

Technical Specifications

General Requirements:

1 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 Remote monitoring & network management system shall be provided for OFC Systems etc. to monitor alarms & facilitate changes up to VF channel level remotely from Control station.
- 1.3 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.
- 1.4 6 quad Telecom. Cable 0.9mm (IRS-TC-30/2005 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.
- 1.5 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 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 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 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.

4.0 COMMUNICATION TO SP/SSP/FP :

- 4.1 6 quad cable as per IRS:TC-30/2005 can sustain the communication up to 11 Kms length and this length is also within induced voltage limit up to 150 V.
- 4.2 PIJF cable as per IRS:TC-41/90 with balancing factor of 53 db, screening factor at 800 Hz of
- 4.3 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.
- 4.4 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.

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.

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 work 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 MAIN ITEMS OF WORK

The following are the main items of work which should constitute the detailed survey;

- 6.1 Closely examining the proposed cable route and prepare cable route plans.
- 6.2 Siting of the cable hut (drop insert equipments) buildings, and the preparation of the site plans.

- 6.3 Siting and preparation of site plans for other buildings required for the execution of the work such as Telecom Depot at different stations.
- 6.4 Siting of areas for loading/unloading of cable drums and siding facilities for the EMTs (Engineering materials Trains) for the project.
- 6.5 Preparation of route charts for derivation, PIJF cables with the size and length of cable for each tapping & termination arrangement.
- 6.6 Estimating of requirement of special cable lengths of cables for long girder bridge.
- 6.7 Deciding locations of each joint and preparation of a joint schedule.
- 6.8 Deciding the number of OFC cable dropping.
- 6.9 Determining earth resistivity measurements for each cable section along the proposed cable route.
- 6.10 Working out the exact length of Optical Fibre Cable, 6 quad cable.
- 6.11 Working out the exact length of derivation, PIJF cable required.
- 6.12 Preparation of the material schedule required for different protective works.
- 6.13 Arranging isolated telephone circuits to be provided in the cable.
- 6.14 Investigation on special problems of the section and finding out proposed solution thereof.
- 6.15 Examination of Chemical composition of soil to see whether any special precautions are to be taken to protect cable from soil corrosion.

7 FINALISATION OF CABLE ROUTE PLAN :

The following are the guidelines for finalising the route and preparation of the cable route plan:

- 7.1 Prepare the “5 Km charts” as explained above and collect the latest copy of approved OHE survey plan to enter the relevant chainages and details in the “5 Km. charts”.
- 7.2 Actual measurement by 30 M steel tape or chain along the route is necessary only in case of important locations, to be termed as “special terrains”, for example, approach to repeater station/cable hut, long bridges, big yards, sharp diversions in the cable route from its parallel course along the main railway tracks due to obstruction, cuttings etc.
- 7.3 Inspect and decide the portions of route falling in category of “special terrains” stated in para 7.2 above, i.e. where actual longitudinal measurement is necessary.
- 7.4 The remaining portions of the route, i.e. other than the portion decided as “special terrain” as per para 7.2 above are to be termed as “straight runs”. Actual chaining along the route is not

necessary for such “straight runs” and these can be marked on the “5 Km. charts” by taking chainages from the OHE plan.

- 7.5 For the “straight runs” on the cable route as per para 7.4 above, an allowance of 3.5% of the drum length should be made for the contours, jointing etc. and each drum length should be considered to cover a route length of $0.965 \times \text{cable drum length}$.

The cable route should be started from a control office. Actual measurement along the route should be done by means of a 30 M steel tape for a few drum lengths upto a convenient point along the main line where from the distances along the route may be reckoned from the OHE Plan. A termination allowance of 5 M cable length inside the repeater station/cable hut building should be made, in addition to a length of about 10 M being kept in a pit just outside the building.

- 7.6 It should be ensured that both “special terrains” and “straight runs” should consist of full drum lengths, so that the position of joints (other than T-Joint) is fixed without difficulty in both cases.
- 7.7 Actual measurements of the separation distance from the centre line of the reference track (a reference track ‘Special terrains’). On ‘straight runs’ this measurement should be made where necessary. In case of ‘Special terrains’ the separation distance at some points on the route may also have to be reckoned from some other permanent structures depending upon the site conditions.
- 7.8 No OFC/Quad cable shall be laid close to existing track. It shall be laid close to Railway boundary at 1mtr. from Railway boundary to the extent possible to avoid any interference with future work (doubling etc). The deviation from this standard separation should be kept to the minimum and as soon as any obstruction has been negotiated, the route should again follow this standard separation distance. It is desirable from the point of view of calculating the induced voltage that the uniformity of separation is maintained for the maximum possible length of the main cable route.
- 7.9 Separation distance should be marked on the “straight runs” portion of the cable route plan (5 Km charts) at intervals of not more than 200 M . In addition, the separation distances at points of change in the cable route such as diversions, track crossings approach to bridges, culverts etc. should invariably be marked on the cable route plan in such a way as the intended cable route is located easily by other railway official/contractor. For “special terrain” the separation distance should be marked at as close intervals as is considered necessary depending on the site conditions.
- 7.10 The route should be decided by walking along the track. On long stretches of “straight runs” a push trolley moving slowly may be used. The trolley should be on the track closes to the proposed route.
- 7.11 Actual measurement should be made for the protective works required for the cable passing over the culverts, under tracks, over long girder bridges, arch bridges, level crossings, rocky areas, under the bed of culverts and near OHE switching posts etc.
- 7.12 Once the cables are laid, the actual length of cable as per the printed marking on the cable is required to be indicated at every km. of cable route, at diversions, crossings, approaches of bridges and joints for Optical Fibre cable and 6 quad cable. This is necessary for fault

localization subsequently the cable length from cable hut can be collaborated with OHE mast Nos.

- 7.13 Completion cable route plan should be finalized Block section by Block section as soon as the work is completed.

8 FINALISATION OF CHANNELLING PLAN & TAPPING DIAGRAM

- 8.1 The Survey Party should visit each location such as cabins, SM's offices, Loco Sheds, Pump Houses, Gate Lodge etc. and verify the details collected during the preliminary survey of all the existing telecommunication facilities, and additional telecommunication facilities to be provided due to RE such as tapings on Traction Power Control. Traction Loco Control, Remote Control and Emergency Control circuits.
- 8.2 For emergency control circuit, in addition to the general tapings to be provided at interval of every 1 Km., the details of tapings specifically required by the Electrical Department for their switching posts such as sub sectioning posts, sectioning posts, traction sub stations and isolator locations etc. should be collected well in time. The exact location of the various tapings on the emergency control should then be worked out taking into consideration the tapings to be essentially provided at specific locations for Electrical Engineering Department so as to ensure that the distance between the consecutive emergency socket posts does not exceeds one Km.
- 8.3 The position of each tapping should thus be finalized and a final tapping diagram prepared.

9 ISOLATED TELEPHONE CIRCUITS:

It is necessary that all telephone circuits such as isolated pump houses, quarry sites, gates lodges etc. are taken note of and provision made for transferring the overhead alignment into cables wherever considered necessary.

10 LENGTH OF OPTICAL FIBRE CABLE AND 6 QUAD CABLES

- 10.1 Cable entry in cabin and other building shall be as per RE/S&T/ALD/SK/495/2000
- 10.2 The cable length is worked out on following basis to arrive at the location of the straight joints:-
- a. Route length as per actual measurement plus contour allowances of 2.5%.
 - b. Extra length for track crossing including 2.5-meter loop on each side etc.
 - c. 10 meter extra length on Approach/crossing of the bridges and culverts on each side as per measurement in the detailed survey.
 - d. 10 meter of cable to be kept on either side of major steel bridges and 5 meters of cable on minor bridges (short bridges)
 - e. At every joint a loop of 10 meters on either side.
 - f. In cable hut a loop of 10 meters in the cable pit.

11 SIZE AND LENGTHS OF DERIVATION CABLES & ROUTE CHARTS

The Derivation cables are required to be laid from Cable Hut to ASM, Cabin, Depot, Electrical location, Supervisor residence etc. for extending control tapings. The plan & requirement of different sizes PIJF/derivation cables shall be suitably worked out. As far as possible derivation/PIJF cables shall be laid in the trenches for main telecom. cable and branched off at suitable locations.

12 PREPARATION OF JOINT SCHEDULES

- 12.1 The details of type and number of joints in main 6 Quad cable is required to be worked out based upon the location of Emergency Sockets, obligatory locations, L.C. Gates, Pump House etc. The typical drum length of 6 Quad Telecom. cable is one Km. and therefore it shall generally be possible to combine straight through and Emergency joints. V.F. Transformer (1 Quad/2T) 470:1120 shall be used for block circuits as well as V.F Circuits.
- 12.2 For long block sections/sidings (more than 15 Kms.) the cable is loaded and balanced, the loading shall be of 2 kms. section and alternate joints shall be loading/condenser joints at every km.
- 12.3 No isolation transformer is considered necessary for L.C. Gate/Pump house telephones upto a distance of 7.5 kms. on 6 Quad Telecom. Cable
- 12.4 For Optical Fibre cables, the requirement and location of splicing joints shall also be worked out.
- 12.5 The jointing schedule shall be made as straight line diagram indicating the locations of various joints with ref. to OHE mast Nos./chainage. The length of OFC & 6 Quad cable from leading cable hut shall be specifically indicated taking into account the factory printed markings on the cables.
- 12.6 The requirement of termination boxes for cables at various locations shall be worked out.

13 MATERIALS REQUIRED FOR PROTECTIVE WORKS

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

- 13.3 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.
- 13.4 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.

14 COMMUNICATION ARRANGEMENT IN MAJOR YARDS & STATIONS:

In big yard and major stations involving large number of Cabins/Depot/Tapping points, it may not be practicable to lay independent derivation cables for various locations. Therefore one main cable shall be laid to transverse in a zigzag way through the yard involving frequent tapping points. Lead sheath derivation, 6 quad or higher size PIJF cable may be laid for this purpose. The circuits should preferably be tapped through V.F. Transformers.

15 SPECIAL PROBLEMS OF THE SECTION

- 15.1 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.
- 15.2 Approaches to large bridges may also present special problems due to high embankment as well as deep ravines.
- 15.3 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.
- 15.4 The survey party should inspect and report to Dy.CSTE, such problems at the very outset so that suitable solutions can be worked out.

16 SITING OF CABLE HUT (OFC INDOOR EQUIPMENT BUILDING)

The site should be decided on the following consideration:-

- 16.1 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.
- 16.2 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.
- 16.3 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.
- 16.4 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.

- 16.5 The site should not be selected in congested areas surrounded by staff quarters and other residential buildings.
- 16.6 As far as possible it should not be too close to any public crowding centre or a busy market etc.
- 16.7 Consideration should be given to avoid shifting of P&T overhead wires and other obstructions.
- 16.8 The site should be level and have road access.
- 16.9 Preference should be given for housing OFC cable hut in existing Microwave Repeaters, RE Repeaters & Telephone exchange buildings etc.
- 16.10 The cable hut should be provided at all the stations.
- 16.11 For Control Room location all the above requirements are to be met except that the location should be as part of the control office.

17 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.

**TECHNCIAL SPECIFICATION AND INSTRUCTIONS FOR TRENCHING AND LAYING OF
UNDERGROUND TELECOMMUNICATION CABLE AND PROTECTIVE WORKS.**

Para No.	Subject.
1	Scope.
2	Supply of Tapping and Route Plan.
3	Instructions for excavation & back filling of Trenches.
4	Track Crossing.
5	Road Crossing.
6	Cable over Steel Girder Bridges.
7	Culverts and Arch Bridges.
8	Laying Cable in Solid and Rocky Soil.
9	Cables in Congested Residential areas and Marshy Areas.
10	Leading in of Main/Derivation Cable in Masonry buildings & Cabins.
11	Laying of Cable in Special Cases.
12	Handling of Cable Drums & Transportation of Optical Fiber Cable.
13	Cable Laying.
14	Cable Reserve.
15	Cable Marker.
16	Laying of Derivation Cable.
17	Tools Required for Trenching, Cable Laying and Filling.

TECHNICAL SPECIFICATION AND INSTRUCTIONS FOR TRENCHING AND LAYING OF UNDERGROUND TELECOMMUNICATION CABLE, AND SPECIAL PROTECTIVE WORKS

1 SCOPE:

This chapter deals with the specifications under which the various work for trenching & laying of underground telecommunication cables coming under the purview of the contract are to be executed by the contractor. During execution of work pertaining to this chapter, Railway will supply materials such as OFC, 6 quad, PIJF etc. as mentioned in preamble. All other materials required for protection works will be supplied by the contractor.

OFC shall normally be blown in HDPE/DUCT pipe by employing blowing machine. Pulling / drawing of OFC in HDPE/DUCT pipe shall be permitted only at those locations where blowing of OFC is either infeasible or extremely difficult due to abnormal condition / location of site. Contractor shall obtain prior permission of Railways engineer for pulling / drawing of OFC in pipe at such abnormal locations. In case, there is no provision of HDPE pipe in the contract for blowing of OFC, OFC shall be directly buried.

Laying of cable should be as per approved cable route plan. Before cable laying is permitted joint inspection of trench has to be carried out jointly by Railway and contractor's representative. Whenever the dimensions of cable trenches as mentioned in the tender document are not achievable fully due to certain condition then, payment will be made for the lesser dimension so achieved on pro-rata basis and decision of site engineer in this regard shall be final. The specific approval of the [Dy.CSTE/CN/UBL](#) of the work will be necessary for such locations. A Certificate (in the format given in Form-18 of tender document) has to be jointly signed by Railway representative and contractor's representative duly approved by [Dy.CSTE/CN/UBL](#) and kept in record.

2 SUPPLY OF TAPPING & ROUTE PLAN:

Cable Route plan, Tapping plan and jointing schedule for jointing of cable will be prepared and supplied by the contractor in consultation with the Engineer before the commencement of the work. This shall give a fairly accurate idea of the number & locations of the various tapings required on various circuits and the quantities and types of various equipments to be fixed, wired and commissioned. These shall be got approved from the Engineer.

Completion cable route plan should be finalized Block section by Block section as soon as the work is completed.

3 INSTRUCTIONS FOR EXCAVATION & BACK FILLING OF TRENCHES

- 3.1.1 After submission of proposed cable route plan to Divisional Authorities (Sr.DSTE, Sr.DEE, Sr.DEN etc) and after getting permission from them in writing, the representative of Engineer In-charge of the work will mark the route of the cable in white chalk or lime as per the tapping and route plan. The contractor shall be present at the time of marking and he shall furnish to the Engineer's representative required quantities of lime, rope, labour etc. for carrying out this work. The marking will be given on the track side of the trench at a distance approximately one meter away from the centre line of the trench. In the difficult terrains such as water logged areas, the position of the cable route will be specified by off sets from the centre line of the nearest track.

- 3.1.2 The contractor shall study the approved cable route plan and follow it meticulously to ensure the safety of the already laid railway cables, emergency sockets etc are not endangered.
- 3.1.3 The name of the contractor, his contact telephone number, the nature of the work shall be notified in Divisional Test-room by representative of Engineer in-charge of the work.
- 3.2 Trenches for Telecommunication cable shall be normally dug to a depth as specified in schedule of work. The width of the trench shall be adequate at the bottom to accommodate cables and their protection. Normally width at the bottom to be kept as per drawing mentioned in schedule of work. . In places where underground pipes, electric main etc. come in the way, trenches deeper than one meter shall be dug and R.C.C. pipe (150mm dia) shall be placed to protect the telecom cables..
- 3.3 Metalled, macadamized, concrete and stone paved roads shall also be cut to a depth as per drawing mentioned in schedule of work. The cable shall be laid through RCC pipe. The road surface shall be restored to original.
- 3.4 The bottom of the trench where HDPE/DUCT pipe is to be laid shall be thoroughly prepared and shall be free from any stones. The bottom of the trench shall be horizontal and shall in no case be undulating. When the trench bed changes from solid to soft surface or from the bridge to soft soil, tamped fill at the transition point shall be provided so that HDPE/DUCT pipe is not pressed against the edge of a hard surface.
- 3.5 At block stations and block huts brick covering is required to be provided in station limit (between Inner DN distant signal to Inner UP distant signal where two distant signals have been provided or between DN distant signal to UP distant signal where one distant signal has been provided or 1 km beyond home signal on either side where distant signals have not been provided) as per the approved 'Cable route plan' or as per the instructions by Engineer. The contractor shall arrange supply and distribution of a second class bricks of standard size at site along the excavated trenches and after uniformly covering the cable laid in the trenches by Stone-free sieved soil up to 150 mm height above Quad cable as per drawing in annexure 3.1, the contractor shall arrange to place the bricks flat and position them breadth wise so that on an average, eight to nine bricks shall be laid in one meter length.

NOTE:

Provision of bricks in the trenches shall be as mentioned in schedule of work. Location where bricks are to be laid shall be decided by Railway Engineer. In order to be certain that the full requirement of bricks has been arranged by the Contractor for placing on the top of the cable to be laid on any day, he shall arrange to spread the bricks side by side on the side of the trenches before the depth of the trenches are inspected by the Railways' representative

- 3.6 After laying of HDPE/DUCT pipe in the trench, the partial back filling of trenches shall be done as per drawing mentioned in schedule of work

After laying of 6Quad / PIJF derivation cables, rest of the back filling of trench shall be done by tamping and consolidating the excavated soil in layers of 15-20 cm at time. All the soil that is excavated shall be put back in the trench and care shall be taken in consolidation to ensure that the back filling does not suffer any shrinkage in monsoon. The left out earth, if any, within station limit has to be thrown out from Railway premises by the contractor at his own cost..

