SPECIFICATION FOR THE ERECTION OF SELF-SUPPORTING OPTICAL FIBRE CABLE ON TRACTION MASTS

SPC-00575
OCTOBER 2006

Revision 5.00

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<td>Technologist, Projects Execution</td>
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<td>Divisional Manager: Transmission</td>
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II DISTRIBUTION
Once updated, a copy of the latest revision will be published in the document management system in use. E-mail to this effect will be sent to the relevant personnel or heads of department.

III DOCUMENT CHANGE HISTORY

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<td>BS</td>
<td>British Standard</td>
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<td>DC</td>
<td>Direct Current</td>
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<tr>
<td>GPS</td>
<td>Global Positioning Satellite (a system whereby the latitude and longitude co-ordinates of any site on earth can be determined via a GPS receiver)</td>
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<td>HDPE</td>
<td>High Density Polyethylene</td>
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<td>Standard Operating Procedure</td>
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<td>Specification for Optical Time Domain Reflectometer (OTDR) (The number has changed to SPC-00033).</td>
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1. SCOPE AND PURPOSE

1.1 This specification covers the erection of self-supporting optical fibre cable on 3 kV DC, 25 kV and 50 kV AC overhead high tension electrification (OHTE) masts for Transnet Freight Rail, a Division of Transnet Limited.

1.1.1 Construction will mostly take place under live traction power conditions and with the normal operation of train services.

1.1.2 Specific attention shall be paid to section 12 of this specification, which covers safety precautions during construction.

1.2 The objective is to install the major component of the cable above ground. Underground sections should be kept to a minimum. Pipe and chamber systems may be constructed or utilised where these exist.

1.3 The same optical fibre cable must be utilised for aerial and buried sections.

1.4 A clause-by-clause statement of compliance to this specification is required. All points of non-compliance must be detailed.

1.5 Should a tenderer’s method of construction and cable erection differ from this specification, full details thereof must be provided for possible prior approval.

2. SPECIFICATIONS AND DRAWINGS

2.1 This specification sets the standards for the materials and techniques to be used in aerial optical fibre cable installations, and may not be deviated from without the permission of Transnet Freight Rail, Project Manager.

2.2 Where reference is made to approved materials or techniques, this approval must be obtained from Transnet Freight Rail, Project Manager, who will co-ordinate any necessary interfacing with the relevant authorities.

2.3 This specification shall be read in conjunction with the Main Specification describing the project requirements. Should discrepancies arise between the Main Specification and this specification the requirements of the Main Specification shall prevail.

2.4 The following annexures form part of this specification:

2.4.1 E7/1: Specification for works on, over, under or adjacent to railway lines and near high voltage equipment.

2.4.2 E.4E: Safety arrangements and procedural compliance with the occupational health and safety Act; Act 85 of 1983 and regulations.
2.4.3 Annexure : Guideline for approval of OFC Suspensions on OHTE Masts.

2.4.4 SOP 002: Protection of construction workers on or near railway lines.

2.4.5 The standard specifications referred to in section 16, form part of this specification.

2.4.6 Installation Guidelines from Senior Manager Electrical (Infra Maintenance) (S.PL&T)1 CAO/13/3/1/6 of 9 November 2001.

3. DESIGN AND APPROVAL

3.1 Installation shall consist of a bracket clamped to the traction mast supporting a cable suspension fitting and the cable. No drilling or welding will be allowed on traction masts for the fixture of support brackets.

3.2 The design of the suspension hook shall be such as to prevent the cable touching or chafing against the suspension bracket or other infrastructure under the various load conditions that the OFC will be subjected to.

3.3 All fittings and brackets installed must be galvanised in accordance with SABS specification 763 or manufactured from approved corrosion resistant materials. Where the installation is within 30 kilometres from the coast, fittings and brackets must be stainless steel 304 as per BS (British standard) 1449/2. Tenderers must comment on the likelihood of galvanic corrosion between the stainless steel bracket and the galvanised mast and propose measures to avoid this possibility.

3.4 An approved range of fittings and brackets, strain grips, suspenders etc. are specified. Should alternative brackets and fittings be offered then the tenderer must submit a drawing and/or sample of each type of bracket and fitting for approval. Design specifications of the brackets and fittings are required.

