

1.0 SCHEME FOR OPTICAL FIBRE SYSTEM WITH 6 QUAD TELECOM. CABLE

- 1.1 The Scheme envisages the Supply, laying, testing and commissioning of Optical Fibre Communication system along with 6 quad telecom. Cable for providing communication facilities as per channeling plan along with the Technical specifications given in the tender document.
- 1.2 Optical Fiber Cable with 24 Fibers is required to be provided in the section under consideration. Two Pairs of fibers shall be derived at every station. One pair of fiber shall be working as STM-1 (**short haul**) and the other pair shall be a ready spare duly terminated on pig tails with FC/LC connector. The remaining fibers (fiber no. 5 to 24) shall be spliced through in Fiber Distribution Management System at short haul locations. The third pair shall be for back up stream working on STM-1 (**long haul**) and fourth pair shall be backup spare. Third and fourth pairs shall be derived at every Long haul locations (40-50 Kms.) and the remaining fibers (fiber no. 9 to 24) shall be terminated in Fiber Distribution Management System. To facilitate testing, the remaining terminated fibers shall however, be made through with fiber jumper cables for end to end continuity.
- 1.3 The optical Repeaters/Drop & Insert equipments are required to be provided at every Railway station to cater for its communication requirements. The 30 Channel Drop and Insert MUX shall be equipped as per Railways requirement to be provided at every Station. The Omnibus Control Circuits remote control, emergency and point to point circuits shall be derived as per the channeling plan at OFC repeater at every station. These circuits shall be extended to the user through PIJF or 6 Quad Telecom. Cable by using DTMF 4 Wire or 2 Wire Way Station Control equipments.
- 1.4 Remote monitoring & network management system shall be provided for OFC Systems & MUX etc. to monitor alarms & facilitate changes up to VF channel level remotely from Control station.
- 1.5 The OFC system shall work on 48 VDC supply, and 230 V AC/48 V DC float charger along with Lead Acid / Low maintenance / maintenance free Battery of adequate capacity shall be provided.
- 1.6 6 quad Telecom. Cable 0.9mm (IRS-TC-30/97 or with latest amendments) shall be provided at a constant & continuous separation all along the route with Optical Fiber Cable. This shall cater for:-
 - a) Block working between two adjoining stations.
 - b) Communication to LC gates & pump houses in the midsection from the adjacent station.
 - c) Emergency communication with sockets at every Km. in the block section.
The emergency communication circuit shall be dovetailed with OFC system at VF level at every drop insert location at the station for communication with the controller in control office.
- 1.7 Induced Voltage in unscreened cable laid close to the track/OHE is 87.5 V/Km. **Therefore the armour of OFC Cable shall be cut open (50 mm) at every 1.6 Km. and the armour cut be protected with heat shrink sleeve, to limit the induced voltage to 150 V.**

2.0 EXTENSION OF CIRCUITS FROM OFC EQUIPMENT ROOM ;

- 2.1 The communications from the optical fibre repeaters to station master, electrical locations and other users shall be extended on PIJF cable (screening factor 0.4) up to 1.5 Km and 6 quad telecom cable (screening factor 0.16) unloaded up to 7.5 Kms without isolation transformers. These lengths are recommended to limit the induced voltage to 60V.
- 2.2 With the permitted induced voltage of 150 V, taking special precautions the 6 quad cable can be used up to 19 Kms, when terminated on isolation transformers 470 : 1120 ohms at either end.
- 2.3 Individual pairs will be wired from OFC hut to subscriber premises.
- 2.4 In big yards where numbers of tapings are more, 6 quad cable may be laid and tapings derived through 470:1120 isolation transformers using heat shrinkable joints.
- 2.5 The psophometric noise up to 2mV (S/N Ratio 48 dB) due to thyristerisation, when two thyrister locomotives are in a feeding section, is acceptable. The sustainable length of Quad cable armoured, as per IRS-30/97 is 11 Kms. Balancing of 6 quad cable may be necessary for longer lengths from noise considerations.
- 2.6 The Intermediate Level Crossing gates will be provided with Telephone, on ½ quad of 6 quad cable. Isolation transformer is not considered necessary up to 7.5 Kms. For LC gate at a distance more than 7.5 Kms isolation transformer shall be necessary. As magneto telephones ring does not pass through isolation transformers, VF telephone may be provided for LC gate beyond 7.5 Kms.

3.0 COMMUNICATION AT INTERMEDIATE LOCATION, GATE / BLOCK / EMERGENCY :

- 3.1 6 quad 0.9 mm copper conductor polyethylene insulated jelly filled cable shall be laid along with the OFC cable in same trench at constant & continuous separation to provide emergency communication, intermediate Level crossing gate and block working between stations.
- 3.2 The quad allocation on 6 quad cable with OFC shall be typically as under:
 - QUAD No. 1 : ½ quad for Block telephone
 - : ½ quad for block bell circuit.
 - QUAD No. 2 : quad spare for Block circuit.
 - QUAD No. 3 : Emergency communication
 - QUAD No. 4 : ½ quad – Gate Telephone.
 - : ½ quad - For Block Proving by Axle Counter (BPAC).
 - QUAD No. 5 : For Block Proving Axle Counter (BPAC).
 - QUAD No. 6 : Train Actuated Warning System (TAWS)
- 3.3 This cable will be earthed at both end stations. The armoury and sheath continuity would be maintained at the joints similar to RE main telecom cable. Quad cable need not loaded

4.0 EMERGENCY COMMUNICATION :

Emergency circuit is fed from both the side end stations. Isolation transformer (470:600 ohms) shall be used at both terminating station. The Emergency socket shall be derived through derivation transformers (470:1120 ohms) using PIJF derivation cable between main quad cable to Emergency socket.

5.0 COMMUNICATION TO SP/SSP/FP :

- 5.1 6 quad cable as per IRS:TC-30/96 or IRS:TC-30/97 can sustain the communication up to 11 Kms length and this length is also within induced voltage limit up to 150 V.
- 5.2 PIJF cable as per IRS:TC-41/90 with balancing factor of 53 db, screening factor at 800 Hz of 0.4 will develop 2 mv noise voltage in cable length up to 1.5 Kms. For limiting induced voltage to 60v, 1.5 Kms length is also found sufficient.
- 5.3 SP/SSP/FP which are within 1.5 Kms distance from nearest station, RC and TPC communication will be provided in 10 pair PIJF cable as per IRS:TC-41/90 from the nearest optical drop insert point.



