NSP/004/123 - Guidance Document on the Installation of Fibre Optic Wrap onto Overhead Line Conductors

1. Purpose

The purpose of this document is to provide guidance on the installation requirements for fibre optic wrap onto overhead conductors installed on wood poles or tower lines located on the Northern Powergrid distribution system.

This document supersedes the following documents, all copies of which should be destroyed;

Document Reference	Document Title	Version	Published Date
NSP/004/123	Guidance document on the installation of Fibre Optic Wrap onto Overhead Line Conductors	1.2	Feb 2019

2. Scope

This guidance document applies to fibre optic wrap installed into bare earth wires or phase conductors located on EHV wood pole or tower lines for use on distribution network of Northern Powergrid.

Special care must be taken while handling fibre optic cable, in any situation, as the optical fibres make the cable much easier damaged than conventional cables.

2.1. Contents

1. Purpose 1
2. Scope 1
2.1. Contents 2
3. Technical Specification 4
3.1. Preparing for a Fibre Wrap Installation 4
3.1.1. Cable Type 4
3.1.2. Fibre Count 4
3.1.3. Clearances and Tensions 4
3.1.4. Cassette Plan 5
3.1.5. Accessories 5
3.1.6. Wayleaves 5
3.1.7. Outages 5
3.1.8. Crossings 6
3.1.9. Arrangement Drawings 6
3.1.10. Preparation of Wrapping Machines 6
3.1.11. Wrapping the Cable 7
3.1.12. Passing the Wrapping Machines around Support Structures 7
3.1.13. Termination or Joint Structures 7
3.1.14. Phase to Ground Terminations (PTG) at Joint Structures 8
3.1.15. Ground to Ground Terminations at Joint Structures 9
3.1.16. Existing Line Hardware 9
3.1.17. Installation of Conduit and Splice Boxes 9
3.2. Splicing 11
3.2.1. Fibre Identification 12
3.2.2. Support Mounted Splice Canister (Low Level Type) 12
3.2.3. Overhead Line Mounted Splice Enclosure (Donut or High Level Type) 12
3.3. Fibre Optic Testing Requirements 13
3.3.1. Testing Prior to Installation 13
3.3.2. Testing After Cabling 13
3.3.3. End to End Testing Following Completion of Terminations 13
3.4. As Built Records 13
3.5. Network Restoration in the Event of Broken Earth-Wire or Phase-Wire 14
3.5.1. Recovery from a Broken Earth-Wire Situation Containing a Fibre Wrap 15
3.5.2. Recovery from a Broken Phase-Wire Situation Containing a Fibre Wrap 15
3.6. Recovery Techniques 15
3.6.1. Tug/Wrapping Machine Recovery 15
3.6.2. Cable Recovery 16
3.7. Emergency Return to Service Option for Fibre Installations 16
3.7.1. Ground Deployed Cable (GDC) Installations 16
3.7.2. Planned Ground Deployed Cable 16
3.7.3. Emergency Ground Deployed Cable 17
3.7.4. Other Optical By-pass Options 17
3.8. Operational Procedures 18
4. References 20
4.1. External Documentation 20
4.2. Internal Documentation 20
4.3. Amendments from Previous Version 20
5. Definitions 21
6. Authority for Issue 23
6.1. CDS Assurance 23
6.2. Author 23
6.3. Technical Assurance 23
6.4. Authorisation 23
6.5. Authorisation 23

Appendix 1 – Earth Wire (Ground to Ground Splice) for use on Terminal / Suspension / Section Tower Supports....24
Appendix 2 – Earth Wire – Suspension / Section - Bypass Arrangement on (Tower Supports)....25
Appendix 3 – Earth wire Suspension / Section (Low Level Splice) on Tower Support....26
Appendix 4 – Phase Wire (Phase to Ground Termination) Section / Terminal (Tower or Wood Pole Supports) 27
Appendix 4a – Phase Wire (Phase to Ground Termination) continued....28
Appendix 5 – Phase Wire - Suspension Tower or Wood Pole Support (With or without Conductor mounted Splice box)....29
Appendix 6 – Phase Wire - Tension Tower or Wood Pole Support (With or without Donut type Splice box) 30
Appendix 7 – Phase wire – Suspension Tower or Wood Pole Support (Phase to Ground Low Level Splice)....31
Appendix 8 – Ground to ground termination – Detail Drawing....32
Appendix 9 – Aluminium Balehanger Detail Drawing....33
Appendix 9 – Cable / Balehanger Clamp Detail Drawing part 1 of 2....34
Appendix 10 – Cable / Balehanger Clamp Detail Part 2 of 2....35
Appendix 11 – Wood Pole Splice Box....36
Appendix 12 – Bale Hanger Cover....37
Appendix 13 – Nylon Insert 100....38
Appendix 14 – Fibre Splice Box....39

3. Technical Specification

Fibre Wrap is a means of utilising an existing overhead electrical power transmission or distribution line to provide a communications route. The fibre wrap cable contains optical fibres that carry telecommunications signals and which are immune from electrical interference from the power line, The cable is installed using specially designed equipment, that wraps the cable in a helical fashion tightly around one of the existing conductors on the overhead line.

The host conductor can be either the earth-wire on a line at any voltage or one of the phase conductors when the line voltage is 132kV or below. The cable is supplied together with the accessories needed for installation such as joint boxes, conduit for guiding the cable down the towers to the joint position, bypass fittings that guide and protect the cable at tension & suspension towers and clamps for fastening the cable at the ends of each span.

3.1. Preparing for a Fibre Wrap Installation

Detailed preparation is essential for a successful fibre wrap installation. This section describes the essential points to address.

3.1.1. Cable Type

Selection of fibre optic wrap type required e.g. – Fibre optic conductor wrap (Full fibre Count) or Fibre optic conductor wrap (reduced fibre count) and the requirement for installation onto phase conductors or earth wire conductors. Further details on the specification requirements for each wrap type can be found in NPS/002/024.

Fibre optic conductor wrap (Full fibre Count) can be installed on either the phase conductors or the earth wire and provides for typical cassette lengths of – 3652m (24 fibre cable) and is normally installed using power tugs.

Fibre optic conductor wrap (reduced fibre count) is a lower fibre count, lighter weight product which is normally applied to wood pole lines with typical cassette lengths of 1743m (12 fibre cable) and is normally installed using light weight wrapping machines pulled from ground level with ropes to limit the impact on weaker conductors. Access Wrap can be installed on conductors down to 32mm HDBC or 50mm AAAC.

3.1.2. Fibre Count

Selection of the required fibre count – see NPS/002/024 for details on Northern Powergrid default fibre counts.

3.1.3. Clearances and Tensions

Fibre wrap has been designed to have negligible impact on the final sagging and design loading characteristics of the host conductor onto which it is installed. However it can significantly impact clearances and conductor tensions during the installation phase due to the additional weight of the installation equipment on it. This may be particularly important where single circuit outage working methods are being considered on double circuit tower lines. The fibre wrap system suppliers have computer software to help analyse this situation to decide on the best working procedure, and any limitations on weather conditions that must be employed during the installation works. To enable these calculations to be performed the system supplier must be provided with following information at the enquiry stage of a project.

- Line Schedules
- Route maps
- Typical pole or tower drawings (in the case of towers it is normally sufficient to just provide the tower family information e.g. L4M, L3C etc.
- The location and type of any mid-span joints or repairs in the spans.

- Preferred splice joint positions if any future T-off or connection points are known or any need for phase to ground terminations at points on the system where jumpers may be cut and removed to create isolation of a section of line.

The following additional checks are not required by the system supplier to analyse the particular scheme requirements; however they shall be carried out by the Northern Powergrid project engineer before the commencement of any works.

- Determine the condition of the existing conductor using data from conductor samples, the application of a Cormon Tester or detailed knowledge of the age and design of the existing conductor.
- Determine the condition of the existing supports to identify any known issues with the supports or sub-standard insulator assemblies. Any issues identified through these checks must be rectified before any fibre wrap is installed.

3.1.4. Cassette Plan

Upon completion of the review of the supplied information, the system supplier will provide a cassette plan indicating the proposed splice joint and spin points locations for review by Northern Powergrid.

3.1.5. Accessories

Special fittings are required at tower / pole locations whether these are splice locations or simple by-pass towers or poles. To ensure the correct accessories are supplied for each location, the system supplier will be requested to accurately determine the accessories needed for a specific project and to do this they require detailed information such as

- line schedules
- profile maps
- tower drawings
- Preferred splice positions.

Note:- Fibre optic conductor wrap (Full fibre Count) can be installed on any phase conductor up to 132kV on a double circuit tower line. However it is preferred that these installations are conducted on the lower phase conductor as this then allows the middle cross arm to be used as a mounting point for a pulley block to enable passing the machinery from one side of the tower to the other. However this default location may be changed to the middle crossarm where it has been identified at the pre-planning phase that this may result in clearances infringements at road and rail crossings during the installation phase.

When this is not possible ('H' Wood Poles etc.) then the supplier will need to be provided with the support construction details in order to arrange suitable attachments for the support bypass.

3.1.6. Wayleaves

Installing the fibre wrap system requires access to every support for personnel and equipment. It is therefore important that landowners are informed if access to their land is required, and failure to do this may disrupt the installation. Providing the fibre optic cable is only being used for internal communications or protection purposes it is not necessary to re-negotiate new wayleave agreements.

3.1.7. Outages

The installation of Fibre optic conductor wrap (Full fibre Count) onto the earth-wire can normally take place under single circuit working, providing that there is sufficient safety clearance between the earth and phase conductors.

Installation of cable wrap onto the phase conductor must take place under outage conditions for the effected circuit. It is usually slightly slower than the earth wire installation because of the need to install high level splices or PTG's (Phase to ground terminations) at jointing structures which typically adds an extra 1 - 2 hours to install.

The average installation rate for Fibre optic conductor wrap (Full fibre Count) is approximately 4km per day utilising a group of 8 linesmen and a pair of wrapping machines & tugs.

3.1.8. Crossings

The application of the wrapping machine and tugs onto the conductors or earth wire can often have a significant impact on the height of the conductors due to the additional weight, albeit for only a few minutes as the equipment transits across the span. As result all crossing spans are reviewed at the project planning stage to identify any that are at risk of braking statutory clearances.

It is not normally necessary to erect scaffolding to protect under running power circuits or road/rail crossings however under running spans shall normally be switched out and contact is normally required with the rail and highways organisations to advise them about the works. It should still be be noted that although scaffolding is not normally required the rail organisation still request 16 weeks' notice for crossings works and may require works orders to carry out assessment or mitigation studies.

3.1.9. Arrangement Drawings

Typical drawing arrangements for use with earth wire or phase wire fibre wrap

Earth- wire Wrap	
Earth-wire (Ground to Ground Splice) for use on Terminal / Suspension / Section Tower Support	See Appendix 1
Earth-wire – Suspension / Section - Bypass Arrangement on (Tower Supports)	See Appendix 2
Earth-wire – Suspension / Section (Low Level Splice) on (Tower Supports)	See Appendix 3
Phase wire Wrap	
Phase-Wire - Section / Terminal - (Tower or Wood Pole Supports) - (Phase to Ground Termination Splice)	See Appendix 4
Phase-Wire - Suspension Tower or Wood Pole Support (With or without Donut Type Splice box)	See Appendix 5
Phase-Wire - Tension Tower or Wood Pole Support (With or without Donut type Splice box)	See Appendix 6
Phase-wire – Suspension Tower or Wood Pole Support (Phase to Ground Low Level Splice)	See Appendix 7

3.1.10. Preparation of Wrapping Machines

Each piece of cable is installed using a pair of wrapping machines together with a pair of petrol engine tugs, which provide the motive power.

The cable is supplied in the form of a 'cassette' - one continuous length of cable, which has been wound onto two drums, one from each end of the cable. The cassette and wrapping equipment are taken to the bottom of a pre-designated tower referred to as a "Spin Point Structure". Each drum is loaded onto a wrapping machine, which is then adjusted to ensure it is in balance.

A linesman will then take a rope up to the conductor/earth-wire and secure it, to enable equipment to be lifted up. This is done following agreed procedures when live line or single circuit outages are involved. The lifting jib is then mounted on the support structure and secured into place. The two tugs and then the two wrapping machines, with cable drums are then winched up to the conductor/earth-wire, one on each side of the support structure (normally using a mechanical winch to pull the rope). The jib is then used to lift the machinery the last metre or so onto the earth-wire/conductor.

The maximum weight of a wrapping machine with a full drum of cable is 200kg and a tug weighs approximately 60kg.

The Field Engineer shall check that the cassette reels have been installed the correct way round before the pulling tug is allowed to move, i.e. they will be travelling in correct direction.

Once the machines are in position on the conductor, the cable between the wrapping machines shall be dressed into a Balehanger and the span end clamps fitted. The first tug can now be started and the first span installed, this must be carried out before starting the second tug to install the span going in the other direction.

This work typically requires two linesmen on the structure and two assistants at ground level. Normally, two hours is required to complete the work described in this section.

3.1.11. Wrapping the Cable

The linesmen at the top of the support structure start the petrol engines on the tugs and then the operator from the ground controls the progress of the wrapping operation. Control is by means of radio signals from a hand set. Once the wrapping machines have left the support structure, the linesmen can remove the lifting equipment from the support structure top and descend the structure.

