NETWORKS

FUNCTIONAL SPECIFICATION FOR THE INSTALLATION OF 38KV UNDERGROUND POWER CABLES FOR CONTESTABLE PROJECTS

Network Assets, Underground Networks

SPEC-171213-AXS

Note: The following document is highly technical in nature and may be complex to understand. If you are having trouble understanding the content of this document, please reach out to ESB Networks and we will assist you to understand their meaning.

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Title:	**Functional Specification for the Installation of 38kV Underground Power Cables for Contestable Projects**
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	(ESB Networks Specifications are subject to change, this specification version shall only be used for the purpose/project for which it was issued by ESB Networks to you)
Approved for Issue:	**Specifications Manager ESB Networks**

History of Revisions

Rev No	Date	Revision Content
0	2013	New Document
1	March 2021	Update with RDT comments

Note:

This specification will be reviewed at minimum before the Latest Review Date, but may also be reviewed in the interim. Consequently the “Latest Review Date” does not indicate that this particular version of the Specification is current. Accordingly, only the version of the specification issued by ESB Networks to the user for the particular purpose/project should be used.

ESB Networks Technical Specification Approval

Title	**Functional Specification for the Installation of 38kV Underground Power Cables for Contestable Projects**
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Table of Contents

1.0 Scope

This document specifies the requirements for the supply, installation, jointing, testing and commissioning of 38kV Underground Power Cables and Accessories and Associated Communications Cables in fully ducted systems for connection to the ESB Networks Distribution System.

The materials used and construction methods employed shall comply with the requirements of

1. This Specification Number 18151 and also
2. Specification Number 18149 – General Specification for Contestably Built Underground Networks
3. Specification Number 18150 – Functional Specification for the Installation of Ducts and Ancillary Structures for 38kV Underground Power Cables and Communication Cables
4. The individual ESB Networks material Specifications for ducting and cables materials and components and ancillary structures

2.0 Design Review

Details of the proposed cable and associated jointing, termination and installation materials shall be submitted to ESB Networks for review.

3.0 Cable Design Considerations

The following shall be taken into consideration when carrying out cable design.

Cable Length and type shall have charging current calculation carried out and submitted to ESB Networks.

Calculations for proposed cable shall be carried out to assess adequacy for proposed MEC, including all non-standard installation locations along the route.

4.0 Materials

The materials supplied and used shall comply with the following ESB Networks Materials Specifications:

Spec Number	Material
16112	Lubricant for pulling Cable into Ducts
16120	Supply and Delivery of 52kV, 24kV and LV Polymeric Insulation Cable
16140	Link and Lug Connectors for 40kV, 20kV, 10kV and LV Underground Cables
16342	42kV Heatshrink, Coldshrink and Premoulded Cable Accessories

All cable and accessory sample and routine tests shall be provided to ESB Networks post manufacturing for review.

5.0 Cable Handling

Care and attention is required in this area as any mishandling of cable drums will lead to damage of cable or injury to installers or members of the public. Proper practices of transportation, loading, unloading and storage on site shall be used.

5.1 Transportation

Drums shall be delivered to site by a drum trailer or on a truck fitted with a hydraulic crane.

5.2 Loading/Unloading

To avoid serious injury to personnel and damage to cable drums, an appropriately sized axle shall be used for lifting along with a spreader bar to prevent the lifting chains damaging the drum and crushing the cable. Appropriately rated proprietary lifting hooks that fit into and lock onto the axle hole may be used in place of a steel axle. The chains and all associated lifting equipment shall be rated to lift the gross weight of the drums, with an appropriate factor of safety.

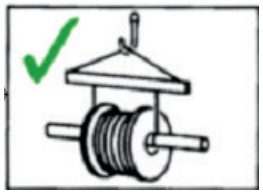


Figure 1: Drum trailer axle and spreader bar for safe damage free cable drum lifting.

5.3 Storage

All cable ends shall be sealed to stop the ingress of water and future deterioration of cable. Cables drums shall be stored on hard even surfaces to prevent the flanges from sinking into the ground thereby causing all the drum weight to rest on the cable with resultant damage due to cable compression and penetration by sharp objects.

Figure 2: Storage of cables.

5.4 Pre Pulling Inspection

Prior to cable pulling the complete outer coils of the cable shall be inspected for any mechanical damage by rotating the drum and visually observing for any bumps/perforations or any other sign of damage. All damaged sections found shall be cut off and scrapped.

This inspection shall take place for all cable drums before cable is pulled in This measure will reduce the incidence of sheath faults which can be very costly and time consuming to locate and rectify at a later stage when cable is installed along the ducted route.