3.5 The design of each bracket and fitting must be sufficient to support one span of cable load under installation and worst load conditions.

3.6 Tenderers must note that Transnet Freight Rail reserves the right to free issue all or part of the necessary fittings and brackets as well as other materials should this option be exercised.

3.7 At termination points (dead ends) the cable tension shall be aligned with the mast to avoid bending moments that cantilever fittings would cause. The tension on any mast, in any direction and under maximum load condition, must not exceed 2000 Newtons.

3.8 Drawings H0270101 indicate the general suspension positions of optical fibre cable on OHTE structures as stipulated by the OHTE Department.
3.9 On an A frame structure, only one suspension arm must be fitted on one leg of the A frame.

3.10 Installation of the optical fibre cable must comply with the attached Guideline for Approval of OFC Suspensions on OHTE Masts (as per Spoornet’s letter reference S.PL&T/1/CAO/13/3/1/6). The location of the OFC cable must not obstruct access to the OHTE conductors for maintenance purposes.

3.11 NOTE: Where this specification refers to HDPE conduit it must comply with SABS specification 533 Part 2/1982.

3.12 Where a signal gantry structure is utilised to cross the tracks, the optical fibre cable must be installed in 50 mm diameter HDPE conduit or galvanised trunking secured to the channelling of the handrail. The HDPE conduit or trunking must be properly secured to prevent sagging.

3.13 Track Crossings

3.13.1 Where a boom structure is utilised to cross the tracks, the optical fibre cable must be installed in 50 mm diameter HDPE or galvanised trunking secured on top of the boom. The HDPE conduit or trunking must be properly secured to prevent sagging. When galvanised trunking is used, an electrical occupation must be arranged to cross tracks.

3.13.2 Diagonal track crossing (fly-over crossings) will be allowed with the proviso that the OFC be secured to the adjacent earth conductor. The method of securing must be approved by OHTE Department. Where no earth wire exists, a non-metallic suspension ember must be installed. The method of installation of the suspension member must be approved by OHTE Department.

3.14 Alternative methods may be used to cross the tracks where a boom structure is utilised, but will require prior approval by OHTE Department.

3.15 No suspension must be made on masts carrying track switches, transmission line switches, make-off arrangements (except on A-frame structures) and transformers. Transnet Freight Rail will use alternative structures. Optical fibre cable deviating onto such alternative structures must clear this equipment by 2 metres in the horizontal.

3.16 Where existing optical fibre is suspended on traction infrastructure, new installations must be positioned as close as possible to the existing cable, in order to minimise possible obstruction, or be installed on the opposite side of the rails in compliance with the revised requirements.

3.17 The design must be such that at any point the bending radius of the cable must not be less than 20 times the outside diameter of the cable.
3.18 At anchor and intermediate positions, there shall be no slippage of the cable under any condition.

3.19 No fitting or clamp shall exert a crushing force on the cable of more than 1 000 N.

3.20 The cable shall be tensioned so that under normal conditions, i.e. when no wind is blowing, a cable temperature of 25 °C, the maximum sag per 70 metre span length must be 500 mm. Under the worst conditions, i.e. when the wind is blowing cross-sectional at a speed of 100 km/hour, at a cable temperature of 65°C, the maximum sideways deviation (sag) shall not exceed 2 metres.

3.21 The cable parameters will be provided in the Main Specification as supplied by the cable manufacturer.

3.22 To avoid Point Loads being applied to the cable, the following guidelines in this regard shall apply:

3.22.1 0 — 15° deviation from the straight run - standard suspension method, Preformed fibre optic suspension type unit or other approved fitting.

3.22.2 15° and greater deviation from straight run - false termination or similar method.

3.23 Excessive lengths of non-terminated cable shall be avoided. On straight runs, false terminations must be installed at intervals not exceeding 500 metres.

3.24 The position and types of brackets to be mounted on bridges and tunnels must be clearly indicated on the bridge plans. The OFC position must be selected to protect the cable against objects protruding from train wagons and wind lashing. The cable may also be protected by means of an approved conduit. Transnet Freight Rail, Project Manager, together with the relevant authorities, must then approve these fittings and plans.

