700	900
>60	1100	1300

Normally, sagging should be carried out on each span about 2 spans behind the last support in which the cable has been laid. It may be necessary to hold down each span while the next one is sagged and a straight edge with a projection at the middle equal to the required sag will be useful.

Supports, which grip the cable, are required only where a tendency to move has to be restrained, such as joints, vertical runs, or slopes. In this instance Ellis Patent Atlas two bolt cable cleats shall be used.

4.3.2 Horizontal Bends

Spacing of cleats on horizontal bends should be similar to that on straight horizontal runs. If the distance between cleats is increased, horizontal supports should be provided on the bends to allow lateral movement of the cable during expansion.

4.3.3 Cable Runs other than Horizontal and Straight

On bends, which are sloping or vertical, the cables should be cleated no more frequently than is required for stable positioning.

For vertical or steeply sloping (> 60 deg from the horizontal) lengthy straight runs, the cable should be snaked by bowing in opposite directions alternatively between successive cleats.

A deflection of 5% of cleat spacing is suitable. For this the cleat should be at an angle of about 6 degrees to the line of run and a single bolt fixing is convenient to enable each cleat to set itself to the cable. Cleating should be carried out from the bottom, with the cable eased off from the top as required. The greater the spacing of the cleats compatible with mechanical strength, the easier will be the setting of the cable.

4.4 Cable End Capping

The capping of cable ends, once the cable has been laid, is very important to prevent the ingress of moisture. With the more modern insulating materials such as PVC, XLPE etc. the need to prevent moisture ingress is to allow the LDPu resin to seal effectively, prevent corrosion of aluminium conductors as well as the requirement for electrical safety when working on these cables.

There are three preferred methods of capping cables: -

(a) Cold shrink cap

(b) Heat shrink cap

(c) Denso seal

4.4.1 **Cold Shrink Cap**

The most commonly used, can be applied to all cable types. Before preparing and applying, a cap of the correct size must be selected, caps are range taking to suit variable cable diameters and to ensure a good moisture seal the selection is most important.

Methods of Application

PVC Oversheath Cables

1. Select correct cap to suit cable diameter, ensure the cap is coated internally with sealant and not pin-holed.

2. Clean and degrease PVC oversheath.

3. Slide the cap onto the cable pushing well onto the cable end.

4. Pull the spiral out of the cold shrink cap in an anti-clockwise direction until the cold shrink cap is fully shrunk onto the cable.

4.4.2 **Heat Shrink Cap**

This is the most widely used method as it can be applied without any specific skills. Before preparing and applying a heat shrink cap, the correct size must be selected, as these caps are range taking to suit variable cable diameters.

In order to seal PVC oversheath cables such as service cable, WAVECON, or PICAS, the following steps should be followed:

(1) Select correct size for cable diameter.

(2) Clean PVC oversheath with approved cleaner.

(3) Abrade PVC oversheath for the length of the cap using a rasp on large diameter cables or emery cloth for service cables. Ensure the abrading is undertaken circumferentially and all glossing if the sheath is removed.

(4) Clean abraded area with approved cleaner.

(5) Slide cap onto cable, pushing onto cable end.

(6) Using a soft blue flame, start shrinking from the closed end of the cap and work towards the open end. Ensure the flame is worked evenly around the cap and enough heat is given to melt the sealant, but not to burn the material. Once the cap is fully shrunk down, a ring of sealant will be seen at the open end of the cap.

In order to seal PILCSTA or PILCSWA, either a heat shrink cap or a plumbed cap can be used. If a heat shrink cap is to be used, the following steps should be carried out:

(1) Mark outer serving the length of the cap plus 50mm from the cable end, apply a wire or PVC tape binder at this point.