SECTION III / CHAPTER II

ROUTE SURVEY FOR OPTICAL FIBRE CABLE

Para No.	Subject.
1	Preliminary Cable Route Survey.
2	Points to be covered in Preliminary Survey.
3	Proposed Cable Route Plan.
4	—Information in Cable Route Plan.
5	Detailed Cable Route Survey.
6	Main Item of Work.
7	Finalisation of Cable Route Plan.
8	Finalisation of Channeling Plan & Tapping diag.
9	Isolated Telephone Circuits.
10	Length of Optical Fiber Cable & 6 quad cable.
11	Size and Length of Derivation Cable and Route Charts.
12	Preparation of Joint Schedules.
13	Materials required for Protective Work.
14	Communication arrangement in Major Yard & Stations.
15	Special Problem of the Section.
16	Siting of Cable Hut (OFC Indoor equipment building).
17	Materials required for survey work.

CHAPTER II

ROUTE SURVEY FOR OPTICAL FIBRE CABLE AND QUAD TELECOM CABLE

1 PRELIMINARY CABLE ROUTE SURVEY:-

The Objective of this survey is:

- a) Designing and finalizing drawing for the proposed route of the optic fiber cable.
- b) Planning Location of crossing tracks, over bridges, culverts etc.
- c) Deciding the cable hut/drop and insert location under the system design.
- d) Deciding system for communication to L.C. gates, Block working, Emergency communication etc.
- e) Planning for extending control communication from electrical location etc.

2 POINTS TO BE COVERED UNDER THE PRELIMINARY SURVEY FOR CABLE ROUTE:

- 2.1 Avoiding underground structures, signaling cable, power cables and pipe lines etc.
- 2.2 Avoid rodent/termite infested or infected side of the alignment.
- 2.3 Off set of the cable trench from the central line of the track such as having burrows.
- 2.4 Avoiding proximity to chemical, paper and such other industries which discharge chemically active affluent.
- 2.5 Avoiding areas prone to water logging.
- 2.6 Avoiding large rock cutting/ thick jungles and areas difficult to approach etc.
- 2.7 Avoid the side of the alignment which is likely to be affected due to addition/alteration of earth work/super structures (such as doubling, shifting of alignment of the existing track etc.). For this, cable route should be discussed with construction and doubling organization.
- 2.8 The orientation of the route (left or right side of the track in the sections) to be decided on following:-

1. That side of main line which is away from coastal side, other cables such as signaling and power.

2. Side which is likely to involve least track crossings and likely to be ————— more convenient for crossing the track, bridges culverts etc.

- 2.9 Figure out and scale crossing of roads, tracks etc.
- 2.10 Scale out proposed arrangement of crossing bridges, culverts etc. out of the many alternative available.
- 2.11 Assess special problems, if any, of the section such as undulating surfaces, long cutting, tunnels etc.
- 2.12 Scale out the cable entry/exit arrangement at the cable huts of drop insert locations. Avoid built up areas including those area where buildings etc are likely to come up in future.
- 2.13 With engineering drawing already in hand, verify pathways/pedestrian crossing and other lateral clearances.
- 2.14 Scale out the special work required if any and the manner of the cable route in approach of the existing bridges locations.
- 2.15 Identify if any special lengths of cable are required to avoid joints on bridges/culverts etc.
- 2.16 For the straight runs as far as possible a separation of 10 Meter should be kept from the nearest track. This is as per CCITT recommendation K.8.
- 2.17 Instructions which are likely to affect traction installations are given below:
- (i) When the cable is laid at a depth greater than 0.5m, a minimum distance of 3m shall be maintained between the cable and the nearest edge of the traction mast foundation. If it is difficult to maintain the distance of 3m, the lateral distance of cable from the nearest edge of the traction mast foundation can be reduced upto 0.5m provided that the depth of the cable does not exceed 0.5m and the cable shall be laid in concrete pipe of 150mm dia for a distance of 3m on either side from the mast. These precautions are necessary to avoid damage to the cable in the event of the failure of an overhead insulator.
 - (ii) In the vicinity of traction substation and feeding posts, the cable shall be laid at least 1m away from any metallic part of the OHE and other equipment at the sub-station/feeding post as well as from the substation earthing system. In addition, the cables shall be laid in concrete pipes for a length of 300m in UP direction and 300m in DN direction from the feeding post. As far as possible the cable shall be laid on the side of the track opposite to the feeding post.
 - (iii) In the vicinity of switching stations, the cable shall be laid in the ground at least 1m away from any metallic structure of the switching station and at least 5m away from the station earthing system. The distance of 5m can be reduced to 1m provided the cable are laid in concrete pipes.
 - (iv) Where an independent earth is provided for an OHE mast / structure i.e. where the mast is connected to a separate earth instead of being connected to rail, the cables shall be laid atleast one metre away from the earth.
 - (v) Where there are traction mast / structures along the cable route, the cable shall be laid in the trench which should be as far as possible but not less than 5.75m from the centre of the track.
 - (vi) Where cables have to cross the track, concrete or GI pipes must be used for crossing. The use of GI pipes or any form of metallic pipes is prohibited within a distance of 300m from the feeding

post. Similarly galvanized iron metallic pipes are prohibited in close proximity to switching station earth or traction masts.

- 2.18 Locations of traction sub stations, feeding posts and other OHE switching posts.

3 PROPOSED CABLE ROUTE PLAN.

Based on above survey, the cable route plan should be prepared:

- 3.1 For the preparation of the main cable and 6 quad Telecom cable route plan, "5 km charts" should be prepared which covers a length of 3 km of the route. The horizontal scale is 10 cm = 1 km.
- 3.1.1 Based on the OHE location survey plan, the locations of ASM's office, cabins, OHE Switching posts, etc. should be marked on the charts. The name of the location should be put in the 'LOC' column and the chainage in the 'CH' column. At every 10 cm. the km. post number should be written and its exact equivalent chainage as per OHE Survey plan entered in the 'CH' column. The length of the cable required. The name of station should be shown against the location of the Station Master's Office.
- 3.1.2 Based on the OHE Survey, the serial number and the length of culverts, bridges and level crossing shall be marked on the 'Track Line' of the cable route plan. The survey party should be supplied with prints of '5 km charts' with the above details entered for enabling them to mark the route, and other details after surveying.
- 3.1.3 Optic Fibre cable & 6 quad Telecom cable route plan (5 Km. charts) with horizontal scale as 1 Km = 10 cm. The approved OHE locations, ASM's office, cabin etc are to be marked on the chart.
- 3.2 Drawings of the laying of the cable in the special terrain viz. station yards, approaches of cable huts, long bridges, culverts etc. are to be made as 1 Km chart. (Scale 1 Km = 50 cm) to show the details.
- 3.3 The name of the location should be put in the 'LOC' column and the chainage in the 'CH' column. At every 10 cm. the Km. post number should be written and its exact equivalent chainage as per OHE Survey plan entered in the 'CH' column. The equivalent chainage is required for working out the length of the main cable required. The name of station should be shown against the location of the Station Master's Office.
- 3.4 Based on the OHE Survey, the serial number and the length of culverts, bridges and level crossings should be marked on the 'Track Line' of the cable route plan. The survey party should be supplied with prints of "5 Km. charts" with the above details entered for enabling them to mark the route, and other details after surveying.
- 3.5 The actual measurement of the separation distance from the central line of the track (the adjacent main line) is initially to be shown keeping the minimum clearances from OHE masts mentioned above. This is to be compiled on the 5 Km. charts.
- 3.6 Based on the requirement of various types of circuits proposed channeling plan on OFC and 6 quad cable is prepared.