6.0 Cable Installation

Prior to any cable installation activities

1. Safety certification for all plant to be used
2. Calibration certification for winches
3. Full RAMS shall be submitted to ESB Networks for review
4. Cable proving certification and calibration certification for winch used

6.1 Risk Assessment and Method Statement for Cable Installation

A full set of risk assessment and method statement (RAMS) shall be provided for the pre proving, lubrication and cable installation prior to any activities taking place. A management plan for the interaction and supervision of the above tasks and with tasks required in Section 3.2 of Functional Specification 18150 Installation of Ducts and Ancillary Structures for 38kV Underground Power Cables and Associated Communications Cables for Contestable Projects must be submitted for review.

6.2 Cleaning and Proving and Pre-Lubrication of Ducts

Each duct shall be cleaned and proven prior to pulling in the cable winch rope by pulling in the appropriate size of ESB Networks approved duct brush and mandrel through each duct. The direction of duct cleaning and duct proving shall be in the direction of the calculated planned cable pull.

Following the cleaning and proving of the entire duct run and immediately prior to cable pulling, all power ducts shall be pre-lubricated during the operation of pulling back of the winch rope from the winch end. The lubricant (recommended quantity 10 litres per 100m of duct or as recommended by the manufacturer) shall be placed in the duct at the winch end and a suitably robust sponge securely attached to the winch rope to spread the lubricant uniformly over the entire length of the duct.

Duct Cleaning – Use of Approved Brushes

Only approved brushes with the ESB Networks material code specified below shall be used to ensure that any dirt or debris within ducts is transported out of the ducts rather than being merely loosened up and left within the duct .The approved suppliers of the brushes for normal and directional drilling 110mm O.D HDPE duct are given on the ESB Networks website.

Brushes shall be cleaned regularly using a powered water hose.

Duct Proving

Duct proving shall be achieved by pulling a mandrel through the duct in the direction of the planned cable pull. The proving equipment shall conform to the details and dimensions in the table below:

Type and Size of Duct	**Mandrel** **ESBN Material code**	**Brush** **ESBN Material code**	**Sonde**	**Sponge** **Diameter and Length 300mm**
110mm HDPE SDR 17.6 For Standard trenching	8783226	8783255mm	required	100mm diameter Minimum Length 300mm
110mm HDPE SDR 11 For Horizontal Directional Drilling	8783225		required	95mm Minimum Length 300mm

All new mandrels shall be stamped with their size and the corresponding duct size to which they are applicable.

Duct Proving – Sponge

Duct Sponge A sponge shall be used to remove excess water and pre-lubricate the duct prior to cable pulling.

Duct Proving – General

ESB Networks shall have the right to witness the duct proving tests.

ESB Networks approved duct brushes, mandrels and sponges are designed to provide thorough cleaning of the duct and a tight fit. The minimum rope size used shall be 12mm polypropylene. Cleaning and proving shall be carried out using a winch which has a calibrated dynamometer and printout. Pulling tension shall not exceed 1 Tons (10kN). The print out results shall be submitted to ESB Networks for review, with the Duct Cleaning/Proving report.

Following the duct proving process detailed in Specification 18150 section 3.22, approved waterproof rubber bungs shall be fitted to prevent ingress of water, sand or other debris. The ducts shall then be left roped in preparation for cable pulling. Approved duct sealing bungs have a rope tie off on the internal side of the bung to allow the bung to seal correctly with rope in the duct.

Use of a Transmitter (Sonde)

A Sonde may be connected close to the mandrel or brush to help locate a blockage quickly. It can be purchased for specific use with a C.A.T. or other precise cable location instruments, equipped with a Sonde detector.

Duct Lubrication Materials

Only ESB Networks approved lubricants which are proven not to damage the cable insulations semi-conductive layers and outer sheath shall be used. Petroleum based oils or greases shall not be used for power cables.

The list of approved suppliers, for the above items is available from the following ESB Networks web site address:

http://www.esb.ie/esbnetworks/en/download_documents/builders_developers/approved_material.jsp

6.3 Cleanliness

All Joint Bays and Lubrication points shall be free from stones, sand, grit, water and other contaminants.

6.4 Duct Lubrication recommendations during cable pulling

Ducts and cables shall be thoroughly lubricated for all cable pulls.

ESB Networks approved Lubricant shall be used at a rate of 10 litres per 100 metres of duct as follows:

1. Pre lubricate ducts with 10 litres per 100 metres from winch end.
2. Apply additional lubricant at a rate of 10 litres per 100 metres run at duct entry and,
3. Insert 20 litres of lubricant in advance of all major bends.

Lubrication points shall be installed in cable runs in close proximity to areas of high bend concentration. Optimised positions shall be chosen, e.g. on the crest of steep incline for maximum lubricant dispersion on the route. Lubrication points shall be reinstated as per ESB Networks minimum standards after the cable is pulled in.

