1. SCOPE

This document details SP Distribution plc's (SPD) and SP Manweb plc's (SPM) technical requirements for the handling and installation of power cables up to and including 33kV onto the SPEN network.

Requirements for the handling and installation of 25kV 1-core power cables onto the SPEN network shall be equivalent to those stated for 33kV in this document.

CAB-15-004 details the handling and installation requirements for 132kV power cables.

Requirements for all Telecom material including cables, warning tapes and ducts for installation on the SPEN network shall be in accordance with specification TEL-03-010 and TEL-03-012 and installed as specified above all telecom cables.

Installation requirements for the installation of non-metallic underground fibre cables in high voltage environments shall be in accordance with TEL-03-012.

2. ISSUE RECORD

This is a Reference document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
09/03/2020	10	Adam Merrilees	Section 12.3 – Marker Tape and Protection Tiles: Reference to installation of ENA TS 12-23 Class 1 & 2 protection tiles. Section 21.9 – Ducts: Minimum diameter specified as an inside diameter. Section 22 – sealing procedure from referenced archived express, EXP-11-068 added.
14/12/2022	11	Adam Merrilees Lewis Cassidy	Related Documents updated. Removal of guidance covering telecommunications and condition monitoring equipment. Clarification on the use and sealing of ducting. Clarification on the use of cable end sealing caps. Inclusion of guidance regarding selection of cable trench reinstatement materials. Clarification of multi-cable separation requirements. Inclusion of guidance regarding mirroring of phases.

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
Name: Adam Merrilees Title: Senior Engineer Name: Lewis Cassidy Title: Graduate Apprentice	Name: Frank Berry Title: Circuits Manager, Engineering Design & Standards	Name: Fraser Ainslie Title: Head of Engineering Design & Standards F Ainslie Digitally signed by Fraser Ainslie DN: cn=Fraser Ainslie, o=SPEnergyNetworks, ou=Processes and Technology, email=fraser.ainslie@spenergynetworks.co.uk, c=GB Date: 2023.01.05 13:59:16 Z ..... Date: .....

4. REVIEW

This is a Reference document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive.

5. DISTRIBUTION

This document is part of the Construction Virtual Manual maintained by Document Control and does not have a maintained distribution list. It is published on the SP Energy Networks website.

6. CONTENTS

7. REFERENCE AND RELATED DOCUMENTS

7.1 Legislation

Electricity Safety, Quality and Continuity (ESQC) Regulations

New Roads and Street Works Act 1991

7.2 National Specifications and Guidance

ENA TS 09-02	Specification for the supply, delivery & installation of power cables with operating voltages in the range 11kV to 400kV and associated auxiliary cables
ENA TS 12-23	Polyethylene warning tape, polyethylene protection tape, polyethylene protection tiles and cable route marker posts for buried electricity supply cable
ENA TS 97-1	Special backfill materials for buried electric cables
HSG47	Avoiding danger from underground services
HSG185	Health and Safety in Excavations

7.3 SPEN Documents

Approved Equipment Register	The Approved Equipment Register is published on the SP Energy Networks' website under Policies, Procedures and Specifications: Documentation (Link).
BUPR-22-015	Recording of Electrical Assets by Contractors
CAB-03-028	Specification for Ducting for Power Cables
SUB-02-613	Electrical Insulation Testing of HV Equipment up to 33kV
CAB-15-004	Handling and Installation Requirements for 132kV Power Cables
TEL-03-010	General Specification for Fibre Optic Cable
TEL-03-012	General Specification for Underground Fibre Optic Cables
Health and Safety Handbook	The Health and Safety Handbook is published on the SNS Group Digital website (Link)
Environmental Handbook	The Environmental Handbook is published on the SPEN Document Library as an uncontrolled document (Link)

8. DEFINITIONS

SPEN	SP Energy Networks, the brand name for the division of the ScottishPower group of companies that encompasses SP Transmission plc, SP Distribution plc, SP Manweb plc, SP Power Systems Ltd and ScottishPower Energy Networks Holdings Ltd.
SP Transmission plc (SPT)	The Transmission Licence Holder for the transmission service area formerly known as ScottishPower.
SP Distribution plc (SPD)	The Distribution Licence Holder for the distribution service area formerly known as ScottishPower.
SP Manweb plc (SPM)	The Distribution Licence Holder for the distribution service area formerly known as Manweb.