- 3.7 The requirement of tapings of different control circuits are assessed based on the existing communication arrangement in consultation with open line Rly. users and a tentative tapping chart prepared.
- 3.8 All the plans and drawings shall be neatly prepared using Auto CAD & plotter etc. The drawings shall be in A3 or A4 size & suitably filed for ease of handling.

4. INFORMATION IN CABLE ROUTE PLAN

The cable route plan shall contain following information:-

- 4.1 Whether the cable route is on the up or down side of the Railway Tracks.
- 4.2 Approximate locations and lengths where the cable shall be laid in steel pipes and G. S. Troughs, and under the bed on culverts.
- 4.3 Locations of sections where the cable shall be covered by burnt bricks positioned breadth wise @ eight – nine bricks / meter (average).
- 4.4 Location of track crossing and the number of tracks to be crossed.
- 4.5 Location of road crossing and the no. of RCC pipes to be provided.
- 4.6 Locations and length for protection of cable in rocky area and platform cutting etc.
- 4.7 Approximate locations of derivation joints LC Gate or emergency socket posts will be provided on 6 quad cable.
- 4.8 The size length and route of derivation/PIJF cables from OFC cable hut to various subscriber points.

5 DETAILED CABLE ROUTE SURVEY

The purpose of the detailed survey is to undertake the closer study of the various existing telecommunication facilities, to [workoutwork out](#) the exact requirement of the Optical Fibre cable 6 quad and derivation/PIJF cable and materials required for different items of work, finalise all the drawings and site plans required for the execution of work as also to examine the details collected during preliminary survey and to effect necessary changes/modification, if any.

6 MATERIALS REQUIRED FOR PROTECTIVE WORKS

- 6.1.1 For building, masonry platform, culverts, crossing traction, level crossing and road etc. special protection for cable is required.
- 6.1.2 Actual measurement shall be made for length for which special protection is necessary and requirement of materials for protective works should be worked out. The requirement of materials based on actual measurement should be shown in the cable route plan at the appropriate place.

6.2 Special length for long girder bridge

For long girder bridges, special length of cable may be required. this is to avoid the location of a joint on such bridges, on slope of leading to bridge, abutments and on top of deep cutting etc. These details regarding the approaches to bridges shall be worked out.

- 6.3 The OFC shall be laid in HDPE pipe by pulling / blowing method at a depth as mentioned in schedule of work and no special protection is required in a plain normal territory except provision of warning bricks over the cables within the station limit as defined in para 3.5 of section III, chapter III. In all other territory methods for different types of protective works are specified in section III, chapter III.
- 6.4 Actual measurement should be made for the length for which special protection is necessary and the requirement of materials for the protective works should be worked out. The requirement of materials based on the actual measurement should be shown in the cable route plan at the appropriate place.

7 SPECIAL PROBLEMS OF THE SECTION

- 7.1 Certain Sections may present special problems such as presence of chemically active soils, marshy areas, deep cuttings in the rocky areas, requirement of specially constructed platforms for distribution of cable drums along a high embankment etc.
- 7.2 Approaches to large bridges may also present special problems due to high embankment as well as deep ravines.
- 7.3 At the junction points of electrified and non electrified areas, the cabling as also the linking arrangements of circuits from electrified to non electrified sections may also present optical problems.
- 7.4 The survey party should inspect and report to Dy.CSTE, such problems at the very outset so that suitable solutions can be worked out.

8 SITING OF CABLE HUT (OFC INDOOR EQUIPMENT BUILDING)

The site should be decided on the following consideration:-

- 8.1 As far as possible the cable hut buildings should be on the side of the tracks along which the cable route is proposed. Site in between tracks should be avoided.
- 8.2 For the reasons of security it should not be too far away from the Railway tracks. As far as possible it should be quite close to the station building / ASM Room.
- 8.3 One of the most important aspects while selecting the site is to see that a suitable approach route is available for the cable to enter and leave the cable hut buildings.
- 8.4 There should be sufficient area available near the building for the installation of earthing system. In certain locations this may require large areas so as to achieve the low resistance of the earthing system for which an electrode grid consisting of 30 or 40 rods at 5M spacing is to be installed or a large ring of earthing wire may have to be buried.
- 8.5 The site should not be selected in congested areas surrounded by staff quarters and other residential buildings.
- 8.6 As far as possible it should not be too close to any public crowding centre or a busy market etc.
- 8.7 Consideration should be given to avoid shifting of P&T overhead wires and other obstructions.
- 8.8 The site should be level and have road access.
- 8.9 Preference should be given for housing OFC cable hut in existing Microwave Repeaters, RE Repeaters & Telephone exchange buildings etc.
- 8.10 The cable hut should be provided at all the stations.
- 8.11 For Control Room location all the above requirements are to be met except that the location should be as part of the control office.

9 MATERIALS REQUIRED FOR SURVEY WORK:

The following are the essential requirements of materials for the survey party:

- i) Jeep.
- ii) Measuring tapes (Steel) 30 m & 50 m.

- iii) Road measure
- iv) Earth resistivity meter with accessories.
- v) White paint and brushes.
- vi) Torch Lights.
- vii) Spade, pick axe, and earth digging tools for soil samples.
- viii) A necessary reference drawing, maps, charts and registers etc. to record the details of survey.

10 HANDLING OF CABLE DRUMS & TRANSPORTATION OF OPTICAL FIBRE CABLE:

- 10.1 While unloading the drum out from a vehicle, the drum SHALL NOT BE DROPPED ON THE GROUND directly to avoid irreparable damage to cable due to impact

or

The drums shall be unloaded by the side of the Railway Track using either a crane or any other suitable means very carefully so as not to cause any damage to the cable. The drums at site shall be protected until they are laid.

or

Unload the drum with fork lift truck with forks long enough to take full width of drum so that the weight is borne by both the flanges. Same precautions as far loading are to be followed. During all stages of storage/use, it is essential that end of cable are effectively sealed by heat shrink end cap. Failure to it will make cable unfit for use.