The wrapping machines travel at walking pace along the conductor until they reach the next support structure. A typical span of 300m will take approximately 5 minutes to complete and requires one operator for the radio control system.

Note: The wrapping machine installs the wrap with an approximate lay length of 1m

Wrapping constraints

- Rope assistance is required for spans with inclines greater than 30° and when conductors are heavily greased.
- The lowest permissible installation temperature is -10°C. Wrap cannot be installed where ice is present on the conductor
- The largest permissible span within Northern Powergrid for Fibre optic conductor wrap (Full fibre Count) is 500m or 150m for the reduced fibre count version.

3.1.12. Passing the Wrapping Machines around Support Structures

The fibre optic installer shall provide small jibs, which are used to facilitate handling the equipment at the tops of support structures. The jib is supported by a mast, which is temporarily attached to the support structure top by ropes, The jib and mast must be installed and any vibration dampers on the conductor must be removed and set aside prior to the arrival of the wrapping machine.

Once the equipment has arrived at the support structure, the linesmen at the support top stops the tug engine and attaches a span end clamp to secure the cable to the conductor. Then they disconnect the tug and lift it over the support structure to the next span. This operation is repeated for the wrapping machine and the equipment is reconnected.

Once the cable has been secured into a Balehanger, then the machine can be restarted and proceed with installing the next span. A second span end clamp is fitted after the machine has gone. Finally any vibration dampers are re-installed.

This work requires two linesmen up the support and one assistant on the ground. Normally, one hour or less is required to complete the work described in this section.

There may be several intermediate support structures until the wrapping machine arrives at a termination/joint support structure. Work with the other cable drum and wrapping equipment proceeds independently as the installation contractor provides enough equipment to support both machines.

3.1.13. Termination or Joint Structures

When the equipment arrives at a support structure that has been designated as a termination or joint structure, the linesmen at the support top stops the tug engine and attaches a span end clamp to secure

the cable to the conductor. Sufficient cable to reach the splice box, and to allow the splicing work to be carried out at ground level, is then removed from the cable drum, before cutting the cable and removing all the installation equipment using a jib, as before. The cable is then installed into the ground to ground, or phase to ground termination, routing finally to the splice or termination point.

Finally, any vibration dampers are re-installed on the conductor and the tug, wrapping machine and jib are lowered to the ground. This work requires two linesmen up the towers and two on the ground. Normally, one hour is required to complete the work described in this section.

The two sets of equipment will now be approximately 4km apart. Both sets of equipment - wrapping machines, tugs and jibs - are collected up in suitable transport, together with the line-crew members and taken off to the start point for the next cassette. The two wrapping machines, two tugs and two masts & jibs, together with one cassette of cable and all the necessary conductor-attached accessories will fit into a vehicle with a load area of approximately 2m x 3m.

3.1.14. Phase to Ground Terminations (PTG) at Joint Structures

To allow phase wrapped fibre cable to be spliced into a low level splice box at the end of a cassette length or to interface with an underground section of fibre cable, the fibre wrap needs to transit from the live phase wire to the earthed PTG bottom end fitting which is attached to the pole or tower at a point above the support anti-climbing guards. The following procedure summarizes this process:-

- Following the installation of the fibre wrap onto the phase wire up to the termination support structure, the fibre cable shall be secured to the phase wire with a pair of span end clamps. This must be carried out before releasing any tension from the wrapping machine.
- Reel off sufficient fibre cable to reach ground level plus a surplus of 15m, care shall be taken when lowering the cable to avoid entanglement and snagging on the anti-climbing guards. During the lowering of the cable it shall be supported as it leaves the span end clamp to prevent damage being caused by the weight of the cable as it is lowered. Once sufficient length has been wound off, the cable may be cut. The cable may then be wound up and left as a coil on the conductor, maintain the required bending radius at all times.
- Install the PTG insulator onto the line using the PTG line bracket ensuring the fibre cable first passes through the top end cap before being routed through the PTG insulator assembly.
- The PTG insulator unit is then filled with a silicon sealant before being sealed to the insulator at the top with a 75mm wrap of amalgamating tape.
- Install the PTG end cap and complete the termination by toping it up with silicon sealant via the filling hole, ensuring the whole cap is filled.
- Seal the lower end of the PTG insulator fitting by installing a heat shrink tube onto the protruding fibre cable.
- Loosely fit the lower PTG insulator support bracket to the tower or wood pole.
- Note:- Where this fitting is secured to a wood pole it shall be achieved using an m20 tie rod with sufficient additional bolt length protruding through the PTG support bracket to allow a portable earthing kit to be applied.
- Feed the end of the fibre cable through the locknut and the aluminium conduit and then screw the aluminium conduit onto the PTG bottom end fitting. The aluminium conduit can then be offered up to the pole/tower support bracket to determine its required length plus 50mm. The conduit can then be marked removed from the lower PTG insulator fitting before being cut to length.
- Re-feed the fibre cable through the aluminium conduit before the conduit is re-fitted to the PTG insulator bottom end fitting. Then feed the fibre cable though a pre-measured length of black plastic pipe before the end of the plastic pipe is inserted into the aluminium conduit.

- The aluminium and plastic pipe interface point is then secured to the support bracket using the supplied saddle clamps. The plastic conduit and enclosed fibre cable shall then be routed to a bottom entry on the Low level splice box which is also located above the ACD.

3.1.15. Ground to Ground Terminations at Joint Structures

To allow an earth-wire wrapped fibre cable to be spliced into a low level splice box at the end of a cassette length or to interface with an underground section of fibre cable, the fibre wrap needs to transit from earthed tower top to the low level splice box attached to the tower at a point above the tower anti-climbing guards. The following procedure summarizes this process:-

- Following the installation of the fibre wrap onto the earth-wire up to the termination support structure, the fibre cable shall be secured to the earth-wire with a pair of span end clamps and the ground to ground clamp. This must be carried out before releasing any tension from the wrapping machine.
- Reel off sufficient fibre cable to reach ground level plus a surplus of 15m, care shall be taken when lowering the cable to avoid entanglement and snagging on the anti-climbing guards. During the lowering of the cable it shall be supported as it leaves the span end clamp to prevent damage being caused by the weight of the cable as it is lowered. Once sufficient length has been wound off, the cable may be cut. The cable may then be wound up and left as a coil secured to the tower, maintaining the required bending radius at all times.
- Secure a length of 25mm black plastic conduit to the outside of the tower leg using tower clamps to guide and protect the fibre cable from the earth-wire ground to ground termination clamp to a bottom entry location of the low level splice box which is located above the ACD. All excess cable shall be pushed down the conduit until none remains at the top of the conduit. Cable at the bottom of the conduit shall be coiled up and secured to the support, awaiting the arrival of the jointing team.

3.1.16. Existing Line Hardware

There will normally be some existing line hardware such as vibration dampers, anti-rotational devices, armour rods, mid span joints/repairs and aircraft warning balls. These must be considered at the project planning stage but generally the following applies:

i) Vibration dampers are removed as the cable is installed and then refitted with the cable in place

ii) Anti-rotational devices are normally bypassed with a Balehanger without being removed

iii) The Balehanger may be fitted on the armour rods or the conductor/earth-wire

iv) Mid span joints up to 54mm can be traversed by standard installation equipment

v) Aircraft warning balls will need to be removed before the installation. If they need to be re-fitted afterwards a larger central hole diameter will be required, with a set of special protective armour rods for the cable. This will require access to the middle of the span. E.g. using a bucket truck.

3.1.17. Installation of Conduit and Splice Boxes

Splice boxes are usually mounted just above the anti-climbing guard on towers or about 3m up wood poles in order to be at a convenient height for future access. A plastic conduit is attached to the tower using clamps at 1-2m intervals to protect the fibre wrap cable over the distance between the splice box and the conductor on which the cable is installed, the top of the conduit is attached to the conductor using a specially configured clamp.

All the fixings used for attachment to the tower are screw-down type and require no drilling, painting or special tools or skills, this work needs to be carried out on pre-selected towers or poles at approximately 4 km intervals and can proceed independently, ahead of the remainder of the installation.

Normally this work requires two linesmen on the tower and one assistant at ground level. Each tower will take 2 - 3 hours to complete, depending on the height

It is essential that the placement of any joint on a tower is within defined parameters. These are that there must be sufficient cable length between the tower peak and the joint canister that it can reach the ground plus a minimum of a further 5 metres. This is so that the joint can be worked on in the back of an engineering vehicle. Also the joint must not be located higher than 15 metres above ground level so as to minimise access requirements during network incidents.

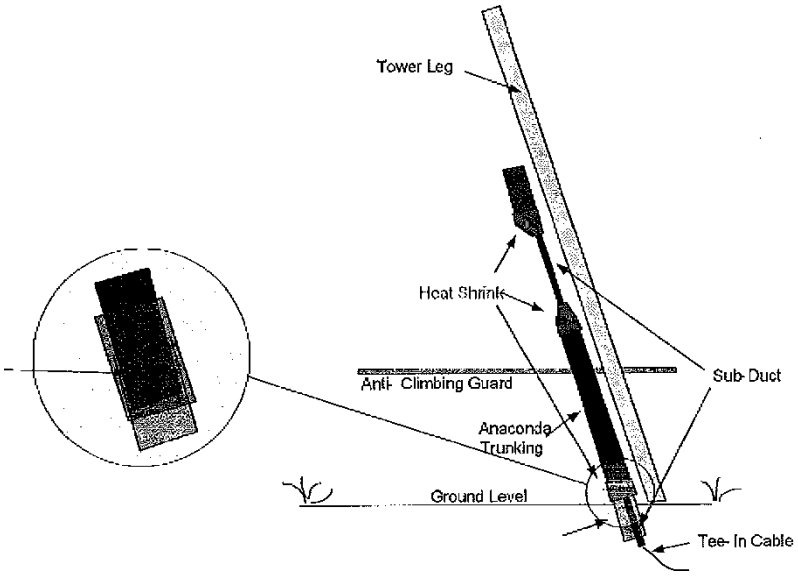
From the tower peak the fibre wrap cable must come down one tower leg with the spare cable necessary to enable the joint canister to be moved to the ground being "stored" on the canister cable loop manager. Note that fibre cables from both directions should follow the same route from the tower peak to the joint enclosure to facilitate easy manipulation during subsequent works. Cables must enter the canister cable loop manager from the bottom of the assembly.

In a WRAP system, splice points are only necessary when two lengths of fibre optic cable need to be joined together, or when two sections of a line need to be isolated due to the presence of a switch or circuit breaker.

The former of these situations shall be accomplished by a donut splice. This splice unit is mounted on the conductor or earth-wire that has been wrapped, and has capacity to hold several cable loops and the splicing tray. This splice enclosure has no requirement for earthing.

The latter requires a support mounted enclosure, with both sides of the WRAP to be earthed. Fibre optic cable wrapped on an earth-wire may be brought down the structure using down lead clamps or conduit and spliced. The WRAP is clamped onto the conductor at the top of the structure, the remaining cable unwrapped from the reel and the cable fed through the conduit or attached with down lead clamps.

For both types of fibre wrap installations the underground cables from sub-station telecoms rooms or network interconnects must arrive at the tower base via standard 96mm duct and subduct. Transiting from this duct to the joint canister location the fibre cable must be installed within a 32mm standard telecoms sub-duct and from the 96mm duct to a point above the anti-climbing guard. The 32mm sub-duct must in turn be housed inside anaconda galvanised steel piping or capping. At the transit points from the 96mm to the Anaconda, from where the Anaconda ends above the climbing guard and where the 32mm sub-duct interfaces with the joint canister a heat-shrink sleeve must be used to protect the network from water ingress. The Anaconda trunking must be fixed to the tower leg using Anaconda tower leg clamps.



3.2. Splicing

Unless required otherwise for fibre T-offs the fibre project shall be designed to have support mounted splice cannisters installed at approximately every 8km along the route with any other required splices points being terminated into phase conductor or earth-wire conductor mounted splice joints (donut type - splice joints).

Fibre optic jointing shall be carried out using fusion type fibre splices manufactured and supplied in accordance with NPS/001/026. All splicing shall be carried out in strict accordance with the cable manufacturer's and splicer manufacturer's instructions. The Contractor shall be suitably trained in such jointing techniques. The colour code for identifying each fibre is detailed in NPS/002/024 - *Technical Specification for Fibre Optic Cables and Fibre Wrap*

The contractor shall identify each fibre optic cable with a waterproof type of cable marker system before it enters the splice.

Wherever practicable the cable preparation and splicing work shall be carried out either in the back of the splicing vehicle or a suitably covered work area, and not on the support structure. The loose tubes containing the optical fibres shall be cut back to the required length using the appropriate tools. The fibres must have all traces of gel removed from their external surface.

The splice cassette shall, on completion of all splicing, contain nominally 2m but not less than 1.5m of excess fibre. The excess fibre should be securely stored observing the minimum bending radius requirements of the fibre.

The cable central strength member shall be either clamped or directed away from the fibres, and be free to move without obstruction or stressing the fibres.