- 3.7 When the excavation is to be done between the tracks, between OHE foundation and track and near OHE foundation, it shall be done as per para 2.17 of Section III, Chapter II of this book, just before laying the cables and in the presence of the Engineer's representative.
- 3.8 Wherever the Engineer's representative considers it necessary to adopt shoring, the Contractor will be required to adopt shoring for which the Contractor shall have sufficient quantities of shoring material on hand as per CORE Drawing No. CORE/S&T/ALD/SK/573/04.
- 3.9 The excavation shall include excavation of trial holes clearing bushes and roots of trees along the trenches, and adopting shoring as per Drg. No. CORE/S&T/ALD/SK/573/04 in case of loose soil or banks made of cinders and ashes.
- 3.10 For trenching on embankment the drawing No. CORE/S&T/ALD/SK/574/04 shall be followed.
- 3.11 Where the direction of the trench has to change, it should be done in a gentle curve of not less than one meter radius and not at sharp angles.
- 3.12 Places where back filling is not done properly are likely to get water logged with the first rains after completion of the work, the Contractor and Engineer's Representative will inspect the entire Section soon after the first monsoon and the contractor will arrange to set right such areas. The Engineer in-charge will then issue a certificate of satisfactory completion of this work and this shall constitute as one of the authorities for refund of the security deposit.
- 3.13 The work of excavating the trench and laying of the DUCT / cable should proceed in quick succession, leaving a minimum time between the two activities.
- 3.14 Any damage caused to already laid OFC / Quad cable/signaling cable, emergency socket cable or Electrical cable during execution of the work, necessary debit for repair cost shall be charged to the contractor in terms of Telecom circular No.17/2013 issued vide Railway Board's letter No.2003/Tele/RCIL/1 pt. IX dated 24.6.2013.

4 TRACK CROSSING

Cable crossings across railway tracks shall be done in R.C.C. pipe of 150 mm dia, taking the cables through this pipe. The contractor shall do the trenching to the required depth wherever necessary such as approaches to track crossing and the length in between the adjacent tracks. Two G.I. wires of 10 SWG size shall be threaded through R.C.C. pipes, one to pull the cable and one for future use. The arrangement of cable and R.C.C. Pipe trunking under Track crossings has been done as per instruction of Railway Engineer Incharge as per Drg. mentioned in schedule of work.

At some of the locations, as decided by Railway Engineer in consultation with division for crossing busy tracks & tracks on embankment, trenchless digging method shall be adopted. Two separate DWC HDPE pipe of 120 mm /103 mm (OD/ID) as per IS-14930 Pt. II or latest shall be provided to lay OFC, 6 quad, PIJF cable and to cater future expansion.

5 ROAD CROSSING

- 5.1 When crossing roadways, it is necessary to lay the cables in such a manner as to avoid the necessity of handling the cable sharply and minimize the excavation of road surface as far as possible. Where cable is laid in surfaced trunking, the trunking alignment should be curved down to the pipes and proper brick or concrete joint should be made between trunking and pipe.
- 5.2 The crossing of main roads often involves difficulties especially if traffic is heavy. Precautions to avoid accidents to workmen, pedestrians and vehicles should be taken. On minor roads which can be temporarily closed to traffic it is possible to open up and cross the entire width of the road. Pipes should be installed quickly in the cutting, which is then filled in thereby reducing to a minimum time for which the road is closed.
- 5.3 Some roadways, which are broad, may be opened for half their width, allowing the other half for use of traffic. Pipes are laid in the trench filled in the first half and the other half opened up after the first half is opened for the traffic. Pipes laid in the second half is linked with those laid in the first half. RCC/DWC/HDPE pipes shall be used for road crossings. In all cases pipes should be laid at a depth of 1000 mm or otherwise as decided by the Engineer at site.
- 5.4 Trenchless horizontal boring (HDD) work to be done as mentioned in schedule of work.

6 CABLES OVER STEEL GIRDER BRIDGES

Cable shall be laid over the bridge as per schedule of work.

6.1. Girder bridges up to 12 meter span length :

Cables shall be laid over the bridge in perforated G.I. pipes of min. 75 mm internal dia as per schedule of work on the girder bridges having span up to 6 mtrs. without any intermediate support and up to 12 mtrs. with an intermediate support. OFC will be laid in a Plain HDPE pipe to to TEC GR No. G/CDS-08/01.Dec'99 with latest amendment with min. 40/33 mm (OD/ID) inside the perforated GI pipe whereas Quad/PIJF cables shall be laid directly inside a separate perforated GI pipe. GI Pipe shall be perforated on all around its surface with a hole of not more than 5mm dia. and distance between two holes shall not be more than 100mm. GI Pipes shall be of IS standard of reputed make with minimum 75 mm internal dia.

In case only one cable (OFC or Quad) is to be laid only one G I pipe to be used for protection of cable.

6.2. Girder bridges of span length more than 12 metre:-

The crossing of Girder bridges of more than 12 metre length can be done as below.. Arrangement for fixing of G I pipe is indicated in drg. no. –CORE/S&T /ALD/ SK/ 589/2007 (PG 1 of 2) and CORE/S&T/ALD/SK/589/2007 (PG 2 / 2). Separate G I pipe shall be mounted for laying of OFC and Quad/PIJF cables.

In case only one cable (OFC or Quad) is to be laid only one G I pipe to be used for protection of cable.

- 6.2.1 OFC will be laid in a Plain HDPE pipe as per TEC No. TEC/GR/TX/CDS-008/03/MAR-11 with latest amendment with 40/33 mm (OD/ID), in G.I. pipe .
- 6.3 When laying cable on long bridges, the question of longitudinal expansion caused by temperature differences should be taken into consideration and suitable cable loops should be provided at the pillars of the bridge.
- 6.4 The laying of the cable on the bridges is to be done with much care and planning. It is necessary that the cable drum to be laid on the bridge is inspected and tested thoroughly so that damaged cable is not installed.
- 6.5 As the laying involves movement of large number of staff over the bridge, the line should be blocked and flagman posted on other side. On a double line only the line near which the cable is being laid should be blocked but care should be taken to see that staff are aware of this and measures taken to prevent staff from straying on to the unblocked line.

7 CULVERTS & ARCH BRIDGES

- 7.1 Wherever possible the cable shall be laid under the bed of the culvert through RCC/DWC /HDPE pipes as mentioned in schedule of work. .
- 7.2 In case of wet culverts or unfriendly terrains where it is not desirable (to be certified by site engineer) to lay cable under the bed of culverts & Arc bridges, cables shall be laid over the culvert & arch bridge in perforated G.I. pipes of min. 75 mm internal dia as per arrangement shown in drg. as per schedule of work.. OFC will be laid in a Plain HDPE pipe to TEC GR No. TEC/GR/TX/CDS-008/03/MAR-11 with latest amendment with min. 40/33 mm (OD/ID) inside the perforated GI pipe whereas Quad/PIJF cables shall be laid directly inside a separate perforated GI pipe. GI Pipe shall be perforated on all around its surface with a hole of not more than 5mm dia. and distance between two holes shall not be more than 100mm. GI Pipes shall be of IS standard of reputed make with minimum 75 mm internal dia. In case only one cable (OFC or Quad) is to be laid only one G I pipe to be used for protection of cable.
- 7.3 The cable at the approach of Arch Bridges and culverts should be protected by providing RCC pipe of 150 mm dia to IS:458-1971 Class NP2 standard as per Drg. mentioned in schedule of work.

8 LAYING CABLE IN SOLID AND ROCKY SOIL

If the terrain is hard rocky, normal dimensions of the trench cannot be ensured. In such cases a chase is cut as shown in Drg. mentioned in schedule of work. Sharp edges on the sides must be smoothened out and bottom of the chase should be leveled and the cable laid in sand or soft earth which should be filled and pressed down up to the step. OFC shall be laid in Plain HDPE pipe to TEC GR No. TEC/GR/TX/CDS-008/03/MAR-11 with latest amendment with min. 40/33 mm (OD/ID). A row of bricks should then be placed on the top and jointed with cement mortar and a layer of concrete should be provided as per drawing.

9 CABLES IN CONJESTED RESIDENTIAL AREAS AND MARSHY AREAS:

- 9.1 When laying the cable in residential sections, the cable should be specially protected on both sides up to a distance of about 300 meters beyond the building line. In such cases the cable should be protected by means of split into two half asbestos cement or RCC ducts which are placed directly over the cable. This is better than using bricks as in a residential area bricks are usually found while digging and its special significance of cable protection may be over looked.
- 9.2 In marshy areas where it is not possible to divert the cable route the cable shall be suitably laid and protected as per decision of Engineer depending on site condition, like laying cable in RCC pipe of min. 150 mm dia supported on masonry pillars/Iron channels etc.
- 9.3 The above method will generally be followed provided there is provision in schedule of work. However engineer may decide the best possible method depending upon provision exist in schedule of work or by planning to create new NON SOR item.

10 LEADING IN OF MAIN/DERIVATION CABLE IN MASONARY BUILDINGS & CABINS

- 10.1 Main / Derivation cable will have to be led inside any masonry building such as Cable hut, ASM's room at a depth of 0.75 meters by cutting the masonry structure of the wall as per instruction of Railway Engineer Incharge as per Drg. mentioned in schedule of work. After the cable has been led inside the masonry wall, the floor inside shall be duly repaired and plastered.
- 10.2 When a Main / derivation cable has to be taken and terminated on the Ist floor of cabin, it shall be first led inside the ground floor of the cabin by cutting the masonry structure of the wall of the cabin and then it will be taken through a HDPE Pipe/ GI pipe fixed vertically on the inside of the cabin wall by suitable clamps to be embodied on the wall as per arrangement as per instruction of Railway Engineer In-charge shown in Drawing mentioned in schedule of work.

11 LAYING OF CABLE IN SPECIAL CASES:

11.1 Near Power Cable

When the contractor comes across any other cable already laid, he shall first report the fact to the Engineer. Should the cable be identified by the Engineer as a power cable (LT or HT), the trench shall be dug as far away from the route of the power cable as practicable.

11.2 Crossing of Telecommunication Cable with another cable

Crossing of the telecommunication cable with another cable shall be avoided wherever possible. Where, however, this is not possible, the telecommunication cable shall be laid in cement or asbestos cement/HDPE/GI/DWC pipes mentioned in schedule of work.. The length of the pipe to be provided on either side of the crossing shall be at least one metre.

11.3 Laying of other than Telecom. cables in the same Trench

No other cable shall be laid in the trench for the telecommunication cable. Where, however, exceptional circumstances exist, the telecommunication cable may be laid along with another cable in the same trench provided a specific permission of each such case is obtained in writing from Engineer. When telecommunication cable and L.T. power cable/Signalling cable

have to be laid in the same trench they shall be separated by placing a layer of brick between them vertically (approx. 16 bricks/meter) or laid in separate pipe.

11.4 LAYING OF CABLE THROUGH PIPES

i) The cable shall be laid through RCC /DWC/HDPE pipes at the locations marked on the tapping and route plan and as advised by the Engineer or his representative as per drawing mentioned in schedule of work

ii) For laying the cable through pipes, galvanized steel wires of a cross section not less than 10 SWG shall be used as a lead wire. Two such lengths of wires shall be laid through the pipes, so that after the cable is taken through the pipe, one lead wire is permanently left in the pipe with a suitable overlay at two ends to enable the cable to be pulled out at a later stage if required to do so.

iii) At arch bridges and culvert bridges, the cables will be taken through G.I./RCC/HDPE pipes etc. while threading the cable through these pipes the Contractor shall do the trenching to the required depth wherever necessary for which no extra charge will be paid.

11.5 LAYING CABLE NEAR FEEDING POST:

In the vicinity of feeding posts, as far as possible, the cable shall be laid on the side of the track opposite to the feeding post. Further the Telecom. cable shall be at least one metre away from any metallic part of the O.H.E. and other equipment at the substation which is fixed on the ground and at least one metre away from the sub-station Earthing. In addition, the cable shall be laid in RCC pipes 150 mm dia pipe as mentioned in complete or capable of being split into two half as per specn. No. ISS-458 with latest amendments / or(DWC pipe as mentioned in schedule)for a length of 300 metre each on both sides of the feeding point.

When the excavation is to be done between the tracks, between OHE foundation and track and near OHE foundation, it shall be done as per para 2.17 of Section III, Chapter II of this book, just before laying the cables and in the presence of the Engineer's representative.

11.6 RUNNING OF CABLES AT FOUNDATIONS OTHER THAN OHE MASTS AND FROM PIPE OUTLETS.

Damage to cable is likely to occur if care is not taken in laying cable where the bed changes from solid support such as a foundation pipe or bridge to soft support such as soft soil. The cable must not press against the edge of the solid support. The soft soil near the edge must be tamped and the cable raised slightly.

11.7 LAYING NEAR OILY SURFACE

If during the excavation of trenches for laying cables, the Contractor or his representative notices the presence of oil or oily substance or any other chemical which is likely to cause the deterioration of the cable's protective material, he shall bring the matter to the notice of the Engineer or his representative and on the latter's decision he shall choose an alternative cable route or he shall protect the cable in such places in such manner as advised in writing by the Engineer or his representative. No additional charges are payable.

11.8 SPECIAL SOIL CONDITION

Cable should not be run through abnormally high acidic or alkaline soil or through sewages. If this is unavoidable, special measures should be taken against corrosion as advised by the Engineer in Charge.

11.9 PREVENTION OF DAMAGE DUE TO SHARP EDGES

When cables are laid in trunking, care should be taken to see that no ballast or stones have been dropped inside the trunking, it should be cleared of all ballast and stones before the cover is secured. When the ends of covers are joined together with cement plaster, a piece of paper or wood should be placed under the joint to prevent the cement plaster from falling on the cables.

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

- 12.1 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.

- 12.2 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.
- 12.3 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.
- 12.4 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.
- 12.5 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.

- 12.6 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.
- 12.7 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.
- 12.8 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.
- 12.9 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.
- 12.10 **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.

13 DUCT / CABLE LAYING:

- 13.1 It is advisable to employ the same people at the same place or job while cable is being laid.
- 13.2 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.
- 13.3 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.
- 13.4 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.

- 13.5 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 affected 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.
- 13.6 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..
- 13.7 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.
- 13.8 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.
- 13.9 Tools and plants as per present practices followed in Railway should be adopted for laying of the duct / cable.
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.
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.
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.
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.

14 CABLE RESERVE:

At the following locations, it will be necessary to provide reserve cable for future possible use.

- 1) Where a change to cable line is expected, the reserve to be allowed depends on circumstances.
- 2) In freshly banked soil to allow for slipping of the bank an allowance of 30 cm. should be provided for every 10 meters of trench (3 percent). The cable should be laid in a sinusoidal form.
- 3) Near roadways, buildings and culverts reserve of 5 meters should be allowed at drum end.

- 4) On each side of major girder bridge, a reserve of 10 meters should be left. For minor bridges, 5 meters shall be left.
- 5) Where remodeling works on culverts, bridges and track doubling work are going on, it may be necessary to keep loops of cable as an extra reserve pending finalisation of its future route.
- 6) At the cable hut, a loop of 10 meters in the cable pit.
- 7) At every joint, a loop of 10 meters on either side.

15 CABLE MARKERS

The cable markers shall normally be provided at the distance of every 50 meters on the cable route and also at places or corner wherever the route of the cable changes. The joint indicators shall be provided at all types of cable joints. The cable markers and joint markers provided shall be as per Drg. mentioned in schedule of work.

In addition Electronic route markers shall also be provided in the trench at every 200 meters in case OFC is to be laid in entire section.

16 LAYING OF DERIVATION CABLE

The derivation cables are required to be laid from cable hut to the subscriber premises (ASM, Cabin, Depots, Residences, Electrical Locations etc.) for extending control and other tapings. The plan & requirement of PIJF / derivation cables shall be suitably worked out and got approved from the Engineer well in advance.

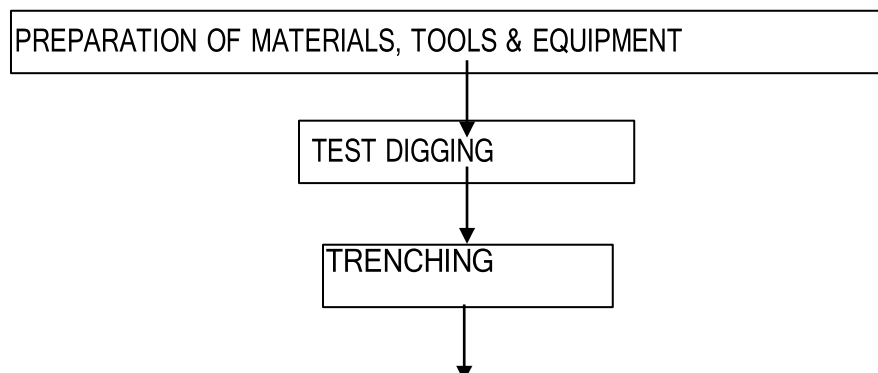
As far as possible, derivation / PIJF cables shall be laid in the trenches / protective works already done for OFC / 6 Quad cable. From the diversion point, cables shall have to be laid in independent trenches. For branching out different tapings on route, the cable may be tapped at different locations. However, it must be ensured that every tapping is taken on independent conductors right from cable hut to the subscriber for ease of isolation in case of malfunctioning.

