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Electricity Specification 400O5

Issue 2 January 2022

Incorporation of Optical Attached Cable and Conductors Carrying Optical Fibres into the Existing Overhead Line Network: Design and Construction

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 2 **January 2022**	New template applied. Prepared by: D M Talbot. Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, Engineering and Technical Director.

Contents

1 Introduction

This document specifies design and construction standards for the incorporation of Optical Attached Cable (OPAC), conductors carrying optical fibres or All Dielectric Self Support cables (ADSS) into the existing overhead line network (Network) owned by Electricity North West Limited, as Distribution Licensee.

OPAC is a non-metallic fibre-optic cable lashed or attached to an existing earthwire or a phase conductor. Helical wrap OPAC is designed to be helically wrapped around the existing conductor or existing earthwire. Lashed OPAC is designed to be placed longitudinally beside the host existing conductor or existing earthwire, and a tape or tapes are wrapped around the pair to hold the lashed fibre optic cable in place. Refer to Appendices A and B for typical arrangements.

Conductors carrying optical fibres are conductors which have optical fibres incorporated during manufacture. These conductors are intended to replace equivalent conductors on the Network where required. There are two types of such conductors: Optical Phase Conductors (OPPCs); Optical Ground Wire Conductors (OPGWs). Refer to Appendices C and D for typical arrangements.

This specification includes guidance on whether to install OPAC, OPPC or OPGW.

Details and guidance on the use of ADSS will be added at subsequent issues.

During the design stage, consideration shall always be given to subsequent operational requirements. An example of such a consideration would be identifying potential isolation points.

2 Scope

This specification covers design and construction standards for the incorporation OPAC, OPPC or OPGW as follows:

- OPAC on earth or phase conductors of steel-tower overhead lines, operating at 33kV and 132kV.
- OPAC on phase conductors of wood-pole overhead lines operating at 33kV and 132kV.
- OPPC and OPGW on steel-tower overhead lines operating at 33kV and 132kV.
- OPPC on wood-pole overhead lines operating at 33kV and 132kV.

3 Definitions

ADSS	**All Dielectric Self Support cable.**
OPAC	**Optical Attached Cable.**
OPGW	**Optical Ground Wire.**
OPPC	**Optical Phase Conductor.**

4 Design and Construction Standards

4.1 General Arrangements

Typical general arrangement drawings are included in Appendices A to D:

- Appendix A covers general arrangements for OPAC on steel tower lines.
- Appendix B covers general arrangements for OPAC on wood pole lines.
- Appendix C covers general arrangements for OPPC and OPGW on steel tower lines.
- Appendix D covers general arrangements for OPPC on wood pole lines.

All designs shall follow the principles illustrated in these typical arrangements and the text of this specification.

4.2 Apply OPAC or OPPC/OPGW?

When considering the use OPAC, take account of the following points:

- The remaining life of existing conductors (it would not be worth installing OPAC on to a conductor that is due to be replaced shortly):

  OPAC shall not generally be used on aluminium conductors older than 30 years.

  OPAC shall not generally be used on copper conductors older than 60 years.

- Potential clearance problems: the addition of OPAC will result in a small increase in the sag of the affected conductor.
- The effects of aeolian vibration which is periodic motion of a conductor induced by the wind predominantly in a vertical plane, of relatively high frequency (of the order of 10Hz or more) and small amplitude, shall be assessed and taken into account during the design stage.
- Potential galloping and clashing caused by the addition of OPAC.

When considering using OPPC/OPGW, note the following points:

- Reconductoring using OPPC or OPGW is an option only where there is a conductor in ES400C25 which is equivalent to the existing line conductor. For example, existing Poplar must be replaced by Poplar from ES400C25 (the conductors must be matched).
- Building OPPC or OPGW into a new line is an option only where there is a conductor in ES400C25 which is equivalent to the new conductor to be used during construction (the conductors must be matched).

Standard overhead line conductors (i.e. conductors that do not contain optical fibres) are specified in ES400C3 and C4.

4.3 Arrangements using OPAC

4.3.1 Design Information

4.3.1.1 Life Expectancy

The minimum life expectancy shall be 25 years. Materials shall be selected, and the system shall be constructed, accordingly.

4.3.1.2 General Arrangements

The approved general arrangements specified in Appendices A and B are suitable for steel tower lines designed to ENA TS 43-125 and wood pole lines designed to ES400O3 and ENA TS 43-50.

OPAC shall be fitted to the middle phase of a tower line or the centre phase of a wood pole line. If two are required on a wood pole line, they shall be fitted to the outer phases.

4.3.1.3 Purpose of Balehangers

Balehangers enable earths to be applied to conductors.

4.3.2 Materials

4.3.2.1 OPAC

The OPAC shall:

- Comply with the relevant parts of BS EN 60794.
- Generally contain 48 or 24 fibres; this will depend on requirements and physical limitations of the conductor, etc.
- Be suitable for fusion splicing techniques used during installation.

The OPAC and associated items shall have susceptibility to external electro-magnetic coupling confirmed by BS EN 61300 – 2-39:1997.

4.3.2.2 Fittings

All fittings for OPAC shall comply with the relevant part(s) of ENA TS 43-126. Sizes and voltage ranges, etc, of fittings shall be selected to match the requirements of the overhead line.

To ensure maximum reliability and avoid cable damage, it is important to ensure that all fittings chosen are compatible with the optical cable system selected.