All fibres shall be fusion spliced (as opposed to mechanical splicing) using a suitable splicing machine. Completed splices shall be protected by a mechanical splice protector. The protected splices shall be placed in the splice organiser (splice trays) within the splice enclosure, which should be sealed upon completion of the work to the manufactures recommended procedures.

Splice Losses – the mean splice loss must be equal to or less than 0.15dB the maximum individual splice loss shall be equal to or less than 0.2dB.

Non-conforming splice losses shall be reworked, the splice will be cut out, the fibres re-cleaved and re-spliced. If the splice still does not conform to the specification, the process must be repeated, up to a maximum of three times. Evidence of these attempts shall be recorded as OTDR traces and presented back to Northern Powergrid with the final test results in the “As built records”.

If the attenuation measurement, after the third splice attempt, still does not conform, then the following concessions will apply:

Mean splice loss <= 0.15dB

Maximum splice loss must not be greater than 0.3dB

If after splicing the fibre the third time, the concession criteria are not met, an alternative splicing machine must be used. If non-conformance still applies, then this effectively eliminates the splicing techniques as a source of the fault, thus implying the fault lies within the fibre optic cable. This shall then be discussed with the project manager.

3.2.1. Fibre Identification

Fibres in buffer tubes shall be coloured for identification purposes using the following sequence.

Fibre No	Colour	Fibre No	Colour
1	Blue	7	Red
2	Orange	8	Violet
3	Green	9	Pink
4	Brown	10	White
5	Grey	11	Black
6	Yellow	12	Turquoise

A single tube shall not contain more than 6 fibres on Full fibre count wrap or 3 fibres on (reduced fibre Count) wrap, the colour sequence will repeat in the next tube, but the tube will also be a different colour using the same sequence of colours

3.2.2. Support Mounted Splice Canister (Low Level Type)

The cable at the splice points is routed via a plastic conduit, through the canister base, down to the ground where the splicing is carried out. The cable is routed through two glands into the inner splice box where the fusion splices are housed. The fusion splicing should always be carried out in controlled conditions (e.g. in a vehicle or tent) The splices are dressed into one or more splice trays before finally sealing the box lid and cable glands. A "racetrack" attachment is fitted to the inner splice box and the excess cable to reach from the tower mounting position (normally just above the anti-climbing guard) to ground is wrapped around it, until the racetrack can be attached to the canister base. Finally the galvanised weather protective hood is placed over the top of the canister base, the racetrack and inner splice box.

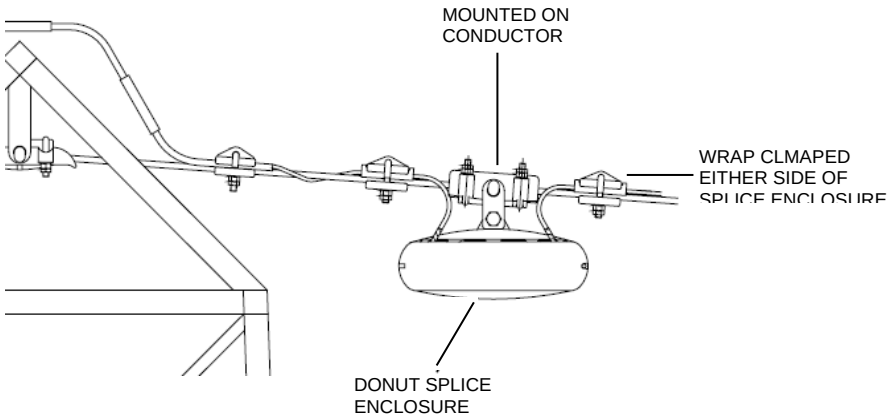
Note:-

Where splice canisters are installed on wood poles they shall be bonded to the adjacent phase to ground termination earthing system.

3.2.3. Overhead Line Mounted Splice Enclosure (Donut or High Level Type)

When using this box the cable is routed outside of the structure down to ground. The donut splice enclosure differs from other splicing fittings as it can hold a length of un-stripped fibre optic cable in its shell. This is to allow the splicing to be carried out at ground level before raising the enclosure to the conductor.

The cable is fed into the aluminium splice box and the fusion splice made and housed as in 3.2.1 above. The cable is sealed into the box using an adhesive lined heatshrink, and the lid is sealed using a neoprene 'O' ring. The sealed box is lifted up to the conductor/earth-wire. The excess cable required to reach the ground is wrapped around the outside of the box and the held in place by two hinged aluminium shells which clip onto the outside of the box. The cable is routed onto the conductor/earth-wire via castellation in the splice box. The completed splice box is then attached to and suspended from the conductor/earth-wire. For exact instructions on how to assemble splice boxes see the individual splice box manuals provided by the supplier.



WRAP Donut Splice Enclosure

3.3. Fibre Optic Testing Requirements

3.3.1. Testing Prior to Installation

Once the cable cassettes have been delivered to the Contractor, tests at 1550nm on each fibre from the cable end on the outside of the cassette shall be taken to ensure that there is no damage prior to installation. Testing at the 1550nm wavelength will show up any microbends from the manufacture process. Northern Powergrid reserve the right to witness these tests. The contractor shall inform Northern Powergrid of any cable damage discovered.

3.3.2. Testing After Cabling

After the fibre wrap has been installed but before any route splicing occurs, OTDR (Optical time–domain reflectometer) tests shall be carried out on each fibre length in one direction to ensure that there is no damage post-installation. These tests shall be carried out at 1550nm to check for macrobends or breaks caused by cabling damage and the results shall be presented to Northern Powergrid.

3.3.3. End to End Testing Following Completion of Terminations

Northern Powergrid Telecoms or their approved contractors shall carry out termination works of all fibre wrap within the Northern Powergrid building. This shall include the internal cabling, mounting of fibre wall boxes, installation of cabinets and ODFs etc. On completion of the installation works the fibre route shall be subjected to bi-directional end to end OTDR and insertion loss measurement (ILM) test at both 1310nm and1550nm. The results shall be recorded and presented to Northern Powergrid for evaluation and comparison with those provided by the installation contractor.

3.4. As Built Records

In addition to the OTDR trace files and insertion loss measurements, the contractor shall provide photographs of each splice enclosure with close ups of the splice trays using a macro camera setting so that the quality of fibre preparation and splicing work is clearly visible. Further photographs of the splice enclosure fitted on a tower or pole (with the tower/pole reference number) shall also be submitted to verify that the close up is of the correct support.

The contractor shall also provide a report including showing the following information as part of the final project record:-

- Details of the optical route
- Date of the tests
- A end identity and B end identity
- Section length in km
- Total number of splices
- The location of each slice and its location in the route i.e. overhead or underground
- Type and location of splice joints including grid ref and OHL tower or pole number.
- Wavelength used for testing
- OTDR – make, model calibration date
- Calculated route attenuation from A end connector to B end connector

Copies of the OTDR traces are to be supplied to Northern Powergrid by the contractor in a digital form.

Optical Power Loss Test

ILM tests are to be carried out on each fibre in the route, in both direction, at 1310nm and 1550nm. All results are to be recorded on the test report.

The test report must contain the following:-

- Details of the optical route
- Optical budget for the route as provided by Northern Powergrid
- 'A' end and 'B' end identification
- Date of test
- Total number of splices
- Equipment details
- Fibre identification number
- Operating wavelength
- Launch Power (dB)
- Attenuation of A-B and B-A (dB)
- Average attenuation (dB)
- Pass / Fail

In addition the contractor shall provide Northern Powergrid with a complete set of map sheets at 1:500 scale marked up to show the as built duct route with all chambers and splice positions marked up accordingly

3.5. Network Restoration in the Event of Broken Earth-Wire or Phase-Wire

In the unlikely event of a broken earth or phase wire the normal priority will be to return the damaged circuit back into service as quickly as possible, in most cases ignoring the fibre wrap repairs until a more convenient time.

It is recommended that during the early stages of any broken fibre situation that contact is established with the Northern Powergrid nominated fibre repair service provider or Northern Powergrid telecoms to arrange for assistance with the repairs.

The method of repair to be employed will be dependent upon were the fibre is wrapped.

3.5.1. Recovery from a Broken Earth-Wire Situation Containing a Fibre Wrap

In the event of a broken earth wire conductor or earth wire termination equipment that results in the broken conductor falling to the ground, this will inevitably also result in a broken fibre wrap. When this occurs, both ends of the broken fibre cable shall be unwrapped from the earth-wire back to the healthy side of the nearest support structure but before the span end clamp. The fibre shall then be wrapped into coils, being mindful of the minimum bending radius for the fibre cable and then each coil shall be secured to the tower. Permanent repairs can then be carried out on the broken earth-wire to allow the circuit to be returned to service. If the broken fibre wrap provides feeder protection and is required back in service before the circuit can be returned to service then several options are available.

- The coils of recovered fibre cable shall be dressed down the outside of each tower, being installed and protected in the approved conduit to create new ground to ground terminations and low level splice termination situated above the anti-climbing guards on each tower. Care shall be taken to ensure that the fibre is left with sufficient length to allow the fibre jointing work to be carried out at ground level. Then dependent upon the required need for circuit availability, the two low level splice boxes can be connected together using a temporary ground deployed fibre cable as detailed in clause 3.7.1. Alternatively a permanent repair can be afforded by installing a new section of fibre wrap between the effected towers and before then being re-terminated in the low level splice boxes.

3.5.2. Recovery from a Broken Phase-Wire Situation Containing a Fibre Wrap

In the event of a broken phase-wire conductor this will inevitably also result in a broken fibre wrap. When this occurs, both ends of the broken fibre cable shall be unwrapped from the phase-wire back to the healthy side of the nearest support structure but before the span end clamp. The fibre shall then be wrapped into coils, being mindful of the minimum bending radius for the fibre cable and then each coil shall be temporally secured back onto the phase conductors (**NOT SECURED TO THE TOWER OR POLE).** Permanent repairs can then be carried out on the broken phase wire to allow the circuit to be returned to service. If the broken fibre wrap provides feeder protection and is required back in service before the circuit can be returned to service then two options are available.

- Establish a phase to ground termination as detailed in clause 3.1.14 and then install a ground deployed cable system as detailed in clause 3.7.1.
- Where time permits the application of a permanent solution this will be carried out as follows:-
- A new section of fibre wrap cable shall be installed along the phase wire of the effected section of line, leaving sufficient length on the fibre to be terminated in to donut type high level splice at ground level as detailed in clause 3.2.3. The coiled up cable on the tower side of the break can then be re-attached to the phase wire and then terminated into the donut splice.

3.6. Recovery Techniques

The fibre wrap system is reliable but to prepare for any eventuality equipment has been developed to recover the cable and equipment from the conductor/earth-wire.

3.6.1. Tug/Wrapping Machine Recovery

The tug (with attached wrapping machine) which has stopped mid-span can be recovered in two ways:

i) A recovery trolley is pulled out to the stopped equipment using a rope. The recovery trolley automatically engages the tug, and all the machines are then winched into the tower. This cannot normally be done under live line conditions.

ii) A recovery tug is sent out to meet the stopped equipment, in this case pulling a rope suspended from the conductor/earth-wire with supporting recovery rollers, at intervals of approximately 10m. The recovery tug engages the stopped tug, is then switched off remotely, and again all the equipment is winched in with the rope. This can be done under live line conditions.

3.6.2. Cable Recovery

If at some point it is necessary to remove some of the fibre wrap cable, this can be done in two ways.

A recovery trolley is placed on the conductor/earth-wire and pushed along by a tug, or pulled by a rope from the ground. The trolley gathers the loops of cable along in front of it to the next tower. This is the quickest and easiest way of removing cable but this cannot normally be done under live line conditions. Also the trolley cannot pass mid-span joints when used in this mode.

A motorised remote controlled unwrapping machine, which is placed on the conductor physically, unwraps the cable from the conductor/earth-wire under controlled conditions. It acts like a reverse spinning machine except that to accommodate any variations in cable pitch, the rate of rotation can be varied relative to the forward speed. The machine itself is fully recoverable using the technique described 3.3.1.ii. This technique is suitable for use under outage conditions.

3.7. Emergency Return to Service Option for Fibre Installations

3.7.1. Ground Deployed Cable (GDC) Installations

Ground Deployed Cable is a temporary fibre connection laid between two existing tower joints and is used to by-pass damaged cable sections while they are repaired thereby maintaining optical connectivity during the works.

The cable route must be negotiated with the appropriate land owners and will typically be laid directly into or on top of the ground whilst following the requirements detailed in clause 3.4.2.

Ground Deployed cables are not to be used to support services for prolonged periods and ideally should be in use for two to six week periods. Should there be a requirement for a longer duration a more robust and tailored installation should be planned and deployed. This will necessitate much collaboration between the various engineering functions engaged in the work, the affected land owners and the Northern Powergrid telecoms section.

Special arrangements for terminating GDC into tower joints and running down tower legs temp Anaconda

3.7.2. Planned Ground Deployed Cable

When laying a GDC that will be used to support services while a planned repair is undertaken it is essential that every effort is made to hide and/or protect the GDC from vandalism and accidental damage (vermin or land management/farming activities). Due attention to the land use must be paid in order to ensure the optimum deployment method is employed. Generally, it is preferable to ensure the cable is hidden from view but, under certain circumstances, it may be more desirable to highlight the cables presence with red & white striped tape in close proximity to the cable. This must be decided after consultation with the land owner.