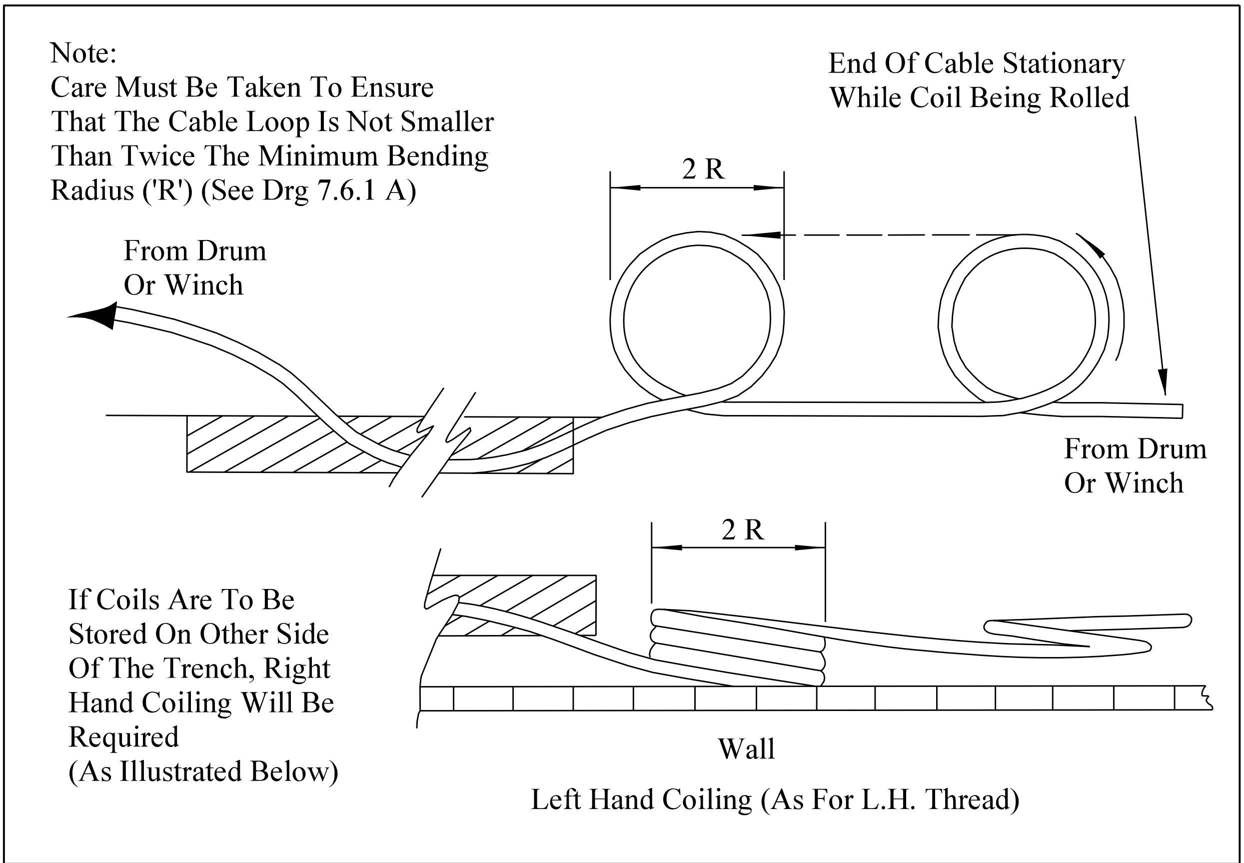
(2) Remove outer serving.

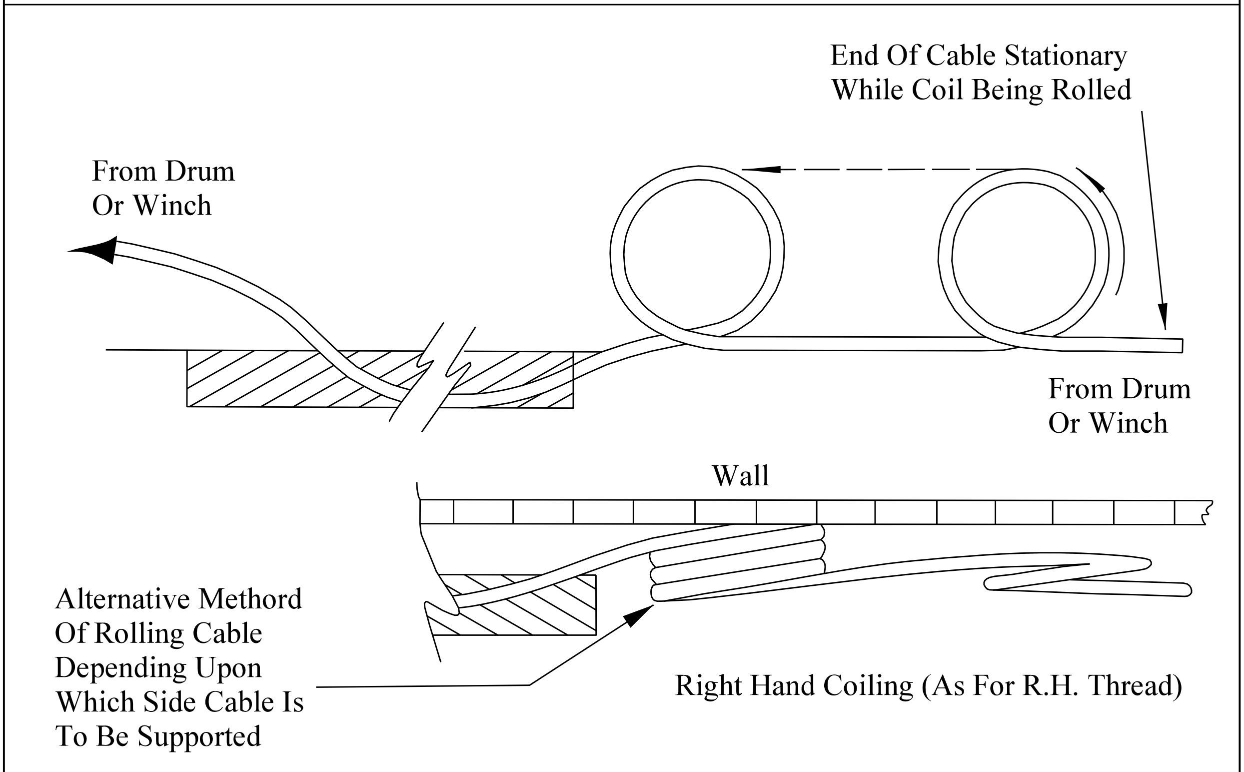
(3) Using a depth gauge, hacksaw cut around the armour at the binder.