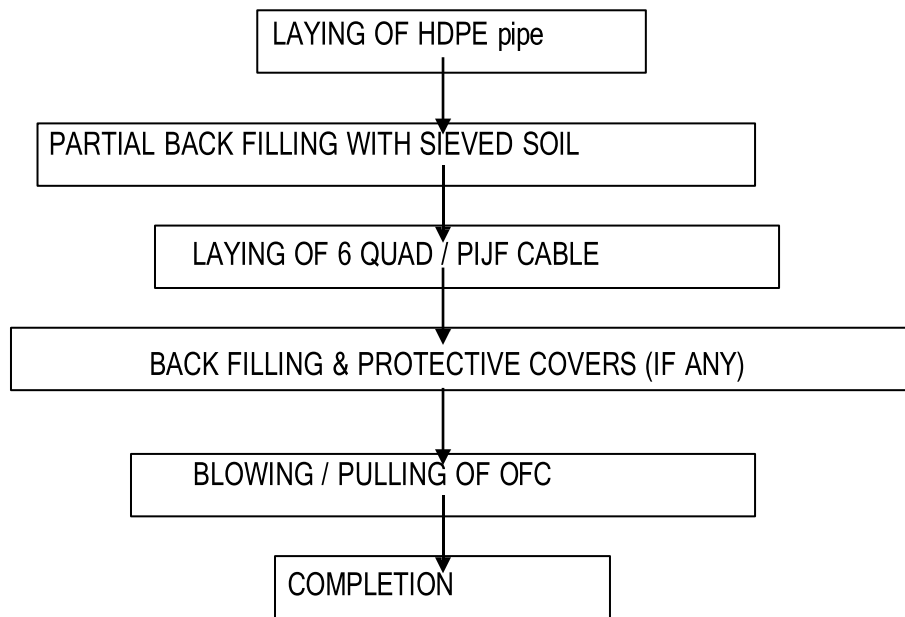
All the required protective works shall be implemented for protecting these cables. These include isolation of armour of OFC cable as detailed in para 20 of Section III Chapter VI of this book.

17 LAYING OF OPTIC FIBRE CABLE IN TRENCHES :

17.1 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.





17.2 CABLE LAYING IN TRENCHES :

- 17.2.1 Armoured fibre optic cable shall be drawn/blown into HDPE pipe already laid into the trench on the soil. The trenching and laying method is dependent on both ground configuration and nature of the soil at site.
- 17.2.2 From specifications and drawings, ascertain the route of the cable, requirements of the materials, labour and work period etc.

17.2.3 PREPARATION OF MATERIALS, TOOLS & EQUIPMENT

- a) Check that all tools and equipments for installation as detailed in para 19 are ready at site.
- b) Check that the required quantity and type of materials for laying of cable in trenches, are ready at site.
- c) Take care to keep tools, metal fittings and equipments in a warehouse to preventing being stolen or lost.
- d) In case, materials have to be kept on the road, care must be taken to ensure that traffic is not hampered or inconvenience is not caused to the public.
- e) Special attention must be paid to avoid keeping the material around the fire plug or hydrants or sewage duct. In case, it becomes unavoidable, use planks across such locations.

18.4 TEST DIGGING

- 18.4.1 Before cable laying, inspect the route with reference to the approved plans and the specification and ensure that there are no obstacles in the route.

18.4.2 Conduct test digging to ascertain the existing facilities and record the position and depth of cable to be laid as well as any existing underground cable or water pipes etc.

18.4.3 **INSPECTION**

- a) Check the cable installation position shown in the cable route plan vis-à-vis the actual condition of site.
- b) Determine the cable jointing points and curving points from the off set shown on the cable route plan and measure the distance between them and the surplus.

18.5 **TRENCHING**

18.5.1 **Traffic Safety:**

At the site of cable installation, take the under mentioned measures for traffic safety:-

- a) Provide "WORK IN PROGRESS" plate wherever necessary at both end of the site and provide lighting devices.
- b) Wherever necessary, provide suitable fences at the end and side of the trenches to keep vehicle and pedestrians away. At night, use warning lamps or equivalent at adequate distances.

18.5.2 **BURYING DEPTH OF CABLE**

- a) The depth of the cable shall be enough to prevent natural, artificial obstacle and damages. The standard depth must not be less than as specified in schedule of work.
- b) In case, it is rocky area, the depth may be reduced by using the protection as per relevant drawing or as specified in schedule of work.

18.5.3 **EXCAVATION**

The excavation for trenching may be made either manually or by mechanical means. The depth of the trench can be measured by a rule made of pipes as per RDSO/TCDO/COP-11 (Annexure 3.15). When the surface of the ground where the trench is dug is slanting or uneven, the depth is measured w.r.t. lower edge

a) **MANUAL EXCAVATIONS**

b) **MECHANICAL EXCAVATION:**

Excavation of trench can also be done mechanically by:-

Loader backhoe (Escorts 710x or similar) equipped with excavating bucket of suitable size, cleaning bucket, back filling blade and lifting tackle. This backhoe can also be suitably used for lifting cable drum if equipped suitably.

CATARPILLAR TRACTOR can be used for laying cable along cable route using adjustable ripper having typical preparation of 1.20 meter depth to install cable at 1.00 meter depth.

- 18.5.4 After digging is done to specified depth, the bottom is leveled by removing the exposed stones or obstacles etc.
- 18.5.5 A day's trenching is to be of such a length that cable laying and back filling can be finished during the day. This however, would not apply to cases where operation does not hamper the traffic and where cable and trenches are not exposed to likely interference/damage.

18.6 LAYING OF CABLE

- 18.6.1 In handling optic fibre cable, full care shall be taken regarding each of under mentioned items
- a) Cable shall normally be laid out by hand. When using winch, tension should be monitored by a tension meter. During moving cable drums, loading and unloading precautions shall be followed.
- b) Cable shall be laid under a specified pulling tension, bending radius and pulling speed as shown below:-

ITEM		VALUE
DURING	PULLING TENSION	.1 x W kg
INSTALLATION	BENDING RADIUS	30 x d
	PULLING SPEED	Max. 15 m/min

d ----- Cable outer dia

W ----- Weight of cable per Km. in Kg.

- c) Tools necessary for laying optic fibre cable as detailed in Para 19 are to be checked as to be physically available before starting the cable laying.
- d) For efficient and safe cable laying, communication may be provided between following points using portable VHF walkie - talkie sets:
- Cable drum end,
 - Any intermediate manhole/diversion/track crossing through which the cable will be drawn,
 - The winch/truck operator (if cable is laid mechanically),
 - The supervisor In charge of the cable laying.
- e) During cable laying care must be taken not to twist cable in any direction. For this purpose, the survival (rotating hook) shall be attached between pulling line and pulling eye at the end of cable so as to avoid any possible twist during pulling and laying of the cable.

- f) Whenever cable is to be laid in the duct (HDPE pipe or RCC pipe), suitable lubricant on cable may be used so as to reduce friction and consequently the tension on the cable.

18.6.2 PREPARATION FOR PAYING OUT CABLE

- a) Check the drum number and length of the cable etc.
- b) Entrust cable drum to the contractor after testing of the fibres by contractor with OTDR for attenuation and to ensure that no mechanical damage of the fibre exists while handing over the cable to the contractor.
- c) Place the cable jack (to support cable drum) on a flat surface
- d) Put cable spindle through drum and adjust cable jacks so that the drum may be clear 3-5 cm from the ground and that the spindle may become horizontal. Remove carefully lags of drum with bar or other means by taking care that no damage to the cable takes place.
- e) Pull out nails from lags or bend them so that operation can be done safely
- f) Normally both end of the cable is provided with cable grip and pulling eye. In case, it is not already provided, fit the cable grip/pulling eye to the survival and pull the wires by means of shackle.

18.6.3 LAYING OF CABLE BY WINCH

- a) When all the things are ready for cable laying, put rollers at intervals of 2-3 meter in the trench. Put them in fix position with longer rollers support portion facing the direction in which cable is to be pulled.
- b) At curved point put rollers in slanting position towards outside so that it may not tumble down during operation.
- c) Stretch pulling rope on rollers and fix its end on to winch.
- d) Use 2-3 tone winch and put it near the dug-up trench. The winch shall be fastened at the back with wire to a pile driven into the ground to prevent it from moving out of place due to pulling tension that may arise during operation.
- e) After all is ready, post workmen at winch, cable drum and in the trench and using communication, pull cable slowly into the trench by means of winch.

18.6.4 LAYING OF CABLE BY HAND

- a) The cable is stretched by workmen without the use of winch and rollers, 2 or 3 man on the pulling rope and other standing at intervals of 2 to 10 meters depending upon the cable weight.
- b) When the cable is held on the shoulder, a suitable protection is needed to prevent its sharp bend.

18.6.5 TREATMENT OF CABLE AFTER IT IS LAID

- a) After completion of cable laying check the following items:
 - Confirm extra jointing length is required at both end.
 - In case cable is damaged, take necessary preventive and remedial steps for removal of

defects.

- If there is any snaking or rise in cable, put it right.
- Examine interior of the trench and remove any stones, pebbles etc.
- Take protective step for such objects projecting into the trench such as sewer pipe etc.

- b) While laying one piece of cable, when part of the work is to be put off till the following day, keep the remaining portion of cable wound on the drum, reduce as much as possible the distance of the drum from already laid cable considering cable bending radius and general traffic safety, and also ensure that drum is prevented from tumbling down or rolling away. Already laid cable shall be fully covered to avoid outside interface.

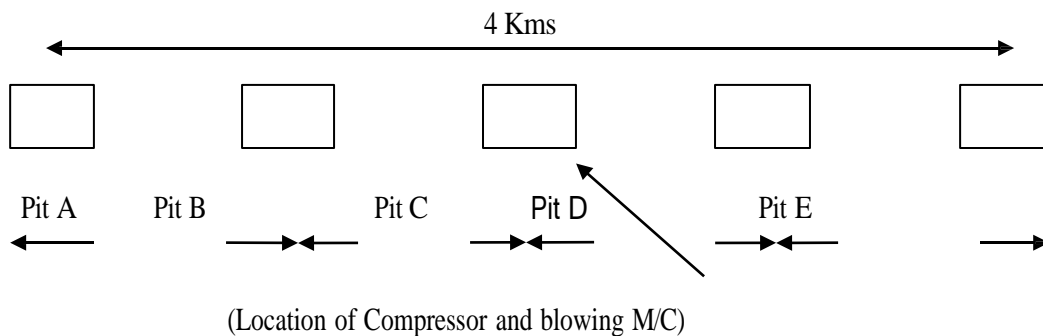
18.6.6 BLOWING OF OFC CABLE

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.



- 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.

18.6.7 Policy guidelines for laying of OFC cable for S&T Works As per RB No. 2006/Tele/TP/1(3359379) dated 02.01.2026

The policy mandates laying of 2×48F OFC each side with strict segregation of short haul, long haul, and miscellaneous OFC through defined nomenclature, colour-coded HDPE ducts, clear physical identification and comprehensive route and tapping documentations.

The policy is reiterated as under:

- i. 2 x 48 Fiber OFC cables will be laid on each side of the track (i.e. 96-Fiber each side) to achieve path redundancy, one for short haul and other for long haul communication requirement.
- ii. These OFC cables shall be laid in ducts as per Board's policy dated 12.04.2006 preferably using HDD below 2m depth to protect existing cables laid at depth of approx. 1 to 1.5m.
- iii. On each side, one 48-fiber OFC cable should be laid for meeting short haul communication requirements (which is terminated at LC, IBS, ABS huts and LTE/Kavach locations etc. in mid-section). OFC cables shall be named as OFC-SH-UP and OFC-SH-DN for UP and DN directions respectively. Bright Yellow and Bright Blue HDPE duct should be used as underground cable conduits for OFC-SH-UP and OFC-SH-DN short haul optical fibre cables respectively.
- iv. On each side, second 48-fiber OFC cable should be laid for meeting long haul communication requirements. OFC cables shall be named as OFC-LH-UP and OFC-LH-DN for UP and DN directions respectively. Bright Red and Bright Black HDPE duct should be used as underground cable conduits for OFC-LH-UP and OFC-LH-DN long haul optical fibre cable respectively.
- v. If, in a station section/block section, there are OFC cables other than those specified above, e.g. OFC cables laid in distributed EI for signalling purpose, these OFC cables shall be named as OFC-MIS-UP and OFC-MIS-DN for UP and DN directions respectively. Bright Brown and Bright Grey HDPE duct should be used as underground cable conduits for OFC-MIS-UP and OFC-MIS-DN optical fibre cable respectively.

Therefore, the colour coding for HDPE ducts are defined as below:

Category of OFC	UP Duct Colour	DN Duct Colour
Short Haul (SH)	Bright Yellow	Bright Blue
Long Haul (LH)	Bright Red	Bright Black
Miscellaneous (M· S) Signaling application etc.	Bright Brown	Bright Grey

vi. OFC cables should also be clearly distinguishable at location of OFC joints/pits/common entry point in huts/relay rooms. Clear demarcation based on colour of duct shall be made on joint enclosures/pits by adopting suitable means along with doing proper tagging/labelling. For identification of different cables at common entry points like OFC huts/relay rooms, proper tagging/labelling as per nomenclature provided above should be done.

vii. Cable route plan and tapping diagrams: The cable route plan should include each OFC cable laid with its tagging/labelling, clearly indicating the route of OFC cables, location of joints in each OFC cable and their distance indicated with respect to the nearest main line track in reference of fixed structures (e.g. OHE mast) and with respect to other available permanent structures for easy identification of cable route and joints. The nomenclature for different OFC cables as provided above should also be followed in cable route plans. A tapping diagram should be prepared for each OFC cable laid in a section indicating the tapping of various circuits from different OFC cables. The colour and label of different OFC cables and joint as shown in route plan should match with the colour and label of actual duct/cable at site.

18.6.8 Cable laying in the vicinity of TSS

- Near TSS, cable shall be laid at least 1m away from any grounded metallic structures and substation earth.
- Cable shall be laid at least 5 m away from the switching station earth.
- Cables laid in concrete pipes may be laid 1m away from it.
- As far as possible, cables near TSS are to be laid on the side of the track opposite to TSS.
- Cables shall be enclosed in concrete channels or pipes for a length of 300 m on either side of TSS.

JOINTING OF 6 QUAD TELECOM. CABLE AND ACCEPTANCE TEST.

Para No.	Subject.
1	Scope.
2	Thermo shrink Joint Closure.
3	Joints of 6 quad Cable.
4	Termination of 6 quad Cable at Station/Cable Hut.
5	Long Block Sections and Sidings.
6	Jointing Procedure.
7	Jointing and Termination of PIJF & Lead Sheath Derivation Cables.
8	Capacitance unbalance.
9	Acceptance Test for 6 quad & PIJF Cables.
10	Tools and Accessories required for jointing.

JOINTING OF 6 QUAD TELECOM CABLE AND ACCEPTENCE TESTS

1 SCOPE:

This Chapter deals with the requirements of various types of joints on 6 quad cable, jointing procedure, V.F. Transformers and the acceptance test etc.

2 Thermo shrink jointing kits as per specification No IRS-TC-77-2012 (rev -3) including amendments 1,2 & 3 with latest amendments shall be used for various types of joints in:

- i. 6 quad jelly filled cable of specification IRS-TC-30-2005 (vers-1) including amendments-5 with latest amendments having 0.5mm or 0.9mm conductor diameter.
- ii. PIJF underground Telecom cable of different pair sizes 10/20/50/100/200 pairs with copper conductor having diameter 0.5mm, 0.63mm or 0.9mm. as per specification IRS/TC-41-97 or latest.1 with latest amendments
- iii. The 2T/3T (1 quad) VF transformer as per specification No. IRS-TC-76/2021 with latest amendments for thermo shrink joints etc. shall be used for thermo shrink transformer joints.

3 With Optical Fibre application, the 6 quads cable is meant for carrying circuits only between two stations. As the joint is always a weak link, efforts shall be made to club two or more joints in one if falling within 100 mtrs.

3.1 The straight through joints shall be provided for normal jointing of cable.

3.2 For L.C Gate, Pump Houses etc. the straight through joints with branching clip shall be provided for deriving the circuit using 10 pairs PIJF cable. No isolation transformer is considered necessary upto the distance of 7.5 Km.

3.3 Transformer joints shall be used for deriving emergency sockets approx. at one Km. distance. This joint shall generally be combined along with normal joint. The tapping shall be derived through V.F. transformer 470:1120 using PIJF cable. As the phantom circuit is not required, the center tap wires of transformer shall be cut permanently and not derived. The pair 2 of quad 2 shall also be tapped at every emergency sockets without transformers in omni-bus mode and shall be terminated on pin Nos. 3 and 4 of emergency sockets

3.4 Where block instruments are connected in end cabins, the block quad shall be derived near the cabin through thermo shrink joint on 6 quad cable using 10 pair PIJF cable. The gate phone and block spare along with spare pairs of the block quad and gate phone between cabin and cable hut shall also be derived. The cable thus derived shall be terminated on CT box of appropriate size.

4 TERMINATION OF 6 QUAD CABLE AT STATION/ CABLE HUT.

4.1 A 19" rack as per drawing no. CORE/S&T/ALD/SK/530/2002 along with 5 nos. of '32 way "U" link panels', 160 nos. "U" links, 10 nos. of 1mtr. long patch cords with "U" links at both ends and wiring & installation materials shall be supplied and mounted by the contractor in the cable hut by the side of OFC equipment rack.

4.2 All the OFC, quad and PIJF cables shall be terminated on this rack. For the ease of testing, the 6 quad cables shall be directly terminated on "U-Link" panels provided on the transformer bay.

- 4.3 The other end of “U-Link” shall be connected with primary winding of 2T/3T (470:1120) V.F. transformers mounted in the rack. The secondary side of the transformers shall be connected to the derivation cables through another “U-Link”.
- 4.4 Where block instruments are provided centrally, the block circuit of one side shall be derived directly from 6 quad cable by providing 2T/3T transformer in under ground thermoshrink joint. The block circuit of other side shall be derived by providing 2T/3T transformer in underground thermo shrink joint on Block quad of 6 quad cable, behind the cable hut.
- 4.5 L.C Gate quad shall be terminated directly without V. F. Transformer to permit passing of magneto ring.
- 4.6 2T / 3T V.F. transformers shall be connected in the transformer bay for both side emergency control circuits.
- 4.7 A Krone termination box as per TEC Specification shall be mounted to facilitate termination of cables for the derivation purposes.
- 4.8 For termination of cable on CT box at the locations other than cable hut, a wooden (teak) board of 25MM thickness and size depending on the types of CT box, shall be supplied and mounted on the wall onto which the CT Box shall be fitted..