Approved	Equipment approved in accordance with SPEN's Equipment Approvals Procedure and which is considered suitable for use and/or installation on SPEN's networks. Approval shall be given in writing by The Engineer.
The Engineer	Person nominated by SP Energy Networks having responsibility and authority for all technical matters relating to execution of the works.

9. GENERAL REQUIREMENTS

SPD and SPM reserve the right to change the data contained in this document without notification. Although specific network extensions may be designed and constructed by third parties, SPD and SPM retain the responsibility for the design and construction standards of the distribution system. Since the guidance cannot cover every eventuality, SPD and SPM reserve the right to apply other criteria where necessary and appropriate.

The installer is responsible for ensuring that they have all the relevant information required to undertake construction. Only installers who have the appropriate skills, training and experience shall use the data and guidance contained in this document. This document provides guidance, however, it is the installer's responsibility to ensure that safe systems of work are employed on site.

10. INTRODUCTION

The document defines the limits prescribed by SPEN for each of the following parameters:

- Maximum pulling tensions.
- Minimum static and dynamic bending radii.
- Depth of cover.
- Positioning of marker tapes and protection tiles.
- Multiple cable spacing.

The following sections detail the procedures which shall be followed when handling and installing power cables. These procedures are based on safe working practices and are designed to minimise the risk of damage to the cable being installed.

Attention is drawn to the requirements of the New Roads and Street Works Act (NRSWA) which must be complied with where appropriate.

11. AVOIDING DANGER

Attention is drawn to the requirements and recommendations contained in Health and Safety Executive guidance notes HSG47 "Avoiding Danger from Underground Services" and HSG185 "Health and Safety in Excavations". Further guidance is provided to SPEN staff in the SPEN Health and Safety Handbook.

12. ENVIRONMENTAL

Attention is drawn to the requirements and recommendations contained in the SPEN Environmental Handbook.

13. MATERIALS

All cables and associated materials for installation on the SPEN network shall be new and classified as Approved on the Approved Equipment Register.

13.1 Cable Bedding and Surround Materials

Cables shall be bedded in and surrounded by appropriate materials as defined in Section 22.2.

13.2 Cable Sealing Caps

Only Approved cable sealing end caps shall be used.

13.3 Warning Tape, Protection Tape and Protection Tiles

All warning tape, protection tape and protection tiles installed on the SPEN network shall be new and classified as Approved on the Approved Equipment Register.

Warning tapes shall be installed as specified above all LV cables.

Protection tapes shall be installed as specified above all 11kV cables.

ENA TS 12-23 Class 2 protection tiles shall be installed to protect cables operating at voltages between 33kV and 132kV.

ENA TS 12-23 Class 1 protection tiles shall be installed to protect cables operating at voltages of 132kV and above.

Protection tiles supplied with a pin interlocking system shall be installed interlocked with the Approved manufacturer's pins.

13.4 Ducts

All ducts and ducting accessories for installation on the SPEN network shall be new and classified as Approved on the Approved Equipment Register.

14. ENGINEERING DESIGN

14.1 Route Selection

All cable installations shall be preceded by a route survey to establish and confirm that the conditions along the route are appropriate for reliable and maintenance free operation of the cable over its expected lifetime.

The route survey should consider, but not necessarily be limited to, the following:

- Ground conditions.
- Access for repairs and maintenance.
- Location of other services.