- 10.2 On each drum there are two ends, A & B. The 'B' end of one cable length shall meet 'A' end of the next cable at a joint. The 'A' end shall be normally on the top unless indicated otherwise on a drum.
- 10.3 The drums shall always be kept upright, i.e. axle in parallel position to the ground. The drums shall not be set by jerks but shall be handled slowly and with care. The drums should not be damaged while moving the same.
- 10.4 The drums shall normally be unrolled at the same place and the cable carried by workmen near the trench. The drums, shall not be dragged in any case, but where drums of cable have to be moved, would always be rolled in the direction of the arrow, otherwise the coils tend to unwind and the cable may get battered. In case no direction arrow is marked on the drum remove several battens and determine the direction in

which the cable is coiled. The arrow should then be painted on the drum pointing in the opposite direction in which the upper cable end is coiled so that future handling of the cable drum is facilitated and then replace the battens carefully.

- 10.5 The drum should be properly mounted on jacks (or on a cable wheel) making sure that the spindle is large enough to carry the weight without bending and that it is laying horizontally in the bearings so as to prevent the drum creeping to one side or the other while it is rotating. Before attempting to pull off the cable, remove the end protection box attached to the flange of the drum and cut the security ropes so as to leave the cable end free to move.
- 10.6 If a portion of the cable only is taken out from the cable drum, the battens should be immediately replaced to prevent damage to the balance of the cable. This is important.
- 10.7 With armoured cables having Hessian serving it is possible under extreme conditions for the bitumen to soften and cause adjacent turns of the cable on the drum to stick to each other. In such cases, particular care must be taken to pull the cable of these drums very slowly and to free the cables carefully from the adjacent turns on the drums. Snatching of the cable to cause it to break away may result in kinks and damage, small size cable require care in this respect.
- 10.8 The use of steel bars between the bolt heads to 'jump' or turn the drum around is dangerous to staff and likely to damage the drums. A better method is to use two steel plates with grease between them by standing the drum on these greased plates, it can be easily elevated round to the desired position.
- 10.9 All care should be taken in handling cable drums with a view to ensure safety not only of the cables but also of the working party handling them. The man should not be allowed to brake the cable drum by standing in front but only from side.
- 10.10 **REWINDING AND REDRUMING OF CABLES.**
 - i. If for any reason it is found necessary to rewind a cable on a drum, cable drum with a proper barrel diameter not less than of the original drum should be chosen.
 - ii. The drums should be mounted on cable jacks during rewinding operations using proper size of spindles passed through the flange holes which will not buckle under the load. The cable should not be bent opposite to the set it is having already.
 - iii. In the redruming operations the full and empty drums should be so turned that the cable passes from the bottom of the original set as little as possible.
 - iv. Replace all the laggings on the cable drum.

11 DUCT / CABLE LAYING:

- 11.1 It is advisable to employ the same people at the same place or job while cable is being laid.
- 11.2 Before commencement of the laying, inspection of the trench and inspection of protection works should be carried out so as to ensure their conformity with the specification. The trench bottom should be clean, smooth and free of small stones. When the soil contains stones or pieces of rock and therefore, cannot be raddled, sieved earth about 10 cm thick should be used both for the bedding on which the cable being laid
- 11.3 The DUCT coil / cable drum should be brought as close to the cable trench as possible. It should be lifted with the aid of jacks.
- 11.4 It is customary for the mate to stand in a commanding position where he can view the entire route, and shout evenly timed calls to his men to pull. If there is proper synchronization between the mate's calls and the pulling by the men, the duct / cable will leave the drum without difficulty. It is important that the duct / cable should be pulled with steady and even pulls and there should not be unnecessarily twists /jerked or strained. On no account should a cable be allowed to twist or kink as this is likely to spring the armour and fracture the insulation and outer serving of the cable. When pulling cable around bends, one or two men should be stationed to give the cable the correct bend when it passes.
- 11.5 When the cable drums are exposed to great heat before laying, then danger exists that the individual coils and layers stick together in spite of the half overlay. Special attention should be paid to see that no buckling of the cable occurs while pulling the cable. A man should stand near the drum and loosen the cable carefully by hand and shout a warning whenever the cable cannot be loosened. Separation must be effected as close to the drum as possible as otherwise kinks may result. The rate of pulling should also be slow to prevent possible damage to cable that is being carried when the paying out stops. The drum should be kept in shade where possible.
- 11.6 While laying the duct / cable, employ adequate number of men such that the cable can be conveniently carried by them in both hands without stretched arms. The distance between any two persons carrying the duct / cable shall be from 2 to 10 metres depending upon weight that the maximum sag of the duct / cable between any two persons is not more than 0.5 metres.
- 11.7 While the laying work is in progress one man must continuously observe the duct / cable and feel along its length in order to determine indentations, holes or other damaged parts are apparent. Such damaged parts have to be protected immediately.
- 11.8 The conditions of the duct / cable shall be visually inspected throughout its length and in case any damage or defect is noticed, the trench shall ~~not be~~ filled up only after ensuring that the damage is not likely to affect the cable.
- 11.9 Tools and plants as per present practices followed in Railway should be adopted for laying of the duct / cable.

11.10 During duct /cable laying care must be taken not to twist duct in any direction. For this purpose, the survival (rotating hook) shall be attached between pulling line and pulling eye at the end of duct/cable so as to avoid any possible twist during pulling and laying of the cable.

11.11 Whenever duct is to be laid in the duct (GI pipe or RCC pipe), suitable lubricant on duct may be used to reduce friction and consequently the tension on the cable.

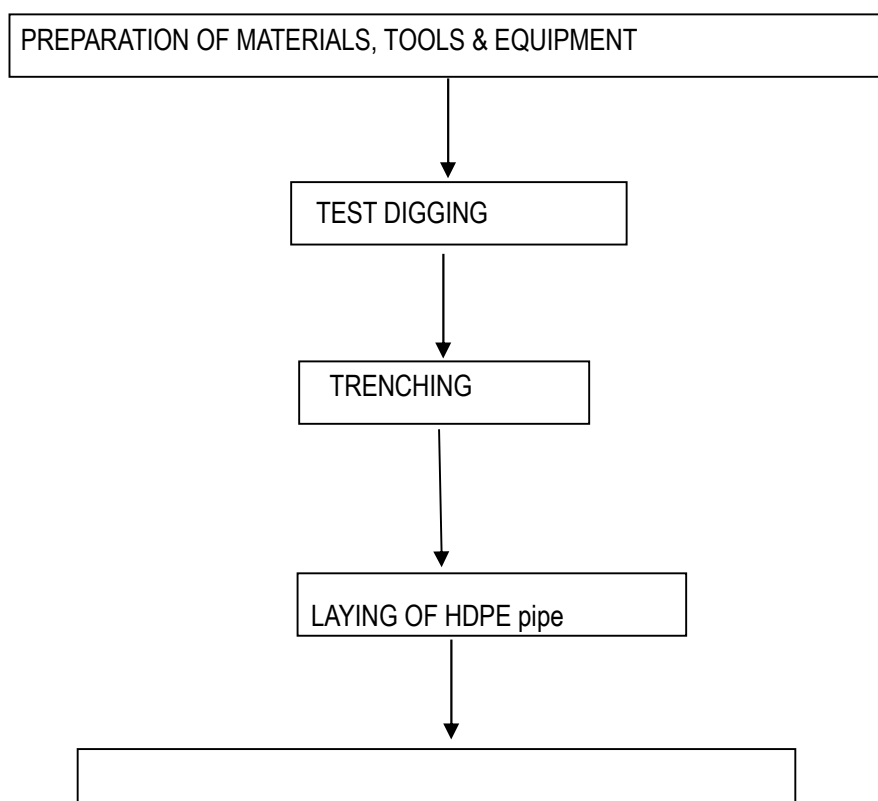
11.12 During duct laying care must be taken not to twist duct in any direction. For this purpose, the survival (rotating hook) shall be attached between pulling line and pulling eye at the end of duct so as to avoid any possible twist during pulling and laying of the cable.