3.25 Clearance must be obtained from Transnet Freight Rail, Project Manager for each bridge, tunnel and retaining wall where brackets must be mounted. These brackets must be fixed against the wall by means of a stainless steel stud grouted into a hole and sealed. Rawl bolts are acceptable if the sheath is made with an aluminium bronze finish. Chemical fixers are also acceptable. Unsuccessful holes must be closed in an approved manner.

3.26 Optic Fibre Aerial Cable Pulley or Sling:

3.26.1 A specially designed pulley or sling for the erection of optical fibre aerial cable should be obtained for the installation and regulation of the cable.
3.26.2 The pulley/sling shall be of a suitable size to accommodate the minimum-bending radius of the cable, of low friction and should be able to accommodate an installation tension in all four directions (i.e. down, up, left and right).

3.26.3 The design of the installation pulley shall be such as to prevent touching or chafing against any infrastructure under the various load conditions that the pulley and OFC will be subjected to during installation.

3.26.4 After regulation it should be possible to remove the cable from the pulley or sling and attach the cable to the suspension fitting.

3.26.5 A sufficient number of pulleys shall be available to install a cable length of 2 000 - 4 000 metres at every suspension point.

3.26.6 Transnet Freight Rail, Project Manager must approve the design of the pulley or sling. The objective is to gent the OFC as close as possible to its final position.

NOTE: Drawing No. D0350102 indicates an approved stringing pulley for fibre optic installation. Alternative designs will be considered, but full technical details and a sample shall be provided for evaluation and approval before use.

4. SURVEY

4.1 Aerial optical fibre cable should normally be ordered in lengths of 2 000 or 4 000 metres. Shorter lengths can be provided on request. It is however advisable not to exceed 4 000 metres due to undue excessive drag under installation conditions.

4.2 When a route is to be measured for the purpose of erecting an aerial optic fibre cable, a measuring wheel should be used for accuracy. It should therefore be determined in advance on which mast a joint/splice will be required.

4.3 Specific lengths should be determined as follows:

4.3.1 Start measuring at the termination cabinet up to the 4 000 metre mark. At the 4 000 metre mark, a suitable mast should be selected at which a joint could be made without any obstructions. The selected mast must be situated in a position where it accessible for splicing. A standard length of slack on either end must be allowed for termination and splicing of the fibres at ground level.

4.4 False terminations must be placed at intervals of less than 500 metres.
4.5 The mast must also be identified for the construction team exactly where the first length of cable ends and the second length starts. These masts are to be indicated on the survey sheets. The whole route must be measured and marked in this way. Masts where joints are to be made must not have any other traction equipment on it.

4.6 It should be noted that no additional splices, without the approval of the Project Manager would be allowed. That means that the cable shall be fed through any obstacle that may occur.

4.7 Care should also be taken, when measuring, to avoid short lengths of cable at the end of the routes, thus eliminating extra splices in the cable. Transmission losses must be reduced to a minimum.

4.8 The final route selected must avoid an excessive number of track crossings. It is important that the correct side of the track be selected beforehand. This should normally be where the service road runs, for ease of access and added fire protection.

4.9 Care must be taken at platforms, bridges and footbridges to keep the cable clear from pedestrians in order to avoid tampering and malicious damage to the cable.

4.10 The positioning of the optical fibre cable on 3 kV DC, 25 kV and 50 kV AC electrified structures must be selected to avoid placing the cable in strong electric fields. Surveyors must specifically adhere to the minimum clearances required.

4.11 Possible damage by grass and bush fires, e.g. on the embankments of cuttings, must be taken into account during the survey. All potential grass and bush fire hazards must be indicated on the survey. An alternative route must be indicated on the survey on how to avoid these potential fire hazards.

4.12 All positions where intermediate poles are required must be indicated on the survey drawings.

4.13 A complete set of survey sheets must be submitted before installation commences. These survey sheets must indicate the start and finish of cable sections, types of brackets and fittings, joints, track crossings, obstacles, etc. The cable route must be distinguished by the international symbol for optic fibre cable.