Consideration needs to be given at the design stage to how the cable system will be maintained and to ensure access provisions are made so that required repairs and maintenance can be carried out as required over the lifetime of the cable.

14.2 Use of Ducts

Cable runs shall be direct buried unless an alternative design has been agreed by The Engineer. Alternative designs may be more appropriate taking into consideration:

- Cable route / logistics / land use
- Risks of exposed open trenches prior to cable installations
- Third party consents

Where ducting installation is to be used, any cable de-ratings shall be taken into account by The Engineer.

Where new 33kV cable circuits are to be installed under the ownership of SPT, cable runs shall not be installed in ducts unless deemed necessary by The Engineer after any de-rating is taken into account.

Examples of where ducting may be required that allow for a more efficient installation, protection of the cable or ease of future access in the case of a fault include but are not limited to bridge crossings, installation under carriageways, crossing carriageways, rail crossings, river crossings and entry into buildings. A spare duct alongside the circuit may also be deemed necessary by The Engineer in order to allow for ease of future fault repairs or utilisation to reduce impact on the customer or public.

All ducts that are intended for installation of power cables operating at voltages below 132kV shall be Class 2 (ENA TS 12-23). All 132kV cable ducts shall be Class 1 (ENA TS 12-23) unless stated otherwise by The Engineer. Class 1+ (ENA TS 12-23), ducts satisfying all requirements of Class 1, are intended for directional drilling/trenchless installation applications of power cables at all voltages.

15. PRECAUTIONS IN COLD WEATHER

To avoid damage to the oversheath and/or insulation of cables in cold weather, PVC sheathed cables (Waveform, service, multicore and multipair cables) shall be maintained above 0°C and Polyethylene sheathed cables (11kV and 33kV XLPE insulated cables) shall be maintained above -5°C for a minimum of 24 hours before laying or otherwise bending.

16. SETTING UP DRUM PRIOR TO CABLE PULLING

16.1 General safety principles

- Carry out, record and maintain a site specific risk assessment.
- Always wear appropriate PPE.
- Always push drums in the direction of travel.
- Never pull drums with back to the direction of travel.
- Push squarely on the flanges and watch for any projecting nails in wooden drums.
- Always use Approved equipment for handling drums, never use improvised equipment.
- Never allow a drum to move in an uncontrolled manner.
- Never position or store a drum underneath an overhead line.

16.2 Positioning the cable drum

Always observe the correct direction of roll indicated by the “roll this way” arrow on the drum flange. Position the drum so that the pull from the drum to the trench is as straight as possible, in any case, the lead in angle of the cable to the trench shall not be greater than 30°. A lead in roller shall always be used to guide the cable into the trench.

When pulling a cable into a duct the drum shall be positioned above the duct so that the cable leaves the drum and enters the duct in a smooth curve. The drum shall be rotated by hand during the installation to minimise tension between the drum and the duct mouth.

Cable drums should be arranged such that the “A” end of one length is positioned for jointing on to the “Z” end of the next length.

16.3 Using drum jacks

Check that the jacks and spindle are adequate for the size and weight of the cable drum, the gross weight of the cable drum will be marked on one flange.

16.4 Removing battens & lagging

Battens or other drum protection should be removed carefully to ensure that any nails or tools do not damage the cable. Care should be taken when removing any metal strapping used to secure lagging, this strapping may be under considerable tension and can spring with some force when cut. Ensure that no nails are left protruding from the drum flanges as these may result in injury when moving or handling the drum. Ensure correct disposal of any excess materials.

16.5 Checking cable details and sealing cap integrity

The end of the cable should be freed and inspected to ensure that:

- The cable is of the correct size and type.
- The cable sealing cap is intact and undamaged.

- On a new drum the length marking on the oversheath agrees with the details marked on the cable drum.