Helical fittings with a reinforcing layer are preferred for maximum optical and mechanical protection of the optical cable. They will ensure that mechanical loads are evenly spread, and the cables are not crushed, thereby affecting the optical performance.

Where vibration damping is considered necessary, the Stockbridge type of damper is preferred; currently available SVDs generate noise.

4.3.2.3 Structure-Mounted Splice Enclosures

Each splice enclosure (also referred to as a canister) shall be resistant to damage. The outer enclosure shall include a galvanized steel or stainless steel protection hood, inside which shall be the splice box with the necessary internal splice enclosure to house the fusion splices and racetrack to accommodate an underground cable. The splice box shall provide sufficient ways to match the requirements of Electricity North West.

Each splice enclosure needs to contain sufficient spare length of OPAC to enable it to be lowered to the ground so that it can be worked on there.

4.3.2.4 Conductor-Mounted Splice Enclosures

Conductor-mounted splice enclosures (also known as donuts) perform a similar function to the structure-mounted enclosures.

Each splice enclosure needs to contain sufficient spare length of OPAC to enable it to be lowered to the ground so that it can be worked on there.

4.4 Arrangements using OPPC or OPGW

4.4.1 Design Information

4.4.1.1 Life Expectancy

The minimum life expectancy shall be the same as that for a line conductored with the standard equivalent conductor (i.e. a conductor not carrying optical fibres).

4.4.1.2 General Arrangements

The approved general arrangements specified in Appendices C and D are suitable for steel tower lines designed to ENA TS 43-125 and wood pole lines designed to ES400O3, and ENA TS 43-50.

OPPC shall be fitted on the middle phase of a tower line or the centre phase of a wood pole line. If two are required on a wood pole line, they shall be fitted on the outer phases.

4.4.2 Materials

4.4.2.1 OPPC and OPGW

OPPC and OPGW shall comply with ES400C25.

4.4.2.2 Fittings

All fittings for optical cable shall comply with the relevant part(s) of ENA TS 43-126. Sizes and voltage ranges, etc, of fittings shall be selected to match the requirements of the overhead line.

To ensure maximum reliability and avoid cable damage, it is important to ensure that all fittings chosen are compatible with the optical cable system selected.

4.5 General Requirements for OPAC, OPPC and OPGW

4.5.1 Optical Fibres

Minimum bend radii, as specified by the optical fibre cable manufacturer, shall be taken into account in order to preserve the integrity of the optical fibres.

4.5.2 Electrolytic Reaction

Any system that employs the use of dissimilar metals shall incorporate measures to reduce the effects of electrolytic reaction to acceptable levels. Methods of protection against electrolytic reaction shall be stated by the Supplier. To validate the statement, test results that show the effectiveness of these measures shall be available for inspection by Electricity North West.

4.5.3 Positioning and Fitting of Items on Steel Towers

4.5.3.1 General

On steel towers, the conduit, splice enclosure, J-pipe and fittings shall be installed on the inside of the lattice tower steelwork. The standard tower identification plates, line colours, etc, shall not be obstructed.

4.5.3.2 Splice Enclosures

Each splice enclosure shall preferably be positioned 1 metre above the gate of the anti-climbing device on the climbing leg (1 metre minimum where this is not practicable). It shall be on the inside face of the lattice frame steelwork.

The splice enclosure shall be earth bonded to the lattice steel framework of the tower to ensure that faults on the 132kV circuit do not cause failure of the fibre optic equipment on the lattice frame steelwork or the associated overhead fibre optic cable. The fibre optic cable is non-conductive (all dielectric).

4.5.4 Jointing Positions and Isolation Points

During design, consideration shall be given to frequently-used electrical-isolation points. A fibre jointing position shall be incorporated at each such position, so that phase conductors can be separated without a fibre crossing the disconnection point. On OPAC and OPPC, these shall be phase to ground terminations.

At section towers or section poles, any fibre-optic arrangement that connects the sections together must be earthed. For example, a splice enclosure on a section tower needs to be earthed to enable electrical isolation at that point. A suitable general arrangement to meet this requirement shall be selected.

The maximum single length of OPGW between jointing positions shall preferably be 2.5 km. This will enable OPGW to be replaced more rapidly in fault situation, because it can be sourced from existing stock. However, other considerations, such as ease of access, may override this requirement.

4.5.5 Earths, Earth Cables and Bonds

The size of earth cables and clamps for bonding and earthing shall be adequate for the maximum steady-state induced currents as well as the largest fault currents to which they are likely to be exposed.

The three categories of possible current exposure are as follows:

- Lightning current.
- Fault current.
- Induced current.

Where a fault current is a possibility, the earthing equipment shall carry this current long enough to allow the line protection system to operate.

All components of the earthing system shall be sized to carry a current of 20,000A symmetrical for 20 cycles and still continue to pass the steady-state current induced without interruption. This will protect against most instances of the above possibilities of current exposure. However, the possibility of a larger fault current occurring deserves special consideration.

When the possibility exists of the optical fibre cable coming into contact with an existing live conductor, during the new cable installation process, the earthing system shall be capable of carrying the maximum expected phase-to-earth or phase-to-phase fault current which the live circuit may deliver.

Such possibilities of contact occur when the new cable passes over an existing transmission or distribution line, and it is not reasonably practicable to de-energise the existing line, or where blowout of the cable could cause live conductor contact.

In cases of severe or maximum induction, the above current-carrying capability may not be adequate, and the magnitude of the induced current should be determined by measurement or calculation and appropriately sized earthing and bonding cables selected.