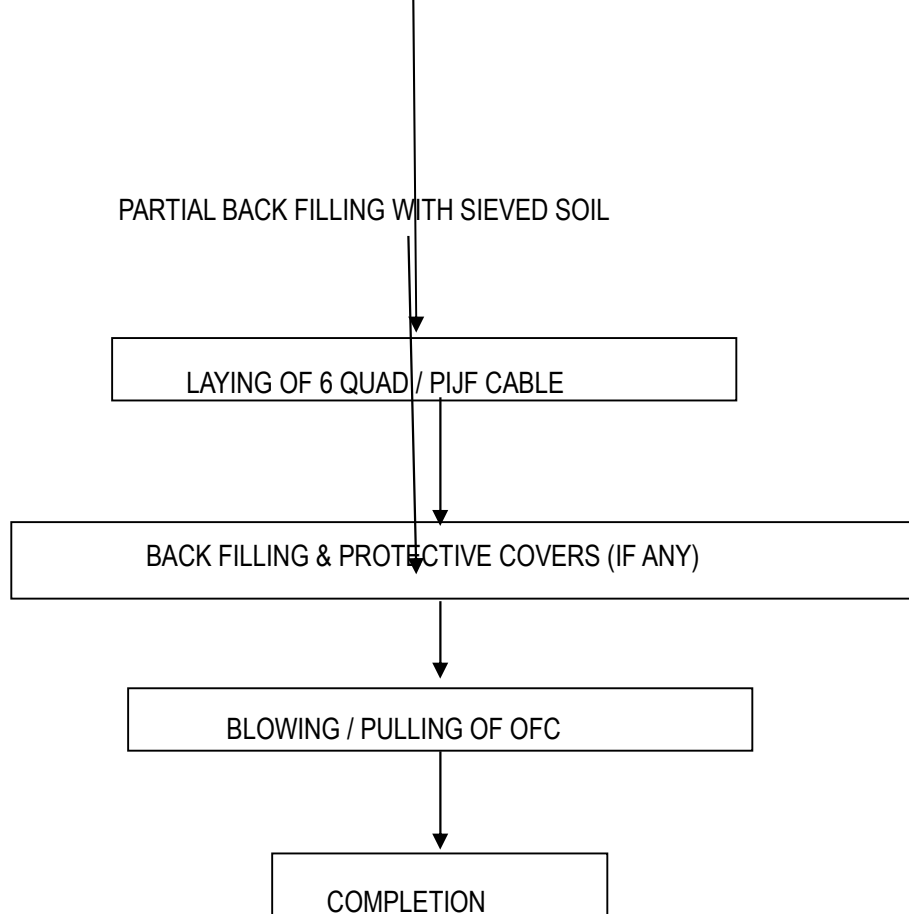
11.13 In case it is planned to lay the cable in duct by pulling the cable by using a winch; the duct should be provided with a nylon rope for pulling the cable.

12 LAYING OF OPTIC FIBRE CABLE IN TRENCHES :

12.1 WORK FLOW DIAGRAM

The major steps for cable laying in trenches are shown below. Before commencing each step, be sure to check how far the work of preceding step has been completed and how well the preparations for the work of subsequent step have been taken.





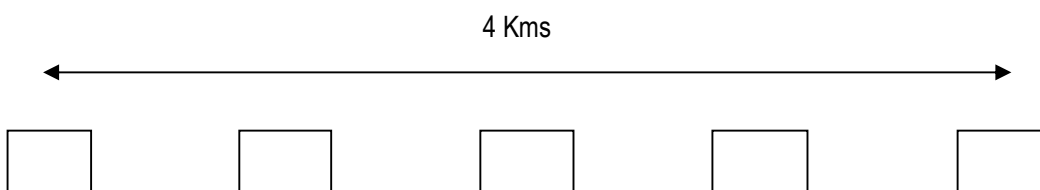
12.2 BLOWING OF OFC CABLE

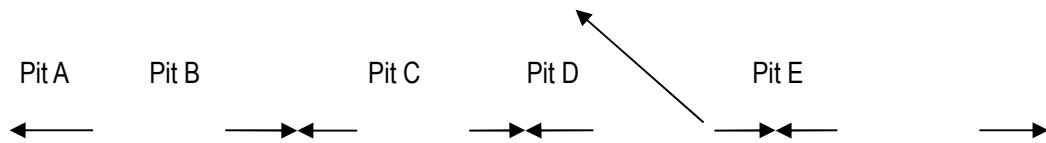
Optical fibre cable will be blown into pre-lubricated HDPE duct laid with the help of a compressor and blowing equipment. (With minimum pressure of 8 bar and maximum pressure of 12 bar with flow rate of minimum 10m³/minute).

The blowing method involves feeding of optical fibre cable into the duct with the help of consistent high pressure airflow, equally distributed along the entire cable throughout the duct.

The following steps may be adopted for safe blowing of OFC :

- i) Position the compressor and blowing machine at blowing pit C for location A & E shown below.





(Location of Compressor and blowing M/C)

- ii) Put the cable drum on cable wheel and blow the OFC towards pit A. A pusher equipment may be placed at B if required.
- iii) When the cable reaches pit A and coil of 10 – 15m of OFC should be kept in pit A. Then seal the duct end at A with the sealing plug.
- iv) Uncoil the cable on the drum in a figure of eight configuration and blow towards blowing pit E and coil of 10 – 15m of OFC should be kept in pit E.
- v) Since the cable will be available in length of 3 km and above, so the contractor has to plan the location of blowing pits before laying of HDPE duct. The contractor has to ensure that excess OFC is not coiled in the blowing pit and also optical fibre cable does not fall short of the location of blowing pit. The contractor has to match the cable drum length with the location of blowing pits, to ensure minimum cut length and wastage of OFC. To achieve the blowing of above shown strength, blowing can be carried out downhill, wherever possible.
- vi) HDPE ducts will be sealed with the help of cable sealing plugs after ———blowing of OFC into the duct at jointing pit locations.