17. PREPARATION OF TRENCH AND DUCTS

- The trench bottom shall be as level as possible and any change in gradient or level shall be made as gradually as possible.
- The trench bottom shall be free of stones and other sharp objects and the edges of the trench shall be cleared of any stones, tools or objects which may fall into the trench and damage the cable.
- Ducts shall be cleaned and proved prior to cable installation by pulling through a mandrel and cleaning pig of suitable diameters.
- Duct entries shall be fitted with split bell mouths to prevent damage to the cable and to the duct entry. The bell mouth shall be fitted so that the cable does not run on the split during installation to avoid the risk of damage to the cable oversheath.
- A shallow pit shall be dug at duct entry positions to ensure that stones etc. are not dragged into the duct.

18. CABLE PULLING

18.1 Installation parameters

Requirements for depth of cover, maximum pulling tensions, minimum bending radii, minimum cable spacings and position of marker tapes and protection tiles are detailed in Appendix 1.

18.2 Drum control during pulling

At all times during cable installation, the drum's rotation shall be controlled and the stability of the drum and jacks monitored.

18.3 Winches

Where a winch is used to pull in cables, the winch shall be fitted with a suitable dynamometer. The dynamometer shall be continuously monitored to ensure that the maximum pulling tension is not exceeded at any time. In all cases an appropriate swivel eye shall be fitted between the pulling bond and the pulling attachment on the cable.

18.4 Cable guides and rollers

18.4.1 Straight horizontal run

The cable shall be supported on free running cable rollers which have no projections or sharp edges.

Rollers shall be placed in the trench to prevent the cable from dragging on the trench bottom or in mud. The roller spacing required to achieve this will depend on the cable type being installed and the pulling tension along the route.

A leading roller shall be used to support the cable over the entire drum width immediately before being fed into the trench.

18.4.2 Bends in route

Vertical corner rollers shall not be used as they may damage the cable by causing excessive side wall pressure. Skid plates of a radius greater than the cable's minimum dynamic bending radius shall be used on all bends.

18.4.3 Roller adjustment and protection of other services

Prior to commencement of pulling, initial tension should be taken up to take the slack out of the bond wire. The rollers along the route should be checked and adjusted to line up with the taut bond and a final check should be made to ensure that other services will not be rubbed or abraded by the cable during installation.

When final roller positions are confirmed and the cable is verified to be clear of all other services, the pull can be started.

18.5 Single core cables

18.5.1 Configuration

Where single core cables are laid direct in the ground to form one three-phase circuit, they shall, unless otherwise instructed by The Engineer, be laid in touching trefoil. They shall be bound together using nylon cable ties at intervals of one metre. The nylon cable ties shall have a smooth internal surface and have a minimum loop tensile strength of 54kg.

18.5.2 Ducted single core installations

Where single core cables are to be installed in ducts to form a three-phase circuit, they shall, unless otherwise instructed by The Engineer, be installed with each core in an individual duct and with the ducts laid in touching trefoil. The duct groups shall be bound together using nylon cable ties at intervals of one metre. The nylon cable ties shall have a smooth internal surface and have a minimum loop tensile strength of 54kg.

It is acceptable to install three single core cables in a single duct for short lengths such as road crossings. In this case all 3 cores must be pulled in simultaneously.

18.6 Completion

When installation is complete, all cut cable ends must be sealed by capping in accordance with approved procedures. All unused cable must be capped before returning to stores.

The loose end of the cable remaining on the drum shall be rewound tightly onto the drum by means of a length of rope tied around the cable end and secured to the drum.

After securing the cable end lower the drum jacks keeping the drum level. Remove, clean and store the spindle and drum jacks.

18.7 Cable sealing

Irrespective of insulation type, all cut ends of cables, including cable left on the drum, shall be sealed immediately and not left exposed to the atmosphere. This applies whether the cables are cut at stores, in the yard or on site. Heatshrink cable sealing caps are the preferred method. Cold applied cable sealing caps can be used in emergencies when no gas torch is available or where naked flames are not permitted.