4.5.6 Protection of Cables

Cable(s) running up from ground level shall not provide an access route through the anti-climbing device. They shall also have adequate metal protection to prevent third party interference.

4.5.7 Installation Requirements

All components used to complete these general arrangements shall match the requirements of, and be suitable for installation in accordance with, ES400F3.

5 Documents Referenced

DOCUMENTS REFERENCED	
BS EN 60794:	Optical Fibre Cables.
BS EN 61300-2-39: 1997:	Fibre optic interconnecting devices and passive components. Basic test and measurement procedures. Tests. Susceptibility to external magnetic fields.
ENA TS 43-50:	132kV Single Circuit Overhead Lines on Wood Poles.
ENATS 43-125:	Design Guide and Technical Specification for Overhead Lines above 45kV.
ENA TS 43-126:	Fittings for Overhead Line Optical Cables.
ES400C3:	Wood Pole Overhead Line Conductors (up to and including 132kV).
ES400C4:	Steel Tower Overhead Line Conductors (33kV and 132kV).
ES400C25:	Overhead Line Conductors Carrying Optical Fibres.
ES400F3:	Installation of Fibre Optic Cable(s) on Steel Tower 132kV Circuits (including Fibre Wrap Method).
ES400O3:	Bare-Wire Overhead-Lines on Wood Poles for 11/6.6 and 33 kV: Design and Construction.

6 Keywords

Not applicable.

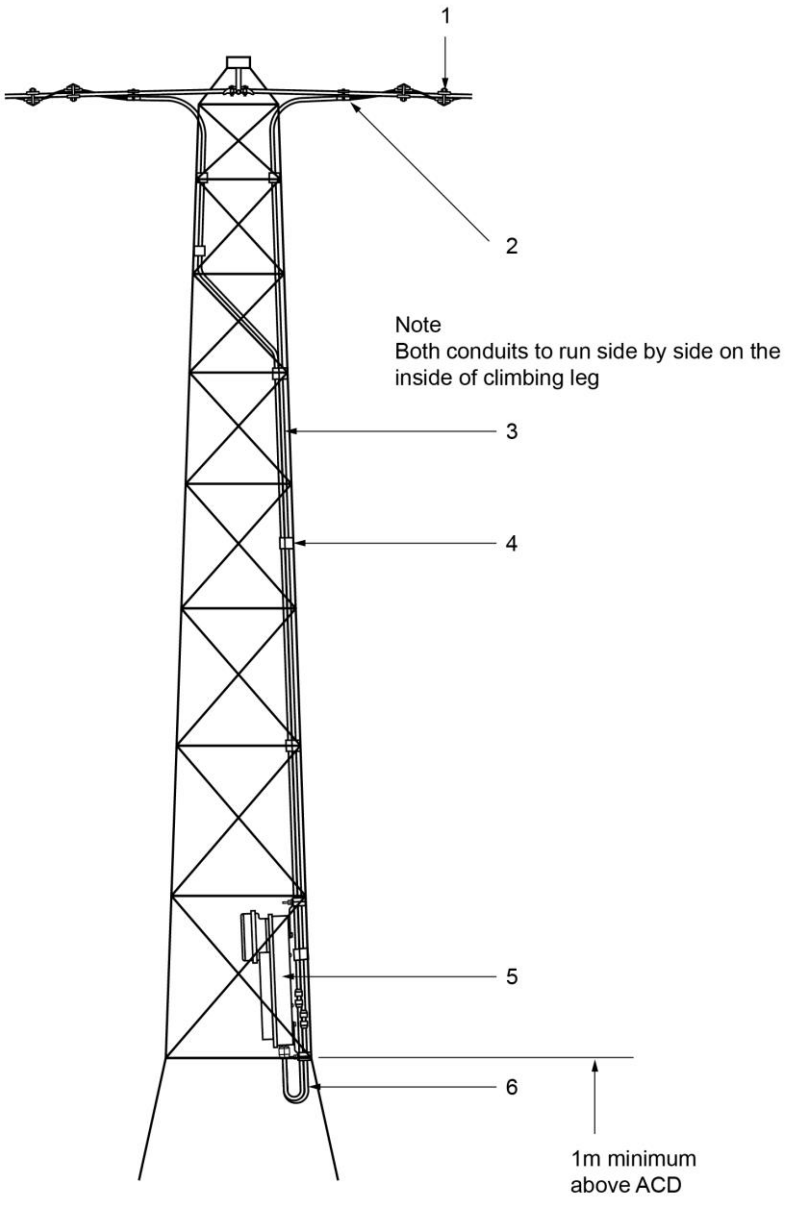
Appendix A – General Arrangement Drawings and Material Lists for OPAC on Steel Tower Lines

(In Drawing Number Order)

NOTE: The equipment shown in these General Arrangement drawings represents typical equipment that will meet the requirements of this specification. The equipment shown is not intended to indicate preference or acceptance of any particular manufacturer's design.