Wherever possible the following GDC guidelines should be adhered to;

- Through contact with land owners & local authorities understand what planned highway and land management activities are planned that may pose a risk to the cable
- Mole ploughed into any soft unmade surfaces
- Road crossings should be achieved using culverts & agricultural underpasses but temporary scaffolds may need to be deployed. The cable should also be placed in sub-duct at these locations.
- Where temporary scaffolds and fence lines are used the cable will be placed in sub-duct

- Some road crossings can be achieved placing the cable in slot cut into the road surface where the road is a lane or "B" road
- Regular contact with the landowner must be maintained to remind them of the temporary cables presence.

3.7.3. Emergency Ground Deployed Cable

When laying an GDC that will be used to support services as a result of a fibre fault every effort should be taken to observe the same principles as that of a planned GDC in clause 3.4.2. However, given that critical services are likely to be affected, unless instructed otherwise by Northern Powergrid Telecoms, the focus must be on achieving service restoration as fast as possible while ensuring the installation does not pose a health and safety risk.

3.7.4. Other Optical By-pass Options

Other methods of providing a by-pass provision on Tower line supported fibre can also include the installation of a span of All Di-electric Self Supporting (ADSS) fibre between the two effected towers, this method will alleviate any potential ground obstacles that might affect a temporary ground deployed cable link. Further details on how ADSS shall be erected and terminated will be added at the associated guidance document is developed.

3.8. Operational Procedures

The following table has been prepared to capture specific operating procedures when work activities are required on fibre wrap installations

Work Activities	Hazard	Required safety documentation	Conditions
Requirement to access a tower supporting a fibre wrapped earth-wire including a tower with a ground to ground termination (GTG)	No electrical hazard	Limitation of Access	electrical safety clearance exists to live conductors
Requirement to access a tower or wood pole supporting a fibre wrapped phase-wire - no PTG termination	No electrical hazard	Limitation of Access	electrical safety clearance exists to live conductors
Requirement to access a tower or wood pole supporting a fibre wrapped phase-wire and containing a PTG insulator termination and low level fibre splice box (located above the ACD) Note. Splice box normally lowered to ground level position to carry out work	Proximity to PTG termination	Limitation of Access	Proposed area of work, outside of the working and access clearances as defined in DSR clause 4.4.1 diagram 1. Notes Where the PTG termination earth connection is missing (due to theft) a temporary earth shall be applied to the securing tie bolt to restore the earth to the PTG and splice canister before work can continue under the limitation of access.
		Permit to work	Proposed area of work, inside working and access clearances as defined in DSR clause 4.4.1 diagram 1.
Fibre wrap cable found broken mid span, hanging down from the earthwire, but outside safety distance from live conductors. If the wrap did continue to unwrap and then encroached on the safety distance to the phase conductors	In the unlikely event of a fibre cable breaking it will not unwrap more than 1m as this represents the lay length of the wrap. Fibre can be left in this situation with both circuits live until repairs organised. Short single circuit interruption would be arranged to secure the	No immediate action required.	Single circuit outage and permit required when work is carried out to repair fibre.

	earth wrap to the earth wire until permanent repairs organised.		
Fibre wrap cable found broken mid span, hanging down from the phase conductor. Fibre above min ground clearance limits. Fibre hanging below min ground clearance limits	Fibre can be left in this situation with both circuits live until repairs organised. Short single circuit interruption would be arranged to secure the phase wrap onto the phase wire until permanent repairs organised.		
Application of circuit main earths to phase conductors carrying wrapped conductors	Temporary earths can be applied as normal to both suspension or tension jumpers or between the span end clamp and the compression dead end clamps		
Replacing insulator strings on supports with phase wrap installed	Insulator strings can be replaced without any issue. Where additional free conductor space is required, the loose wrapped fibre installed between the two span end clamps at each side of the support can be unwrapped leaving the conductor bare. This method can also be used where it is necessary to completely remove a jumpers to create a point of isolation between two sides of a support on a section structure.		
Working on a section of underground fibre optic cable located at or between the terminal tower and the substation.	If no access is required to the tower, then no safety document is required for work on an underground section of fibre optic cable between a tower and a substation.		

4. References

The products described within this specification shall comply with all current versions of the relevant International Standards, British Standard Specifications and all relevant Energy Networks Association Technical Specifications (ENATS) current at the time of supply.

4.1. External Documentation

Reference	Title
ENATS 43-126 Part 2	Fittings For Overhead Line Optical Cables - Wrapped Optical Cables

4.2. Internal Documentation

Reference	Title
NPS/001/026	Technical Specification for Overhead Line Fibre Optic Wrap Fittings
NPS/002/024	Technical Specification for Fibre Optic Cables, Wrap, OPGW and ADSS

4.3. Amendments from Previous Version

Reference	Description
Whole Document	Document reviewed by Ged Hammel no changes required. Doc republished to grid - LB 03/05/2023 Doc approved by email Paul Black 11/01/2023

5. Definitions

Term	Definition
Anti-climbing Devices	Methods of preventing unauthorised access to pole and tower tops. Usually involves loops of barbed wire.
Attenuation	The reduction in optical power as a signal passes along a fibre due to dispersion, absorption and scattering. Usually expressed in decibels (dB).
Balehanger	Length of grooved aluminium used to guide a length of cable across a cross arm or insulator.
Balehanger Clamp	A clamp designed to hold the Balehanger against the conductor or earth-wire.
Canister	A structure mounted splice box with: an internal splice enclosure to house fusion splices, a race track to accommodate the cable required to splice at ground level, and a galvanised steel protective hood
Cassette	2 reels of fibre cable spooled back to back, to maximise splice spacing.
Cassette Plan	A list of cassette and/or reel lengths indicating spin points and splice locations.
De-energised	free from connection to a source of potential difference or electric Charge, and not having a potential different to that of the ground. This term only refers to current carrying parts and is not normally earth-wires unless they are insulated. Even if the circuit is De-energised it may be electrically charged through induction from nearby circuits.
Earth Bond	Bond to electrically connect equipment to ground potential for safety purposes.
Energised	Electrically connected to a source of potential difference, or electrically charged so as to have a potential different to that of the ground.
Fibre wrap (full fibre count)	A 24 fibre optical cable suitable for wrapping onto bare phase or earth-wires
Fibre wrap (reduced fibre count)	A 12 fibre optical cable suitable for wrapping onto a bare phase-wire
Fittings	Any hardware attached to a fibre optic cable or related to its connection to a tower, conductor or another cable.
Ground to Ground	Conduit system used at splice and termination points designed to guide and protect the cable in passing from the earth-wire to the structure, and then down the structure to the splice point.
ILM	Insertion Loss Measurement - insertion loss is the loss of signal power resulting from the insertion of a device in an optical fiber route and is usually expressed in decibels (dB).
Jib	Lifting device designed to fit to a structure, to lift and move installation equipment.
Jumper	The loop of conductor/earth-wire formed between incoming and outgoing conductors or earth-wires at a dead-end structure.
Live Line Working	Term used to describe working condition for earth-wire installations when all adjacent phase circuits are energized.
Mid-Span Joint	A joint in the earth-wire/conductor, normally a crimped sleeve or helical wire preform, between two structures.
NBL	Nominal Breaking Load. 95% of RTS.
ODF	Optical Distribution Frame
Optical Budget	The optical power budget in a fibre-optic communication link is the allocation of available optical power (launched into a given fibre by a given source) among various loss-producing mechanisms such as launch coupling loss, fibre attenuation, splice losses, and connector losses, in order to ensure that adequate signal strength (optical power) is available at the receiver. In optical power budget attenuation is specified in decibels (dB).
Optical Fibre	A strand of very thin, optically pure glass that can carry digital information over long distances
OTDR	Optical time-domain reflectometer – An OTDR tester is used for testing and fault finding within fibre optic networks and fibre cables
Overhead Splice Box	A splice box designed to be mounted on the conductor or earth-wire.
Patch Lead	Short length of fibre optic cable, with a connector at each end, used to join items of equipment such as optical distribution frame and relay panel

Phase to Ground	a patented high voltage insulator designed to guide and protect the cable, both electrically and mechanically, at splice and termination points, in passing from the conductor to the structure and into a protective conduit to the splice or termination point.
Recovery Rollers	A set of rollers that support a rope attached to a recovery tug, as it travels along the conductor/earth-wire.
Recovery Trolley	A trolley pulled by a rope, or pushed by a tug, designed to recover existing cable, or broken down equipment.
Recovery Tug	A remote controlled petrol driven pulling device designed to attach to an existing tug which has stopped in the middle of the span.
Remote controlled tug	A remote controlled petrol driven pulling device, designed to pull the spinning machine along the conductor/earthwire.
RTS	Rated tensile strength. Calculated by adding the strengths of the individual wires making up the cable.
Shackle	U-shaped piece of metal secured with a pin or bolt across the opening.
Single-mode Fibre	An optical fibre designed to carry only a single ray (mode) of light.
Span End Clamp	A clamp designed to grip the SkyWrapTM cable at transition and termination points, and prevent it moving relative to the conductor or earth-wire.
Spinning Machine or wrapping machine	Machine used to helically wrap fibre optic cable on a conductor or earth-wire. Pulled by a tug or rope and carries a spool of WRAP.
Structure	A general expression for a tower or pole.
Termination Point	The last structure on the cable system, or a structure where a splice is located.
Transition Point	A structure where the installation equipment and cable has to be transferred from one side to the other.
Unwrapping Machine	A remote controlled machine designed to unwrap a single span of existing cable under controlled conditions
WRAP	A fibre optic cable, helically wound on ground wires or phase conductors.

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	03/05/2023

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years?	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
G Hammel	Policy & Standards Engineer	29/12/2022

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
M Crowe	Protection Manager	24/04/2013

6.4. Authorisation

Authorisation is granted for publication of this document.

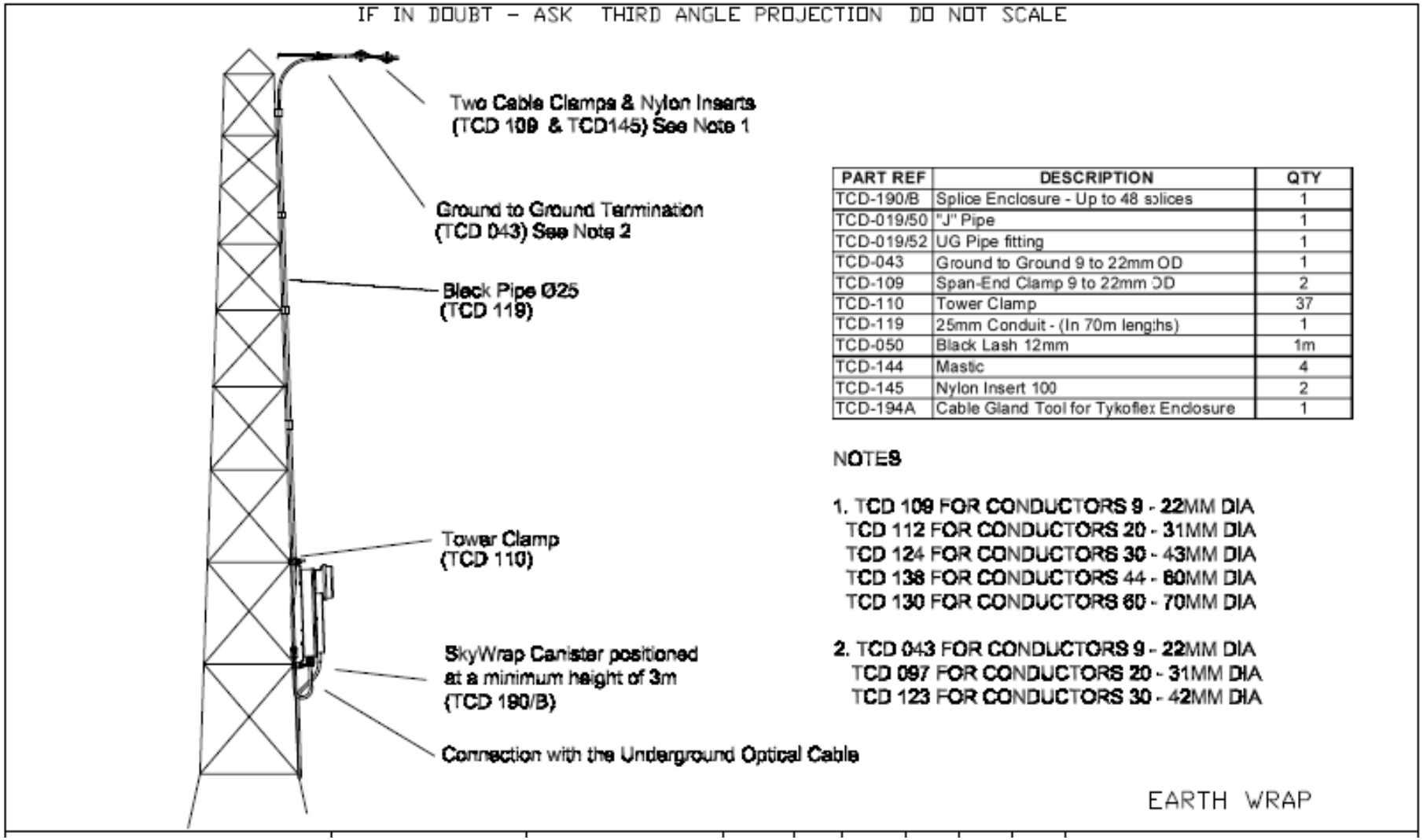
		Date
C Holdsworth	Policy & Standards Manager	22/04/2013

6.5. Authorisation

Authorisation is granted for publication of this document.