4.14 The survey sheets must be A4 pages in landscape, and each page shall cover 1 km. The start of the cable shall be on the top of the first page, and each page will follow in logical order. Refer to Annexure 1.

4.15 Transnet Freight Rail will survey the route of optical fibre cable and will provide drawings and positions for the suspension on each mast to the Project Manager for approval by the Regional Spoornet, Metrorail Maintenance Manager at each Infrastructure Depot or local authorities.
4.16 On completion of the work, "As Build" route drawings must be submitted, as per the survey sheets and as stipulated in the Main Specification, which must indicate the following:

4.16.1 Requirements as per sub subclause 4.12.

4.16.2 Joint numbers and traction mast numbers.

4.16.3 Amount of cable slack at joints, underground deviations and at other intermediate points.

4.16.4 All cable and drum numbers must be recorded on the survey sheets.

4.17 The co-ordinates of all joints, terminations and significant changes in direction must be recorded via GPS. These co-ordinates must be shown on the "As Built" drawings, and must be provided in electronic format (MS Excel) in order for it to be loaded into Transnet Freight Rail’s Fibre Information Management system. Refer to Annexure 1.

5. **INSTALLATION**

5.1 On receipt of the cable, the following steps must be taken:

5.1.1 Ensure that the cable delivered is of the correct type and fibre count e.g. anti-tracking cable for AC electrified sections.

5.1.2 Ensure that the cable or drums are not damaged.

5.1.3 Record drum numbers and lengths, and verify cable lengths.

5.1.4 Arrange drums according to the survey to ensure that the relative lengths are erected in the correct order.

5.2 Ensure that all pre-testing has been completed and approved.

5.3 Preparation must be carried out on the route on which the cable is to be erected. Trees, bushes and grass must be cut so that work can be carried out without any obstacles. The aerial route must be at least 3 metres clear of bush and trees within the Transnet reserve. Where excessive trees or bush, which could become a fire hazard are encountered, an alternative route must be chosen. Tree branches overhanging the cable must be removed.

5.4 It is recommended that a 7 mm nylon ski-rope of ±2 000 metres shall be obtained to haul the cable through the special manufactured pulleys.

5.5 The rope must be fed through the pulleys before hauling commences. Equipment must be inserted between the end of the cable and the hauling rope to prevent the cable from twisting during installation. A mechanical fuse of the required rating must be inserted between the hauling rope and the cable.
5.6 **Erection of Cable on DC Traction Masts**

5.6.1 Fit a pulley or sling on every suspension bracket for a distance equivalent to the length of the cable to be hauled in.

5.6.2 Feed the hauling rope through the pulleys or slings. Two hauling ropes may be used to expedite the hauling i.e. while the one is used for hauling, the other can be fed through the pulleys of the next section.

5.6.3 Place the drum with cable at least one span length of 70 metres away from the mast where the cable will pass through the first pulley. This would prevent the cable from bending too much while being hauled. Under no circumstances should the cable be bent excessively. This drum should be placed on cable jacks with an axle. The rate of the hauling should be controlled from this point.

5.6.4 Secure the hauling rope to the cable end by means of a hose grip and swivel or other device approved by the Project Manager.

5.6.5 The cable must be fed off the drum according to the speed with which the cable is hauled. Care must be taken that the cable is not tightening between the drum and the first pulley. A constant tension must be maintained on the cable by braking of the cable drum when necessary. Tension must be maintained to avoid contact with trains. Hauling should be avoided on very windy days.

5.6.6 The hauling team must haul the cable evenly and slowly to prevent the cable from jerking which can result in broken fibres.

5.6.7 Good communication between persons at the drum, alongside the cable end and the hauling team, is absolutely essential and must be available at all times. If the communication breaks down, the hauling must be stopped immediately until such time that communication had been re-established.

5.6.8 When hauling the cable, a person with a two-way radio must walk alongside the cable-end to ensure that the cable is not twisting with the rope, especially at angle-masts where the possibility of twisting is great. When the cable starts twisting, hauling must be stopped immediately. The cause of the problem must then be pinpointed and rectified.