Index to Drawings

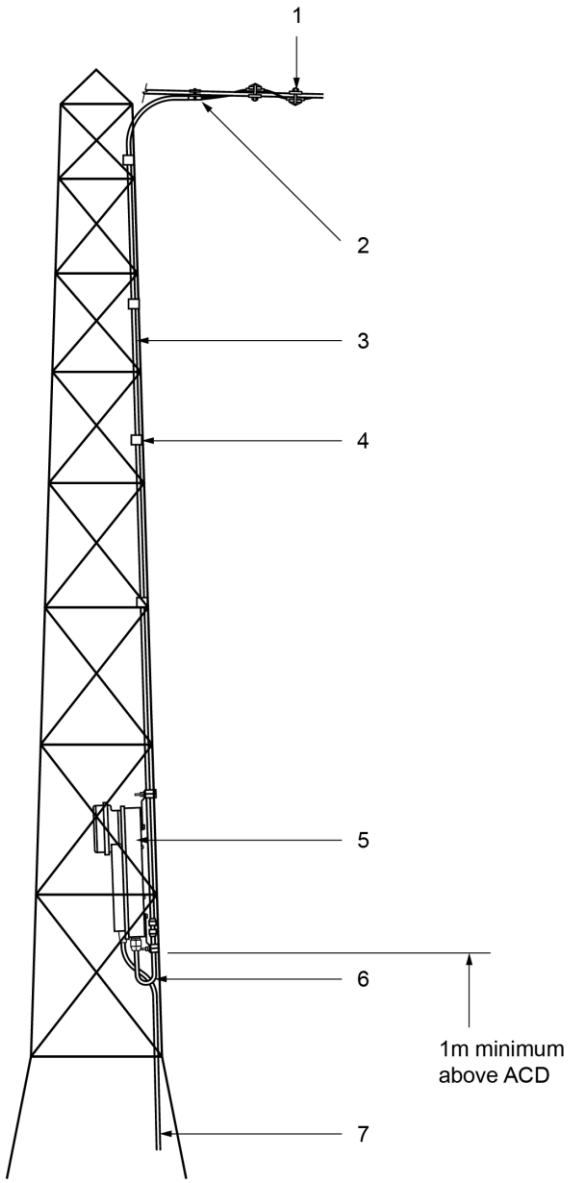
TITLE	DRAWING NUMBER
OPAC on Steel Tower Earth Conductor – Suspension Splice	I-400O5-GA-001
OPAC on Steel Tower Earth Conductor – Termination Splice	I-400O5-GA-002
OPAC on Steel Tower Earth Conductor – Standard Bypass	I-400O5-GA-003
OPAC on Steel Tower Phase Conductor – Suspension Splice, Tower Mounted, Earthed	I-400O5-GA-004
OPAC on Steel Tower Phase Conductor – Termination Splice, Tower Mounted, Earthed	I-400O5-GA-005
OPAC on Steel Tower Phase Conductor – Section Splice, Conductor Mounted	I-400O5-GA-006
OPAC on Steel Tower Phase Conductor – Suspension Splice, Conductor Mounted	I-400O5-GA-007
OPAC on Steel Tower Phase Conductor – Suspension Bypass	I-400O5-GA-008
OPAC on Steel Tower Phase Conductor – Section Bypass	I-400O5-GA-009



OPAC ON STEEL TOWER EARTH CONDUCTOR – SUSPENSION SPLICE	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-001 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Earth Conductor – Suspension Splice	**Materials for Drawing I-400O5-GA-001**

No	Item	Qty
1	Clamp, span end Nylon insert 100	4 4
2	Termination, ground to ground	2
3	Conduit, 25mm, 70m length	2
4	Clamp, tower	A/R
5	Splice enclosure (up to 48 splices)	1
6	J-pipe	2
Additional materials required, but not shown on the drawing:		
Mastic		8
Lash, black, 12mm		1m
Note: Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).		



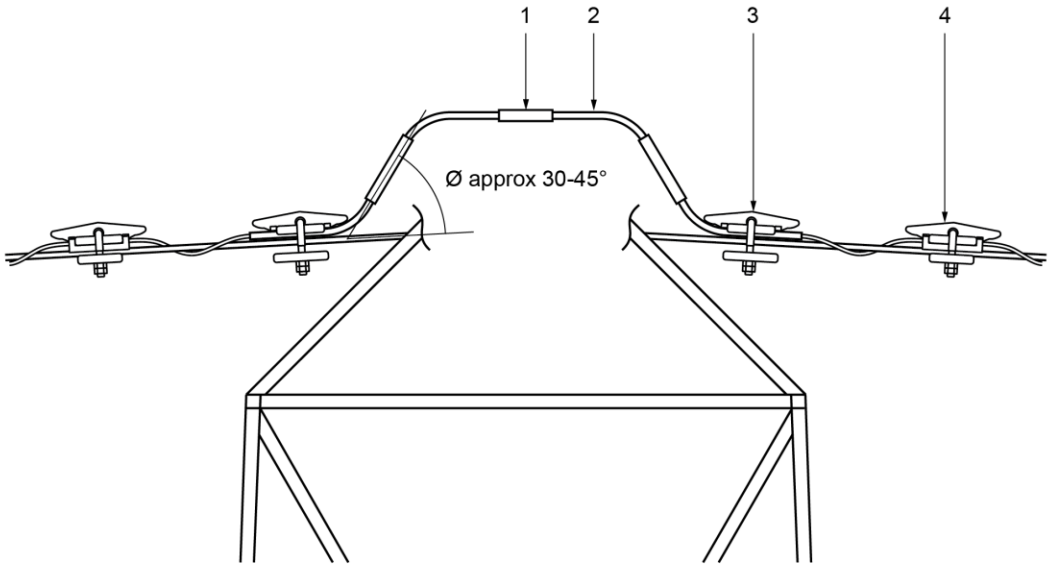
OPAC ON STEEL TOWER EARTH CONDUCTOR – TERMINATION SPLICE	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-002 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Earth Conductor – Termination Splice	**Materials for Drawing I-400O5-GA-002**