		Date
Paul Black	System Engineering Manager	11/01/2023

Appendix 1 – Earth Wire (Ground to Ground Splice) for use on Terminal / Suspension / Section Tower Supports



PART REF	DESCRIPTION	QTY
TCD-190/B	Splice Enclosure - Up to 48 splices	1
TCD-019/50	"J" Pipe	1
TCD-019/52	UG Pipe fitting	1
TCD-043	Ground to Ground 9 to 22mm OD	1
TCD-109	Span-End Clamp 9 to 22mm OD	2
TCD-110	Tower Clamp	37
TCD-119	25mm Conduit - (In 70m lengths)	1
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	4
TCD-145	Nylon Insert 100	2
TCD-194A	Cable Gland Tool for Tykoflex Enclosure	1

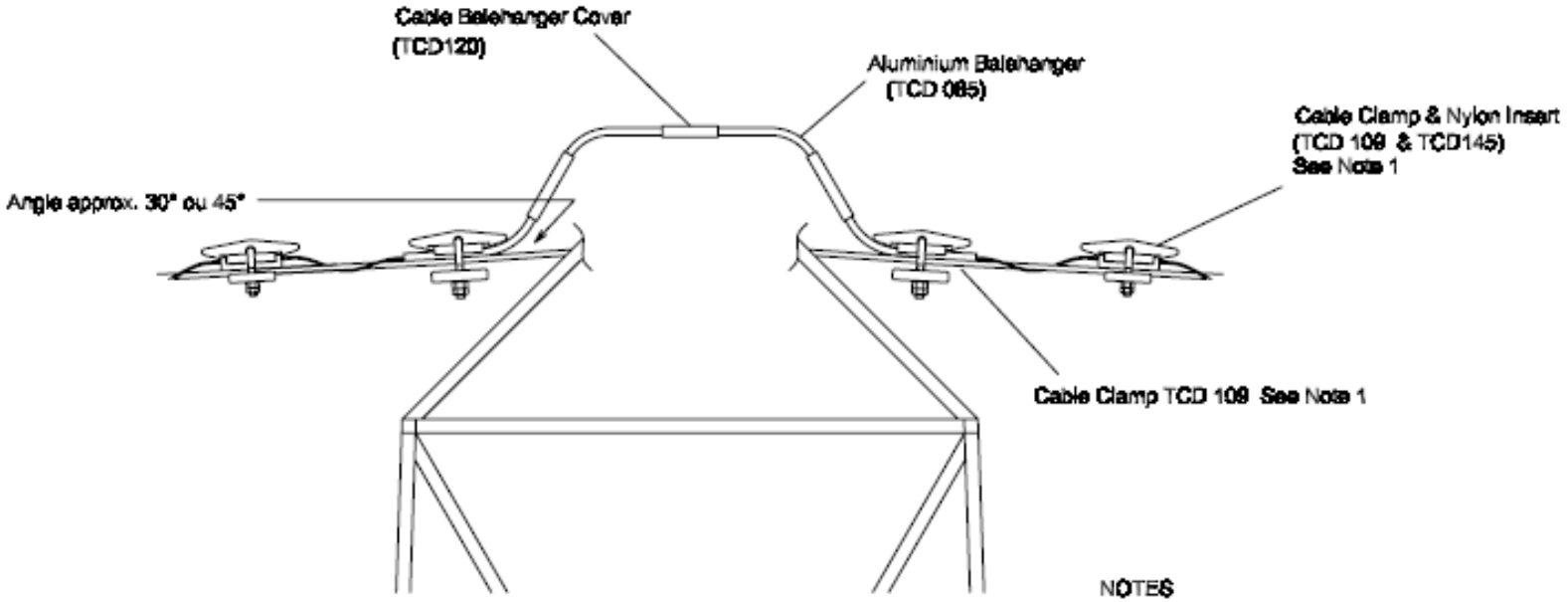
NOTES

1. TCD 109 FOR CONDUCTORS 9 - 22MM DIA
   TCD 112 FOR CONDUCTORS 20 - 31MM DIA
   TCD 124 FOR CONDUCTORS 30 - 43MM DIA
   TCD 138 FOR CONDUCTORS 44 - 60MM DIA
   TCD 130 FOR CONDUCTORS 60 - 70MM DIA

2. TCD 043 FOR CONDUCTORS 9 - 22MM DIA
   TCD 097 FOR CONDUCTORS 20 - 31MM DIA
   TCD 123 FOR CONDUCTORS 30 - 42MM DIA

Appendix 2 – Earth Wire – Suspension / Section - Bypass Arrangement on (Tower Supports)

IF IN DOUBT - ASK THIRD ANGLE PROJECTION DO NOT SCALE



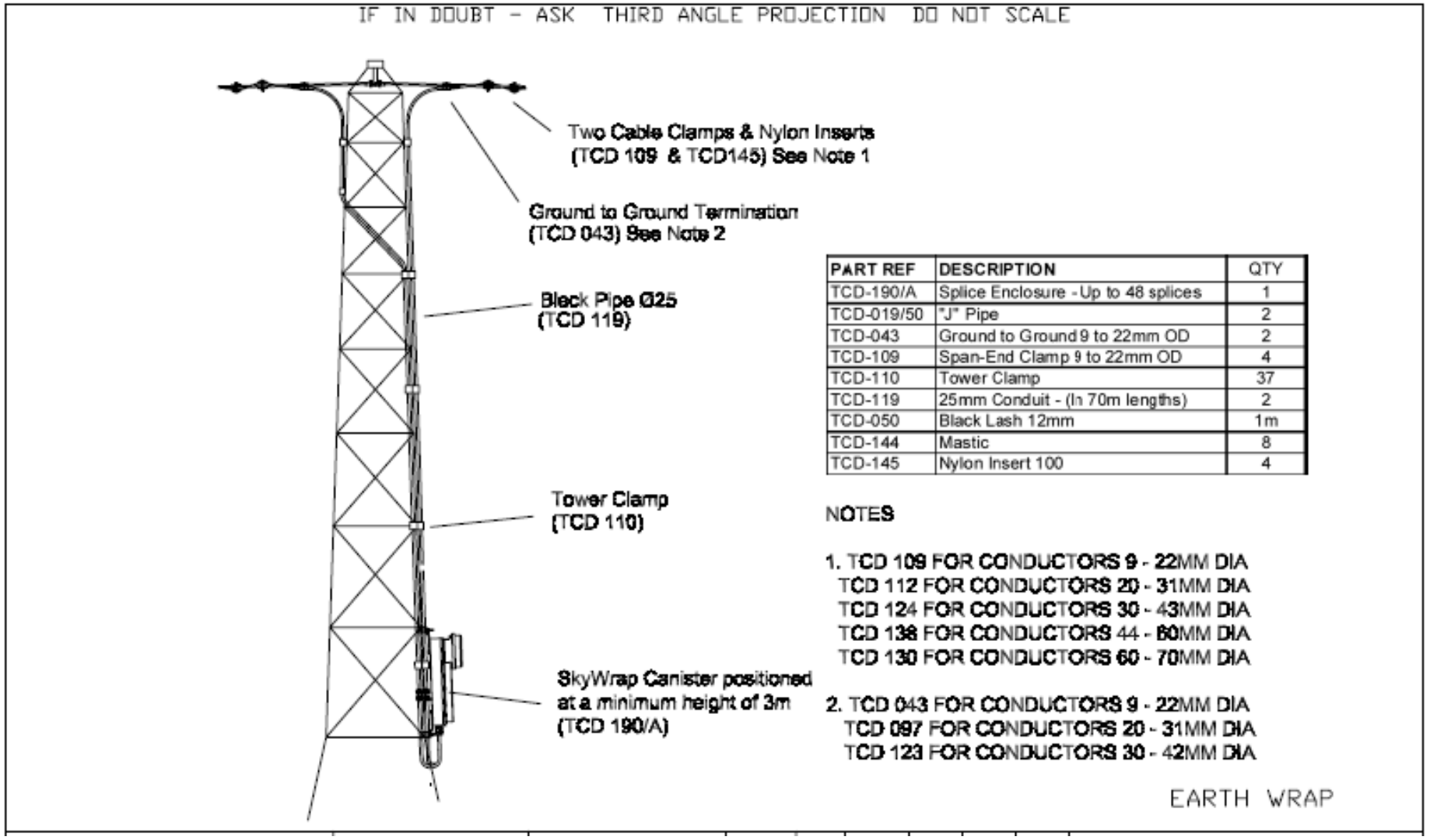
PART REF	DESCRIPTION	QTY
TCD-085/8	Aluminium Balehanger 3.3m Straight	1
TCD-109	Span-End Clamp 9 to 22mm OD	4
TCD-120	Balehanger Cover	8
TCD-144	Mastic	8
TCD-145	Nylon Insert 100	2

NOTES

1. TCD 109 FOR CONDUCTORS 9 - 22MM DIA
TCD 112 FOR CONDUCTORS 20 - 31MM DIA
TCD 124 FOR CONDUCTORS 30 - 43MM DIA
TCD 138 FOR CONDUCTORS 44 - 60MM DIA
TCD 130 FOR CONDUCTORS 60 - 70MM DIA

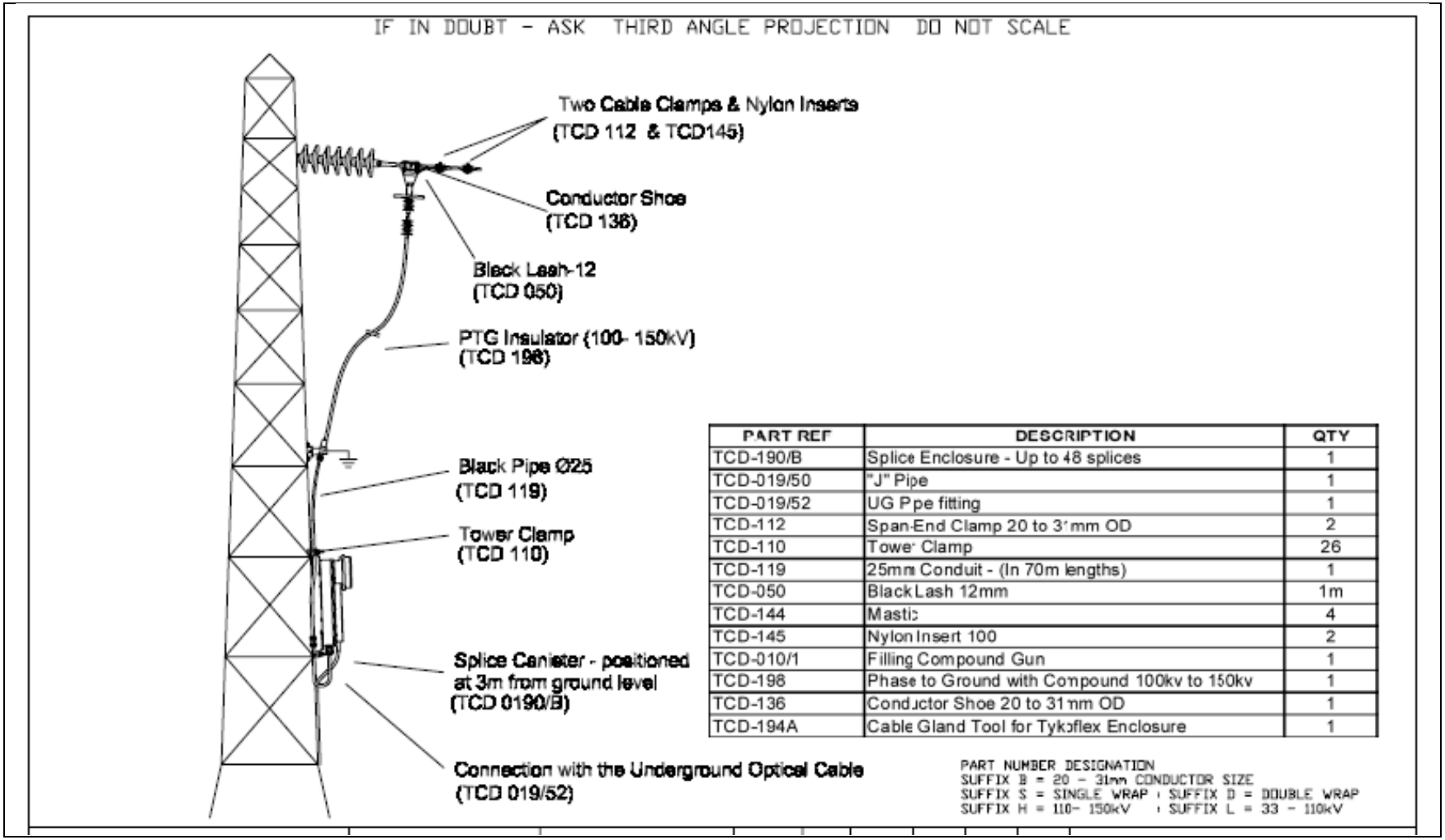
EARTH WRAP

Appendix 3 – Earth wire Suspension / Section (Low Level Splice) on Tower Support



PART REF	DESCRIPTION	QTY
TCD-190/A	Splice Enclosure - Up to 48 splices	1
TCD-019/50	"J" Pipe	2
TCD-043	Ground to Ground 9 to 22mm OD	2
TCD-109	Span-End Clamp 9 to 22mm OD	4
TCD-110	Tower Clamp	37
TCD-119	25mm Conduit - (In 70m lengths)	2
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	8
TCD-145	Nylon Insert 100	4