Where the manufacturer of the cable recommends an alternative and specific cable pulling lubricant, such lubricant shall not be used without the prior agreement of ESB Networks.

6.5 Supervision

The cable installation works shall be continuously supervised by competent persons. Quality control checks shall be carried out throughout the cable pulling and jointing phases in addition to the pre-commissioning checks.

6.6 Cable Installation into Ducts

The following equipment shall be used for the installation of cable into ducting

- Bell mouth installed for entry and exit positions
- Rollers to support cable entering and exiting duct
- The following as specified by the cable manufacturer
  - Cable pulling stocking
  - Cable pulling eye
- Swivel with torque relief
- Calibrated Winch with
  - force measurement facility
  - Speed control
  - Print out facility
- Mandrel
- Brush
- Sponge
- Sonde

Cable rollers shall be used at duct entry and exit positions to guide the cable from the drum into the duct and to prevent abrasion/ripping of the cable via contact with the trench bottom and sides and also to prevent the cable picking up debris before entry into the duct..

Appendix 1 details the roller set up arrangement for cable pulling.

6.7 Cable Pulling

Cable pulling shall be preceded by calculation of the pulling and sidewall forces for each cable pulling section based on the ‘as built’ duct installation.

The following shall be presented to ESB Networks for review 2 weeks prior to cable installation activities.

- calculated cable pulling forces and calculated cable side wall forces
- calibration cert for the winch
- RAMS for this activity

When bends are present in a duct run, the cable drum shall be positioned at the end closest to where most of the bends lay and the winch shall be positioned at the end furthest from the bends.

This method reduces

- The tensile and side wall forces on the cable
- The likelihood of the winch rope sawing through or burning through the ducts at bend positions.
- The pulling forces and wear and tear on the winch and the winch rope.

See Appendix 2 for details on drum and winch set up on a route with a high bend concentration.

Cable pulling tensions shall be monitored and recorded during installation. The values obtained from the winch printout shall accompany the Cable Installation Report and in addition the values shall be, electronically presented to the ESB Networks representative and sent to ESB Networks for review. The values shall also be within the cable manufacturers specification.

All cables shall be sealed against water ingress and protected and adequately supported after cable pulling.

6.8 Cable Jointing

Cable jointing shall be carried out by suitably trained and experienced cable jointers and in accordance with manufacturer's instructions. Experience and training records for proposed cable jointing personnel shall be submitted to ESB Networks for review prior to any jointing activities taking place.

6.8.1 Cable Clamping due to Thermo/Mechanical effects

Where the risk of excessive thermo/mechanical forces require clamping of cables, this shall be carried out to an approved design in line with manufacture's recommendations.

6.8.2 Sealing of cable ducts

Cable ducts shall be sealed using an ESB Networks approved method after completion of the cable joint. Details of the sealing method shall be submitted to ESB Networks for review.

7.0 Cable Testing

All cables shall be electrically tested immediately after each pull is complete. All cables shall be tested again prior to any jointing activity to ensure that sheath fault location difficulties are minimised. Terminations shall not be connected to switchgear during tests.

The following list of tests shall be carried out after each cable pulling

1. Measure Insulation resistance, phase to screen and phase to phase
2. Check phasing of conductors
3. Sheath test cables by measuring the resistance, cable screen to earth

(A 5kV calibrated Insulation resistance test kit shall be used for this purpose)

The following list of tests shall be carried out on the cable before and after each cable joint is assembled on the circuit

1. Measure Insulation resistance, phase to screen and phase to phase
2. Check phasing of conductors
3. Sheath test cables by measuring the resistance, cable screen to earth

(A 5kV calibrated Insulation resistance test kit shall be used for this purpose)

If the sheath test results do not meet values in Appendix 4 Table 28, then jointing works of further sections shall not commence. Based on results below the minimum standard, the cable may require replacement this will be determined by ESB Networks.

All test information shall be recorded and available for inspection and shall also be included in the 'As-Built' documentation.

All cables shall be sealed/capped after cable testing if not being jointed or terminated on immediately.

The following list of tests shall be carried out after the all cable jointing and termination activities have taken place and all backfill and reinstatement has been completed prior to cable commissioning.

1. Measure Insulation resistance, phase to screen and phase to phase
2. Check continuity of all phase and screen conductors
3. Check phasing of conductors
4. Check phase clearances and phase to earth clearances
5. Sheath test cables by measuring the resistance, cable screen to earth (A 5kV calibrated Insulation resistance test kit shall be used for this purpose)
6. Perform Voltage withstand with
    i. Partial discharge, monitoring and recording
    ii. Tangent Delta, measurement and recording

Partial discharge test and Tangent Delta shall be carried out as per table below at 50 Hz, VLF or other ESB Networks approved frequency and time duration. Partial discharge monitoring shall be carried out on the cable system e.g. on jointed sections including termination s of length not exceeding 10km or capacitive limit of cable.