No	Item	Qty
1	Clamp, span end Nylon insert 100	2 2
2	Termination, ground to ground	1
3	Conduit, 25mm, 70m length	1
4	Clamp, tower	A/R
5	Splice enclosure (up to 48 splices)	1
6	J-pipe	1
7	Connection to underground optical cable	1
Additional materials required, but not shown on the drawing:		
Mastic		4
Lash, black, 12mm		1m

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



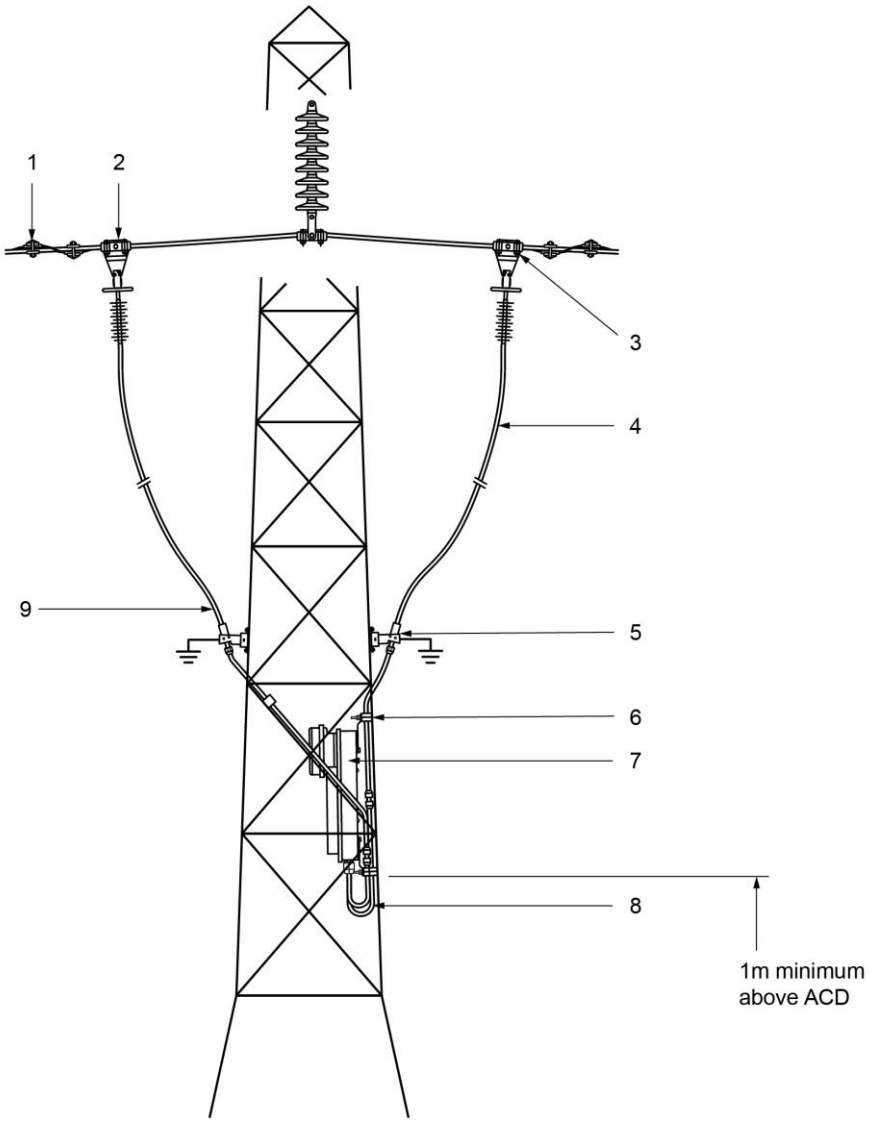
FIBRE-WRAP ON STEEL TOWER EARTH CONDUCTOR – STANDARD BYPASS	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-003 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Earth Conductor – Standard Bypass	**Materials for Drawing I-400O5-GA-003**

No	Item	Qty
1	Balehanger cover	8
2	Balehanger, aluminium, 3.3m straight	1
3	Clamp, span end Nylon insert 100	4 2
Additional materials required, but not shown on the drawing:		
Mastic		8

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



Wherever practicable, conduit and stand-off brackets are not to be fitted to the climbing leg

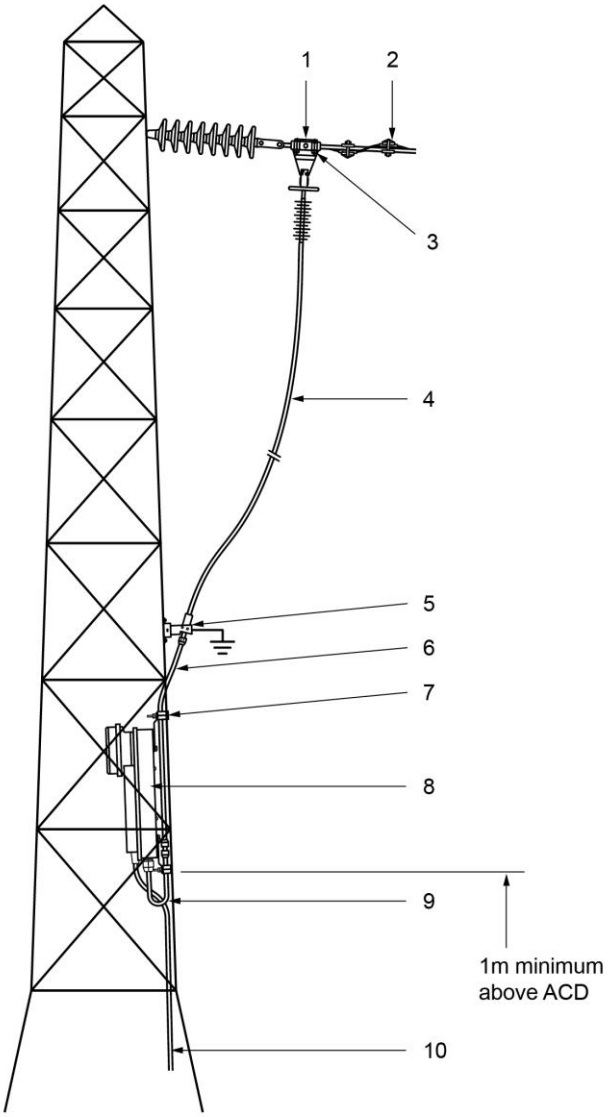
OPAC ON STEEL TOWER PHASE CONDUCTOR – SUSPENSION SPLICE, TOWER MOUNTED, EARTHED	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-004 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Suspension Splice, Tower Mounted, Earthed	**Materials for Drawing I-400O5-GA-004**