19. Tools and plants as per present practice followed in Railway should be adopted for cable laying.

CHAPTER VI

JOINTING AND TERMINATION OF FIBRE OPTIC CABLE

1 TECHNIQUES FOR JOINTING OF FIBRE OPTIC CABLE:

1.1 Following types of techniques are used for splicing of fibres:-

a) Mechanical Splices

This aligns the axis of the two fibres to be joined and physically hold them together.

b) Fusion Splicing :- This is accomplished by applying localized heating (i.e. by electric arc or flame) at the interface between two butted, prealigned fibre ends, causing them to soften and fuse together.

1.2 Mechanical splicing can be used for temporary splicing of fibres or where fusion splicing is impractical or undesirable.

1.3 At all other location and during initial installation of fibre optic cable, fusion splicing should be adopted.

2 STRAIGHT JOINT FOR FIBRE OPTIC CABLE

2.1 There are various types of joint enclosures available in the market. The procedure for assembly of joint closure is described in the installation manual supplied with straight joint closure. This includes the following:

a) Material inside joint closure kit

b) Installation tools required

c) Detailed procedure for cable jointing.

d) Procedure for re-opening the closure.

2.2 The Optic Fibre straight through joint closure shall be as per RDSO specn. with latest modification. The joint shall be protected in brick chamber as per drawing no. RDSO/TCDO/COP -21.

2.3 However, generally, the following steps are involved for jointing of the cable:

- Preparation of cable for jointing
- Stripping/cutting the cable
- Preparation of Cable and joint closure for splicing
- Stripping and Cleaving of Fibres
- Fibre splicing
- Organizing fibres and Finishing joints
- Sealing of joint closure and
- Placing joint in pit

3 PREPARATION OF CABLE FOR JOINTING

- a) During laying, a minimum of 10 meter of cable of each end is coiled in the jointing pit to provide for jointing to be carried out at convenient location as well as spare length to be available for future use in case of failures.
- b) The pit size must be chosen carefully to ensure the length of the wall on which joint is mounted is greater than closure length plus twice the minimum bending radius of the cable. A pit length of 1.2 meter is sufficient for most of the cable and joint closures. Bracket to support the cable coil are also fixed on the wall of the pit.
- c) The cable is then coiled on to the pit wall in the same position as required after the joint is completed. The marking is done on all the loop so that it will be easier to install it later.

- d) The distance from the last centre to the end of the cable must be atleast 1.8 Metre. This is being the minimum to be stripped for preparation of joint.
- e) Sufficient cable at each end up to the jointing vehicle / enclosure is then uncoiled from the pit for jointing.

4 STRIPPING/CUTTING OF THE CABLE

- a) The cables are stripped of their outer and inner sheath with each sheath staggered approximately 10 mm from the one above it.
- b) Proper care must be taken when removing the inner sheath to ensure the fibres are not scratched or cut with the stripping knife or tool. To prevent this, it is best to only score the inner sheath twice on opposite side of the cable, rather than cutting completely through it. The two scores marking on either side of the cable are then stripped of the inner sheath by hand quite easily.
- c) The fibres are then removed from cable one by one and each fibre is cleaned individually using kerosene to remove the jelly.

5 PREPARATION OF CABLE JOINT CLOSURE FOR SPLICING

The type of preparation work performed on the cable prior to splicing differs on the type of joint closure and fibre organizer used. However, the following steps shall be usually common for different type of joint closure:-

- a) The strength member of each cable is jointed to each other and /or the central frame of the joint closure.
- b) The joint closure is assembled around the cable.
- c) The sealing compound or heat shrink sleeve is applied to the cables and closure, or prepared for application after splicing is complete.
- d) The fibres are protected (usually with plastic tubing) in their run from the cable core to fibre organizer trays (particularly if cable construction is slotted core type).
- e) Tags which identify the fibres no. are attached at suitable location on the fibres.
- f) Splice protectors are slipped over each fibre in readiness for placing over the bare fibre after splicing.

6 STRIPPING AND CLEAVING OF FIBRE

- a) Prior to splicing each fibre must have approximately 50 mm of its primary protective U.V. cured coating removed, using fibre stripper which are manufactured to fine tolerances and only score the coating without contacting the glass fibre.
- b) The bare fibre is then wiped with a lint free tissue doused with ethyl alcohol.
- c) Cleaving of fibre is then performed to obtain as close as possible to a perfect 90 degree face on the fibre.

7 SPLICING OF THE FIBRE

As discussed above there are two types of methods which can be used for fibre splicing. Some of basic steps for both the type are as under :-

A. FUSION SPLICING OF FIBRE

Some of the general steps with full automatic micro processor control splicing machine are as under :-

- a) Wash hands thoroughly prior to commencing this procedure.
- b) Dip the clean bare fibre in the beaker of ethyl alcohol of the ultrasonic cleaver. Switch on ultrasonic cleaver for 5-10 seconds (Some of the manufacturers does not prescribe the above cleaning).
- c) Place the bare fibre inside 'V' groove of splicing machine by opening clamp handle such that the end of fibre is app. 1 mm over the end of 'V' groove between the electrodes and end of the fibre being spliced and heat shrink protector inserted.
- d) Repeat the same procedure for other fibres, however, first insert heat shrink splice protector.
- e) Press the start button on the splice controller.
- f) The machine will pre fuse, set align both in 'X' and 'Y' direction and then finally fuse the fibre.
- g) Inspect the splice on monitor if provided on fusion splicing machine and assure no nicking, bulging is there and cores appears to be adequately aligned. If the splice does not visually look good repeat the above procedure.

- h) Slide the heat shrink protector over the splice and place in tube heater. Heat is competing when soft inner layer is seen to be 'oozing' out of the ends of outer layer of protector.
- i) Repeat (a) to (h) above for other fibres

B. MECHANICAL SPLICING OF FIBRE

In this there are two types of splicing system, one with precision alignment of fibre in 'V' groove and their ends are sealed with some index matching fluid and adhesive. The other uses ultrasonic light source for curing optical adhesive in addition to alignment etc.

The general steps involved for above are as under :-

- a) Stripping and cleaving of fibres is done as per clause 4 and 6 above.
- b) Remove protective end cap from mechanical splice and pull out vent tube.
- c) Inject adhesive as specified by supplier in to splice.
- d) Insert fibre until it butts against fibre end already bonded in place.
- e) Cure adhesive with UV light following exposure times as indicated by supplier, if required.
- f) Repeat the same procedure (a) to (h) above for all the fibres.