All end caps, including factory fitted end caps, shall be examined after laying and any cap found to be damaged shall be removed and the cable resealed immediately and The Engineer notified.

18.7.1 Cables with lead sheath

- For cables with lead sheaths the sealing cap shall be applied directly onto the lead sheath.
- Measure the diameter over the lead sheath and select the appropriate size of sealing cap.
- Expose the lead sheath for a distance equal to the length of the sealing cap plus 50mm from the cut cable end.
- Clean the exposed lead sheath using Approved cable degreasing solvent wipes.
- Install the sealing cap in accordance with the instructions provided with each cap.

18.7.2 Cables without lead sheath

- For cables without lead sheaths the sealing cap shall be applied directly onto the PVC or MDPE cable oversheath.
- Measure the diameter over the PVC/MDPE oversheath and select the appropriate size of sealing cap.
- Clean and abrade the cable oversheath.
- Install the sealing cap in accordance with the instructions provided with each cap.

19. ALTERNATIVE INSTALLATION TECHNOLOGIES

The requirements specified in this document apply in general to all underground cable installations irrespective of the installation method used.

Installation shall be carried out by experienced teams with a thorough understanding of the risks specific to the installation methods being used.

The installation design, equipment and techniques shall be designed to:

- Minimise pulling forces on cables.
- Cause no damage to cable sheaths during handling and installation.
- For single core cables, be capable of reliably installing the cables in touching trefoil formation.
- For single core cables in ducts, be capable of reliably installing the ducts in touching trefoil formation.

The following gives some clarification and guidance.

19.1 Ducted Installations

Ducted installations shall be installed to meet the same requirements for surround materials, depth of cover and warning tapes/tiles as applied for direct buried cables.

19.2 Trenchless Installations

Cables shall not be installed directly by trenchless means. Trenchless installation shall be achieved by installation of a duct which the cable(s) can be subsequently pulled into. In this situation it is not possible to install warning tapes/tiles and the markings on the Approved ducts in conjunction with the presence of the specified surround material can usually be considered adequate to provide the warning required by the ESQC Regulations. In certain situations it may be necessary to install additional warning such as marker posts or signs depending on the route, location and depth of cover.

19.3 Installation by Plough or Trenching Machine

Cables or ducts may be installed using ploughing or trenching techniques. The requirements for surround materials and depth of cover remain unchanged for this type of installation. Standard 11kV and 33kV warning tape/tiles are not suitable for installation by these methods and an Approved and appropriate alternative warning tape shall be used. In certain situations it may be necessary to install additional warning such as marker posts or signs depending on the route, location and depth of cover.

The capabilities of ploughing and trenching contractors must be fully assessed by SPEN prior to Approval to carry out installation work.

20. BLINDING OF CABLES AND JOINTS

The following points are recognised as good practice and should be followed where reasonably practicable:

- Blinding shall be completed immediately following the installation of sections of new cable, with the exception of joint bays.
- Joint bays shall be opened for as short a time as possible prior to commencement of jointing.

- All 11kV and 33kV joints and associated cables shall be blinded before the Jointer leaves site.
- LV joints and associated cables shall preferably be blinded before the Jointer leaves site and by the next day at the latest.

21. CABLE TESTING AND COMMISSIONING

Cables shall be tested in accordance with SUB-02-613 prior to energisation.

22. APPENDIX 1 – REQUIRED INSTALLATION PARAMETERS

22.1 General

The requirements of this section must be complied with for all cables, up to and including 33kV, which are installed with the intention that they will become part of SPEN's network.

22.2 Bedding and Blinding Materials

All cables and ducts shall be bedded and blinded as defined below.

22.2.1 Definitions

Soft finefill material

Soft finefill material shall be as per ENA TS 97-1, of consistent composition under all conditions of humidity and temperature and shall not contain any readily visible foreign matter such as pieces of clay or organic detritus. The material shall not contain any sharp stones or flints.