5 LONG BLOCK SECTIONS & SIDING:

- 5.1 In case of long block sections and sidings (>15 kms) it may be necessary to carry out loading and balancing of 6 quad cable to reduce the loss & cross talk.
- 5.2 The loading section shall be 2 kms. and loading and condenser joints shall be provided at alternate one kilometer similar to conventional quad type main telecom. paper cable. The loading coil assembly for thermo shrink joints contains loading coils of 88 MH for 2 quads and is similar to 2T(1 quad) Transformer in shape & size. Therefore, thermo shrink jointing kit for transformer joint is suitable for loading coil joint also. In condenser joints only 2 wire condensers are to be used for balancing purpose.

6 JOINTING PROCEDURE:

- 6.1 For jointing of cable, pit as per Drg. No. CORE/S&T/ALD/SK/ 438/95 is made. The pit surface is leveled by ramming the earth. In case of loose soil or mud, bricks or ballast may be used, if necessary. A tent may be placed over the pit to protect against adverse weather/dust.
- 6.2 Bend the two cable ends slowly into an “S” shape taking care that the cables are not strained excessively and minimum overlap of 350 mm is available.
- 6.3 Prepare the cable ends as per the detailed installation instructions supplied by jointing kit manufacturer for making heat shrinkable joints for 6 quad Cable.
- 6.4 Preliminary checks may be carried out using multimeter for continuity of conductors & breaks/crosses etc. if any. The insulation is measured between all conductors bunched together and screen/ armour by 500 V megger. The equivalent average insulation resistance /

conductor / km is obtained by multiplying the megger reading with the number of conductors and the length of cable in Kms.

- 6.5 Slip the quad rings on a PE insulated quad of the cable end. Similarly slip another quad ring on the corresponding PE insulated quad of other cable ends. Select a conductor, slip a PE sleeve over it. Take the corresponding conductor of the corresponding PE quad of the other cable end. Peel off the PE insulation from these conductors for a length of 50 mm.
- 6.6 Bring the two conductor together perpendicular to the cable. Twist the two conductors by rotating giving approximately 10 turns for length of 25 mm. Cut off the surplus wire. Solder half the length of twisted conductors using solder resin core, solder bit flat & blow lamp. Fold the twisted conductors along the main cable conductors and allow it to cool. Draw the PE sleeve over twisted joint in such a way that former projects equally on the two sides of the latter and equally covers the polyethylene insulation of the two conductors. It should be ensured that the PVC sleeve fits properly over the twisted joint and is not able to move easily over it.
- 6.7 For tapping joint, select the quad from which the circuit is to be tapped. Cut the quad. Slip numbered group ring over both ends as also on the lead wire bunch of required transformer. Select a conductor in one quad and slip a P.E sleeve over it and its other end. Select a conductor, a short lead wire and transformer lead wire and make twisted joint. With the other end of the short lead and other cut end of same conductor, make another twisted joint.
- 6.8 The conductors of remaining PE quads should also be joined accordingly.
- 6.9 Complete the joint as per the detailed installation instructions instructions supplied by jointing kit manufacturer for making heat shrinkable joints for 6 quad Cable.

7 JOINTING & TERMINATION OF PIJF DERIVATION CABLES.

- 7.1 Thermo shrink joints of appropriate size for straight through or branch off joints as per specification shall be provided.
- 7.2 All the PIJF cables shall be terminated on krone or CT box of suitable size duly mounted on the wall in subscriber premises.

8 CAPICITANCE UNBALANCE:

- 8.1 In the electrified sections, the capacitance unbalances between cable conductors and the cable sheath / armour (earth) introduces appreciable noise in the circuits. This can be reduced by polling i.e. connecting cable pairs straight or across at normal joints.
- 8.2 In any manufactured length of a cable, the capacitances between conductors of a quad and between conductors of adjacent quads and those between conductors of a pair and the cable sheath (earth) are not perfectly balanced which gives rise to the capacity interference between various circuits and the circuits and earth. Balancing of these capacitances is hence necessary to limit the cross-talk and to bring the cross-talk attenuation within permissible values.

This is done by adding extra capacitances between pairs. The permissible limit of capacitance unbalances in balanced cabling is 40 pf for full loading section.

9 ACCEPTANCE TESTS FOR 6 QUAD AND PIJF CABLES:

The characteristic impedance of unloaded 6 quad Telecom. Cable (IRS TC-30) is 470 ohm +/- 10% at 800Hz. When loaded with inductance of 88mH, the characteristic impedance is 1120 ohm +/-10%.

Joint tests are to be carried out by Engineer's representative and contractor's representative for accepting the cable from the Contractor.

9.1 Testing of V.F. Transformers: Following tests may be conducted on VF Transformers before using in the joint.

- a) **Continuity and DC resistance of windings:** Use an AVO meter to check continuity. Measure DC resistance of primary / Secondary windings with a LCR bridge. The readings obtained should be comparable.
- b) **Insulation Resistance:** Connect one lead of a 500 V megger to one winding connect the other lead of Megger First to another winding and take reading. Next connect it to all other windings connected together and the case and again take the reading. Insulation resistance should not be less than 10,000 Mega ohms.
- c) **Insertion Loss:** Adjust output level of transmission measuring set to 0 db and connect it across the primary of transformer. Connect a dB meter on the secondary side. dB meter reading should not be more than 1 dB.

9.2 LOOP RESISTANCE AND CONTINUITY TEST:

Instrument to be used: Multimeter

- a) The Multimeter will provide ready means for continuity test and also it will be capable of testing D.C. and A.C. Voltages, D.C. resistance and also low frequency levels for test and maintenance purpose. The input sensitivity shall be at least 100 k ohm per volt of D.C. and 10 K ohm per volt of A.C.
- b) The maximum average loop resistance of a pair measured with direct current at 20 deg. C. shall be 56 ohm per km. for the PE quads of 0.9 mm diameter copper conductors. The nominal loop resistance of a pair shall be 55.2 ohms per km at 20 deg. C. This test shall be carried out only on untapped pairs of cable.

9.3 INSULATION TEST:

Instrument to be used - Megaohm Meter/Megger

- a) The insulation resistance measured between a conductor of a quad and all conductors of all other quads connected together to the sheath and earth shall not be less than 625 megohms per kilometer when measured at 500 volts D.C. after energizing for one minute at a temperature of not less than 16 deg.C. The remaining three conductors of the quads under test may be left floating.

The insulation at 16 Deg. C may be found out by the formula -

$$\text{Insulation at 16 Deg.C} = \text{Insulation at T Deg.C} \times 1.04^{(T-16) \times 9/5}$$

- b) For measuring insulation all conductors may be bunched together and tied properly with a bare wire and insulation to the sheath/screen measured. The insulation resistance per km can be obtained as - No. of wires tested x Deflection (Megs) x Length (KM) =Megohms per Km..

9.4. FREQUENCY ATTENUATION & TRANSMISSION MEASUREMENTS:

Instrument to be used - Transmission Measuring Sets (IRS TC 43-87).

Two Transmission Measurement sets are required for this measurements. One set is kept at one end of the cable and the other at the other end of the cable. Before sending the set to other end the zero errors of all meters are checked. Zero dB tone is sent from one end and the level received at the other end and is measured. Wherever the frequency is changed the zero level should be adjusted again. Zero level of the tone should also be adjusted first before taking any reading.

The reading are taken at the following frequencies 300 Hz, 400 Hz, 600 Hz, 800 Hz, 1000 Hz, 1400 Hz, 1600 Hz, 2000 Hz, 2400 Hz, 2800 Hz and 3000 Hz. and recorded.

The transmission loss, return loss, insertion loss etc are measured and recorded.

9.5. CROSS-TALK MEASUREMENT:

Instrument to be used –

a) Cross talk measuring set (IRS TC-45)

b) Oscillator 1 kHz / 800 Hz Zero dB

Tone of 800 Hz is given on one Pair and cross Talk is measured on the other pair in the same quad. Also the Cross-Talk has to be measured in adjacent quads, Cross-Talk is measured at 'Near-End' and also 'Far-End'. The Far-End Cross-Talk attenuation between any two air spaced paper insulated VF pairs at a frequency of 800 Hz shall not be less than 65 dB. The Near-End Cross-Talk shall not be less than 61 db.

9.6 PSOPHOMETRIC NOISE LEVEL MEASUREMENT:-

Instrument to be used - PSOPHOMETER (RDSO SPECN. No. STE/RE/C/SPN(MI)-1975(or Latest)

SIEMENS Germany Model No. V 2233(1994) or APLAB India Model No. 1071/R(1995) are presently used for measurement of noise. The detail procedure for measurements is supplied by manufacturer. The far end of test pair is terminated at the resistance equivalent to characteristic impedance of the cable (600 or 470 or 1120 ohms). At near end psophometer is connected. The readings of weighted and un weighted noise can be directly read on the meter. The permissible limit of psophometric voltage is 2 mv.

9.7 Measurement of Circuit elements:

Instrument to be used - Impedance Bridge (LCR Bridge) {Specn.No. STT/RE/SPN(MI)- 1973 or latest}

This measures electrical data of components like coils, capacitors and transformers as well as of subassemblies, amplifiers, filters etc. The measurement of resistive and reactive components of impedance and admittance can also be measured with this bridge. These parameters are generally factory tested and need not be measured at site. The impedance bridge can also be used for assessing the distance of cable fault/low insulation quad with reference to healthy quads.

- 10.** Tools & accessories required for jointing of 6 quad / PIJF / derivation cable & termination should be available as per manufacturer's instructions/ manual.



Para No.	Subject.
1	Erection of Emergency Socket Posts.
2	Protective Measures for Telecom lines entering 25 KV Sub-Stations/Switching posts..
3	Protection against Surge & Lightening.
1	<p>Erection of Emergency socket posts & Termination on emergency socket & plug :</p> <p>Emergency socket boxes shall be provided on Rail posts as per sketch No. CORE/S&T/ALD/SK/414/94A and these shall be erected alongside the railway track at a regular interval not exceeding 1 Km. as per the location given by the Engineer.</p> <p>The derivation/PIJF cable shall be directly terminated at the 6 pin emergency socket fitted in Emergency socket Box. Controller's RECIEVE shall be terminated on the outer pins (pin no. 1 & 6) of emergency socket and controller's TRANS shall be terminated on pin nos. 2 & 4 of the socket as per RDSO Drg. No. TCA-15225. Pairs nominated for Disaster management in both side quad cables shall be extended (by using two pairs of derivation/PIJF cable) up to emergency socket box without any transformer and shall be terminated on pin nos. 3 & 4 of the emergency socket so that in future disaster management pairs can be used for making isolation, testing and extending communication independently.</p> <p style="text-align: center;">-</p> <p>Trans of the emergency control telephone shall be terminated on the plug at outer pins (pin no. 1 & 6) and receive of the control phone shall be terminated on pin nos. 2 & 4 of the plug as per RDSO Drg. No. TCA-15221.</p>
2	<p>PROTECTIVE MEASURES FOR TELECOMMUNICATION LINES ENTERING 25 KV SUB- STATION/SWITCHING POSTS.</p> <p>When Telecommunication lines enter 25 KV sub-stations and switching posts (Feeding posts), section and sub-sectioning posts, the following protective measure shall be taken to protect the staff and Telephone equipment against any fault occurring on the Traction side.</p> <p>(a) Each Telecommunication lines before its connection to Telephone, shall be provided with heavy duty lightening arrestors and fuses. The heavy duty lightening arrestors shall be of rare gas type with normal flashing voltage of 250-300 volts. The fuses shall be of 250 volts, 3 amps type and shall be wired as per Sketch No. CORE/S&T/SK/421/94A.</p> <p>(b) A common Earthing shall be used for Earthing of the heavy duty lightening arrestors and all metallic bodies of sub-stations/switching posts so that no potential difference may arise between these bodies in case of a fault occurring on the Traction side.</p>
3	<p>PROTECTION AGAINST SURGE AND LIGHTENING:</p> <p>3.1 All the equipments shall be protected against the insurgence of surge voltages and lightening etc. by</p>

providing Gas discharge tubes before they are connected to main / derivation cables.

- 3.2 GD tubes (rare gas type) with normal flashing voltage of 250-300volts along with fuses of 3 amps. 250 volts shall be used as per TEC or IRS specifications.
- 3.3 In Cable Hut these shall be provided on Krone or mounted independently as per manufacturers instructions.
- 3.4 The GD tubes with fuses shall also be provided on LC gate, emergency, spare quads and derivation circuits. The block circuits shall be protected through block filter unit.
- 3.5 All the GD tubes shall be suitably connected to proper earth. The Earthing arrangement shall be provided with G.I. Pipe earth as per Drawing No.TCA/565 and detail instructions given in Chapter VII.
- 3.6 The detail procedure for installation of junction equipment as given by manufacturer shall be followed.
- 6.6.1 In case control circuit originates in 2 wire territory with impulse signaling and DTMF signalling is to be used in 4 wire territory, it is recommended to operate the 4 wire DTMF circuits through a Railway MW circuit or hiring a VF channel from DOT.



JOINTING AND TERMINATION OF FIBRE OPTIC CABLE.

Para No.	Subject.
1	Techniques for Jointing of Fibre Optic Cable.
2	Straight Joint for Fibre Optic Cable.
3	Preparation of Cable for jointing.
4	Stripping/Cutting of the cable.
5	Preparation of Cable joint closure for splicing.
6	Stripping and cleaving of Fibre.
7	Splicing of the Fibres.
8	Fusion splicing of Fibre.
A.	Mechanical splicing of the Fibre.
B.	Organising Fibre & Finishing Joints.
9	Placing of completed joint in Pit.
10	Reopening of the joint.
11	Termination joint for Fibre Optic Cable.
12	Marking the Cable.
13	Cutting/Stripping the cable.
14	Gripping the cable.
15	Fixing of Tension member.
16	Fibre Splicing.
17	Enclosing Fibres.
18	Mounting of Termination Box.
19	Fixing the Cable.
20	Isolation of armour of OFC cable.
21	Acceptance test for Fibre Optic cable.
22	Test Protocol for Optical Fibre Cable.
23	Tools and Equipments required for jointing and termination of Fibre Optic Cable.



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 inside 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 1,</u> 2, 3, 24
Fibre no. 1		
Measurements □	At 1310 nm with OTDR	At 1550 nm with OTDR
	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.

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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.

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TECHNICAL REQUIREMENTS FOR OPTIC FIBRE CABLE COMMUNICATION SYSTEM

<u>Para No.</u>	<u>Subject.</u>
1	General/Objective
2	Equipment Rack
3	System Design Requirements
4	Optical & Digital Equipments
5	Power supply equipment
6	Protection against transients, surges and lightening
7	Part Commissioning of section.
8	Radio Patching arrangements
9	Mobile Train Radio & Universal Emergency Communication
10	Network Management Supervisory System.
11	Technical Literature & Instruction Books
12	Description of the nature and working of Omnibus Voice circuits with selective calling.
13	Point to Point Circuit
14	Supervisory Remote Control and Data Acquisition System (SCADA).
15	Emergency Control Circuit.
16	Measurement for Fibre Optical Communication System.
17	Measurement for Optical Fibres and Cables.
18	Measurement of Optical Line Terminal Equipment.
19	Primary Multiplexer.
20	System Test

TECHNICAL REQUIREMENTS FOR OPTIC FIBRE CABLE COMMUNICATION SYSTEM

1 GENERAL

1.1 GENERAL REQUIREMENTS

1.1.1 This part of the tender document details the generic requirements and technical specifications for the SDH (STM-1) equipment with Network Management System (NMS) and primary digital drop insert Mux in Optical Fibre based telecommunication network.

1.1.2 The tenderer's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification. The tenderer shall submit technical documents containing at least the following information, accompanied with the tender documents.

- Equipment details in respect of technical performance, functions and objectives, working principles, block diagrams, power consumption, rack structure (including capacity, dimensions and weights), frame structure and shelf layout etc.
- Types and technical objectives of optical transmitter and receiver, clock and other main components used in the equipment.
- Equipment reliability, MTBF or failure rate (FIT) and calculation methods.

1.1.3 The tenderer's proposal shall clearly identify all features, described in the specifications or in any supporting reference material that will not be implemented. Clause-by-clause compliance statement shall be included with sufficient documentation for validation. While listing the compliance the tenderer will specifically state:

- FC (Fully Compliant) - In case systems and functions offered fully meet the tender requirements.
- PC (Partly Compliant) - In case system and functions offered meet the tender requirement partially. The tenderer shall state the reason why the offer is partially compliant.
- NC (Non Compliant) - In case system and functions cannot meet the requirements. The tenderer shall also state the reasons for it.
- In addition to the above mentioned compliance statements, wherever information is detailed for some numerical parameter specified in the tender document, then tenderer will state the actual numerical value of specification as met by the offered equipment/system.

1.2 OBJECTIVE

The end objective of this system is such that it shall be capable of providing:

- a) Omnibus voice circuits with selective calling.
- b) Point-to-point circuits with associated signaling.
- c) Point-to-point data circuits at $n \times 64\text{kbps}$, E₁ level and above.
- d) Ethernet (10/100 Base T) connectivity directly from STM-1 equipment.
- e) Circuits suitable for remote control switching of electric traction system.
- f) Circuits for emergency control working in conjunction with emergency sockets provided on 6 Quad Telecom. Cable in the section between two stations and subsequent extension to control office on optical fiber cable system.
- g) Circuits for emergency control working in conjunction with mobile radio through optic fiber cable system.
- h) Provision of Radio patching with Micro Wave.