No	**Item**	**Qty**
1	Clamp, span end Nylon insert 100	4 4
2	Conductor shoe	2
3	Lash, black, 12mm	1m
4	Phase-to-earth insulator with compound	2
5	Clamp with earth bond (TBA)	2
6	Clamp, tower	A/R
7	Splice enclosure (up to 48 splices)	1
8	J-pipe	2
9	Conduit, 25mm, 70m length	2
Additional materials required, but not shown on the drawing:		
Mastic		8

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



Wherever practicable, conduit and stand-off brackets are not to be fitted to the climbing leg

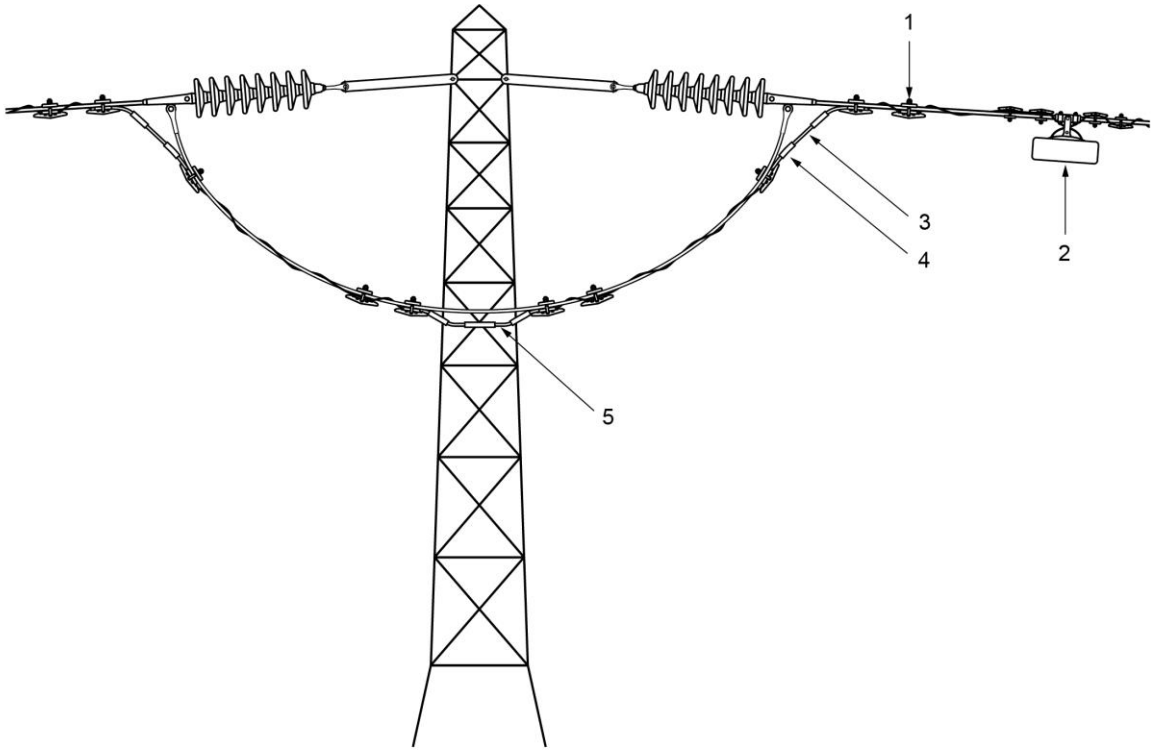
OPAC ON STEEL TOWER PHASE CONDUCTOR – TERMINATION SPLICE, TOWER MOUNTED, EARTHED	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-005 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Termination Splice, Tower Mounted, Earthed	**Materials for Drawing I-400O5-GA-005**

No	Item	Qty
1	Clamp, span end Nylon insert 100	2 2
2	Conductor shoe	1
3	Lash, black, 12mm	1m
4	Phase-to-earth insulator with compound	1
5	Clamp with earth bond (TBA)	1
6	Conduit, 25mm, 70m length	1
7	Clamp, tower	A/R
8	Splice enclosure (up to 48 splices)	1
9	J-pipe	1
10	Connection to underground optical cable	1
Additional materials required, but not shown on the drawing:		
Mastic		4