8 ORGANISING FIBRE AND FINISHING JOINTS

- a) After each fibre is spliced, the heat shrink protection sleeve must be slipped over the bare fibre before any handling of fibre take place, as uncoated fibres are very brittle and can not with stand small radius bends without breaking.
- b) The fibre is then organized in to its tray by coiling the fibres on each side of protection sleeve using the fully tray side to ensure the maximum radius possible for fibre coils.
- c) The tray are placed in the position.

- d) OTDR reading taken for all splices in this organized state and recorded on the test sheet to confirm that all fibres attenuation are within specification. This OTDR test confirms fibres were not subjected to excessive stress during the organising process.
- e) After this the joint can be closed with necessary sealing etc. and ready for placement in the pit.

9 PLACING OF COMPLETED JOINT IN PIT

- a) Joint is taken out from the vehicle and placed on the tarpaulin provided near the pit.
- b) The cable is laid on the ground, and looped accordingly to the marking done in beginning as mentioned in clause 3 (c) above. Tape these loops together at the top of the coil.
- c) The joint can now be permanently closed and sealed by heating heat shrinkable sleeve etc. However, before closing, silica gel to be kept inside for moisture protection.
- d) Now the joint closure is fixed to the bracket on the pit wall and pit is closed. Refer Drg. No. RDSO/TCDO/COP-21.

10 RE-OPENING OF THE JOINT

If required for attending to faults etc, manufacturers supply special kits for opening of joint and the steps to be followed. However, the general steps are as under :-

- a) Using suitable knife cut heat opening shrink sleeve longitudinally along its entire length.
- b) Do not damage the smaller heat shrink sleeve on the ends of joint.
- c) Apply heat to the cut sleeve until it begins to separate.
- d) Gently remove the cut sleeve from the joint. Now the joint can be opened.
- e) Protective sleeve / cover can be removed for attending to faults etc.

11 TERMINATION JOINT FOR FIBRE OPTIC CABLE

- 11.1 This joint is provided in the cable hut for terminating the outdoor fibre optic cable of both the sides, splicing through Fibres, connecting fibres to pig tails for connection to optical line terminal equipment etc.

- 11.2 The OFC cables shall be mounted on 19" standard rack provided in the cable hut as per para 4 of section III, chapter IV. (The armour of the OFC cable shall be cut before taking the cable in the rack). The cables shall be terminated on OFC termination box / Fibre Distribution Management System.

The Optic Fibre termination box / Fibre Distribution Management System (FDMS) as per RDSO specification with latest amendments shall be provided in each cable hut to terminate both optical fibre cables and deriving required pig tails. Two pairs of fibres shall be derived from either side cable for 2 Mb streams at every OFC cable hut through pigtails with FC/PC connectors. All the fibres from both sides shall be dropped at Repeaters and terminated on FDF / Fibre Distribution Management System through pig tails.

11.2.1 Jumper cable (10 Metre long)

The jumper cable shall be cut into two pigtails of 5 Metre long which is considered adequate since fibre termination box / Fibre Distribution Management System is mounted on rack itself. The material may be supplied as per latest specifications.

- 11.3 The procedure for installation of Fibre termination box / Fibre Distribution Management System depends upon the type of Fibre termination box or FDMS. The installation manual supplied with box gives the step by step procedure for installation. However, the general steps are as under:-

- Marking the cable
- Stripping/cutting the cable
- Treatment of tension member
- Fibre splicing
- Enclosing fibre
- Fixing strength member
- Closing the cover
- Fixing the termination box

- Fixing the cable

12 MARKING THE CABLE

- a) Determine the cable length upto the proposed location of termination box. It is also to be ensured that at least 10 meters of cable is coiled in the cable pit.
- b) Determine the cutting point and mark the cable.
- c) Determine the sheath peeling point and mark the cable.

13 CUTTING / STRIPPING THE CABLE

- a) Cut the cable as per marking.
- b) Remove the sheath from cable ends. During sheath stripping care should be taken not to damage the fibres.
- c) The length and the steps for various sheath by cutting shall be as per the instruction given in the manual.

14 GRIPPING THE CABLE

- a) wind PVC tape around the cable core just beside edge of the sheath.
- b) Insert the bushing inside sheath by cutting the cable sheath for about 25 mm.
- c) Place the sheath grip (lower half and upper half) and cut tighten it with the help of torque wrench.

15 FIXING OF TENSION MEMBER

- a) Mark the tension member for specified length and cut it.
- b) Clean the tension member thoroughly by Alcohol and cotton cloth.
- c) Fix tension member holder with the help of instant adhesive at the end of tension member.

16 FIBRE SPLICING

The procedure for splicing is same as described for straight joint closure in clause 5 above.

17 ENCLOSING FIBRES

- a) Set the fibre cassette on the base.
- b) Arrange excess length of fibre to make double figure of eight.
- c) Enclose the spliced fibre and its excess length carefully.
- d) Repeat the procedure for other fibres.
- e) After this, the box can be closed. However, a packet of silica gel may be placed in side for protection from entry of moisture.

18 MOUNTING OF TERMINATION BOX / FIBRE DISTRIBUTION MANAGEMENT SYSTEM

Termination box / FDMS shall be fixed on 19" rack.

- a) Place the termination box on 19"rack and tight the nuts to fix the base box.
- b) Put the covers.

19 FIXING THE CABLE

Secure the cable on at two places within one meter from termination box / FDMS keeping in view straight entry of cable in termination box.

20 ISOLATION OF ARMOUR OF OFC CABLE

The maximum continuous length of armour of OFC cable should not exceed 1.6 Kms. in order to keep the induced voltage within permissible limits. Where the continuous length of cable exceeds 1.6 Kms., a 50 mm cut shall be made in the armour after every 1.6 Kms. The exposed cable at the cut shall be covered by suitable heat shrink sleeve as per TEC specifications.

21 ACCEPTANCE TEST FOR FIBRE OPTIC CABLE

The procedure for testing of Fibre optic cable shall be jointly finalised by contractor with Engineer of the Railways. The parameters specified by manufacturer shall be taken as reference. The test shall be conducted at 1310nm and 1550nm from cable hut to cable hut once the splicing and termination joints are completed. A standard calculated loss table at 1310nm and at 1550 nm is placed in para 22. The length of cable (as per marking in cable & OTDR), loss in cable, average loss per Km, No of splices, splice loss, etc shall be recorded and jointly signed as per proforma given in para 22 below.