5.6.9 The person walking at the hauling end must ensure the best route for the cable, avoiding the cable chaving against stays or other obstacles.
5.7 **Tensioning**

5.7.1 A termination bracket and fitting (dead end) must be installed at the beginning of each length. Where only false terminations occur in a cable section the cable must be tensioned sequentially for every false termination section.

5.7.2 The cable sag and tension under normal installation conditions may vary around bends. Special care must be taken when the cable is removed from the pulley and placed onto the termination fitting so that the cable do not exceed the prescribed tension.

5.7.3 The cable shall be tensioned by means of an approved device and the tension shall be continually monitored not to exceed the parameters provided by the cable manufacturer.

5.7.4 On sections with a number of angle masts, it may be required to tension the cable over shorter distances. In this case care should be taken not to damage the cable at the intermediate tensioning points.

5.7.5 Sufficient time shall be allowed for the tensioned cable to settle. This time is when there is no longer a movement on the tensioning scale. When the correct tension has been achieved, the suspension and termination fittings shall be fitted.

5.7.6 The cable must be marked at all anchor points in an approved manner to indicate possible slippage.

5.7.7 The site supervisor must record the final stringing tensions and terminated span lengths on a control sheet. The site supervisor must submit these sheets with the site diaries for scrutiny and retention.

5.8 **Cable Slack**

5.8.1 At positions where it may be required to accumulate cable slack due to the nature of the route, this slack must always be coiled in a figure of eight to avoid twisting of the cable. In muddy conditions the figure of eight must be done on a ground sheet to avoid soiling of the cable.

5.8.2 After the hauling process, sufficient slack must be left for splicing purposes. The cable must reach ground level plus 10 metres plus another 10 metres on the hauling end, which must be cut off by the installation team. The installer must ensure that this length is cut off during the installation process.
5.8.3 The slack shall be coiled in two separate coils of minimum 500 mm diameter, tied with UV stabilised coated stainless steel cable ties at four positions and secured on the PLP dead-end. See drawing TC 000172 for details.

5.8.4 If slack boxes are specified in the main specification, these must be of sufficient size to accommodate the cable minimum bending radius. Transnet Freight Rail may supply these items under a supply agreement if so specified in the project specification.

5.8.5 Care shall be taken not to twist the cable when coiling the cable slack. Refer to drawing TC-00172.

5.8.6 A small amount of slack, between 250 and 300 mm (sag) must be allowed at false terminations.

5.8.7 For handling cable slack see drawings TC-00172 and TC-00174.

5.9 In order to avoid sharp angles in the vertical plane when going over or under bridges a gradual increase or decrease of the route shall be obtained by adjusting the suspension brackets upwards or downwards on the masts.

5.10 Intermediate Poles

5.10.1 Intermediate telephone poles (where required) must be installed where span lengths exceed 70 metres or where the cable veers away from the track for any reason. Intermediate poles must be of the wooden, steel or concrete telephone type. The ground clearance of the suspended cable must not be less than 7.0 metres. Where the intermediate wooden pole is in the danger of burning, a 2 metre high galvanised metal sleeve must be fitted around the base of the pole.

5.10.2 The Project Manager must obtain approval for the erection of intermediate wooden, steel or concrete poles in the vicinity of electrified tracks.

5.10.3 Similar cable support fittings must be utilised for the suspension of the cable on poles as that used for the electrification masts.

5.10.4 Transnet Freight Rail may supply intermediate poles on request.

5.10.5 Stays or struts must be fitted as required or as directed by the Project Manager. Critical poles must be concreted in position.

5.10.6 To make the poles more visible at night, a reflective band of UV resistant material must be fixed to the pole next to service or other roads at 1.5 metres above ground level.
5.11 Underground Installation

5.11.1 Underground cable installations must be kept to a minimum except where the use of proper cable ducts are installed.

5.11.2 Underground installations must comply with specification SPC-00029 where applicable.

5.11.3 At all instances where it becomes necessary to install the cable underground the cable must be protected as follows:

5.11.3.1 High-density polyethylene conduit of minimum 50 mm diameter.

5.11.3.2 Approved concrete slabs placed longitudinally over the cable.

5.11.3.3 A combination of the methods above, depending on the class of protection required.

5.11.4 Warning tape with a distinctive marking, i.e. "optic fibre cable" must be installed above the cable and 300 mm below ground level.