These tests shall be carried out in conjunction with ESB Networks prior to the commissioning of the completed cable circuit. Test result acceptability shall be determined by ESB Networks

As per

U0 Multiple	PD	TD	Voltage Withstand Time	
0.5			x	
1.0			x	
1.5			x	
2.0			15 Mins	

Results from above shall be submitted to ESB Networks for review prior to cable commissioning taking place.

8.0 Cable Reinstatement/Backfill Thermal Sand

Thermal Sand shall be used to backfill around 38kV cables and joints, usually in the following locations; 38kV cable joint bays, 38kV cables on approach to a cable mast and pull pits near substation basements. ESB Networks keeps a live list of pre-approved suppliers around Ireland. New suppliers are added regularly upon completion and passing of the tests set out below.

The thermal sand shall meet the requirements set out in this Specification and ENA Technical Specification 97-1 (latest Revision) section 6.1 (with this Specification taking precedence).

There are 3 main criteria for the thermal sand;

1. It shall have no sharp stones or flints (may damage the cable sheath during compaction).
2. At least 95% shall pass a 4 mm sieve and 100% shall pass an 8 mm sieve.
3. The fully dried sample @ 0% moisture shall have a maximum thermal resistivity of 2.7 K.m/W. This test shall be completed by an approved ESB Networks test laboratory by the thermal needle probe method as outlined in ASTM D5334. The thermal resistivity @ 2% moisture shall also be recorded.

The IPP shall, before commencement of the Contract, select samples of sands which fall within the above grading, and subject them to testing for thermal resistivity, particle distribution and dry relative density all at his own cost and submit the following information to the ESB Networks for approval prior to commencement of the Works:

- The source or sources of the material
- Certificates of Compliance with the specified grading limits
- Thermal resistivity test results demonstrating the ability of the material to meet the above criteria

Test sheets confirming the thermal properties shall be sent to ESB Networks for review prior to sand being used on site and shall be submitted with the 'as-built' documentation.

The sand shall be manually compacted around the cable and joints.

Full list of approved Thermal sand suppliers can be found in link below

https://www.esbnetworks.ie/docs/default-source/publications/approved-material-suppliers-for-lv-mv-38kv-110kv-associated-works8b84642d46d164eb900aff0000c22e36.pdf?sfvrsn=3a5500f02