(4) Remove armour and underlying bedding.

(5) Apply heat and remove bitumen impregnated paper, thoroughly clean lead sheath and allow to cool.

(6) Clean lead sheath with approved cleaner.





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Drawn	RJB	11.97
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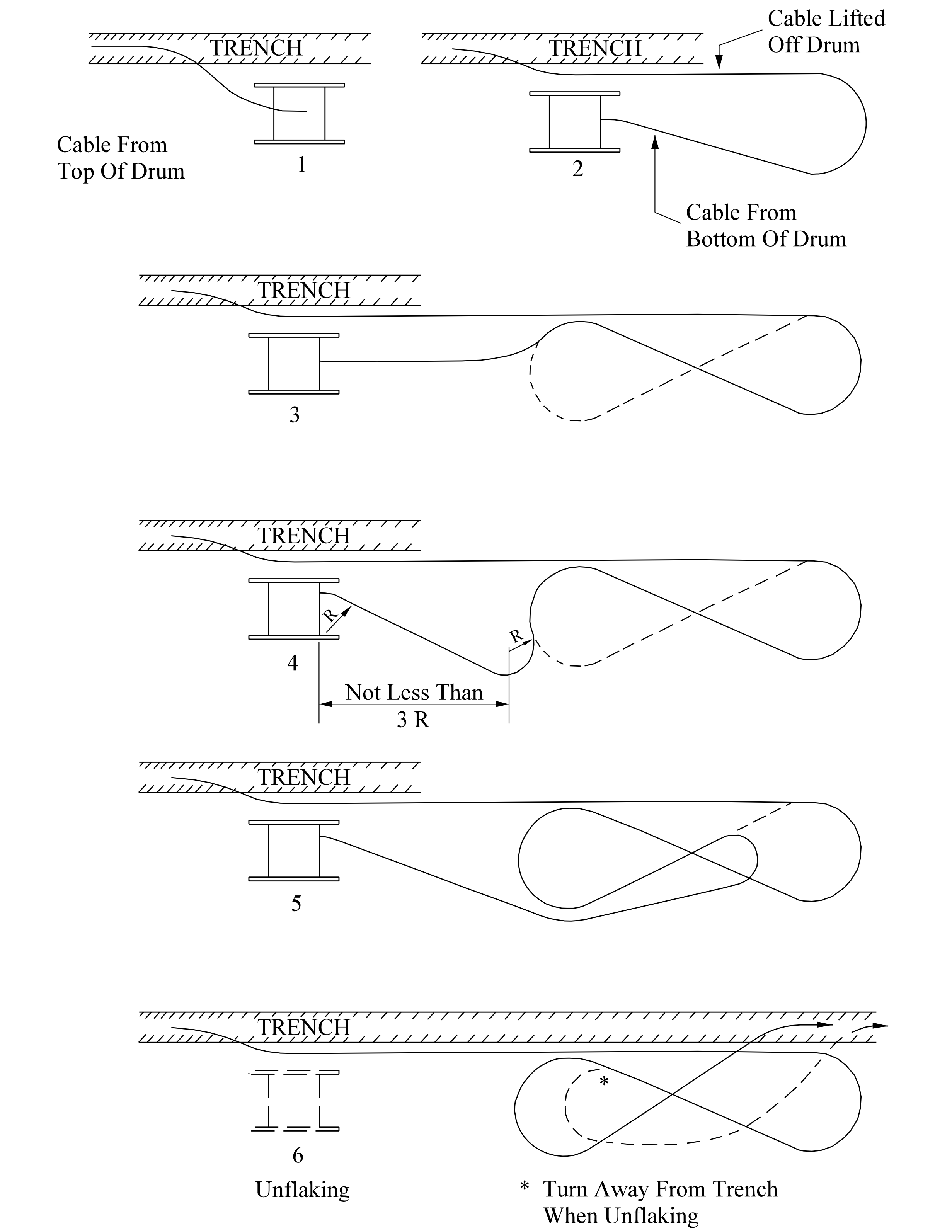
Title	Drg. No.	Rev No
CABLE COILING	4.2.4.A.	2