2.0 EQUIPMENT RACK & MOUNTING ARRANGEMENTS:-

- 2.1 The Optical & Digital equipments shall be mounted on standard 19 inch racks of suitable size as per IEC/I.S. Specn. 25% of space shall be available for future requirements. The rack shall be provided with metallic covers with suitable ventilation arrangements from all sides. The front panel shall be provided partially with toughened glass or high quality polycarbonate sheet for viewing alarm indications etc. Covered rack shall be so designed so as to ensure that rodents and vermin do not enter inside.
- 2.2 The equipment shall be of modular construction. Chassis front panels and mounting may be either aluminum or steel of equivalent section. If steel is used, all parts must be given corrosion-resistant treatment after all matching operations have been completed. If aluminum is used for the panels, the front surface must be etched prior to finishing. Adequate rigidity shall be provided to prevent undue distortion. The rack be erected with a suitable anti-vibration mounting arrangement. The equipment and cable shall withstand all the vibrations imparted to the building and adjacent sites during the train operations.
- 2.3 All the switches, control circuit components & Sub assemblies or modules shall be mounted as to permit their replacement without appreciable disturbance to other components.
- 2.4 Provision shall be made by means of mechanical and electrical interlocks and safety covers etc., so that operating and maintenance personnel are not exposed to harmful radiation and cannot come into accidental contact with dangerous voltages. Safety covers shall be fitted over terminals to which dangerous voltages are applied. The

words, e.g. 'Danger', 'High Voltage' etc. shall be suitably printed or engraved on the cover.

- 2.5 Cables complete with connectors that may be required to interlink the various stages shall be substantially long and sturdy enough to withstand frequent handling and be suitably protected against corrosion. All wiring shall be cabled where practicable and clamped to the chassis. Where insulated leads pass through holes in the chassis, the holes shall be equipped with smoothly finished grommets. Colour code shall be employed in wiring.
- 2.6 All the indoor cables/power supply wires/OFC cables etc. shall be taken through overhead aluminum ladder from equipment rack to the cable termination board. The wiring on wall may be taken on suitable casing and capping or PVC conduit.
- 2.7 The equipment shall be protected from damage due to a faulty condition or the operation of controls in the wrong sequence, by the provisions of fuses/circuit breakers, interlock circuits and similar safety devices. Fuses shall be mounted in an accessible position clearly labeled regarding their capacity and circuit position and shall be easily replaceable. An over-voltage tripping device shall be provided for the battery supply. Protection and isolation against transient voltages through power supply or any other higher voltages/current shall be provided.
- 2.8 Each component shall be clearly identified with its circuit designation by an appropriate marking method so that complete description and circuit position of the components can be located in the Instruction Hand book. Each sub-assembly shall be clearly marked to show its function and circuit reference so that its complete description can be located in the Instruction Handbook. All controls, switches, indicators, meters, etc. shall be clearly marked to show their circuit designation and function. Symbols used for the identification of components, sub-assemblies etc. shall be those shown in the circuit diagram of the equipment. '**Danger**' or '**Warning**' markings shall be prominently displayed.
- 2.9 Arrangements shall be made for power distribution panel mounted on the rack itself. Arrangements for termination of all 30 channels from PDMux and provision of surge, lightening protection etc. may also be provided on the rack itself.
- 2.10 The equipment rack shall be provided with forced cooling arrangements. The cooling fans should work with 48V D.C. supply. Suitable heat deflectors shall be provided after each equipment Sub-rack/Shelf.
- 2.11 Detailed layout of equipment rack shall be submitted by the tenderer and got approved from purchaser's Engineer well in advance.

3. SYSTEM DESIGN REQUIREMENTS

3.1 GENERAL

- 3.1.1 The Optical Fibre System envisages provision of two independent systems (In ring topology). Both the systems shall consist of STM-1 (155 MB), digital equipment employing SDH technology. One system called as "**Main System**" consisting STM-1 dropping 2MB stream

for control communication and shall be dropped at every station. The other system called, as "Backup System" for long haul consisting STM-1 shall be dropped at Major/junction stations at every 20kms-50 Km. STM-1 ring will be connected to the two pairs of fibre in such a way that if one link fails, the working E₁ tributary is automatically connected to the other STM-1 link.

- 3.1.2 In the Main system one 2 MB stream shall be used for control application & shall be provided with PDMX. It should be possible as required under the specification of digital drop insert multiplexer to configure the working of channels through NMS as omnibus / point to point as per requirement of Railways.
- 3.1.3 The network elements envisaged in the present scheme are of Add Drop Mux configuration. However, it shall be possible to reconfigure these ADMs into Regenerator or Terminal Mux without any need of additional hardware or software.
- 3.1.4 In the backup system, one 2MB streams shall be used as loop back hot standby for 2 MB control communication stream of main system. Another 2 MB stream shall be used for VF trunk circuits of point to point circuits and important control circuits. PDMX shall be provided on this 2 MB stream and important circuits derived. Where additional requirement of channels due to inter exchange Junction lines etc. exists, terminal MUX shall be provided on third 2 MB stream. The remaining 2 MB streams shall be looped through.
- 3.1.5 At all stations suitable digital cross connect switch at 2 MB level shall be provided for branching of circuits on both streams. It shall also be possible to cross connect the omnibus circuits at channel level.
- 3.1.6 The STM-1 ADMs in this section are being envisaged to be used in ring topology. In future the network may be converted to a protected ring. It should be ensured that for migration to protected ring topology, no extra hardware is required. Software reconfiguration for such migration will not involve any extra expenditure.
- 3.1.7 wherever, software programming has been used in any equipment, the firm must supply the software so that alterations to the software for incorporation of additional facilities can be made at a later date. Also the staff to be sent for training as per Special Conditions of Contract Should be trained for making the alterations in the software, so that they are well conversant to make the software changes whenever required.
- 3.1.8 The tenderer shall in detail describe the redundancy protection functions which the equipment to be provided, have such as redundancy of timing board, power supply board, switch matrix board, aggregate board, tributary board etc and state whether or not the board used for redundancy protection is the same (or replaceable) with its master board.
- 3.1.9 The equipment shall be able to work for its aggregate rates in all possible configurations that is as a terminal node, Add/Drop node, Regenerator node, cross connect node etc.

3.2 LOOP PROTECTION

- 3.2.1 In case of failure of main equipment at a wayside station the continuity of link shall be maintained by end / mid patching the control section with the STM-1 (155 MB) backup system on to the 2 MB streams automatically with remote monitoring at 2 MB level. For Main

data stream at 2MB this may be realised by the cross connect/switching arrangement of D/I MUX at either end-terminal station of the control section.

One 2 MB stream of SDH main system containing the omnibus conferencing circuits, shall be automatically protected on a pre-designated 2 MB stream over SDH backup chain without any intervention from NMS.

Additional hardware interfaces necessary to meet this requirement, if any, should be indicated along with their cost. The offer of the tenderer shall be loaded accordingly. Any limitation on this account or any alternative solution may be explicitly brought out in the offer.

3.2 CHANNELS' ALLOCATION

At a way-station, it shall be possible to connect up to four way station control equipment to the same omnibus channel in parallel without calling for any additional multiplexing equipment. The extensions will be within a distance of two kilometers connected through copper cable of suitable diameter (normally 0.63mm PIJF Cable) to be provided by Railways. The extensions shall be on four or two wire basis.

Additional hardware interfaces necessary to meet this requirement, if any, should be indicated along with their cost. The offer of the tenderer shall be loaded accordingly. Any limitation on this account or any alternative solution may be explicitly brought out in the offer.

The system shall allow any two way stations establishing the communication through the same four wire omnibus channels after the Control Office calls the attention of one way station through the selective calling at the oral request of the other way station.

Any in-band / out-band / any other type of signaling used for this purpose shall not in any way interfere with or be interfered by the telephone conversation.

The channeling plan shall be finalised in consultation with Railways, the exact number of circuits/channels required at every station shall be worked out and appropriate interface card provided.

CABLE CUTTING OUT AND COMMUNICATION

If the fibre optic cable gets cut, the communication between the various points on the control office side shall remain undisturbed with point to point communication in the portion beyond the cut remaining undisturbed and only the through circuits beyond the cut getting affected.

FAILURE OF WAY-STATION MUX EQUIPMENT:

Any failure of MUX equipment at way-side station shall not affect communication at any other station especially in the case of omnibus circuits.

OPTICAL LOSS BUDGET AND POWER SOURCE:

The optical loss budget shall be worked out for each sub section between adjoining stations. The optical attenuation of F.O. cable, splice loss, connector loss, Equipment margin, cable operation margin, system operational margin shall be specified and subsequently measured.

Based on this and receiver sensitivity, the minimum optical power of the transmitter/power source is decided.

Railway shall provide armoured Optical fibre cable as per IRS:TC 55-2000 or latest. The average optical loss of cable shall be 0.4 db/km.

The laid OFC shall be made over to the contractor duly spliced and terminated section-by- section. The contractor may undertake required test to ensure that the OFC in the section is to the required standards.

SIGNAL-TO-NOISE RATIO AND NOISE BUDGET:

The signal-to-noise ratio for the worst channel at any time of the year from any point to Control Office on omnibus channels shall be better than 40db; considering a length of 300 kilometers for such omnibus channels and irrespective of the number of tapings.

The signal-to-noise ratio of all other channels shall be better than 45 db at any time of the year.

For the purpose of designing and noise criterion, a maximum of four telephones shall be taken as “in circuit” at any given time simultaneously over each omnibus channel.

The tenderer shall submit details of the noise budget & loss budget keeping a safety margin and safety margin shall be spelt out clearly.

LOCATION OF OPTICAL SHORT HAUL & LONG HAUL REPEATERS/CABLE HUTS:

All the Opto-electronic equipment shall be located in a small hut or building as per typical layout (Drg. No. CORE/S&T/ALD/SK/431/95 or in a prefabricated structure of 10’x8’x8’ (internal dimensions) specially constructed for this purpose near to the existing station buildings. The improvements/modification in the hut or building if any required for proper functioning of the optical fibre system may be advised. No air-conditioning is proposed to be provided in cable huts.

The equipment should be able to work at the parameters of the specifications under environmental conditions specified for QM-333 category B-1.

EXTENSION OF CIRCUITS FROM OFC EQUIPMENT ROOM:-

The communications from the optical fibre repeaters to station master, electrical locations and other users shall be extended on already laid PIJF (Screening Factor 0.5) 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 60 V.

Individual pairs will be wired in OFC equipment room so that the same can be extended from OFC hut to subscriber premises.

4.0 OPTICAL & DIGITAL EQUIPMENTS

4.1 SDH System

- a. SDH System (STM-1) at all stations shall be equipped with 21 Nos 2 MB streams. **The STM-1 equipment shall be fully wired for its ultimate capacity and future expansion shall require only insertion of corresponding cards(E-1, E-3, Ethernet, DS-3 etc).** Any common control card or impedance matching interfaces or other hardware (except tributary card) necessary for achieving the objectives of expansion will be supplied at this stage as part of ADM.
- b. The Long haul & Short haul STM-1 equipments shall be capable to support following interfaces :
 - i) Ethernet (10/100 BaseT) (tributary)
 - ii) 2Mbps Electrical(tributary)
 - iii) 34Mbps Electrical(tributary)
 - iv) STM-1 Electrical(tributary)
 - v) STM-1 Optical (tributary & aggregate)
- c. The electrical interfaces (E1, E3, and STM-1 electrical) shall comply with ITU-T G.703.
- d. The ADM will be as per TEC specification No. GR/SDH-04/02 Mar'2002 or latest to be read along with the following paragraphs:

ADM includes aggregate interface (Optical) of bit rates of STM-1 system. Optical interfaces shall comply with ITU-T Rec.G957 specifications. They should support the following as per the design requirements worked out by the tenderers-

- 1) Short haul 1310 nm
 - 2) Long haul 1310 nm
 - 3) Long haul 1550 nm
 - 4) Support addition of optical amplifiers for extended reach.
- e. **Equipment configuration:**

The network element are being procured as Add Drop MUX configuration, it will be possible to reconfigure these ADMS as per clause 3.1.3.
 - f. It should also be possible to configure the ADM as a synchronous digital cross connects with a VC-12 granularity. The cross-connect directions supported shall be from aggregate-to- aggregate tributary-to-aggregate, aggregate-to-tributary and tributary-to-tributary. The cross connect shall be non-blocking.
 - g. The following protection schemes shall be supported on the aggregate and tributary side which shall be user provisional on a per port/circuit basis

i). SNCP	ii). MSP
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 - h) The equipment shall have a built in Element Management support. The software shall provide a simple to use interface to manage the equipment using standard protocols like HTTP and SNMP. The software shall be capable of providing the TMN standard management concepts like FCAPS (Fault Management, Configuration Management, Administration, Performance

Monitoring and Security Management) in a user-friendly manner. It shall provide the remote management of the equipment from an external NMS connected via an Ethernet or embedded control channels. It shall provide following features:

- Automatic fault detection and diagnostics
- Support for point-and-click provisioning of cross-connects.
- Support for protection schemes- MSP, SNCP.
- The NES shall support alarm reporting in graphical format. The severity of alarms classified as critical, major or minor shall be displayed.
- Remote software download shall be possible including the identifications of software versions.
- NES shall be capable of obtaining the inventory list of equipment installed. It shall keep its updated information in its database. On request of NMS such data are to be provided to NMS.
- NES shall define access privilege for different user accounts. Access Privileges determines the permissions a user has for performing various tasks.
- There shall be a 10 Base T/100 Base T interface for management.

4.2 PRIMARY DIGITAL DROP INSERT MUX (PD MUX)

4.2.1 The Primary digital MUX shall be as per IRS TC 68-2012 or latest. The MUX shall be programmable drop insert MUX with conference facility and shall have the facility of Network Monitoring and control (Clause 7.7 IRS-TC-68-2012) The PDMUX shall be fully equipped with all card including V-24 low speed data interface card meant for SCADA and completely wired for 30 channels. The channel side interface cards shall be provided station wise as per the requirement..

4.2.2 The number of circuits in one card shall be advised by the tenderer. If the cards contain different circuit configuration, the equivalent number of cards required for providing the circuits as indicated in the schedule shall be taken into consideration for evaluating and comparing the equipment.

4.3 RELIABILITY:

The reliability shall be worked out independently for both the systems. This shall also be worked out for combined system. The overall reliability of the Optical Fiber Communication system shall not be less than 99.9 percent considering the MTTR of three hours and a limit of Thirty Stations.

4.4 REDUNDANCY.

Wherever the tenderer requires redundant equipment like hot stand-by to achieve the system reliability with his equipment, he shall do so. If redundancy is shown, it will be treated as obligatory for his system. Phrases like “preferable”, “recommended”, etc. should be avoided. If

such phrases are used, they will be taken to mean that redundancy is obligatory and the evaluation will be done on the basis of hot stand-by offer.

5.0 POWER SUPPLY EQUIPMENT

- 5.1 The SDH & MUX equipment shall be capable of working on nominal 48 V DC supplied through lead-acid type storage batteries/low maintenance batteries with voltage varying from 40V DC to 60 V DC. The equipment shall operate over this range without any degradation in performance. The equipment shall be capable of withstanding voltage spikes of 3 Volts over the maximum voltage.
- 5.2 The power consumption of the complete equipment shall be worked out at 48V DC and 230V AC. The power plant shall be 48V SMPS based. The float cum boost chargers 230V AC/48V DC, min 25 Amp in 2+1 configuration i.e. using 3 modules of 12.5 Amp with automatic switching between the modules as per RDSO/SPN/TL/23/99(VER-II) or latest is proposed along with one set of 48V (2x24) min 120 AH capacity Low Maintenance Lead Acid batteries as per IRS-88/93 or latest. Batteries should be charged as per specification & shall be installed on wooden rack. The rack should be made of Sal wood & painted with two coating of Black Acid proof paint. Design of wooden rack shall be decided by site Railway Engineer.
- 5.3 The protection against transients, Surge & Lightning shall be provided by GD tubes (300V) & MOV's (320V, 30mm Dia. min.) or other better protection arrangements of required capacity, at the input of the charger. GD tubes and MOV's shall also be provided at the feeder end (near load terminals). In addition to above EMI/RFI filter as per TEC Specification shall also be provided at the charger input.
- 5.4 The battery charger shall have arrangements for under & over voltage protection at the input, maintaining the output voltage at load point within +/-10%.
- 5.5 Arrangement for reading battery voltage, load voltage and AC mains shall be provided. Two Nos. of 10A DC MCB's shall be provided for load.
- 5.6 The 48V DC supply shall be extended to equipment rack using 16 mm² (min.) stranded PVC insulated copper cable as per IRS/TEC specifications. The voltage drop from the load point to equipment rack shall not be more than 500mv. For AC wiring 2.5 mm² (min) copper cable shall be used.
- 5.7 The suitability of the battery chargers shall be confirmed by the tenderer and additional features/protection if any, required for the equipment shall be provided along with the equipment separately. The capacity of battery charger and batteries required shall also be worked out and advised considering 12 hrs. back up under field conditions and high ambient temperatures.
- 5.8 AC and DC supply to different equipment bays/shelves shall be segregated by providing a power distribution panel with MCBs of required capacity in the equipment rack.

6.0 PROTECTION AGAINST TRANSIENTS, SURGES AND LIGHTNING:

- 6.1 All the equipment, cables and outdoor/indoor installation shall be protected from induced current, voltage as per CCITT Regulations against 25 KV catenary carrying 1000 Amp. current. Protection should be provided against all surge/transient voltages.