Selected sand backfill

Selected sand backfill shall be as per ENA TS 97-1, of consistent composition and shall not contain any readily visible foreign matter such as pieces of clay or organic detritus. Not less than 95% by weight of the material shall pass through a British Standard 5mm sieve. The material shall not contain any sharp stones or flints.

The dry relative density of the selected sand backfill shall not be less than 1.6 when determined in accordance with Appendix A of ENA TS 97-1.

22.2.2 LV Cables

All LV cables shall be surrounded by a minimum of 50mm of soft finefill material.

22.2.3 11kV Cables

All 11kV cables shall be surrounded by a minimum of 75mm of either soft finefill material or selected sand backfill.

22.2.4 33kV Cables

All 33kV cables shall be surrounded by a minimum of 75mm of selected sand backfill.

22.3 Cable Trench Reinstatement Materials

Cable trench reinstatement materials shall be selected in accordance with ENA TS 97-1 and ENA TS 09-2.

Foam concrete should not be used as a void filler or in the reinstatement of a cable trench, except in situations such as ducted cable crossings where it may be considered. Each proposed use of foam concrete ducted solution must have a thermal assessment carried out and be approved by The Engineer.

22.4 Maximum Pulling Tensions

Maximum permissible pulling tensions for each cable type are given below. These tensions must not be exceeded under any circumstances. Efforts should always be made to achieve lower figures by careful route design, setting out of the work and positioning of the cable drum.

LV & 11kV Cables

	Maximum pulling tension (kN)				
Conductor size (mm^2)	95 Al	185 Al	240 Al	300 Al	300 Cu
3-phase waveform	2.89	7.78	8.67	9.79	-
11kV 1-core XLPE	2.85	5.55	-	9.0	15.0
11kV 3-core XLPE	3.91	6.36	-	9.79	-

33kV Cables

	Maximum pulling tension (kN)				
Conductor size (mm^2)	150	240	400	500	630
Aluminium Conductor	4.0	5.5	8.0	-	-
Copper Conductor	5.5	8.0	-	14.6	18.0

22.5 Minimum Bending Radii

Minimum bending radii to which cables in new condition may be bent are given below for the installation conditions stated.

The following installation conditions apply:

Dynamic – When cables are being pulled in.

Static – When cables are bent in-situ adjacent to joints or terminations.

Under no circumstances must the minimum dimensions given below be infringed, as damage will be caused to the cable's insulation and screening systems resulting in premature failure.

Cable Type		Conductor size (mm^2)							
		95	150	185	240	300	400	500	630
		Minimum Bending Radius (mm)							
Three phase waveform	Dynamic	500	-	650	850	850	-	-	-
	Static	*240*	-	*400*	*540*	*540*	-	-	-
11kV 1-core XLPE	Dynamic	560	-	650	-	750	-	900	-
	Static	*420*	-	*490*	-	*560*	-	*680*	-
11kV 3-core XLPE	Dynamic	600	-	750	-	900	-	-	-
	Static	*500*	-	*600*	-	*750*	-	-	-
33kV 1-core XLPE	Dynamic	-	900	-	950	-	1050	1150	1250
	Static	-	*650*	-	*700*	-	*750*	*850*	*950*

22.6 Depth of Cover

Cables and ducts shall be installed as to provide the minimum depth of cover detailed below.

Surface Type	Voltage		
	33kV	11kV	Low Voltage
	Minimum Depth of Cover (mm)		
Unmade ground, footways & footpaths	775	600	450
Roads	775	700	600
Cultivated ground inc. gardens	775	700	600
Agricultural land	910	910	910

NOTE: In certain situations it may not be possible to achieve the minimum cover detailed above. In these cases, it will be necessary to:

- Minimise the length over which minimum depth is not attained.
- Install additional mechanical protection as appropriate for the location and circumstances.
- Install additional warning, for example in the form of posts or signs, appropriate to the location and circumstances.
- Ensure that the cable records clearly detail the depth and extent of the shallow section of cable.