5.11.5 Track crossings must be in accordance with specification SPC-00029. On specific lines, Transnet could insist on doing the track crossings themselves.

5.11.6 Where the underground cable deviates away or gets onto a mast, the cable must be protected by means of galvanised ducting from the top of the mast as depicted on drawing Nos. D 0280101(1 of 1), TD00028(2 of 3) and TD00028(3 of 3). The top end of the ducting must be properly sealed against ingress of water. Where the installation is within 30 kilometres of the coast the cable must be protected by means of approved non-corrosive conduit for the full length to the top of the traction mast.

5.11.7 Metal ducting or conduit may not form an electrical path from the mast into the ground.

5.11.8 The ducting must be clamped to the mast in an approved manner and installed to obtain maximum protection from the mast structure. The ducting or non-corrosive conduit must follow the profile of the concrete base of the mast. The possibility of damage to the ducting and cable during track maintenance must always be considered. See drawing TD 00028 sheet 3 of 3.
5.11.9 The cable must be protected by means of split tubing between the top of the ducting and the termination fitting. A concrete protection block must be installed at the base of the mast as per drawing TD 00028 sheet 3 of 3.

5.11.10 Cable markers must be provided and planted wherever the cable is laid in the ground. Cable markers must be planted as stipulated in specification No. SPC-00029. The fibre optic marker shall have a distinctive mark, i.e. OF/OV, and must be painted yellow.

5.12 **Erection of Cable on AC Traction Masts**

5.12.1 Fit the universal multipurpose bracket at ±1,5 metres above ground level.

5.12.2 Fit a pulley/sling on every suspension bracket at a working height for a distance equivalent to the length of the cable to be hauled in.

5.12.3 Place the drum with cable away from the mast where the cable will pass through the first pulley/sling. This would prevent the cable from bending too much while being hauled. Under no circumstances should the cable be bent excessively. This drum should be placed on cable jacks with an axle. The rate of the hauling should be controlled from this point.

5.12.4 The cable must be fed off the drum according to the speed with which the cable is hauled. Care must be taken that the cable is not tightening between the drum and the first pulley. A constant tension must be maintained on the cable by braking of the cable drum when necessary. Tension must be maintained to avoid contact with trains. Hauling should be avoided on very windy days.

5.12.5 The hauling team must haul the cable evenly and slowly to prevent the cable from jerking which can result in broken fibres.

5.12.6 Good communication between persons at the drum, alongside the cable-end and the hauling team, is absolutely essential and must be available at all times. If communication breaks down, the hauling must be stopped immediately until such time that the communication had been re-established.

5.12.7 When hauling the cable, a person, in full communication with the team, must walk alongside the cable-end to ensure that the cable is not twisting, especially at angle-masts where the possibility of twisting is great. When the cable starts twisting, hauling must be stopped immediately. The cause of the problem must then be pinpointed and rectified.
5.12.8 Tensioning shall be as per subclause 5.7.

5.12.9 Less cable slack is required for AC-type installations but sufficient slack must be left for splicing purposes.

5.12.10 Once tensioning and splicing of the cable is completed, the suspension bracket shall be moved up the mast in at least three steps with various lengths of installation tools to the correct position on the mast. Note that approved non-conductive tools must be used and installation teams must avoid touching any high voltage carrying infrastructure at all times.

5.12.11 The splicing team must strive to keep-up with the hauling team. If this is not the case, additional labour will be is required to lower and raise the cable for splicing purposes.

5.13 **Hauling Cable into Pipe and Chamber Systems and Underground HDPE Conduit**

5.13.1 Optical fibre cable should always be hauled into a dedicated sub duct where installed in pipe and chamber systems. The sub duct may be hauled in with existing cables already occupying the main (100 mm) duct. The sub duct shall be a 32 mm diameter HDPE conduit. The sub duct shall be coloured yellow with a distinctive marking i.e. optical fibre cable at 1 metre intervals.