- 6.2 The protection against surge, transients and lightening should be graded and provided at 230V AC input to the battery charger ('X' Protection), 48V DC input to the equipments ('Y' Protection) and channel level output from the equipment for extending telephone circuits etc. ('Z' Protection). Gas discharge tubes in tandem with MOVs of appropriate capacity shall be provided. Adequacy of these suggested arrangement shall be confirmed by the tenderer. The tenderer may also propose alternative arrangements bringing out complete technical details necessary to protect the equipment offered by him.
- 6.3 Typical arrangements to be followed for providing surge/lightning protection as per Drg. No. RDSO/TCDO/158 as recommended by Department of Electronics, Centre of Electromagnetic, CEM, MADRAS on the basis of preliminary studies done in Nagpur on 19-22 Jan.'93.
- 6.4 The pipe earth electrode as per Drg. No. CORE/S&T/ALD/SK/430/93 is proposed to be provided for earthing of optical & digital equipments. The recommended value of earth resistance is not more than one ohm. The adequacy of the arrangements including the referred earth resistance shall be fully taken care of and confirmed by the tenderer and alternative if any, to meet the requirement, shall be indicated along with cost.

7.0 PART COMMISSIONING OF SECTION:

It may not be possible to commission the complete section in one go because of various constraint. The commissioning of part section may be resorted to. For the purpose of signaling for impulsing in overhead control (2 wire) territory, 4W DTMF to 2W Conventional Signaling Conversion equipment or E&M signaling shall be used. Alternatively the impulsing selectors in 2W O.H. territory shall be replaced by DTMF decoders and only speech conversion unit provided at Junction Station.

8.0 RADIO PATCHING ARRANGEMENTS:

The optical fibre channels shall be interfaced with Railways Microwave/UHF channels or rented channels from DOT which support E&M signaling for important circuits. In the event of failure in the optical fibre transmission system the continuity of communication shall be maintained by automatic radio patching equipment as per spec. No.IRS-TC-59-93 with latest amendment. Necessary interface and other equipment including the signaling arrangements shall be provided by the contractor within the cost. This facility is envisaged for six omnibus E & M conference circuit. The radio channels shall be provided by Railways. The technical details of proposed interface shall be submitted by the tenderer.

9.0 MOBILE TRAIN RADIO & UNIVERSAL EMERGENCY COMMUNICATION:

The OFC system shall support interfacing of mobile train radio & universal emergency communication system for extending the communication to control office on omnibus VF channels from their base stations. The interface required in STM equipment shall be indicated along with cost as optional item. Any restriction on this account shall be explicitly brought out. The universal emergency communication is simplex communication from running train to every Railway station (10 to 15 Km.) extendable to control office on optical fibre system. The mobile train radio is duplex communication from running train to their base station at every 40-50 Kms. which is extended to control office on OFC system.

10 NETWORK MANAGEMENT SYSTEM

- 10.1 A common comprehensive NMS with uniform alarm & with single software application, which can monitor and control all network arrangements for the SDH system & Primary MUXs shall be supplied along with the system.
- 10.2 The common comprehensive NMS system shall be provided for remote programming, monitoring the performance and display of faults of the optical fibre cable, STM-1 and multiplexing equipment from a centralized location for the SDH system.
- 10.3 The network management will offer the OAM&P (Operation, Administration, Maintenance and Provisioning) functions. All the equipments supplied shall be manageable by an integrated single NMS. The NMS shall deliver end-to-end network management. It shall be of open architecture and shall have built in supervisory facilities for monitoring health of various stations automatically. The NMS shall provide following functionality:
- a) Intuitive graphical user interface.
 - b) Point-and-click provisioning to create/tear down VC-12, VC-3, VC-4 protected/unprotected end- to-end circuits.
 - c) Unified management of different transport layers.
 - d) Support for TMN functionalities such as fault management, configuration management, administration, performance management and security (FCAPS).
 - e) Customer Network Management services must be enabled that allows the service provider customers to be able to monitor their resources.
 - f) Optical VPN service must be enabled that allows service providers and their customers to establish and monitor their virtual topologies and circuits.
 - g) Availability to query the nodes and obtain the available resources in the network as well as the current list of end-to-end circuits in the network.
 - h) Support for change of date and time setting of multiple NEs.
 - i) Support for addition and deletion of network elements.
 - j) Hot stand-by support shall be there.
- 10.4 The NMS system shall be controlled by a master terminal at a control station. All stand-bys and remote terminals shall act as a slave to this master control terminal. There shall be constant intelligent communication between the master control terminal and the dependent and other station repeaters.
- 10.5 There shall be a possibility to connect the equipment simply using a standard workstation or PC (Desk Top or Laptop) with a compatible Web browser and an Ethernet or RS-232 port using a modem. The connection shall be possible:
- 10.5.1 Locally through a 10 Base T/100 Base T interface on the equipment shelf
- 10.5.2 Remotely through a TCP/IP network, using
- a. A 10BaseT/100BaseT interface, such as intranet or public internet.
 - b. Dial up modem connections, using PPP/RS-232 interface to the equipment shelf.

10.6 The first work station i.e. master terminal station and second work station i.e. standby terminal station (which shall be in hot standby mode) shall be PC based with SVGA colour monitor and have all necessary line interface & peripherals. The PC shall be capable of continuous uninterrupted working. A printer shall be provided with supervisory system for hard copy of various alarms generated with time and address of repeater/MUX equipment, print out of various parameters of system on demand etc. The specifications for each PC workstation shall be of following or higher configuration, (As per Clause No. 11 of RDSO Specification No. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No.3 or latest.)

- a. CPU : Intel Core i5-12400 (12th Gen, 2.5 GHz, 6 cores, 12 threads)
- b. CACHE : 32-36 MB Intel Smart Cache or 16 MB L3 (AMD)
- c. RAM : 64 GB DDR5-5600 MT/s (or DDR4-3200 minimum)
- d. Hard disk : 1TB NVMe M.2 SSD (PCIe 4.0) or 2×1TB SSD RAID 1
- e. Ports : Min.1 enhanced parallel & Min 2 serial port + min 4 USB ports
- f. Monitor : 24" wide screen LCD monitor or higher
- g. Modem : 2 Mbps internal modem
- h. Graphics : Dedicated NVIDIA RTX 3050/4060 or AMD Radeon RX 6600/7600 (4-8 GB)
- i. Printer : one no. A3 size Inkjet printer, HP make or Equivalent
- j. Operating system : Windows 11 Pro (64-bit) or RHEL 9.x / Ubuntu 24.04 LTS
- k. Key board : USB Multimedia Keyboard (with media keys)
- l. Mouse : USB Optical Mouse (with scroll wheel)
- m. UPS : On Line UPS 2KVA with 1 hour battery backup.
- n. Network Ethernet Card : 2.5 Gigabit Ethernet (10/100/1000/2500 Base-T)
- o. Backup for NMS Software : Digital backup (ISO on USB 3.0/external SSD) or CD/DVD (This is additional requirement, other than NMS supplied in two PC workstation).

10.7 Standard Computer furniture i.e. Two PC tables, Two Printer tables, Two revolving chairs & two side racks etc, of Godrej Make or superior shall be provided within the cost of NMS.

10.8 The maintenance portable terminals should also be capable of comprehensive management of all network element. It should be possible to use maintenance portable terminal from any of the station on the network. It should be possible to connect maintenance portable terminals to any network element. Maintenance portable terminals shall be common for management of the SDH network elements. It shall be possible to connect these terminals to any network element of the system for comprehensive arrangement of the local node as well as any element on the entire element. The maintenance portable terminals shall be with following features: (As per Clause 8.7 & 8.9 of RDSO Specification No. RDSO/ SPN/ TC/ 99/ 2012 Rev.2 or latest.)

- a. CPU : Intel® Core™ i5-1240P or i5-1335U (12th/13th Gen, 10 cores)
- a. RAM : 16 GB: LPDDR5, 5200 MT/s (onboard), dual-channel
- b. Hard Disk : 1 TB, PCIe x2 NVMe, SSD integrated
- c. Port : USB 3.0 Ports-2, HDMI Ports-1 & LAN Port-1
- d. Monitor : 13.4", FHD+ 1920x1200, 60Hz, Non-Touch, Anti-Glare, 500 Nit, Infinity Edge
- e. Operating system : Windows 11 or higher
- f. Power back up : Internal Battery Pack with min. TWO hours backup or higher.
- g. Carrying Case : Superior quality leather bag with hand and Shoulder strips.

10.09 Supervisory path should be realized on the overhead bits of optical link and no separate channel will be allocated.

10.10 System should be capable of monitoring all Alarms of all the OFC equipment Minimum two auxiliary Alarms like low Battery Voltage, 230V mains and temperature etc. should also be monitored by the system. The required interfaces shall also be provided by the contractor within the cost.

10.11 System should be capable to configure, supervise and measure all the important parameters of all the OFC equipment including PDMUX in the link (VF interfaces level) from central station as well as locally.

10.12 All information from slave stations are monitored and displayed on the master stations terminal. Incoming messages are processed and displayed on the monitor in text form. Any change of status will be recognizable through available indication. Commands to slave stations are given from the keyboard and command feedback messages are displayed.

11 TECHNICAL LITERATURE & INSTRUCTION BOOKS

- 11.1 The purpose and scope of the Instruction Books shall be for the guidance of the personnel who shall install, commission, operate and maintain the equipment. The books shall be in English or Hindi Language.
- 11.2 The information contained in the Instructions shall be such as to convey a thorough understanding of the operation of the equipment so that improper functioning may be readily detected and corrected.
- 11.3 The Instruction Books shall give all the 'Dos' and 'Don'ts' boldly so that the personnel without much of knowledge of theory and design of opto-electronic equipment can prevent failures and also locate the faulty stages. The wordings shall be clear, concise and free from ambiguities and duplications.
- 11.4 The Instruction Books shall enlist all the safety precautions to be taken by personnel employed in the installation or maintenance of the equipment specially with respect to transmission with laser.
- 11.5 Part lists and typical test data shall be included in the Instruction Books.
- 11.6 In addition to the schematic diagrams of complete equipment and detailed description with circuit diagrams of the sub-assemblies of various stages, a complete detailed circuit diagram of the equipment with appropriate markings for the block containing such circuits in the equipment shall also be furnished in the Instruction Books. Such detailed circuit diagram shall contain the voltages and levels at various points.
- 11.7 Maintenance procedure, trouble shooting details giving symptoms and remedies shall be included in the Instruction Books.
- 11.8 Detailed installation procedures, drawings, spelling out the correct type of equipment connections etc. shall be included.
- 11.9 Testing & Measurement procedures and the parameters to be measured, monitored shall be included.

12 DESCRIPTION OF THE NATURE AND WORKING OF OMNIBUS VOICE CIRCUITS WITH SELECTIVE CALLING:

- 12.1 DTMF (Dual Tone Multi Frequency) Signaling is proposed to be used for selective calling in V.F. control circuits. The control office equipments and way station equipments shall be as per IRS TC 60/93 (latest). The control office equipment shall be located in Control Office with the respective controller and way station equipments shall be provided to various users in different stations in the section under consideration. Block Schematic diagram is available as Drg. No. CORE/S&T/ALD/SK/440/96 Annexure 2.2.

12.2 The Control Office will have the facility of calling any particular way side station through the use of selective calling equipment with a pre-determined code for the way side station control telephone whereas the way side station will establish connection by lifting the telephone and speaking into the telephone at way-station control equipment.

12.3 The relevant parameter of DTMF control office equipment (IRS TC 60/93) are mentioned here under:

- (i) Input and output impedance 1120 or 600 +/- 10%
- (ii) Frequency response +/-3dB from 300 Hz to 3400Hz with reference to 1 KHz and output 0dbm.
- (iii) Trans level -20 dbm to 0dbm (adjustable)
- (iv) Receive level-20 dbm (nominal).
- (v) DTMF Signaling level 0 to -16 dbm (adjustable). Signaling level shall at least 8dB below speech level.
- (vi) Working voltage 12V DC (nominal).
- (vii) Current drain 150 mA. (quiescent condition).500 mA max.

12.4 The relevant parameters of 4 wire/2 wire way station equipment are mentioned hereunder:

- (i) Input impedance : high
- (ii) Frequency response +/- 3 dB on 300 to 3400 Hz. with reference to 1 KHz and output 0 dBm.
- (iii) Trans level 0dBm to -15 dBm (adjustable).
- (iv) Receive level -2 dBm to -17dBm.
- (vi) Working voltage 12V dc (nominal).
- (vii) Current drain 25mA (quiescent condition), 150mA max.
- (viii) Bridging loss 0.1 dB with handset 'ON' the cradle. 0.3 dB with handset 'OFF' the cradle. 1.0 dB with 'press to talk' pressed.
- (ix) Return loss better than 20dB.

13.0 POINT-TO-POINT CIRCUIT

13.1 The system design shall be such that the circuit shall not extend beyond the two points under any circumstances. It shall be possible to use conventional auto telephones at either end for establishing this communication without any additional interface.

14.0 SUPERVISORY REMOTE CONTROL AND DATA ACQUISITION SYSTEM (SCADA)

14.1 The 25 KV 50 Hz overhead traction equipment has a number of circuit breakers/interrupters located at feeding posts, sectioning posts, sub-sectioning posts along the electrified railway track for controlling power supply to various sections of traction overhead equipment (OHE).

These equipments are remotely controlled from the Remote Control Center through computer based SCADA (supervisory Remote Control and Date Acquisition System). The SCADA also monitors the status of various equipments by collecting in formation and data relating to 25 KV traction power supply on real time basis.

14.2 The system works on two pairs of wires when main underground copper quad cable is used. One pair is used for transmitting commands/data (send channel) and other pair is used for receiving information/data (receive channel). The system employs Trans-receive frequencies within the band of 420 - 2460 Hz, with operating speed not exceeding 1200 Baud in accordance with CCITT recommendations. Transmission characteristics are as follows:-

- a) Common send and receive channels are utilized for all the controlled stations within the above frequency range.
- b) Frequency shift Keying (FSK) modulation of carrier frequency is utilized for transmission of both send and receive channels.

14.3 The remote control channel in the proposed optic fibre cable will be used to work the remote control Systems. As the RTUs at FP/SP/SSPs may be upto 2 kms away from the optical drop insert location at the station VF channel suitably configured is envisaged in OFC system. The data shall be extended from optical cable hut at station to RTUs on 0.63 mm PIJF cables/0.9 mm 6 quad cable. Arrangement is required to be made to ensure that the data generated and transmitted by various RTUs (Remote Terminal Units) of SCADA does not interfere and corrupt the date. Adequate isolation between trans and receive channels shall be provided.

15.0 EMERGENCY CONTROL CIRCUIT

15.1 The purpose of this circuit is to enable any person like a driver or guard or a maintenance engineer to talk to the remote control centre/control office. This is proposed to be achieved by providing emergency sockets located by the side of the railway track approximately every kilometer on the 4 quad copper cable laid along with optical fibre cable. These sockets are connected to two pairs of the cable system through isolating transformers. By plugging in a portable control telephone, the conversation is established. Voice operated signaling is employed for drawing attention of the Control Office. The emergency circuit on 4 Quad cable is dovetailed with optical fibre system at drop-insert location in every station.

15.2 One 4-wire omnibus channel configured on F.O. System is dropped at all stations.

Emergency circuit is fed from both side end stations. Isolation transformer (470:600 Ohm) shall be used at both the terminating stations. The Emergency sockets shall be derived through derivation transformers (470:1120 Ohm).

15.3 With the digital drop insert MUX having three way conference facility arrangements as per Drawing No.CORE/S&T/ALD/SK/441/96 be adopted. Separate Hybrid circuit is used to combine VF Signal coming from either end.

15.4 In case the digital drop insert MUX has multiple conference facility arrangement as detailed in Drawing No.CORE/S&T/ALD/SK/443/96 may be adopted. No hybrid network is required.

15.5 With above arrangements practically no loss connection would be possible:

- a) From controller to emergency location and vice versa,
- b) From any emergency location to another emergency location.
- c) The emergency connection would be possible even in case of failure/damage of cable or the failure of optical fibre system (optical cable or MUX).

- 15.6 The above arrangement of Emergency Communication would support another radio patching. Patching arrangement will be used to patch emergency circuit on Railway analogue microwave circuit or on DOT hired circuit from ends.
- 15.7 The 6 Quad cable need not be bifurcated in the mid section. No leak amplifiers are required.
- 15.8 The emergency control room equipment as per IRS. TC 61-93 suitable for use with Quadded main telecom. cable shall be provided with the emergency controller. This shall be required to be suitably interfaced with optical fibre system. The relevant parameters of emergency control room equipment are mentioned hereunder:
- a) Input and Output Impedance : Fairly high output of combining amplifiers. impedance 1120 ohm.
 - b) Output level of microphone - 10db. amplifier across a load of 1120 ohm.
 - c) Frequency response at+/-1db. - range of 300Hz. to 3.4KHz.

16.0 MEASUREMENT FOR FIBRE OPTICAL COMMUNICATION SYSTEM

- 16.1 The measurement & test protocol for all the equipments and complete system shall be provided by the contractor & finalised in consultation with Railways. The Performa shall contain max/min & nominal values of parameters. The measured values shall be recorded for each location.
- 16.2 In general the measurement and test protocol for all the equipment and complete system shall be as per para 14 of SCC and the latest guidelines detailed by RDSO.

17.0 Measurement for Optical Fibers and Cables:

- 17.1 The various optical and mechanical test which are to be conducted on optical fibbers and on finished cable during the prototype tests and acceptance test are detailed in the IRS specification for armoured fibre optic cable. Most of these tests are for ensuring the quality during the manufacturing process and only the attenuation measurement is required to be conducted during the installation and maintenance. The attenuation in optical fibre is due to absorption process, scattering mechanism and wave guide effects. The equipment used for this is called optical time domain reflectometer (OTDR). With this techniques in addition to the attenuation of fibre, following are also arrived at :-
- Distance of splices and splice loss.
 - Length of optical fibre.
 - Location of fault.
- 17.2 The OTDR uses the scattering properties of the fibre to map the way in which light intensity decays in cable. The pulse of light with a short time duration is launched into

fibre. The optical pulse is attenuated due to Raleigh scattering which is caused by non-uniformities in the core of the cable. Some of the optical pulse is transmitted forward in the direction of propagation of the incident light and some is scattered back in the direction that it comes from. The later is called back scattered light. The back scattered pulse is also attenuated while traveling in the backward direction. Thus the resultant attenuation is twice over any given length of fibre.