Appendices

Appendix .1 Set Up for Cable Pulling

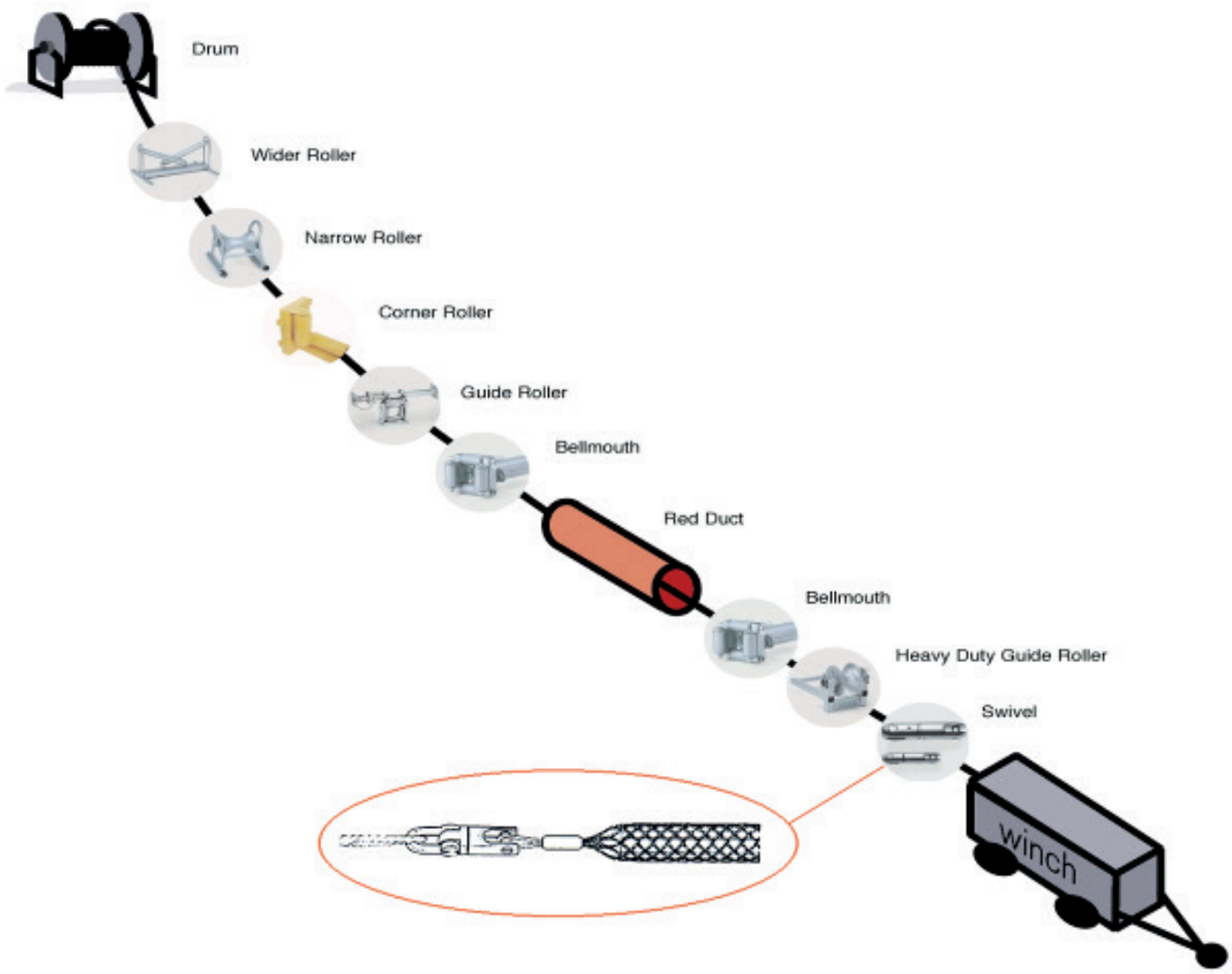
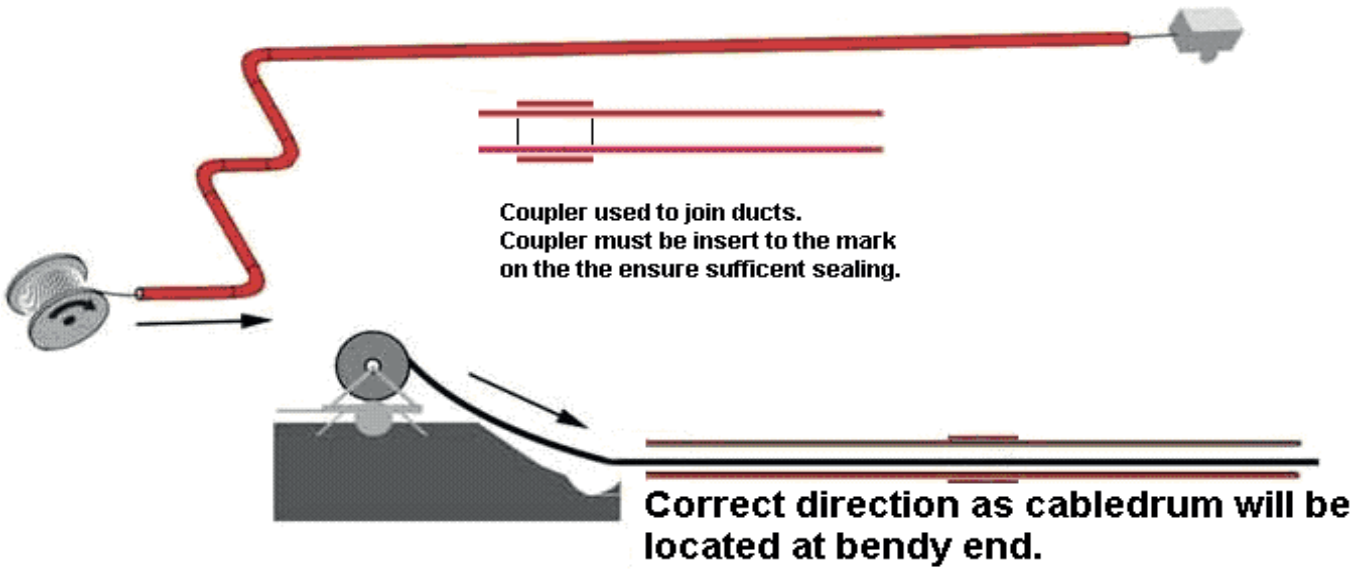