Appendix 4 – Phase Wire (Phase to Ground Termination) Section / Terminal (Tower or Wood Pole Supports)



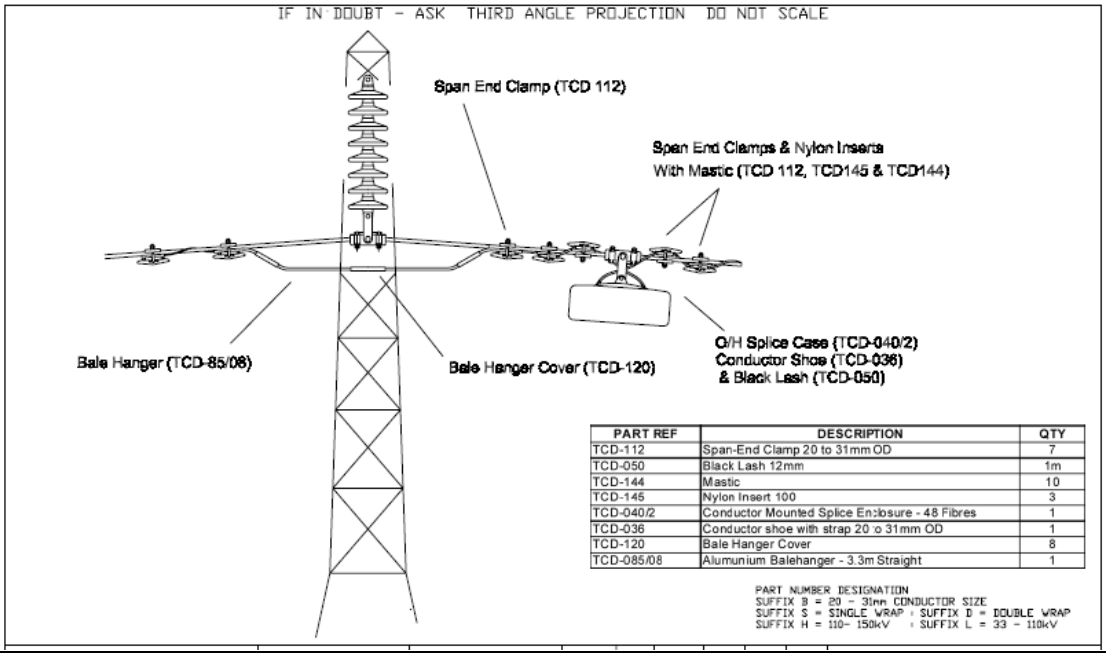
PART REF	DESCRIPTION	QTY
TCD-190/B	Splice Enclosure - Up to 48 splices	1
TCD-019/50	"J" Pipe	1
TCD-019/52	UG Pipe fitting	1
TCD-112	Span-End Clamp 20 to 31mm OD	2
TCD-110	Tower Clamp	26
TCD-119	25mm Conduit - (In 70m lengths)	1
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	4
TCD-145	Nylon Insert 100	2
TCD-010/1	Filling Compound Gun	1
TCD-198	Phase to Ground with Compound 100kv to 150kv	1
TCD-136	Conductor Shoe 20 to 31mm OD	1
TCD-194A	Cable Gland Tool for Tyko flex Enclosure	1

Appendix 4a – Phase Wire (Phase to Ground Termination) continued

PTG insulator terminations are 5m long on towers & 3.5m on wood poles

Notes
This arrangement can be applied to a wood pole with the following variations.
The Splice cannister shall be secured to the wood pole using an M20 Coachscrew
The lower earthed clamp associated with the phase to earth termination shall be secured to the wood pole using a M20 Tierod. The Tierod shall be connected to earth using a 70mm HDBC earthing conductor and shall be off sufficent length to protude through the fitting allowing sufficent thread to allow temporary portable earths to be applied to the rod to cater for theft or removal of the earths.
The splice cannister shall be bonded to the phase to gound terminations and to the HV crossarm assemblies using 70mm HDBC earthing conductor

Appendix 5 – Phase Wire - Suspension Tower or Wood Pole Support (With or without Conductor mounted Splice box)

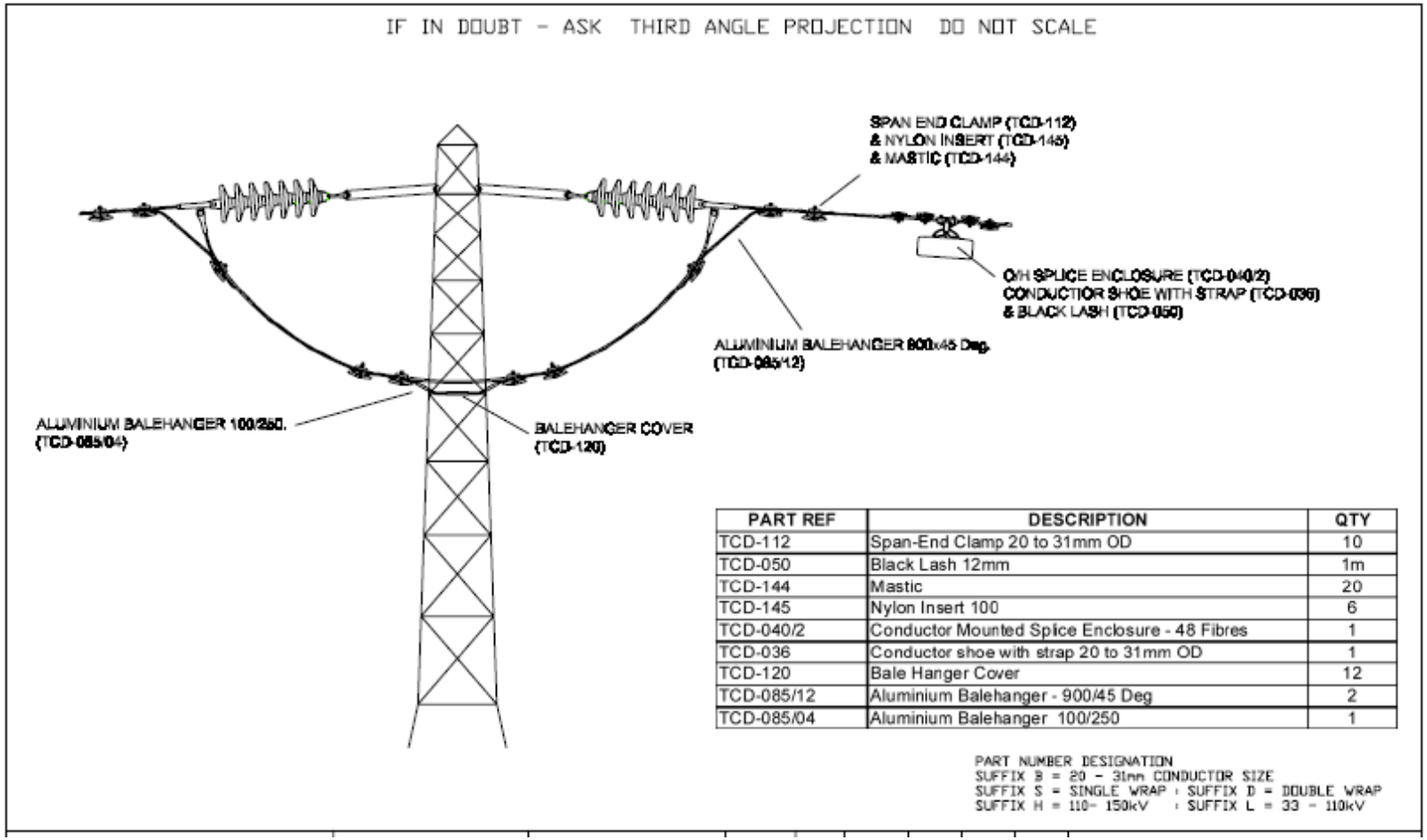


PART REF	DESCRIPTION	QTY
TCD-112	Span-End Clamp 20 to 31mm OD	7
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	10
TCD-145	Nylon Insert 100	3
TCD-040/2	Conductor Mounted Splice Enclosure - 48 Fibres	1
TCD-036	Conductor shoe with strap 20 o 31mm OD	1
TCD-120	Bale Hanger Cover	8
TCD-085/08	Alumunium Balehanger - 3.3m Straight	1

Notes

This general arrangement drawing has been prepared to show the arrangement of the fibre at a phase wire suspension support. The in-line splice shall be omitted were not required.

Appendix 6 – Phase Wire - Tension Tower or Wood Pole Support (With or without Donut type Splice box)

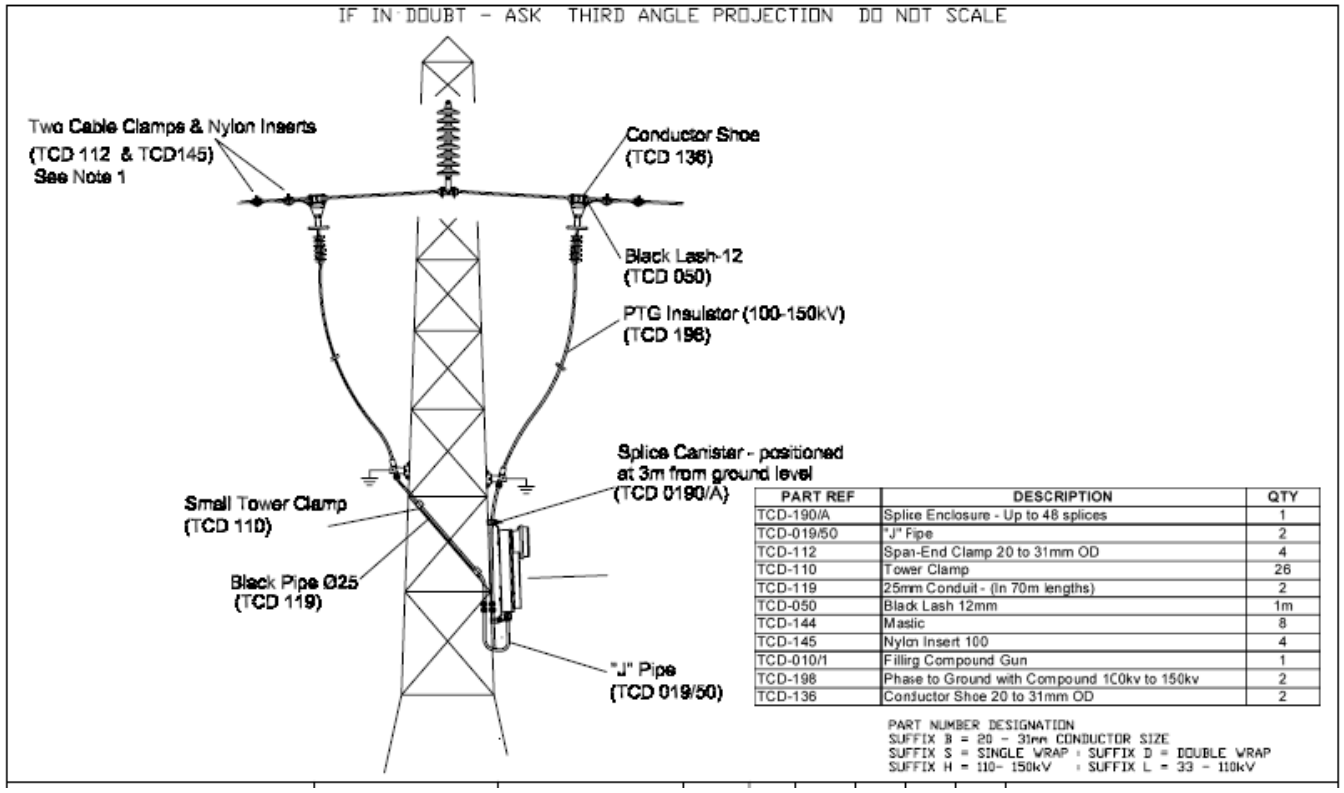


PART REF	DESCRIPTION	QTY
TCD-112	Span-End Clamp 20 to 31mm OD	10
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	20
TCD-145	Nylon Insert 100	6
TCD-040/2	Conductor Mounted Splice Enclosure - 48 Fibres	1
TCD-036	Conductor shoe with strap 20 to 31mm OD	1
TCD-120	Bale Hanger Cover	12
TCD-085/12	Aluminium Balehanger - 900/45 Deg	2
TCD-085/04	Aluminium Balehanger 100/250	1

Notes

This general arrangement drawing has been prepared to show the arrangement of the fibre at a phase wire tension support. The in-line splice shall be omitted were not required.