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



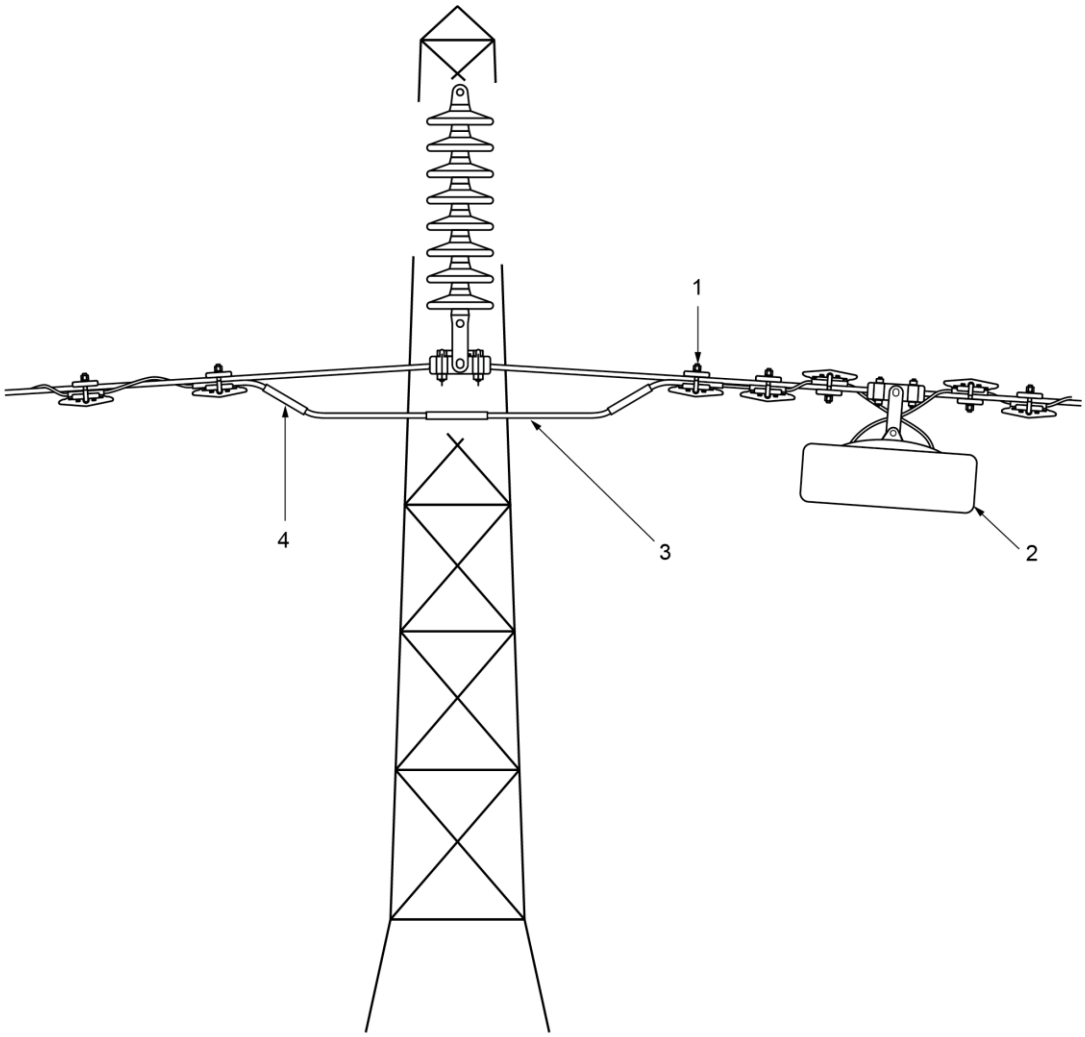
FIBRE-WRAP ON STEEL TOWER PHASE CONDUCTOR – SECTION SPLICE, CONDUCTOR MOUNTED	Change information for this issue: N/A	Appears in: ES400O5	electricity north west
			I-40005-GA-006 Iss 1 sht 1 of 1
			Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Section Splice, Conductor Mounted	**Materials for Drawing I-400O5-GA-006**

No	Item	Qty
1	Clamp, span end Nylon insert 100	10 6
2	Splice enclosure (up to 48 splices) Conductor shoe with strap Black lash	1 1 1
3	Balehanger, aluminium, 900x45 deg	2
4	Balehanger cover	12
5	Balehanger, aluminium, 100/250	1
Additional materials required, but not shown on the drawing:		
Mastic		20

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



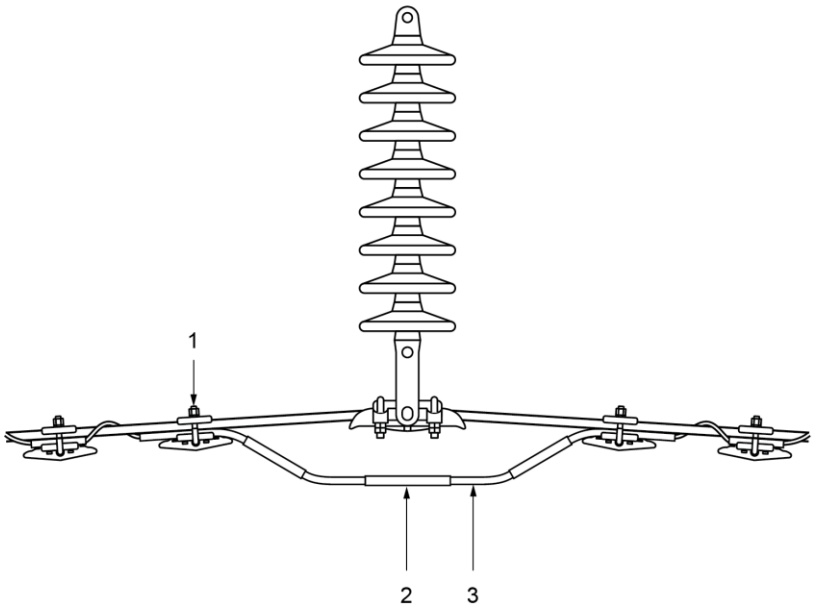
FIBRE-WRAP ON STEEL TOWER PHASE CONDUCTOR – SUSPENSION SPLICE, CONDUCTOR MOUNTED	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-007 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Suspension Splice, Conductor Mounted	**Materials for Drawing I-400O5-GA-007**