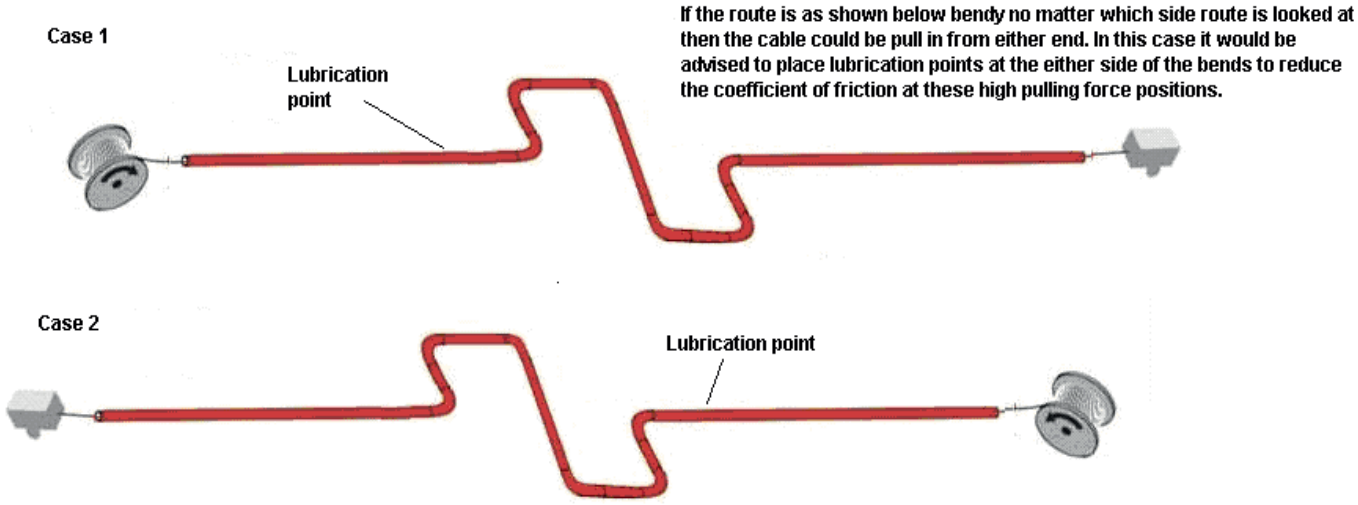
Fig 11B - Set up for Swivel, Brush, Mandrel and Sonde for Duct proving and Cleaning

Appendix 2. Drum and Winch Set up on Bendy route

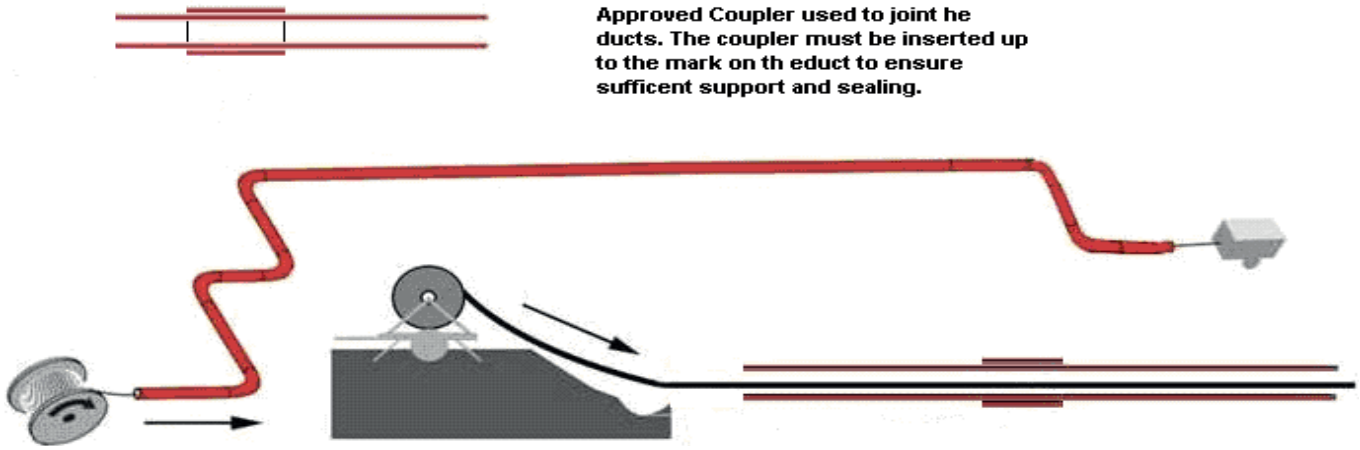
Duct Route with all bends at one end



Bendy no matter which end duct route is looked at.