Appendix 7 – Phase wire – Suspension Tower or Wood Pole Support (Phase to Ground Low Level Splice)



PART REF	DESCRIPTION	QTY
TCD-190/A	Splice Enclosure - Up to 48 splices	1
TCD-019/50	"J" Pipe	2
TCD-112	Span-End Clamp 20 to 31mm OD	4
TCD-110	Tower Clamp	26
TCD-119	25mm Conduit - (In 70m lengths)	2
TCD-050	Black Lash 12mm	1m
TCD-144	Mastic	8
TCD-145	Nylon Insert 100	4
TCD-010/1	Filling Compound Gun	1
TCD-196	Phase to Ground with Compound 100kv to 150kv	2
TCD-136	Conductor Shoe 20 to 31mm OD	2

Notes

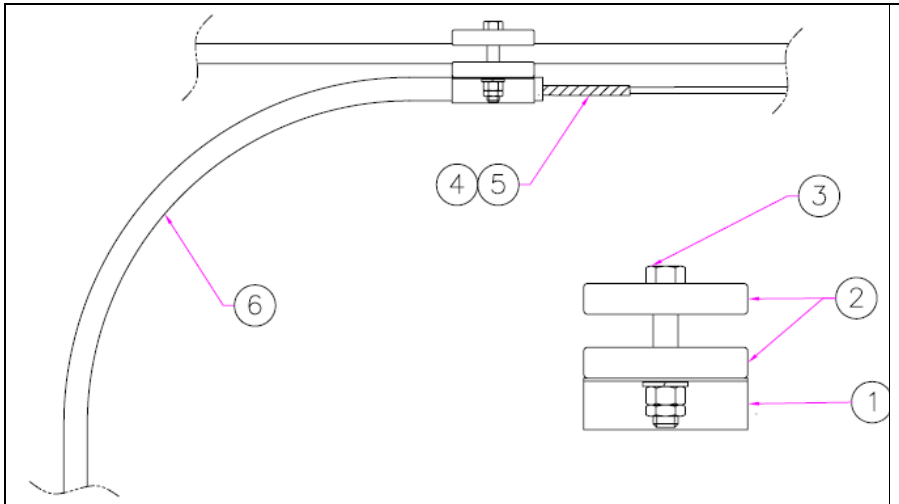
This arrangement can be applied to a wood pole with the following variations.

The Splice cannister shall be secured to the wood pole using M20 Coachscrew

The lower earthed clamps associated with the phase to earth terminations shall be secured to the wood pole using a common M20 Tierod. The Tierod shall be connected to earth using a 70mm HDBC earthing conductor and shall be off sufficent length to protude through the fitting allowing sufficent thread to allow temporary portable earths to be applied to the rod to cater for theft or removal of the earths.

The splice cannister shall be bonded to the phase to gound terminations and to the HV crossarm assemblies using 70mm HDBC earthing conductor

Appendix 8 – Ground to ground termination – Detail Drawing



Accessory Number: TCD 043

Description: Ground to ground termination

Component List:

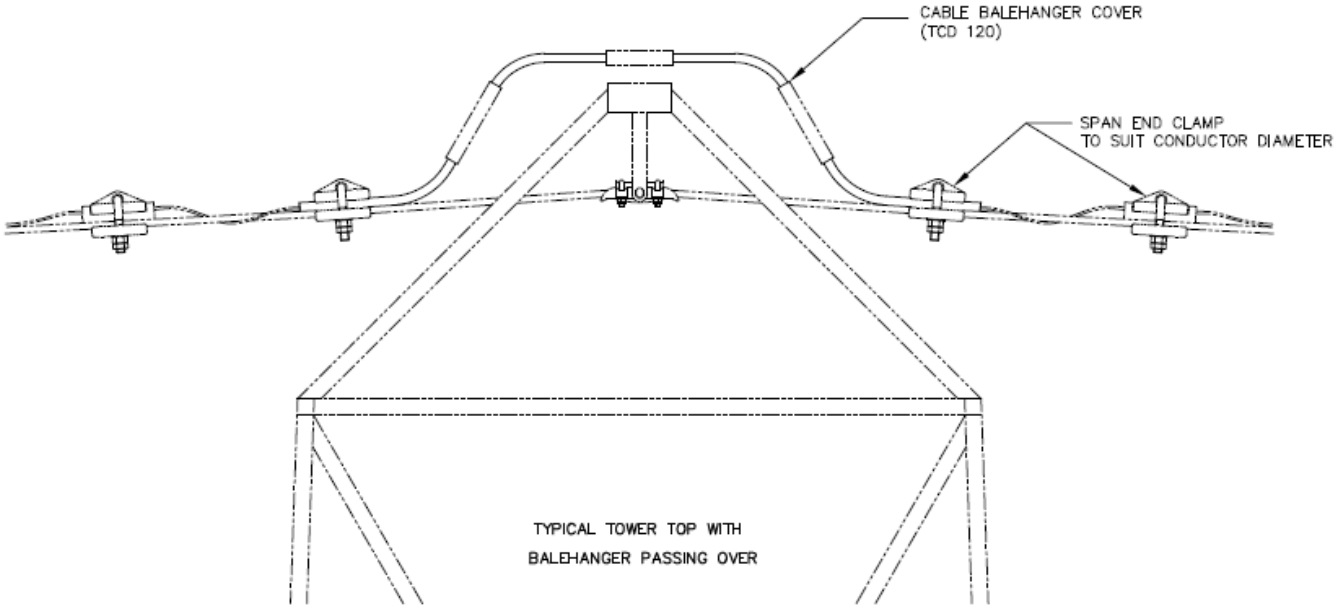
1.	Conduit clamp	A/2020	1 off)
2.	Clamp Lower	F/3060	2 off) A/2021
3.	Bolt Hex M12x 70 Galvanised		2 off)
4.	Lash Black – 6	TCD 049	300mm
5.	Lash Bl;ack – 12	TCD 050	300mm
6.	25mm conduit pipe	TCD 119	as required

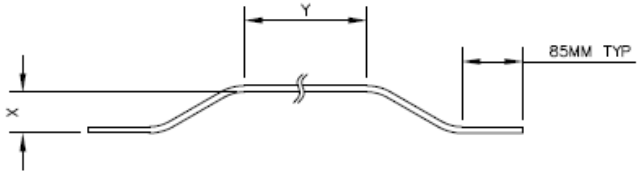
Purpose: This product is used to secure the conductor to enable the transition of the fibre wrap cable to the earthwire for splicing.

Limitations: Conductor diameter range this conductor span end clamp = 9 to 22mm and must not be used on copper conductors

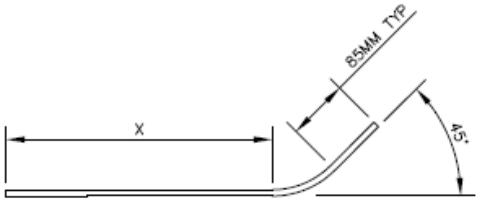
Torque tighten all fasteners to 20Nm

Appendix 9 – Aluminium Balehanger Detail Drawing





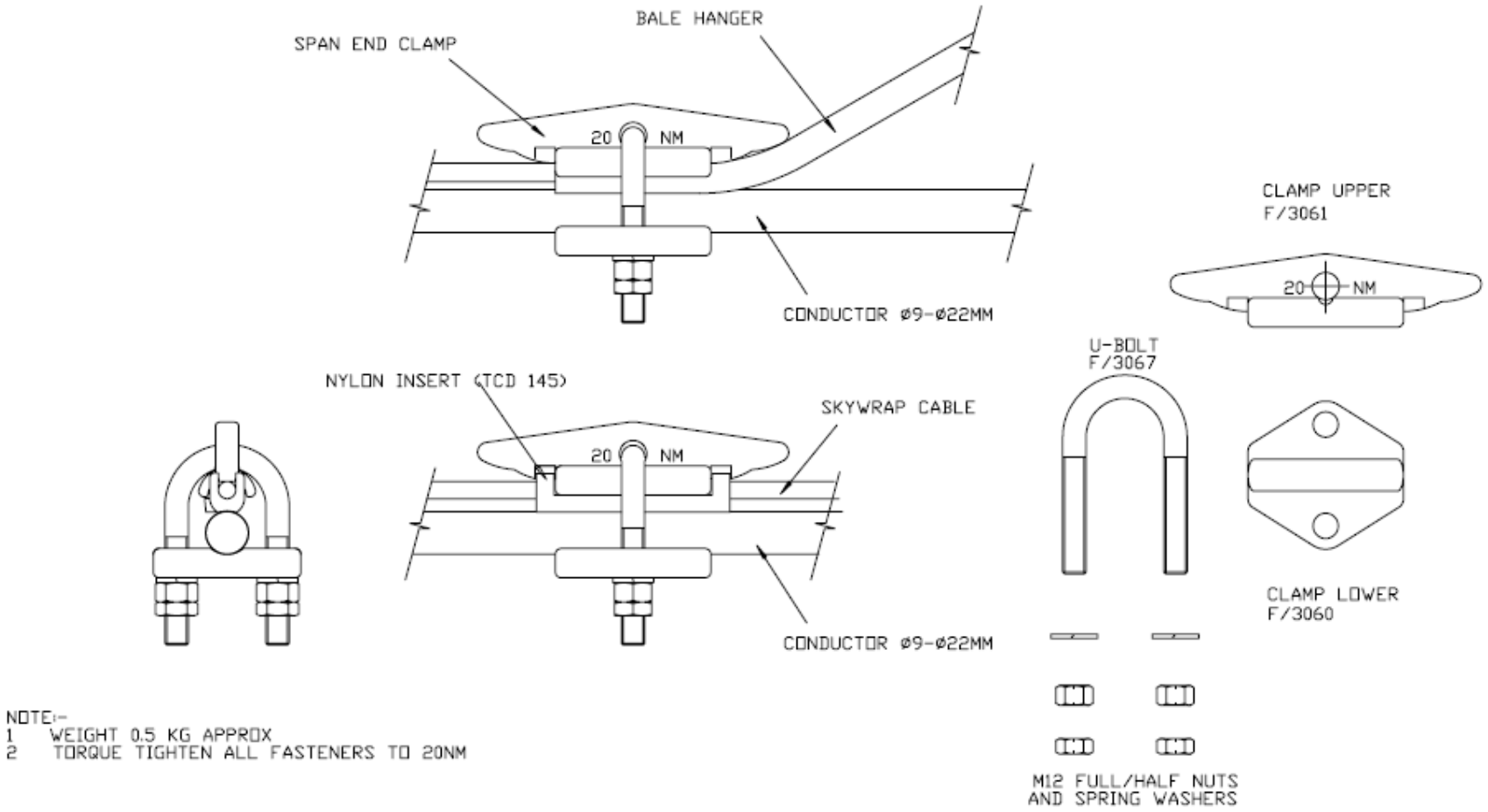
STRAIGHT SECTION BALEHANGER



* JUMPER TYPE BALEHANGER

TCD NUMBER	X	Y
TCD–085/01	100	300
TCD–085/02	100	800
TCD–085/03	100	1400
TCD–085/04	100	250
TCD–085/05	100	400
TCD–085/06	–	1300
TCD–085/07	–	1600
TCD–085/08	–	3300
TCD–085/09	100	1000
* TCD–085/12	900	45°
TCD–085/13	–	2100
TCD–085/14	100	500
TCD–085/16	150	2100
TCD–085/17	125	1000
TCD–085/18	150	1000
TCD–085/19	175	1000
TCD–085/20	200	1000
TCD–085/21	125	400
TCD–085/22	150	400
TCD–085/23	175	400
TCD–085/24	200	400
TCD–085/25	150	1500
TCD–085/26	450	300
TCD–085/27	490	570
TCD–085/28	550	1000

Appendix 9 – Cable / Balehanger Clamp Detail Drawing part 1 of 2



Appendix 10 – Cable / Balehanger Clamp Detail Part 2 of 2

Accessory Number: **TCD109**

Description: **Span End Clamp**

Component List:

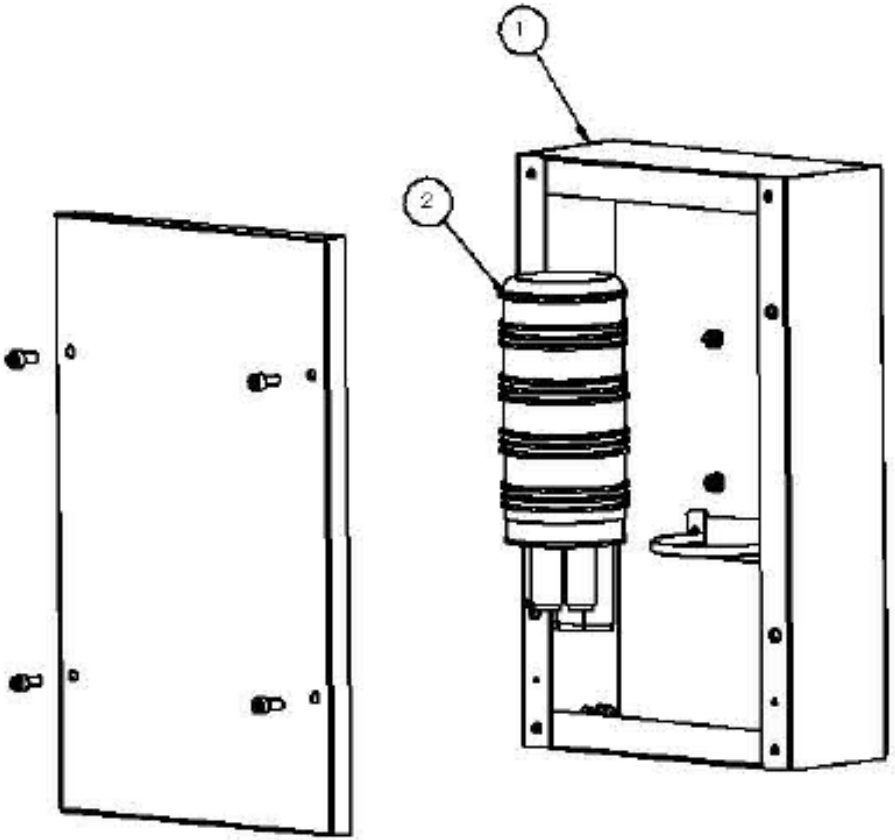
U-Bolt		1 off
Clamp Upper		1 off
Clamp Lower		1 off
M12 Spring washer – Galvanised	2 off	
M12 Full Nut – galvanised	2 off	
M12 Half Nut – Galvanised		2 off

Purpose: This product is used to secure any type of balehanger to the conductor, It is also used to secure the fibre wrap cable to the conductor at either end of the wrapped span to stop any loose cable migrating to the centre of the span.

Limitations: Conductor diameter range this conductor span end clamp = 9 to 22mm and **must not be used on copper conductors**

Comments: Specify 2 per balehanger plus 2 per span, therefor 4 off for each normal transition

Appendix 11 – Wood Pole Splice Box



SPLICE CAPACITY: UP TO 24 FIBRES

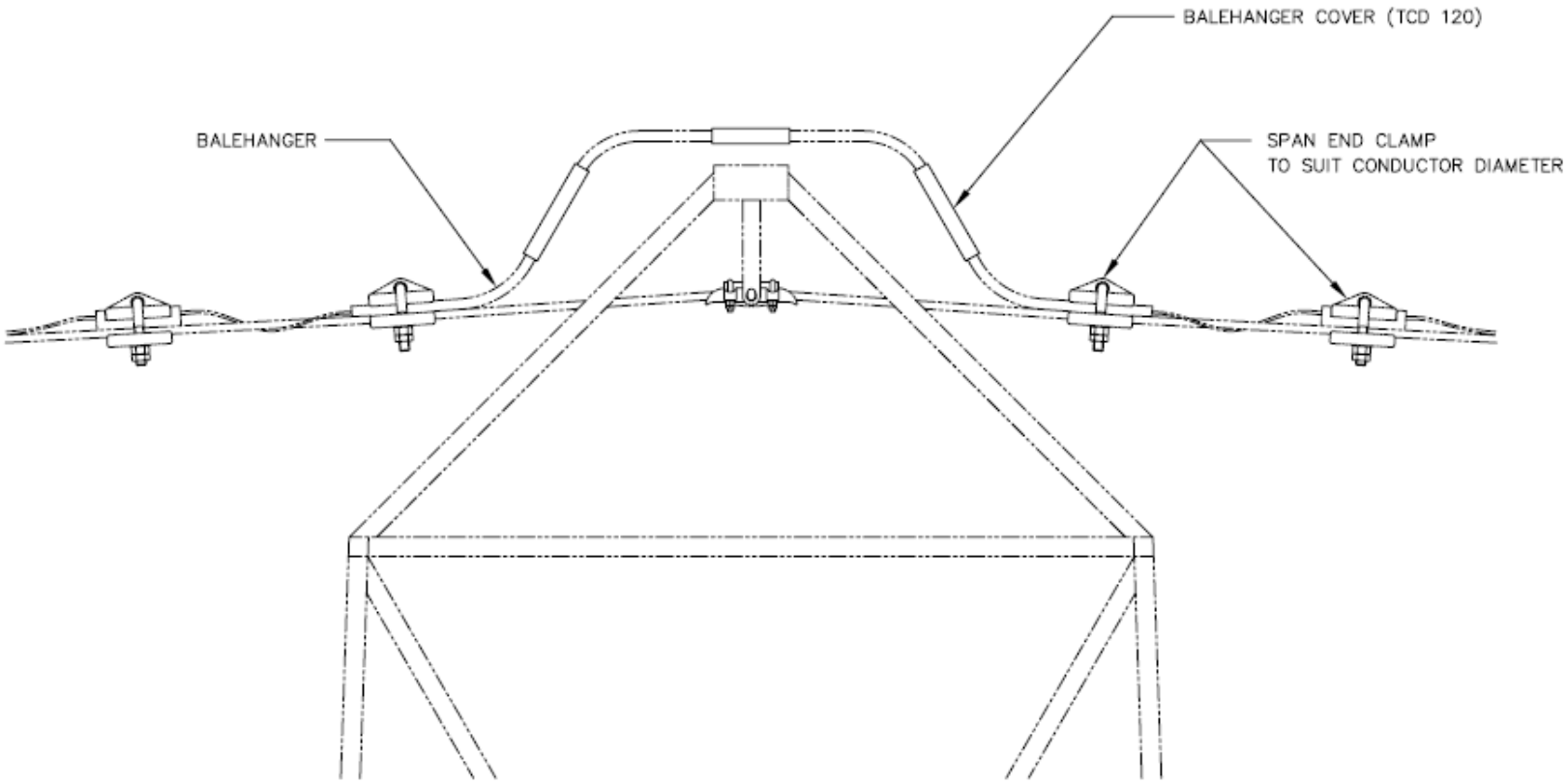
DIMENSIONS

HEIGHT : 500mm
WIDTH : 300mm
DEPTH : 125mm

WEIGHT : 6kg

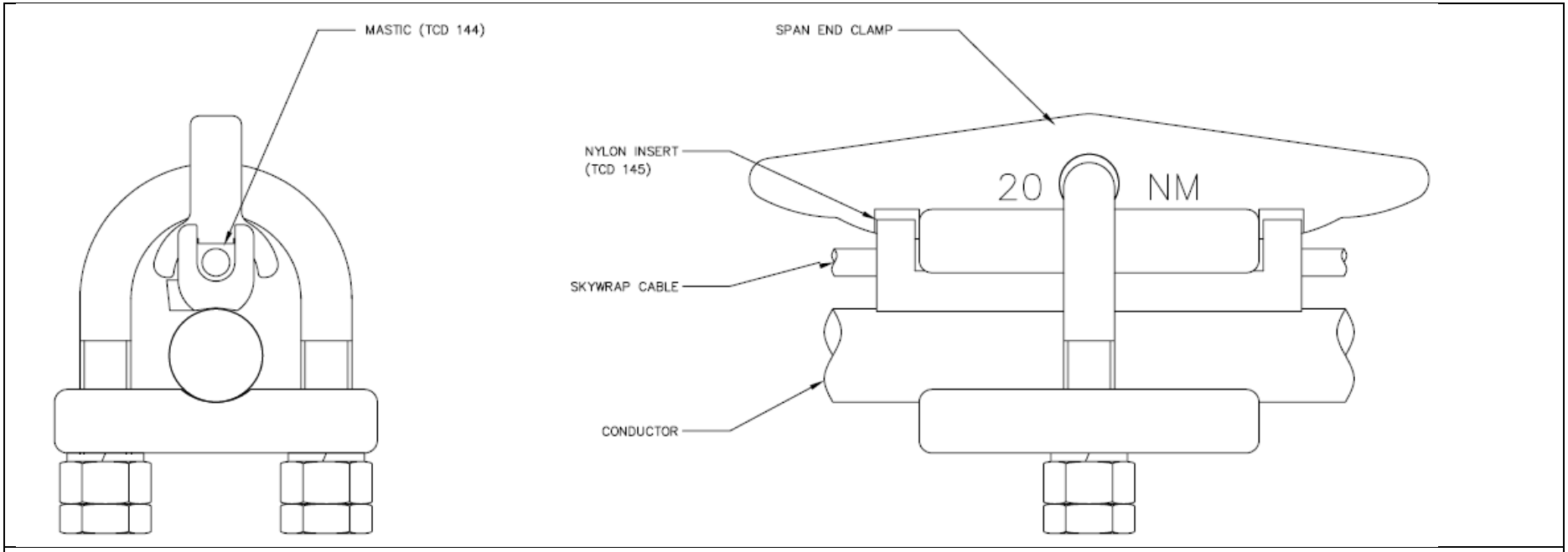
ITEM NO.	DESCRIPTION	QTY.
1	POLE BOX ASSY.	1
2	SPLICE ENCLOSURE	1

Appendix 12 – Bale Hanger Cover



NOTES:
1. 3 x TCD 120 SUPPLIED PER BALEHANGER

Appendix 13 – Nylon Insert 100



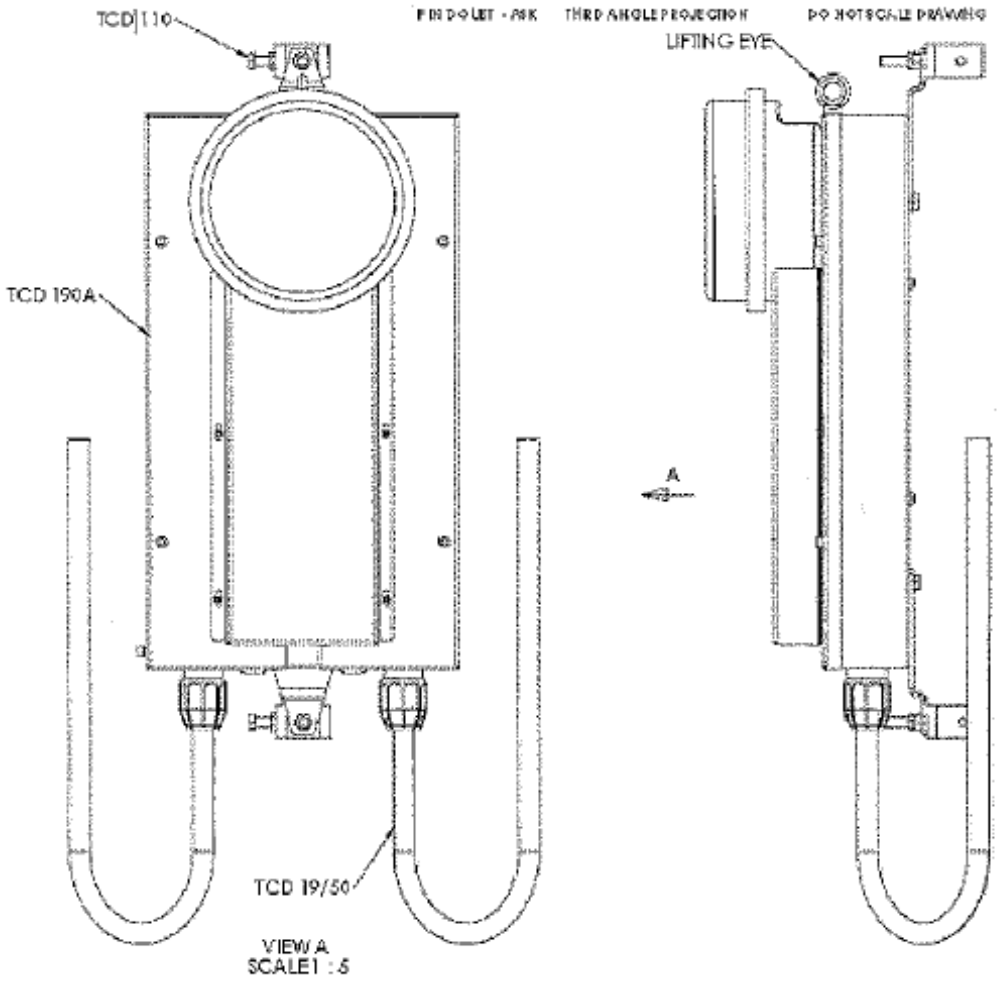
Component List:

1. Nylon insert 100 1 off

Purpose: This product is used to secure the fibre wrap cable at the end of a wrapped span in conjunction with s span end clamp.

Limitations: Specify 1 Nylon Insert 100 per span end clamp (end clamp to suit the conductor diameter)

Appendix 14 – Fibre Splice Box



DIMENSIONS:

HEIGHT : 830mm
WIDTH : 380mm
DEPTH : 260mm

WEIGHT (WITHOUT CABLE) : 20kg

SPLICE CAPACITY: UP 48 FIBRES

FOR UP TO 96 FIBRES ORDER
ADDITIONAL TCD188