5.13.2 The sub duct shall be supported in intermediate manholes by means of cable supporting brackets mounted against the wall of the manhole. Should the sub duct be situated in a vulnerable position, e.g. persons entering the manhole, it must be protected by steel ducting.

5.13.3 Cutting of the sub duct in a manhole must be avoided except in cases where the hauling length is excessive or a joint/splice position falls within a manhole. The sub duct must be jointed by means of a coupling and heat shrinkable sleeve after the completion of the hauling process.

5.13.4 A 7 mm nylon ski-rope must be used to haul the cable through the sub duct or underground HDPE conduit.

5.13.5 Blowing in of the optical fibre cable will be allowed on approval of the Project Manager.
5.13.6 A mechanical fuse with a fusing strength of ±1 000 Newtons must be inserted between the hauling rope and the cable to prevent stress on the cable, which can damage the fibres. These fuses are equipped with heavy-duty swivels, which will prevent the cable from twisting.

5.13.7 The mechanical fuse must be secured to the cables and hauling rope by means of hose grips or other approved device. A swivel must always be inserted between the hauling rope and cable to avoid twisting.

5.13.8 When hauling long lengths of cable (±500 metres) the figure-of-eight technique shall be used at least once at each 500 metre interval.

5.13.9 It is recommended that a cable lubricant similar to Polywater be used in sub ducts during the hauling process.

5.13.10 Care must be taken not to bend or kink the cable whilst hauling in.

5.13.11 Communications between persons at the cable drum, intermediate points and the hauling team is absolutely essential and must be used at all times.

5.13.12 If a joint/splice position falls within a manhole, 10 metres of cable slack must be left on either end to enable the splicing team to do the splicing outside the manhole (preferably in a vehicle or shelter). The hauling team must cut off the first 3 metres of the hauled length. A heat shrinkable cap must be shrunk over both ends of the cable.

5.13.13 The splice housing and cable slack must be fixed to the manhole wall in an approved manner.

5.13.14 The mechanical fuse must be examined after every few hauls. If the fuse has worn more than half way it must be replaced with special copper fuse wire.

6. SAFETY PRECAUTIONS

6.1 Due to the proximity of live wires the installer must ensure that his employees installing the cable on the masts obtain a Category C certificate from Transnet Freight Rail, Project Manager before any work can be carried out on the masts.

6.2 The contractor's employees must be trained for competence and understanding of the basic electrical safety requirements. The certificate obtained will not be transferable. The cost of the training will be borne by the Installer or Transnet Freight Rail as stipulated in the contract document.

6.3 The installer and his employees installing the cable must be fully conversant with the Electrical Safety Instructions and the Transnet specification E.7/1 and E.4E.
6.4 No work within 900 mm from live DC equipment and 11 kV AC transmission lines, and 1200 mm from live AC equipment. Preferably this clearance should be as great as possible.

6.5 In all instances where the safety of workmen is jeopardised, electrical and/or track occupations must be requested. Transnet Freight Rail, Project Manager will arrange these occupations. Notification is however required four (4) weeks in advance.

6.6 Under bridges where live cross span wires are involved and at make off masts and where the live conductors approach the optical fibre cable very closely, a standard warning board must be fitted. Electrical personnel must be approached to arrange for a work permit to fit the cable and warning boards.

6.7 No attempt must be made to install the cable in windy conditions, especially when the sag (before tensioning) is blown in the direction of the track. Supervisors must use their discretion in this regard.

6.8 Tenderers must note that no metal ladders will be allowed but only wooden or fibreglass ladders.

6.9 Tenderers must note that the AC bracket installation tool (stick) may not be used in wet or rainy conditions.

6.10 Hard hats, protective clothing and safety belts must be worn whilst working on masts and other structures.

6.11 Optical fibres are extremely thin and can easily penetrate skin and eyes. Any off cuts or bare pieces of fibre must be properly disposed of. Optical fibres are categorised as hazardous materials and require special disposal measures.

6.12 Care must be taken when testing as the laser in test equipment produces an invisible light, which can cause permanent eye damage. All fibres should be treated as "live".