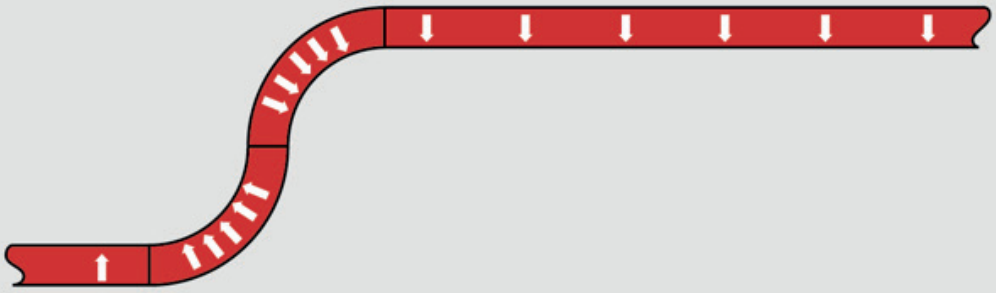


More Bends at one end of the duct route



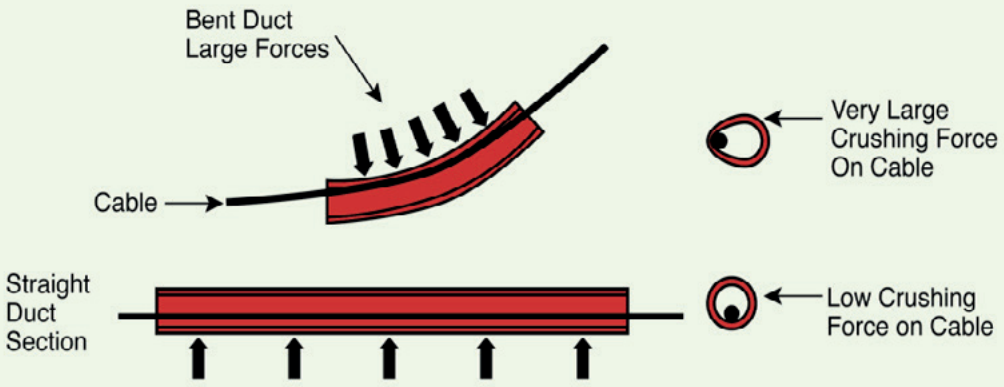
Appendix 3. Cable Side Wall Forces

Fig.22 COMPARISON OF LARGE FORCES AT DUCT BEND POSITIONS COMPARED TO STRAIGHT SECTIONS OF DUCT



Duct Section	Duct forces on that duct section		
	Side-Wall Crush	Tensile Shear	Abrasion
	Low x1	Low x1	Low x1
	High x500 times	High x500 times	High x500 times

Fig.23 MINIMISING CRUSHING SIDE WALL FORCES ON CABLES DURING PULLING



Minimise these crushing side wall forces by:

- Good lubrication of both duct and cable
- Place drum near section of route with most bends - place winch furthest away
- Reduce length of pull if doing this eliminates a number of bends at winch position
- Take due care at the duct exit position, which is the last "bend" on every duct pull (see fig 17)
- Ensure that the winch rope does not exit the duct at sharp angle by excavating a minimum 3m of ground beyond the duct end. (see fig 18)

Appendix 4. Pre-Commissioning Standards

ESB NETWORKS CABLE PRE-COMMISSIONING STANDARDS FOR 38kV CABLES

Commissioning Policy for all new XLPE 38kV cable circuits is to:

1. Measure insulation resistance (phase to earth with cable screen earthed)
2. Sheath test, measure insulation resistance between the metallic cable screen (disconnected from earth) and earth
3. Check continuity of phase conductors
4. Check phasing
5. Check inter-phase clearances and phase to earth clearances

See Table 28 below for Commissioning Test Standards.

All tests to be preformed using calibrated test equipment.

All testing on 38kV cables must be carried out using a 5kV insulation Resistance tester.

Sheath Faults on 38kV cables will not be accepted by ESB Networks.

Table 28 – Commissioning Test – Standards for 38kV Cable

Note: For route lengths greater than 19kM pro rate the minimum requirement

	Screen to earth		**Core to Earth**	
Route km	**Minimum Values**		**Minimum Values**	
Km	*Giga Ohms*	*Micro Amps*	*Giga Ohm*	*Micro Amps*
0.25	2	2.5	8	0.62
0.5	1	5	4	1.25
	Mega Ohms		Mega Ohms	
0.5-1	500	10	2000	2
2	250	20	1000	5
3	170	29	666	7
4	130	38	500	10
5	100	50	400	12
6	83	60	333	15
7	71	70	286	17
8	62	80	250	20
9	55	90	222	22
10	50	100	200	25
11	45	111	182	27
12	41	122	167	30
13	38	131	154	32
14	36	139	143	35
15	33	151	133	37
16	31	161	125	40
17	29	172	118	42
18	27	185	111	45
19	26	192	105	47

NB: Above values refer to cables only – not to cables connected to OH lines or other apparatus which would reduce the values considerably.