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Drawn	RJB	11.97			
Checked			Title PROCEDURE FOR FLAKING CABLES BY THE FIGURE EIGHT METHOD	Drg. No. 4.2.4.b.	Rev No 2
Approved					
SCALE	N.T.S.				

(7) Abrade the circumference of the lead sheath the full length of the cap, using a file.

(8) Clean abraded area with approved cleaner.

(9) Ensure all sharp edges are removed from the cable end.

(10) Complete using steps 5 and 6 as for PVC oversheathed cables.

In order to seal Single core XLPE, Single core EPR or Triplex EPR, a heat shrink cap shall be used and the following procedure applied: -

(1) Select correct size for cable diameter.

(2) Clean oversheath with approved cleaner.

(3) Abrade sheath for the length of the cap using a rasp on large diameter cables or emery cloth for service cables, whilst ensuring the abrading is undertaken circumferentially.

(4) Clean abraded area with approved cleaner.

(5) Using a very soft blue flame, gently heat up the abraded area until it appears to slightly change colour.

(6) Complete using steps 5 and 6 as for PVC oversheathed cables.

4.4.3 Denso Tape Seals

As a temporary measure Denso tape seals may be applied to each individual cable core end to affect a moisture seal.

5.0 REINSTATEMENT

5.1 Backfill to Marker Tape

Particular care is required when laying unarmoured cables in order to ensure that no objects can cause a pressure point on the cable sheath. It may be necessary to pad the sharp edged ends of earthenware ducts if there is any likelihood of cable settlement.

Crushed limestone dust, 3mm to dust, or crushed granite dust, 3mm to dust, must be used when bedding and blinding cables. The depth of crushed stone dust bedding will depend on the cross sectional area or physical size of the cable being laid; this should be compacted prior to laying the cable. The blinding should be laid in a single operation after the cable has been lifted off the cable rollers. Cables shall be blinded by 75mm of imported crushed stone dust before warning marker tape be laid above the run of the cable. Should site conditions warrant the use of protective equipment such as the 'Stokboard', the blinding of crushed limestone or granite dust, shall still be 75mm.

5.2 Re-use of Excavated Material

Temporary spoil and material heaps should be sited to interfere as little as possible with the work to be carried out. Whilst, for convenience in handling, it might be necessary to place them near excavations, the following points should be borne in mind: -

a) They should not interfere with free access to the excavation.

b) They should be so constructed that there is no danger of the spoil slumping in wet weather and entering the excavation.

c) Spoil heaps should not be placed in such a position as to endanger the stability of existing works above or below ground or of the excavation, the sides or side supports of which should be so designed as to be capable of withstanding the additional stresses due to any superimposed load.

Spoil heaps should be graded to safe slopes taking into account the nature of the material and the effects of wet weather, the material should remain substantially unaltered in wet weather, but with materials that soften and slump a substantial reduction in the slope should be anticipated and a adequate distance maintained between the spoil heap and the edge of the excavation.

The clearance between the toe of the spoil heap and the edge of the excavation should give sufficient working space at all times, and for this purpose the clearance should be a distance equal to the depth of the excavation with a minimum width of 1.50m

The following materials are categorised as unacceptable for reuse: -

- Peat and materials from swamps, marshes, or bogs.
- Logs, stumps, and perishable materials.
- Materials in a frozen condition.
- Liquid clays.
- Materials subject to spontaneous combustion.
- Materials having hazardous chemical or physical properties.