6.13 All personnel involved in the installation and testing must be made aware of the above safety aspects.

6.14 A Health and Safety Agreement shall be entered into between Transnet Freight Rail and the successful tenderer.

6.15 The contractor must comply with the "Standard Safety Work Procedures for the Installation of Optical Fibre Cable" (latest version). This document must also be attached to the Health and Safety Agreement.

6.16 The Contractor must comply with the "Protection of Construction Workers on or near Railway Lines". This document must be read in conjunction with this specification.
7. SPLICING, TERMINATION AND TESTING

7.1 Splicing can commence after approval is obtained from the Transnet Freight Rail, Project Manager.

7.2 All splicing and testing must be done inside a vehicle or a dust free shelter. Cleanliness is absolutely essential to make satisfactory splices.

7.3 A competent team using an optical fibre fusion splicer in compliance with specification No. SPC-00568 (with the stipulated software) must carry out fusion splicing and terminations. Tenderers must state the competence and experience of the personnel envisaged to do the fusion splicing. Splicing must be carried out in accordance with procedures and instructions as stipulated by the cable and splice housing manufacturers.

7.4 The splicing team must be suitably equipped with all the necessary materials, accessories and equipment to carry out the fusion splicing. The splice losses expected during installation must be similar to those obtained during the drum tests (PRC-00107 Pre-test Quality of Optical Fibres on Drums).

7.5 Splicing must comply with the splice housing manufacturer's specifications i.e. securing of the strength member and Kevlar, slack inside the splice closure and protection of the individual splices. Refer drawing TC 00174.

7.6 The individual fibres must be numbered or easily identified inside the splice organiser. The up and down ends of the cable and loose tubes must be identified.

7.7 On completion of the individual splices the organiser must be placed in an approved hermetically sealed splice housing. Transnet Freight Rail may supply these splice housings under a supply agreement with an approved manufacturer as specified in the main specification.

7.8 The splicer must ensure that the silica-gel packet, supplied with the dome closure, be opened and inserted in the dome closure before closure of the dome.

7.9 The splice housing must be fixed to the mast and numbered in an approved manner with sufficient cable slack.

7.10 Termination of the fibres must be carried out on approved connectorised pigtails and termination cabinets as specified in the Main Specification. Transnet Freight Rail may supply these items under a supply agreement with an approved manufacturer specified in the main specification.

7.11 After the complete installation each individual fibre must be tested from both fibre ends in accordance with procedure No. PRC-00106 (Post Installation Test of Optical fibre Cable). Testing must be carried out in conjunction with Projects personnel from Transnet Freight Rail. The test to be conducted shall be:
7.11.1 Fibre continuity.

7.11.2 Overall attenuation (loss) - tested by means of optical power source and power meter.

7.11.3 Splice Loss - for each individual splice.

7.11.4 Attenuation profile - tested by means of OTDR.

7.11.5 The Project Manager reserves the right to carry out individual tests should this be required on any length of installed fibre during any phase of the construction. The installer shall be required to witness these tests.

7.11.6 Graphic print outs or software files must be submitted to the Project Manager for his scrutiny and forwarded for approval by QAD.

8. FINAL ACCEPTANCE

8.1 Each fibre must be tested before it is introduced as directed by Transnet Freight Rail's Quality Assurance department. The purpose of these tests is to ensure that the fibres are acceptable for use in Transnet Freight Rail network.

8.2 An approved optical time domain reflectometer (OTDR) in compliance with specification No. SPC-00033, with the stipulated software must be used for the testing and measuring of the fibres. Records of all the results must be kept for reference purposes.

8.3 Tests must be carried out at both 1310 nm and 1550 nm wavelengths. These test results must be forwarded to QAD for scrutiny and approval.
ANNEXURE 2 : GENERAL SUSPENSION POSITIONS OF OPTICAL FIBRE CABLE

NOTE: SAFE WORKING DISTANCES MUST BE MAINTAINED AS PER LATEST SPOORNET / METRO RAIL ELECTRICAL SAFETY INSTRUCTIONS.

GENERAL SUSPENSION POSITIONS OF OPTICAL FIBRE CABLE (OFC) ON OVERHEAD TRACK STRUCTURES

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