Wet, damp weather and dirty leads or cable ends can also reduce the values considerably.

Large differences between insulation values for different phases should be noted and investigated as such differences can be an indication of cable damage or deterioration

Clearances Metal to Metal/Metal to Screen

Voltage	Indoor	Outdoor
38kV	360mm	470mm

38kV Cable Pre Commissioning Test Report

To Be Completed for Each Separate Cable Section

Location of Cable Section: _____
City/Town/Townland

Connection From: END 1 _____

To: END 2 _____

Length & Type of Cable: _____

INSULATION TEST

Note: Where the connection consists of underground cable to an overhead line, the jumpers, (point of interconnection) should be removed and separate insulation tests carried out on the line and on the cable.

Cable Insulation Test Screen must be earthed for this test.	Insulation Test Reading *See Table 28 for values specific to particular cable length*	Remarks Fail/Pass
R phase to Earth		
S phase to earth		
T phase to Earth		
Insulation Test* Voltage & duration of test = 5kV for 2 minutes or time for stable reading	State: Calibration Date of Instrument	
Weather Conditions Coastal/Inland	State: Dry or Wet	

INSULATION TEST: PASS YES ☐ NO ☐

OVERALL

Comments _____

CABLE SHEATH TEST

Test the cable sheath insulation of each cable length prior to jointing. Use a calibrated 5kV Cable Sheath Test Instrument. Cable screens must be disconnected at both ends from earth.

Insulation Resistance TesterType & Calibration Date of Instrument	**Overall Screen Resistance to Earth** (Mega Ohms) **In accordance with Table 28**	**Test Time**** (minutes)	**Length** (metres)	**Sheath Insulation Resistance Value** (Mega Ohms)
				R = **S =** **T =**

* Insulation Tester Voltage 5kV (**Note:** 1kV Insulation resistance Tester is inadequate – it will not breakdown sheath spark gap.)

** Test time minimum 2 Minutes (or longer to obtain stable or increasing reading)

SHEATH TEST: PASS YES ☐ NO ☐

(See Table 28 for Pass values of screen insulation resistance to earth for lengths 0-20km long)

Comments _____

PHASING/CONTINUITY		**R**	**S**	**T**
Test Point	(Station//Pole)	___	___	___
Remote Point	(Station//Pole)	___	___	___

GENERAL INSPECTION

	Yes/No.	End 1	End 2
Are clearances both from live parts to live parts & live to earth parts adequate?			
Is all structural steelwork earthed?			
Are lightning arrestors earthed?			
Are cable screen wires earthed?			
Is cable trench backfilled?			
Is cable trench reinstated?			
Are all joint bays and lubrication points reinstated?			
Is cable adequately clamped/supported?			
Are pole/mast vertical cable guards in place?			
Are cable anti-climbing guards fully fitted in place?			
Are sheath disconnect vault covers in place?			
List of items requiring attention before cable may be put into commission			
Outstanding work on site, other than that on the cable, which must be completed before cable may be put into commission e.g. labelling, phase identification, anti-climbing screens etc.			

Signed: _____ **Date:** _____

Appendix 5. Cable Installation Report for 38kV Cable

ESB Networks

Cable Installation Report

Project:				
Duct ID	**Duct Diameter(s) (mm)**	**Sponge Diameter (mm)**	**Brush Diameter (mm)**	**Mandrel Diameter (mm)**

Winch Serial No: _____ Calibration date: _____

Direction of proving from: _____ to _____

Typical circuit cross section & Ducts ID	Ducts formation & ID at the start of the pull	Ducts formation & ID at the end of pull

Pre-Taking Over

Duct ID	Duct Designation	Max Pulling Tension (tonnes)	Comments
1			
2			
3			
4			
5			
6			
7			
8			
9			

Have the ducts maintained the correct formation?	Yes ☐	No ☐
Rubber bungs fitted after ducts proving?	Yes ☐	No ☐
Have the ducts been cleaned and proved successfully?	Yes ☐	No ☐
Name of Contractor:		
Signed for Contractor:	Date:	
ESB N Supervisor who witnessed the tests:		
Signed for Contractor:	Date:	

Note:

- The proving of the ducts will be deemed as failed if:
- The pulling tension exceeds 1 tonne (10 kN)
- If max speed of 25M/minute is exceeded.
- Mandrel is stuck
- Mandrel is moving with sudden bursts even if the pulling tension is less than maximum specified
- Rope shoots suddenly up the duct
- Ducts do not maintain the same formation as at the start of the pull

Appendix 6. 38kV Cable installation (+ Fibre Cable)

The following flow chart is the project process for a non-contestable 38kV and Communication ducting and cables. This process is aimed at how ESB Networks and the IPP interact and the roles ESB Networks have.

38kV Cable Installation