17.3 The schematic block diagram for OTDR is illustrated in Drg. No. CORE/S&T/ALD/SK/444/96. By sampling the resulting exponential wave form at different position in time, the attenuation coefficient can be determined. Back scattered trace of six fibres section totaling about 20 kms is illustrated in above Drg.

18.0 MEASUREMENT OF OPTICAL LINE TERMINAL EQUIPMENT:

18.1 Optical line terminal equipment consist of optical transmitter to convert digital electrical signal into optical signal and optical receiver to convert optical signal into digital electrical signal. The following parameters are required to be measured.

- Optical output power.
- Bit error rate Vs. optical received power to measure receiver sensitivity and dynamic range.
- Jitter characteristic including jitter immunity, residual jitter and jitter transfer function.

The procedures and set up of above tests are discussed below:-

18.2 BIT ERROR RATE v/s OPTICAL RECEIVED POWER:

- i) This test is used for measurement for receiver sensitivity which indicates the minimum power for receiver at desired minimum bit rate and dynamic range of receiver which indicates the saturation level of the receiver.
- ii) Test setup of this measurement is indicated in Drg. No.CORE/S&T/ALD/SK/445/96.
- iii) In this send and receive side are connected back to back through variable optical attenuator and digital signal is sent through PRBS generator and on the receive side the digital error detector is connected to observe the errors/bit error rate.
- iv) Optical input level is reduced and bit error rate is observed.
- v) The receiver sensitivity shall be minimum optical power for the specified residual error rate.
- vi) To determine upper or saturation threshold of the receiver the input power is increased up to the point where bit error rate starts increasing. In some cases for this measurement eye pattern is observed on CRO instead of BER measurement to arrive at the power at which eye pattern starts closing indicating the saturation level. The dynamic range is the difference between the saturation level and the receive sensitivity.

18.3 JITTER MEASUREMENT

There are three jitter specification specified in CCITT.

- Residual output jitter.
 - Jitter tolerance of input port.
 - Jitter transfer function.
- i) The CCITT limits for maximum permissible jitter, jitter immunity and jitter transfer characteristics are to be followed.
 - ii) The test set up for the measurement of jitter is indicated in Drg. No.CORE/S&T/ALD/SK/445/96. Optical attenuator is adjusted to keep optical received power near the receiver sensitivity level.
 - iii) Residual output jitter is measured by transmitting unjittered PRBS and measuring output jitter in the receiver with various filters.
 - iv) Jitter Transfer Function is measured at various jitter frequencies. Jitter frequency is fixed and amplitude of jitter is increased until bit error rates are observed in receiver and the curve is plotted to see that it is above the CCITT Mask.
 - v) To measure jitter transfer function, input jitter amplitude is fixed to about 1 UIPP and output jitter for various frequency are measured selectively to calculate jitter transfer from input port to output port and the same is plotted to see that curve is out side the CCITT mask.

19.0 PRIMARY MULTIPLEXER

- 19.1 For primary MUX in addition, analogue/digital test on various types of interface (2W / 4W / Exch / Subscriber / interface) is required to be performed. The list of various tests to be conducted on 2W/4W voice interface shall be as per CCITT Recommendation and RDSO report STT-23.

20.0 SYSTEM TEST

- 20.1 After commissioning of the system end to end, various tests and measurements shall be conducted as per para 14 of SCC and latest guidelines detailed by RDSO. In addition, the clock jitter is to be measured with various filters to see that it is within the maximum limits specified by CCITT.
- 20.2 For digital links such as fibre optic, the quality is adjudged by assessing error performance. Digital system uses 64 Kbit for the transmission of voice and data circuit, as such CCITT has defined the standard link called hypothetical reference connection to specify the performance of individual 64 KBPS channel for long digital section.

**INSTRUCTIONS ON EARTHING OF TELECOM. EQUIPMENTS IN
25 KV, 50 Hz AC ELECTRIFIED SECTIONS.**

<u>Para No.</u>	<u>Subject.</u>
1.	General.
2.	Objective.
3.	Soil Resistivity.
4.	Earth Resistance.
5.	Limits Of Earth Resistance.
6.	Resistance Of Earth Electrode.
7.	Earth Electrodes.
8.	Earth Wires And Leads.
9.	Location Of Earth Electrodes.
10.	Multiple Earth Electrodes.
11.	Arrangement for Ring Earth.
12.	Measurement of Earth Electrode Resistance.
13.	Measurement of Earth Resistivity.
14.	Maintenance and Testing of Earths.

INSTRUCTIONS ON EARTHING OF TELECOM. EQUIPMENTS IN 25 KV, 50 Hz AC ELECTRIFIED SECTIONS

1. GENERAL

These instructions cover the technical requirements and complete earthing arrangements for Optical Fibre Cable / Telecom. Cable Communication System and associated equipments in RE area on Indian Railways.

Reference is made to the following:

- i) The CCITT report on "Earthing of Telecommunication installations 1976".
- ii) The CCITT report on "The Protection of Telecommunication Lines and equipment against lightning discharges".(Chapter 6,7 & 8) 1978.
- iii) CCIR Report 932 - "Protection of Radio Relay stations against Lightning discharges."
- iv) RDSO/SPN/317/84 dated 25.10.85 "Code of Practice for the protection of Radio Relay stations against lightning ."
- v) RDSO No. S&T/EARTH dated 10.5.74 "Instructions on earthing for signalling and telecommunication equipment.

2. OBJECTIVE -

The object of the earth may be one or more of the following :-

- i) To provide a return path as for example in block instruments, unbalanced HF serial circuits etc.
- ii) To afford safety to personnel against shock by earthing the casing or other exposed paths.
- iii) To protect equipment against build up of unduly high voltages by earthing protective devices like surge, arrestors and lightning dischargers.
- iv) To ensure safe and reliable operation of equipment by eliminating / limiting induced voltages by earthing of metallic sheathing and armouring of cables.
- v) To provide path for heavy fault currents to ensure effective and quick operation of protective devices, as in power supply induced systems.

3 SOIL RESISTIVITY

- i) The resistivity of soil depends upon the moisture content, chemical composition of the soil and concentration of salts dissolved in the contained moisture. Grain size, mode of distribution and closeness of packing also affect the resistivity as these factors control the manner in which the moisture is held in soil. Many of these factors vary locally and some seasonally, and as such soil resistivity varies not only from location to location but also from season to season. Besides, the areas where the soil is stratified, the effective resistivity also depends upon the underlying geological formation.
- ii) Temperature also affects the resistivity of the soil. However, it is of consequence only around and below the freezing point, which means that earth electrodes should be installed at depths where frost cannot penetrate.

4 EARTH RESISTANCE

- i) The total resistance of an 'earth' is the sum of three separate resistance, (a) the resistance of the conductor joining the earth electrode to the installation (b) the contact resistance between the surface of the earth electrode and the soil, and (c) the resistance of the body of soil surrounding the earth electrodes.
- ii) Normally the first two resistance are negligibly small compared with third, so the resistance of an 'earth' is primarily determined by the nature of soil and not by the electrode itself.

5 LIMITS OF EARTH RESISTANCES

Maximum values of earth resistances specified for earthing signalling and telecommunication equipment are as under:-

i)	Telegraph and Block instrument return circuit earths.	Should not be more than 10(ten)ohms.
ii)	Earths for surge arrestors / lightening dischargers for S&T equipment.	Should not be more than 10(ten)ohms.
iii)	Equipment earth for optical fiber cable huts.	Should not be more than 1(one)ohms.
iv)	Telephone exchange earths.	Should not be more than 5 (five)ohms.
v)	Aluminium sheathed Telecom. cable screen earths in AC electrified areas.	Should not be more than 1 (one)ohms.
vi)	Equipment earth in VF Repeater Station.	Should not be more than 5 (five) ohms.

6 RESISTANCE OF EARTH ELECTRODE

The resistance of the pipe and driven rod electrodes may be calculated from the following formula:

$$R = \frac{100 P}{2 \pi L} \log_e \frac{4 L}{d}$$

Where,

P= Resistivity of soil in ohm-meter.

L= Length of the rod or pipe in cm. and d= diameter of rod or pipe in cm.

$$\pi = 22/7$$

The above formula shows that the resistance to earth of a driven rod/pipe electrode depends to a larger degree upon its buried length and to a lesser extent upon its diameter. The resistance of these electrodes in a soil of uniform resistivity decreases with depth but there is little to be gained by driving the rod to more than 3 to 3.5 meters. Also the decrease in the resistance

with increase in rod diameter is not significant. It is, therefore, recommended to use the rod electrodes of such diameters as can easily withstand the strain of driving.

7. EARTH ELECTRODES

Earthing arrangement shall normally consist of :-

- 7.1 One or more galvanized iron pipes of not less than 38 mm internal diameter and not less than 2.5 meter in length with a spike at one end and arrangement at the other for connecting the earth lead (RDSO Drg. No. TCA-565(Adv) with latest amendments for outdoor works (Annexure 8.1)/ Drg. No.CORE /S&T/ALD/SK/430/95 for indoor works. The Pipe shall be embedded vertically after first digging a pit of 70 cm deep leaving the top of the electrode 30 cm above the bottom of the pit.
- 7.2 Galvanized iron/steel rods of not less than 16 mm dia or copper rods of not less than 12.5mm dia and not less than 2.5 meter length. The rod electrodes are driven vertically in the ground.
- 7.3 When rocky soil is encountered at a depth of less than 2.0 metres or the length of the electrode, the electrode may be buried inclined to the vertical, the inclination being limited to 30 Deg. from the vertical.
- 7.4 Earth electrodes shall not be buried in a position likely to cause an obstruction or where it is likely to be damaged.
- 7.5 Earth resistance and date of last testing should be painted suitably on the earth pipe / earth pit or wall of a nearby structure or post on a conveniently placed sign board.

8. EARTH WIRES AND LEADS

- i) EARTH WIRES shall be protected against mechanical damage and possibility of corrosion particularly at the point of connection (welding between GI pipe and flange) of earth electrode either by providing painting or covering with tar.
- ii) The earth wires should be 35 mm² galvanised stranded steel wire and connected to earth bus bar in the equipment room with metallic clamp. The steel wire rope shall be connected with galvanised steel lug to the galvanised steel flange, which is welded on G.I. pipe.
- iii) In case the conductor is buried underground, it should be protected from corrosion by an application of suitable anticorrosive paint or bitumen or varnish. The length of the cable so treated should extend half a meter beyond the buried length.
- iv) The earthing leads should be of 16 mm² standard copper wire and shall connect all equipment earthing points i.e. battery charger, MDF etc. to the copper bus bar of earth.
- v) The released Railway Signalling Copper cable 1.5 mm² copper conductor stranded together with net dia of more than 16 mm Square may be used for earth wire & leads in place of steel wire.

9. LOCATION OF EARTH ELECTRODE

- 9.1 While the fundamental nature and properties of a soil in a given area can not be altered, local conditions can be utilised in choosing suitable electrode sites as also a method of preparing the site selected to secure an optimum resistivity in strata under the surface loam, clay and lime stone have lower resistivity, while sandy and rocky soils have higher resistivity. Therefore, the site for earthing should be chosen in the following order of preference:
- a) Wet marshy ground and grounds containing refuse, such as ashes cinders and brine waste.
 - b) Clayed soil or loam mixed with varying quantities of sand.
 - c) Clay and loam mixed with varying proportions of sand, gravel and stone, and
 - d) Damp and wet sand pit.
- 9.2 A site should be chosen which is naturally not well drained. A water logged situation, however, is not essential unless the soil be sand or gravel as in general no advantage results from an increase in moisture content above about 15 per cent to 25 percent. Perennial wells may also be used as sites for earth electrodes with advantage where the bottom of the earth is rocky.
- 9.3 Electrodes should preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. Where practicable the soil should be shifted and lumps should be broken up and stones removed in the immediate vicinity of the electrodes.
- 9.4 Recourse may be had to chemical treatment of soil to improve the conductivity. Common salt is generally used for this purpose and the addition of less than one part of weight of salt to 200 of soil moisture has been found to reduce the resistivity of 80 percent but there is little advantage in increasing the salt content above 3% Calcium Chloride, Sodium Carbonate and other substances too have been found beneficial. But before chemical treatment is applied, it should be verified that no deleterious effect on the electrode will result.
- 9.5 Use of land should be made where possibility of natural salts in soil produced by bacteriological action on decaying plants. The resistivity of the soil on which plants are growing will be lower than that of a similar soil in the absence of plants.
- 9.6 In places where the soil is extensively corrosive, the soil may be chemically examined before deciding the material of the earth electrode.
- 9.7 As far as possible, the earthing arrangement should be located in the natural soil. The made up soil which has not consolidated or is likely to be eroded by weather, should be avoided.

10. MULTIPLE EARTH ELECTRODES

- 10.1 In the sections where earth resistivity is high, it may not be possible to get the desired value of earth resistivity by single pipe earth even after treatment. Two or more earths may be made and connected in parallel by the Galvanised steel wire rope arrangement to obtain the value of earth resistance within acceptable limits. In lightening prone areas, the ring earth is required to be provided.
- 10.2 Where more than one earthing arrangements are employed, the distance between earthing electrodes shall not be less than **three meters**. The earthing leads for separate earthing

arrangements should be electrically insulated from each other throughout and also from metallic structures in contact with the different earthing arrangements.

- 10.3 The minimum clearance of equipment earth from H.T. system earths provided by the Electrical Department either of the Railways or of the other Administrations should be **twenty metres**.
- 10.4 The telecom. equipment earth in cabins may be connected to lever frame earth or earth provided for the signalling equipments.
- 10.5 There should not be any possibility of simultaneous human contact with metallic bodies connected to different earthing. Wherever it is not possible to provide suitable spacing for partition between various metallic bodies, they must be connected to a common earthing.

11. **ARRANGEMENTS FOR RING EARTH**

- 11.1 The ring earth for OFC installations shall consist of minimum four Nos. of pipe earth (40 mm dia) or Angle iron (50mm x 50mm x5mm) electrodes buried in circle of approx. 5-6 Meter Dia, preferably encircling the building. The number of electrodes may be increased to 6 or 8 nos. for covering larger area buildings or radio towers etc.
- 11.2 The earth electrode shall be connected with each other in a horizontal ring form using a trench electrode made of galvanised steel wire rope 17x7 (6/1) (WSC) type with 12mm nominal diameter conforming to IS 2266:1989. The minimum breaking load of the wire rope shall be 74 KN Min. The galvanising shall confirm to type A of IS 1835:1976. The trench electrode shall be buried at least 800 mm. below the surface.
- 11.3 Suitable galvanised mild steel clamp with galvanised steel nuts and bolts arrangement shall be made to connect trench electrode with earth spikes. The connections shall be mechanically firm and electrically good. The arrangement shall be approved by Railway Engineer.
- 11.4 The earth ring shall be connected at least from four electrodes to earth collector copper bar in the building using released Railway Signaling cable, 1.5mm square copper conductor stranded together to give effective diameter of min. 16 mm sq duly crimped in Galvanised steel lug min. 75 mm sq. The cables shall be buried min. 800 mm below the surface.
- 11.5 The earthing for the tower, equipment, antenna wave guide, OFC & Copper cables and power supply to the system etc. shall be common.

12. **MEASUREMENT OF EARTH ELECTRODE RESISTANCE (FALL OF POTENTIAL METHOD).**

In this method two auxiliary earth electrodes besides the test electrode are placed at suitable distances from the test electrode. A measured current is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C' and the potential difference between the electrode 'A' and the auxiliary potential electrode 'B' is measured.

The resistance of the test electrode 'A' is then given by $R=V/I$ where; R= resistance of test electrode in ohms.

V=reading of the voltmeter in volts I=reading of the ammeter in ampere.

13. MEASUREMENT OF EARTH RESISTIVITY

- 13.1 Earth tester normally used for these tests comprise the current source and meter in a single instrument and directly read the resistance. The most frequently used earth tester is the four terminal megger shown in Annexure 7.2. The resistivity may be evaluated for equation:

$$\rho = \frac{2 \pi S R}{22/7}$$

ρ = resistivity of soil in ohm-metres.
 S = distance between successive electrodes in metres.
 R = Megger reading to ohms.

13.2 TEST PROCEDURE

At the selected test site, four electrodes are driven into the earth along a straight line in a chosen direction at equal intervals (unequal spacing may also be used but this will make the formula unnecessarily complicated). The depth of the electrodes in the ground shall be of the order of 10 to 15 cm. The megger is placed on a steady and approximately level base, the link between terminals P1 and C1 opened and the four electrodes connected to the instrument terminals as shown in the figure. An approximate range on the instruments is then selected; to obtain clear readings, avoiding the two ends of the scale as far as possible. The readings are taken while turning the crank at about 135 revolution / min. Resistivity is calculated by substituting the values of 'R' in the equation $\rho = 2 \pi S R$.

14. MAINTENANCE AND TESTING OF EARTHS

- i) Earths should be watered regularly.
- ii) All earths and connections should be examined at interval of not more than one month, to ensure that all connections are intact and soldered joints are in proper conditions.
- ii) Resistance of every earth should be measured at intervals not exceeding one year. Earth resistance, date of last test and location of earth should be entered in maintenance register.