**

22 TEST PROTOCOL FOR OPTICAL FIBRE CABLE

SYSTEM TEST PROTOCOL OPTICAL FIBRE CABLE FIELD TEST

Route : _____ Date : _____
 Station: _____ No. of mid-section splices : _____
 Section: _____ Measured by : _____
 Length _____ Length as per meter _____
 (By OTDR): _____ Marking on cable sheath : _____

1) Optical Measurements (on Line) :

Measurement	<u>Fibre - number</u>	<u>Accepted Value</u>
	1, 2, 3, 24	

Fibre no. 1

Measurements →	<u>At 1310 nm with OTDR</u>	<u>At 1550 nm with OTDR</u>
	Total Attenuation	Total Attenuation
	<u>attenuation per Km.</u>	<u>attenuation per Km.</u>

Splice locations
as per OTDR

Splice loss in dB

Location of splice as
per actual laying

OHE Mast No.

A.

B.

C.

NOTE - ALSO ATTATCH OTDR RESULTS

2. VISUAL INSPECTION (ON LINE) :

2.1 S.No. of cable and length of each drum :

S.NO.	LENGTH
1. _____	_____M
2. _____	_____M
3. _____	_____M
4. _____	_____M
5. _____	_____M

2.2 Location of Isolation sleeve : 1. 2. 3.

()

()

Contractor's Representative

Railway Representative

OPTICAL LOSS VALUE AT 1310 nm

Cable length Km.	Basic fibre loss db/Km	Drum length in Km.	No. of splices	per splice Max Loss	Total splice Loss	Connector loss (in db)	Total theoretical loss	Standard Loss/Km
Basic value	0.36	3		0.02		0.6		
3	0.36	3	2	0.02	0.04	0.6	1.720	0.573
6	0.36	3	3	0.02	0.06	0.6	2.820	0.470
9	0.36	3	4	0.02	0.08	0.6	3.920	0.436
12	0.36	3	5	0.02	0.10	0.6	5.020	0.418
15	0.36	3	6	0.02	0.12	0.6	6.120	0.408
18	0.36	3	7	0.02	0.14	0.6	7.220	0.401
21	0.36	3	8	0.02	0.16	0.6	8.320	0.396
24	0.36	3	9	0.02	0.18	0.6	9.420	0.393
27	0.36	3	10	0.02	0.20	0.6	10.520	0.390
30	0.36	3	11	0.02	0.22	0.6	11.620	0.387
33	0.36	3	12	0.02	0.24	0.6	12.720	0.385
36	0.36	3	13	0.02	0.26	0.6	13.820	0.384
39	0.36	3	14	0.02	0.28	0.6	14.920	0.383
42	0.36	3	15	0.02	0.30	0.6	16.020	0.381
45	0.36	3	16	0.02	0.32	0.6	17.120	0.380
48	0.36	3	17	0.02	0.34	0.6	18.220	0.380
51	0.36	3	18	0.02	0.36	0.6	19.320	0.379
54	0.36	3	19	0.02	0.38	0.6	20.420	0.378
57	0.36	3	20	0.02	0.40	0.6	21.520	0.378
60	0.36	3	21	0.02	0.42	0.6	22.620	0.377
63	0.36	3	22	0.02	0.44	0.6	23.720	0.377
66	0.36	3	23	0.02	0.46	0.6	24.820	0.376
69	0.36	3	24	0.02	0.48	0.6	25.920	0.376
72	0.36	3	25	0.02	0.50	0.6	27.020	0.375

75	0.36	3	26	0.02	0.52	0.6	28.120	0.375
78	0.36	3	27	0.02	0.54	0.6	29.220	0.375
81	0.36	3	28	0.02	0.56	0.6	30.320	0.374
84	0.36	3	29	0.02	0.58	0.6	31.420	0.374
87	0.36	3	30	0.02	0.60	0.6	32.520	0.374
90	0.36	3	31	0.02	0.62	0.6	33.620	0.374
93	0.36	3	32	0.02	0.64	0.6	34.720	0.373
96	0.36	3	33	0.02	0.66	0.6	35.820	0.373
99	0.36	3	34	0.02	0.68	0.6	36.920	0.373

OPTICAL LOSS VALUE AT 1550 nm

Cable length Km.	Basic fibre loss db/Km	Drum length in Km.	No. of splices	per splice Max Loss	Total splice Loss	Connector loss (in db)	Total theoretical loss	Standard Loss/Km
Basic value	0.23	3		0.02		0.6		
3	0.23	3	2	0.02	0.04	0.6	1.330	0.443
6	0.23	3	3	0.02	0.06	0.6	2.040	0.340
9	0.23	3	4	0.02	0.08	0.6	2.750	0.306
12	0.23	3	5	0.02	0.10	0.6	3.460	0.288
15	0.23	3	6	0.02	0.12	0.6	4.170	0.278
18	0.23	3	7	0.02	0.14	0.6	4.880	0.271
21	0.23	3	8	0.02	0.16	0.6	5.590	0.266
24	0.23	3	9	0.02	0.18	0.6	6.300	0.263
27	0.23	3	10	0.02	0.20	0.6	7.010	0.260
30	0.23	3	11	0.02	0.22	0.6	7.720	0.257
33	0.23	3	12	0.02	0.24	0.6	8.430	0.255
36	0.23	3	13	0.02	0.26	0.6	9.140	0.254
39	0.23	3	14	0.02	0.28	0.6	9.850	0.253
42	0.23	3	15	0.02	0.30	0.6	10.560	0.251

45	0.23	3	16	0.02	0.32	0.6	11.270	0.250
48	0.23	3	17	0.02	0.34	0.6	11.980	0.250
51	0.23	3	18	0.02	0.36	0.6	12.690	0.249
54	0.23	3	19	0.02	0.38	0.6	13.400	0.248
57	0.23	3	20	0.02	0.40	0.6	14.110	0.248
60	0.23	3	21	0.02	0.42	0.6	14.820	0.247
63	0.23	3	22	0.02	0.44	0.6	15.530	0.247
66	0.23	3	23	0.02	0.46	0.6	16.240	0.246
69	0.23	3	24	0.02	0.48	0.6	16.950	0.246
72	0.23	3	25	0.02	0.50	0.6	17.660	0.245
75	0.23	3	26	0.02	0.52	0.6	18.370	0.245
78	0.23	3	27	0.02	0.54	0.6	19.080	0.245
81	0.23	3	28	0.02	0.56	0.6	19.790	0.244
84	0.23	3	29	0.02	0.58	0.6	20.500	0.244
87	0.23	3	30	0.02	0.60	0.6	21.210	0.244
90	0.23	3	31	0.02	0.62	0.6	21.920	0.244
93	0.23	3	32	0.02	0.64	0.6	22.630	0.243
96	0.23	3	33	0.02	0.66	0.6	23.340	0.243
99	0.23	3	34	0.02	0.68	0.6	24.050	0.243

23 Tools and equipments required for jointing and termination of fibre optic cable should be available as per manufacturers instructions/ manual.