On railway property, other than across or near railway track, normal depth of cover shall be used subject to a minimum depth to comply with the standard railway wayleave agreement.

22.7 Position of Warning Tapes, Protection Tapes and Protection Tiles

Approved warning tapes shall be installed 200mm above all low voltage cables and joints.

Approved protection tapes shall be installed 250mm above all 11kV cables and joints. Where an 11kV cable is installed directly below another cable, its protection tape shall be installed immediately below the higher cable.

Approved ENA TS 12-23 Class 2 protection tiles shall be installed 75mm above all 33kV cables and 33kV joints.

Where existing warning markers on any cable are disturbed or removed during excavation, these markers shall be replaced or renewed as appropriate.

Where existing cables without marker tapes or tiles (including LV cables) are uncovered during the course of excavation, new marker tape or tile shall be installed over the complete exposed section of the existing cables. **This is necessary to comply with ESQC Regulations**.

22.8 Multiple Cable Spacing and Positioning

Minimum spacing between adjacent cables is as shown below:

33kV	450mm
11kV	300mm
LV main	250mm
LV service	100mm

These spacings are the minimum required to allow for future access and jointing works. They do not take into consideration any ratings requirements. The actual minimum spacing requirement may be greater than those given above depending on ratings requirements and the proximity of other cables or sources of heat. Where there are multiple ratings of cables in close proximity, the greater minimum spacing between adjacent cables shall apply.

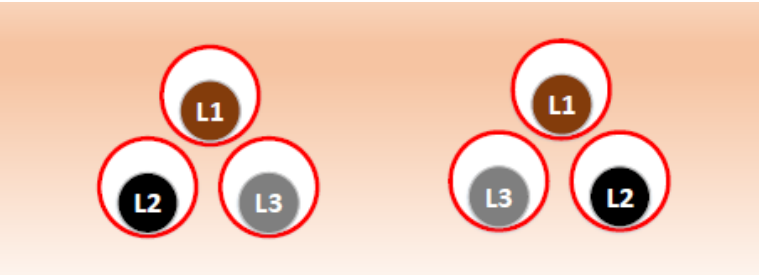
For single core trefoil installations, the dimensions above shall be measured between centres of the closet cores in the trefoil groups.

Cable and telecoms circuits shall not be laid directly above or below other circuits. They shall be offset as to enable future access to the higher voltage circuits.

In the cases of multiple circuits, the magnetic field may cause one phase cable to carry more current than the other cable connected to the same phase. Where an installation has more than one cable per phase, it is possible to minimise electromagnetic fields by orienting the cables of each phase to achieve the mirrored configurations demonstrated in the examples below. These illustrations are not to scale: the spacings between ducts and between circuits have been compressed and should not be taken as indicative of spacing requirements in real installations.

Planning and installation using this geometry is a simple and efficient way of mitigating the effects of electromagnetic fields without incurring additional costs.

22.8.1 Double Circuit – Touching Trefoil

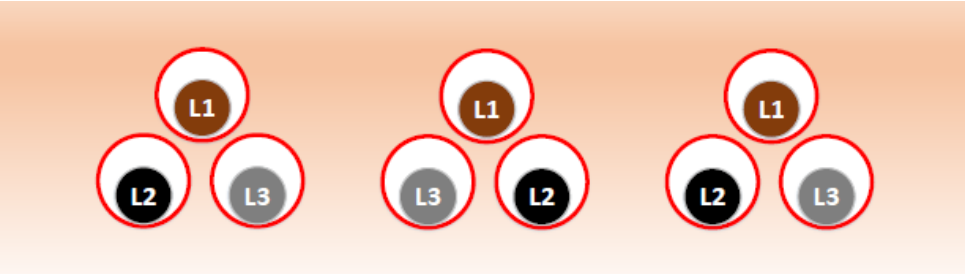


The circuits are impedance balanced, the same phase cables will share the phase current equally.