5.3 Compacting

Special care should be taken not to damage the cable during consolidation and only hand rammers should be used within 150mm of the cable. When mechanical rammers are used, there should be enough material placed in the trench so that it can be compacted to a 150mm layer, particular care must be taken if the 'thumping' type rammer is used.

5.4 Reinstatement above Marker Tape

The reinstatement, whether it is 'permanent' or ’interim’, should meet the requirements as set out in the Department for Transport Specification for the Reinstatement of Openings in Highways April 2010. This also applies reinstating verges adjacent to highways.

For the reinstatement of open ground, it is usually adequate to compact the ground from the surface. The ground should be left 'proud' to allow for subsequent settlement. If turf has to be re-laid, it should be watered thoroughly during dry weather.

6.0 PRIOR TO ENERGIZATION OF THE ALL CABLE CIRCUITS

In compliance with the ESQC Regulations 2003 no cable circuit shall be energized unless the following minimum conditions have been meet: -

On building sites where cable has been laid, and/or additional cable will be required to be laid in the near future then the minimum, which will be acceptable prior to the cable, being energized, is the cables are covered with 75mm of crushed limestone or granite dust, 3mm to dust, and marker tape laid on top of the crushed limestone or granite dust, as per ST: NC2H – Relating to Inspection and Recording.

Where joint holes have been dug and exposed the cables the minimum requirement shall be that the joint hole shall signed and guarded as per ST: HA14D.

Where the cable has been laid up to a pole, the minimum requirement shall be that the cable and pole shall signed and guarded as per ST: HS14D.

A.3.3.1 Impact Measurement

For double circuit 132kV circuits running in the same trench then the impact assessment shall take into account three specific parameters: -

1) Number of customers affected, this is the number of customers that will experience supply loss if both circuits were hit simultaneously with e.g. an HDD or by a digger or some other common mode failure.

2) Time to restore supplies; this is the time to restore supplies to customers, taking account of the circumstances, conditions and environment when the event occurs. In practice restoration of supplies maybe through more than one stage.

3) Having double 132kV circuits in a single trench will increase the impact/risk of other shut downs or outages where the load will be flowing in these two underground circuits because then there is a heightened impact/risk if these circuits are then hit during the shutdown or outage of adjacent circuits. This will need to be considered when undertaking shutdowns or programming outages.

In assigning likelihood and impact, it is important to decide whether the impact should be on the basis of: -

- The worst that could happen (the realistic upper bound) or
- The most likely outcome (the most probable outcome taking into account of typical circumstances).

The basis of both likelihood and impact assignment should be clearly understood. For the risk estimate to be realistic it is important that likelihood and impact are assigned on the same basis, e.g. assigning impact on the basis of the worst that could happen and the likelihood based on the what is mostly likely would result in a gross over estimate of the risk.

Single parameters shall be based on the value of a particular likelihood, impact or expectation. Risk shall also be considered as likelihood and impact in combination.

A single parameter evaluation of the double circuit e.g. customers interrupted compares the predicted level of performance with the level that WPD is prepared to tolerate or may consider acceptable. This shall take into account relevant targets, recent performance, regulator perception etc. and judges purely on the basis of potential likelihood, impact or expectation value.

The matrix below sets out the parameters to evaluate the risk significance, exceeding thresholds should trigger an action consistent with the description in the action column of the prioritisation table overleaf: -