No	Item	Qty
1	Clamp, span end Nylon insert 100	7 3
2	Splice enclosure (up to 48 splices) Conductor shoe with strap Black lash	1 1 1
3	Balehanger, aluminium, 3.3m straight	1
4	Balehanger cover	8
Additional materials required, but not shown on the drawing:		
Mastic		10

Note:

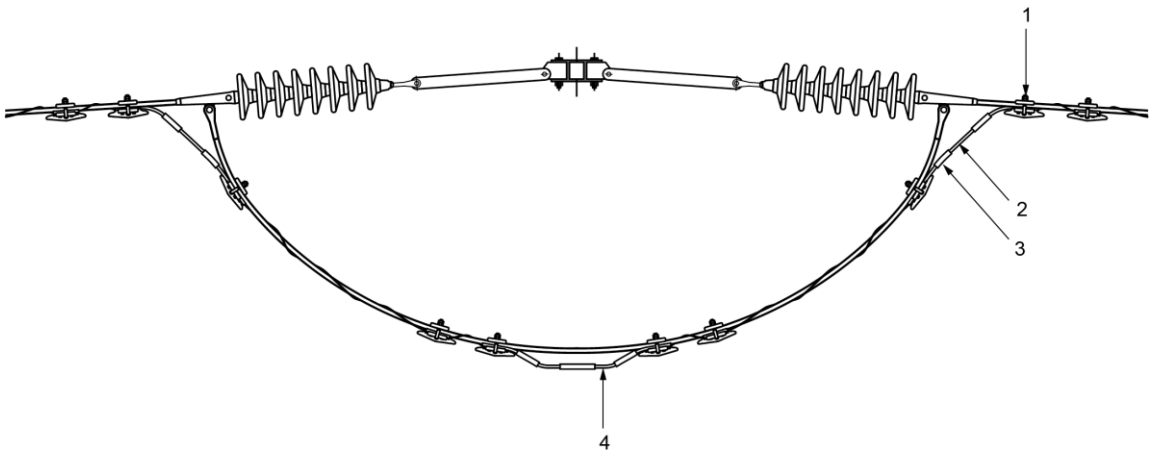
Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).



FIBRE-WRAP ON STEEL TOWER PHASE CONDUCTOR – SUSPENSION BYPASS	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-008 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Suspension Bypass	**Materials for Drawing I-400O5-GA-008**

No	Item	Qty
1	Clamp, span end Nylon insert 100	4 2
2	Balehanger cover	8
3	Balehanger, aluminium, 3.3m straight	1
Additional materials required, but not shown on the drawing:		
Mastic		8
Note: Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).		



FIBRE-WRAP ON STEEL TOWER PHASE CONDUCTOR – SECTION BYPASS	Change information for this issue N/A	Appears in ES400O5	electricity north west I-40005-GA-009 Iss 1 sht 1 of 1 Scale: nts Auth: DMT Date: 20/1/2015

OPAC on Steel Tower Phase Conductor – Section Bypass	**Materials for Drawing I-400O5-GA-009**

No	Item	Qty
1	Clamp, span end Nylon insert 100	10 4
2	Balehanger, aluminium, 900x45 deg	2
3	Balehanger cover	12
4	Balehanger, aluminium, 100/250	1
Additional materials required, but not shown on the drawing:		
Mastic		20

Note:

Where appropriate, items must be matched to conductor size and voltage (see text for full range of conductors).

Appendix B – General Arrangement Drawings and Material Lists for OPAC on Wood Pole Lines

(In Drawing Number Order)

Index to Drawings

Title	Drawing number
TBA	TBA

Design drawings are not yet available for this series of general arrangements. Until then, similar general arrangements of OPAC to those included in Appendix A shall be used on wood pole lines, ie the arrangements shall be transposed on to wood poles and modified to suit, ensuring all mandatory requirements for clearances, etc, are met.

Appendix C – General Arrangement Drawings and Material Lists for Conductors Carrying Optical Fibres on Steel Tower Lines

(In Drawing Number Order)

Index to Drawings

Title	Drawing number
TBA	TBA

Design drawings are not yet available for this series of general arrangements. Until then:

- Conductoring shall comply with the Electricity North West standards.
- Similar general arrangements to those included in Appendix A shall be used for optical fibres.

Appendix D – Arrangement Drawings and Material Lists for Conductors Carrying Optical Fibres on Wood Pole Lines

(In Drawing Number Order)

Index to Drawings

Title	Drawing number
TBA	TBA

Design drawings are not yet available for this series of general arrangements. Until then:

- Conductoring shall comply with the Electricity North West standards.
- Similar general arrangements to those included in Appendix B shall be used for optical fibres.