22.8.2 Double Circuit – Flat Formation

The circuits are impedance balanced, the same phase cables will share the phase current equally.

22.8.3 Triple Circuit – Touching Trefoil



22.8.4 Triple Circuit – Flat Formation

22.9 Joint Bay Dimensions

Minimum required joint bay dimensions are shown below. In all cases, the joint bay shall be excavated to a depth of 200mm below the bottom of the cables to allow adequate access for jointing:

Voltage	Joint Type	Joint bay minimum dimensions (length x width) m	SPEN Drawing Number
LV	All service cable joints	0.9 x 0.6	SP4081856
	All mains joints and service branch joints except breech joint with 240mm° cables or larger	1.2 x 0.9	SP4081857
	Breech joint with 240mm° cables or larger	1.5 x 0.9	SP4081858
11kV	All 11kV joints except breech and loop joints	2.2 x 1.2	SP4081859
	11kV breech and loop joints	2.5 x 1.2	SP4081860
33kV	All 33kV joints	2.7 x 1.5	SP4081861

22.10 Ducts

All ducts for installation on the SPEN network shall be new and classified as Approved on the Approved Equipment Register.

Where ducts are specified, the recommended internal diameters are as shown below. These minimum duct diameters should be used wherever possible to minimise circulating currents for single core installations. Larger diameter ducts shall only be used in situations where the route is unusually tortuous.

Cable Type	Minimum inside diameter of duct (mm)
LV mains cable	100
11kV 1-core cables and 95mm² 3-core cable	100
11kV 185mm² and 300mm² 3-core cables	150
33kV cables up to and including 400mm²	100
33kV cables above 400mm²	150

Where single core cables are to be installed in individual ducts the ducts shall be installed in touching trefoil arrangement. In this situation the use of ducts of a larger diameter than necessary should be avoided in order to minimise de-rating of the installed cables due to sheath circulating currents.

After installation of ducts the installer shall:

- Confirm that they are correctly aligned by pulling through a mandrel of a diameter slightly less than that of the duct.
- Clean them by drawing through a suitable cleaning pig.
- Install a non-perishable draw rope.
- Seal the duct mouths temporarily until they are required for cable installation.

Where additional ducts are to be left empty for future use, they shall be identified by laying polythene marker tape through the duct. In unmade ground the ends of the marker tape shall be brought out above ground level.

Where sections of ducts terminate within unmade ground, after installation of the cable, the duct shall be sealed with an Approved duct sealing system (minimum IP4X) to close the duct void and prevent any ground movement of backfill material into the duct. Cable ducts must remain free of debris during and after cable installation.

Where cables enter a building via ducts the duct entry, both internal and external to the duct wall, shall be sealed against the ingress of gas and moisture by an approved method. The SPEN Approved Equipment Register details Approved products.

22.11 As Laid Records

As laid records shall be provided in accordance with the requirements of SPEN document BUPR-22-015.

22.12 Typical Cable Trench Arrangements

Examples of the typical cable trench arrangements as per the requirements of this standard are given in the table below.

Voltage	Cable Trench Arrangement	SPEN Drawing Number
LV	Direct laid LV single circuit (option for double circuit)	SP2058308
	Ducted LV single circuit (option for double circuit)	SP2058309
11kV	Direct laid 11kV single circuit (option for double circuit)	SP2058259
33kV	Direct laid double trefoil circuit	SP2058241
	Ducted double trefoil circuit	SP2058251
LV & 11kV	Direct laid 11kV single circuit (option for double circuit) with direct laid LV single circuit (option for double circuit)	SP2058261
11kV & 33kV	Direct laid 33kV double trefoil circuit with direct laid 11kV single circuit (option for double circuit)	SP2058247
	Ducted 33kV double trefoil circuit with ducted 11kV single circuit (option for double circuit)	SP2058257