Single Parameter and Prioritisation Thresholds				
Impact measure	Base Value	Low	Medium	High
CI	Customers interrupted actual number of connected customers losing supply for greater than 3 minutes as a result of a double circuit strike	<1,000 – 10,000	10,000 – 100,000	>100,000
CI	Customer Interruptions – actual value of CI's (customers interrupted / customer base * 100)	<1.0 - 10	10 - 100	>100
CI	Customer Interruption Financial Impact – calculated value of CI penalty payments under IIS	<£500k - £1m	£1m - £5m	>£5m
CI	Customer Interruption Target – actual value of CI's as a % annual target	<0.3 – 1%	1% - 10%	>10%
CML	Customer Minutes Lost – actual value of CML's (customer minutes lost / customer base)	<1.0 - 10	10 - 100	>100
CML	Customer Minutes Lost Target – actual value of CML's as a % of annual target	<0.3 – 1%	1% - 10%	>10%
CML	Customer Minutes Lost Financial Impact – calculated value of CML penalty payments due under IIS	<£1m - £10m	£10m - £50m	>£50m
ERTS	Emergency Return to Service – time to provide back-up supply	<6hrs – 12hrs	12hrs – 24hrs	>24hrs
Duration	Duration of fault repair	<2 weeks – 6 weeks	6 weeks – 16 weeks	>16 weeks
EGS	Electricity Guaranteed Standards – actual value of EGS payments necessary (irrespective of whether they are valid, ex-gratia or subject to extraordinary event claims)	<£1k - £10k	£10k - £100k	>£100k
Probability	Probability of loss of alternative supplies – actual per unit likelihood of the loss of alternative circuit while repairs are being carried out	<0.001 – 0.1	0.1 – 1.0	>1

A.3.3.2 Actions arising from Risk Prioritisation

The requirement in prioritisation is for a simple traffic light system based on the risk level. It sets out options and principles for risk prioritisation through determination of the tolerability and acceptability to the business.

A red risk might still be acceptable, the prioritisation relates to the level at which WPD should be aware of a particular risk and the type of action that might be appropriate.

The nature of double circuit in a single trench is such that there could be a number of risks in the project that have red or high as the lowest reasonably economically achievable level. In practice many of these maybe acceptable to the business as an inherent risk of network improvement. The level at which the business is aware of particular risks should be that which will authorise and implement the optimum management plan this may include recovery plans, media management etc.

The table below provides some general guidance on actions that may be appropriate to particular prioritisation levels and operates through a simple red/amber/green or high/medium/low traffic light system supported by descriptions of effect on the business and the level of action that could be appropriate for that risk level.

Guidance on Risk Prioritisation by Category.			
Risk Category	**Definition**	**Clarification/Effect**	**Typical Actions**
Red	High	- High/very high potential impact to the business. - Strong case for adoption of further risk control and/or mitigation. - Risk may be tolerated but might require senior management awareness and sign off	- Identify and evaluate all possible additional risk controls and mitigations. - Formal note that all reasonable risk controls and mitigations are in place. Decision to proceed or take alternative action course of action typically taken at senior manager/director level.
Amber	Tolerable	- Significant potential impact to the business. - Evaluate further risk control and/or mitigation. - Risk tolerable subject to control to the lowest practical and practicable level.	- Identify and evaluate additional risk controls and mitigations. - Formal note that all reasonable risk controls and mitigations are in place typically endorsed by appropriate senior manager/director.
Green	Acceptable	- Low potential impact to the business. - Potential for additional inexpensive risk control and/or mitigation. - Potential for relaxation of controls/mitigations where saving is disproportionate to risk increase. - Risk acceptable to the business.	Review to identify any additional simple and low cost risk controls and mitigations. Review to identify potential for relaxation of proposed controls/mitigations. Formal note that all reasonable risk controls and mitigations are in place typically endorsed by appropriate manager.

The degree of detail and amount of resource in analysis of risks and management options will depend on priority of the risk to the business.

Impact measure	Dual 132kV circuit in single trench Unmitigated Risk Scores			Notes on range of risk.
	Low	Medium	High	
Customers interrupted actual number of connected customers				
Customer Interruptions – actual value of CI's (customers interrupted / customer base * 100)				
Customer Interruption Financial Impact calculated value of CI penalty payments under IIS				
Customer Interruption Target actual value of CI's as a % annual target				
Customer Minutes Lost – actual value of CML's (customer minutes lost / customer base)				
Customer Minutes Lost Target as a % of annual target				
Customer Minutes Lost Financial Impact calculated value of CML penalty payments due under IIS				
Emergency Return to Service time to provide back-up supply				
Duration of fault repair				
Electricity Guaranteed Standards actual value of EGS payments necessary (irrespective of whether they are valid, ex-gratia or subject to extraordinary event claims)				
Probability of loss of alternative supplies actual per unit likelihood of the loss of alternative circuit while repairs are being carried out				
Impact/risk on other shut downs or outages if this double circuit were to be hit.				

Risk score sheet for double 132kV circuits in a single trench.

APPENDIX B

SUPERSEDED DOCUMENTATION

This document supersedes ST: CA6A/5 dated February 2018 which has now been withdrawn.

APPENDIX C

KEY WORDS

Cable, Installation, Excavation, Laying, Reinstatement