INSTALLATION OF JOINT CLOSURE & SPLICING OF OFC

1. Following types of techniques are used for splicing of fibers:
 - a) **Mechanical Splicing:** This aligns the axes of the two fibers to be joined and physically holds 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, pre-aligned fiber ends, causing them to soften and fuse together.
 - i.) Mechanical splicing should be used for temporary splicing of fibers and shall be housed in Joint Enclosure.
 - ii.) At all other locations and during initial installation of fiber optic cable, fusion splicing should be adopted.
 - iii.) The decision of Engineer-in-Charge shall be final and binding in this regard.
2. STRAIGHT JOINT FOR FIBRE OPTIC CABLE:
 - 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.
 - The Optic Fibre straight through joint closure shall be of TVSE, R&M, Raychem, 3M make and shall be approved in advance by Railway. The joint shall be protected in concrete chamber as approved by engineer-in-charge.
 - However, generally, the following steps are involved for jointing of the cable.
 - a) Preparation of cable for jointing
 - b) Stripping/cutting the cable
 - c) Preparation of cable and joint closure for splicing
 - d) Fibre splicing
 - e) Organizing fibers and finishing joints
 - f) Sealing of joint closure and
 - g) Placing joint in pit.

3. PREPARATION OF CABLE FOR JOINTING

- 3.1 During the installation, a minimum of 10 meters 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.
- 3.2 The pit size must be chosen carefully to ensure the length of the way 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.
- 3.3 The cable is then coiled on to the pit wall in the same position as required after the joint is complete. The marking is done on all the loops so that it will be easier to install it later.
- 3.4 The distance from the last centre to the end of the cable must be atleast 1.8 meter. This is being the minimum to be stripped for preparation of joint.
- 3.5 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

- 4.1 The cable is stripped of their outer and inner sheath with each sheath staggered approximately 10mm from the one above it.
- 4.2 Proper care must be taken when removing the inner sheath to ensure the fibers 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 sides of the cable, rather than cut completely through it. The two scores marking on either side of the cable are then stripped of the inner sheath by hand quite easily.
- 4.3 The fibers 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 fiber organizer used. However, the following steps are usually common:

- 5.1 The strength members of each cable are joined to each other and/or the central frame of the joint closure.
- 5.2 The joint closure is assembled around the cable.
- 5.3 The heat shrink sleeve is applied to the cables and closure or prepared for application after splicing is complete.
- 5.4 The fibers are protected (usually with plastic tubing) in their run from the cable core to the fiber organizer trays (particularly if cable construction is slotted core type).
- 5.5 Tags which identify the fibers nos. are attached at suitable locations on the fibers.
- 5.6 Splice protectors are slipped over each fiber in readiness for splicing over the bare fiber after splicing.

6. STRIPPING AND CLEAVING OF FIBRE

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

7. SPLICING OF THE FIBERS

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

8. FUSION SPLICING OF THE FIBER

Some of the general steps with full automatic microprocessor control splicing machine are as under:

- 8.1 Wash hands thoroughly prior to connecting this procedure.
- 8.2 Dip the clean bare fiber 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).
- 8.3 Place the bare fiber inside 'V' groove of the splicing machine by opening clamp handle such that the end of fiber is app.1 mm. over the end of the 'V' groove towards the electrodes.
- 8.4 Repeat the same procedure for other fiber, however first insert heat shrink splice protector.
- 8.5 Press the start button on the splice controller.
- 8.6 The machine will pre fuse, set align both in 'X' and 'Y' direction and then finally fuse the fiber.
- 8.7 Inspect the splice on monitor if provided on the fusion splicing machine and assure no nicking, bulging is there and cores appear to be adequately aligned if the splice does not visually look good repeat the above procedure.
- 8.8 Slide the heat shrink protector over the splice and place in tube heater. Heat is complete when soft inner layer is seen to be 'oozing' out of the ends of the outer layer of the protector.
- 8.9 Repeat the same procedure for all the other fibers.

9. MECHANICAL SPLICING OF THE FIBER

In this there are two types of splicing system, one with precision alignment of fiber 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 the above are as under:

- 9.1 Stripping and cleaving of fibers is to be done
- 9.2 Remove protective end cap from mechanical splice and pull out vent tube.

- 9.3 Inject adhesive as specified by supplier into splice.
- 9.4 Insert fiber until it butts against fiber end already bonded in place.
- 9.5 Cure adhesive with UV light following exposure times as indicated by supplier, if required.
- 9.6 Repeat the same procedure for all the fibers.

10. ORGANISING FIBER AND FINISHING JOINTS

- 10.1 After each fiber is spliced, the heat shrink protection sleeve must be slipped over the bare fiber before any handling of fiber takes place, as uncoated fibers are very brittle and cannot withstand small radius bends without breaking.
- 10.2 The fiber is then organized into its tray by coiling the fibers on each side of the protection sleeve using the full tray side to ensure the maximum radius possible for fiber coils.
- 10.3 The trays are placed in the position.
- 10.4 OTDR reading taken for all splices in this organized state and recorded on the test sheet to confirm that all fibers attenuation are within 0.1 db per splice. This OTDR test confirms fibers were not subjected to excessive stress during the organizing process.
- 10.5 After this the joint can be closed with necessary sealing etc and ready for placement in the pit.

11. PLACING OF COMPLETED JOINT IN PIT

- 11.1 Joint is taken out from the vehicle and placed on the tarpaulin provided near the pit.
- 11.2 The cable is laid on the ground, loop the cable such that pen mark previously place on the cable line up. Tape these loops together at the top of the coil.
- 11.3 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.
- 11.4 Now the joint closure is fixed to the bracket on the pit wall and pit is closed.
- 11.5 If required for attending to faults etc., manufacturers supply special kits for opening of the joint and the steps to be followed. However the general steps are as under:
- 11.6 Using suitable knife cut heat shrink sleeve longitudinally along its entire length.
- 11.7 Do not damage the smaller heat shrunk sleeve on the ends of the joint.
- 11.8 Apply heat to the cut sleeve until it begins to separate.
- 11.9 Gently remove the cut sleeve from the joint. Now the joint can be opened.
- 11.10 Protective sleeve/cover can be removed for attending to faults etc.

12. EXCAVATION AND BACK FILLING OF TRENCHES FOR ATENDTING TO FAULTS:

- 12.1 The back filling of trenches shall be done by tamping and consolidating the excavated soil in layers of 15-20 cm at time. All the soil that is excavated shall be put back to the trench and care shall be taken in consolidation to ensure that the back filling does not suffer any sinkage in monsoon. The left out earth if any within station limit has to be thrown out from Railway premises by the contractor at his own cost.
- 12.2 It is recommended that excavation of trench be done manually, since use of mechanical devices like JCB likely to damage existing Signal & Telecom cables carrying safety circuits and vital train control circuits.
- 12.3 However, use of mechanical devices like JCB can be permitted to a limited extent in mid-section with prior approval of Engineer-in-charge.
- 12.4 Use of mechanical devices like JCB in station sections is strictly prohibited.
- 12.5 The excavation shall include excavation of trial holes clearing bushes and roots of trees along the trenches.
- 12.6 During excavation of the trenches, the earth should not be thrown on the ballast. The earth should be thrown by the side of the trenches away from the track. Complete excavated earth shall be back filled in the trench after laying the cable and well rammed.
- 12.7 When the contractor comes across any other cable already laid, he shall first report the fact to the Engineer.

FOUNDATION & ERECTION OF APPARATUS CASES:

1. The apparatus case of full size (GKP type) with 'E' type lock & key, fixed on one side of the door as per DRG. No. S&T/MFT/2378 (Single) shall be supplied by the contractor. E Type lock of Ward No. 32 / 31 as per RDSO DRG. No. SA 3376/M and Key to DRG. No. S.3377 shall be used. Apparatus cases of full size only shall be used.
2. The work consists of pit excavation, casting foundation with bolts of adequate size having cement concrete of ratio 1:3:6 as per:-
 - (i). Drg. No. SG/CN/02/6 (Apparatus case full size)
 - (ii). Drg. No. SG/CN/02/7 (Apparatus case Half/ Quarter size)The location of apparatus case will be indicated by Railways.
3. Two 'E' types locks on the doors of full size apparatus case and one 'E' type lock on the front door for half size apparatus cases shall be firmly fixed and tested with 'E' type key. Locking and unlocking shall be smooth with least force. Suitable fixing arrangements for 'E' type lock on the door of apparatus case shall be fabricated by the contractor, if such arrangements do not exist. One hard wood shelf plank 37mm thick, planed and varnished shall be firmly fixed for all types apparatus cases/ battery boxes. Also latching arrangement for the back door shall be provided, if required
4. The apparatus case shall be painted with one coat of primer after making the surfaces smooth by emery paper polishing. The apparatus case shall be painted with two coats of aluminum paint on outer surface and two coats of white paint inside. The location numbers are to be painted in 'Bold' letters outside location box as per SWR practice.
5. At each apparatus case/CTB, the work consists of fixing all cables, fixing of Phynolic synthetic industrial fiber base fine weave cotton fiber sheet – 6mm thick to IS specification 2036 - 1995 - Type board along with terminal blocks and termination of cables/cores (conductors) using PVC/ Nylon sleeves as per details of termination in approved location diagrams. The contractor shall prepare cable termination and wiring details of apparatus cases and C.T. boxes and obtain the approval of the Railway Engineer before execution as per the approved cable plan
6. The underground signaling cable-main, tail and power shall be properly secured by wooden clamps of 50mm x 50mm teak wood inside apparatus case on 25mm x 100mm base plank. The cables shall be neatly skinned, duly mending and taping of cable ends for termination, bunched and terminated on the terminal board at the required place in order as per approved apparatus case circuit diagram.
7. The contractor shall fix Phynolic synthetic industrial fiber base fine weave cotton fiber sheet – 6 mm thick to IS specification 2036 - 1995 - Type F5 sheet as required by Railway. Terminal blocks with links, fuse blocks with fuse shall be fixed on the terminal board pertaining to each apparatus case and cable termination box using proper size of wood screws. Two suitable holes shall be made on either side of terminal block and fuse block for bringing cable for termination. Termination of main cables, tail cables, power cables, core/cores shall be made at the proper terminal as per approved wiring diagram pertaining to each apparatus case and C.T. Boxes. Before final termination, each cable shall be tested for continuity, insulation etc. and readings recorded and jointly tested and signed.
8. As per site conditions, the termination of new cables may be required on the existing terminal blocks or by fixing new

terminal/fuse blocks in old apparatus cases which shall be done as per approved circuit diagram wherever required. The terminal particulars are to be re-painted or corrected on the doors of apparatus cases as instructed by Railways. Suitable clamping arrangements have to be made for the new cables and also the bottom the opening of the apparatus cases shall be closed with masonry brick work and sealed with cable compound.

9. After fixing all the signaling cables inside the apparatus case, the side opening shall be closed with masonry work and plastered. The inner side is filled with Sand and finally the bottom is sealed with sealing compound.
10. All the underground cables shall be provided with punched name plates showing total no. of cores, cross section of each core, Aluminum or copper conductor and from and to details etc. and also painted inside each apparatus case
11. Excavating earth and casting concreted foundation as per Drg. No. SG/CN/02/8 and C.T. boxes are to be erected on Rails/L-angles vertically by using suitable size of bolts and nuts. The cables shall be taken through 2 Nos. of G.I. Pipes of size 32mm inner Dia and 300mm length fixed at the bottom of the CTB with suitable fixing arrangements. It shall be ensured that there should be no break in the cable core during the process of taking the cables through pipes. In case of CTB for Point machine, one no. of GI pipe 150mm long shall be fixed at the side of the CTB for drawl of jumper wires from point machines/lever locks with proper fixing arrangements. The CTB should be provided with EWS lock.
12. CT Box shall be painted with Aluminum paint and rails/L-angles with black paint. The circuit particulars shall be painted neatly on the CT Box cover and the location number have to be painted in 'BOLD' letter.

SHIFTING OF APPARATUS CASES/ CT BOXES:

The work consists of excavation of pit around the existing apparatus cases full/ half size and CT boxes, shifting of the location box along with foundation clear of infringement from the track. The pit shall be excavated with maximum care to avoid any possibility of damage to the existing cables. The location box shall then be shifted carefully along with the foundation and cable termination, equipment etc., without disturbing the wiring. While shifting apparatus cases of full size, the brick wall covering the cables shall be broken before shifting the location box. After the location box is shifted, brick masonry walls shall be constructed on the front and back sides of the location box foundation. River/M-sand sand shall be filled up to the floor of the location and the bottom shall be sealed with sealing compound

FILLING OF EARTH AROUND LOCATIONS: The work consists of filling of earth around the foundations of signals and apparatus cases for a width of 0.5m on all sides from 150mm below the foundation top to ground level. The earth shall be consolidated after filling.

EARTHING: All apparatus cases, battery boxes, CT boxes, armors of cables, battery chargers, transformers, power panels, Control panel, Block Instruments/Control test panel/Cable Termination Rack/Relay Racks, etc., shall be earthed. If number of apparatus cases are grouped at a place, one earth shall be provided up to 2 Full Locations and 1 Half Location. Over and above this, additional earth to be provided at the other end and both the earth need to be connected to all the locations in ring path. Otherwise, separate earth is to be provided for each apparatus case. The earth resistance shall not be more than 10 Ohms.

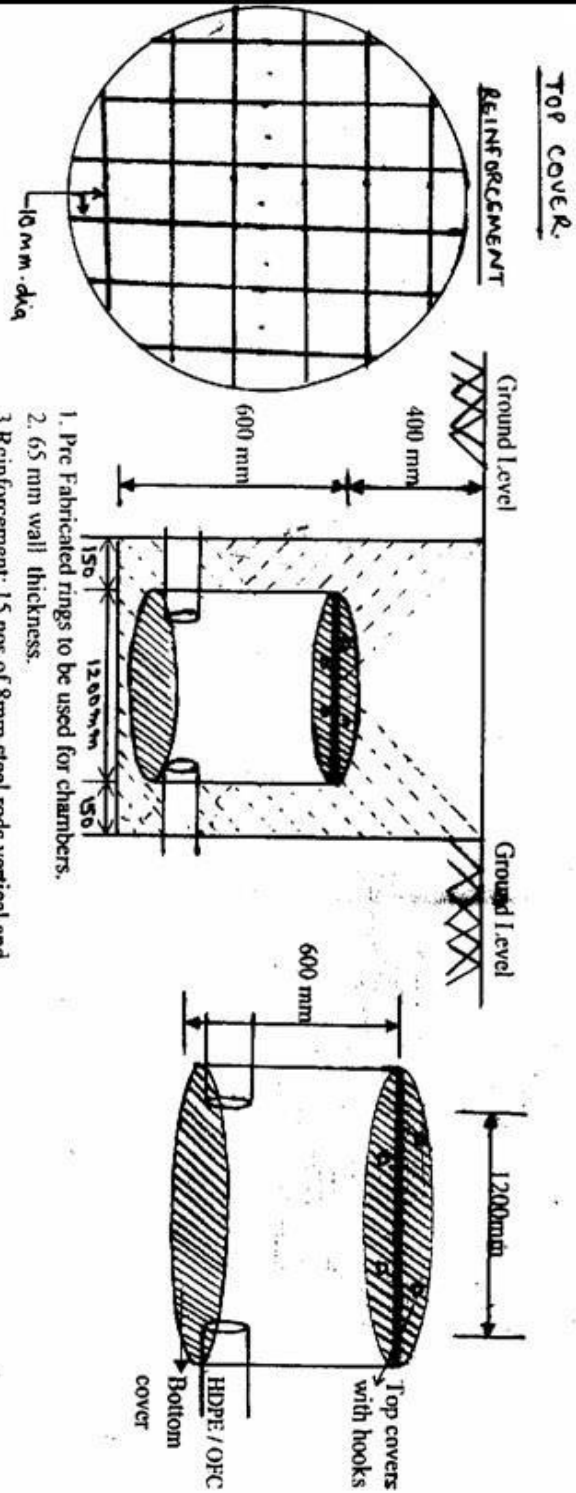
For signal earthing GI pipe earthing shall be provided. For all location boxes copper plate earth shall be used. In addition for MSDAC or HASSDAC or any other electronic equipment installed in location box equipment shall be grounded using maintenance free UNIT earth as per RDSO specification to achieve less than 1 OHM s.

GI PIPE EARTHING SYSTEM: shall be provided as per RDSO Drawing No.SG/SWR/057 and Earthing of metallic sheath and armour of all cables in all apparatus cases, signal post etc.

COPPER PLATE EARTHING SYSTEM: shall be provided as per Copper Plate Earthing System complete as per Drg.No.SG/SWR/058 with provision of (i) Copper plate 300 mm X 300mm X 3 mm, (ii) Earth Pit 6 ft depth filled up with charcoal 10 kg & salt 25 kg in alternate layers up to 2 ft from bottom, (iii) Water funnel on Perforated GI pipe of length 4.5 ft., (iv) Cast Iron top plate 12 x 12 (v) Drawing of copper - earth from earth to location with 25 mm x 3 mm copper strip for termination.

PROVISION OF LOCKS: Universal locks (EWS Locks)/ GI locks/Navtal Locks shall be provided for CLS units, Route Indicators, point machines, apparatus cases, battery boxes and C.T. boxes, wherever necessary. Two Navtal locks (Godrej make) 75mm with 2 keys shall be provided for Relay Rooms at all stations.

RailTel Corporation of India Limited EASTERN REGION, KOLKATA
Diagram of Construction of Loop/Splice chamber



1. Pre Fabricated rings to be used for chambers.
2. 65 mm wall thickness.
3. Reinforcement: 15 nos of 8mm steel rods vertical and 5 Rings of 6mm steel round
4. Chamber should be filled with river sand mixed with Anti termite after placing the OFC inside

Prepared By	Approved By
<i>Sumit</i> Sumit 31/08/12 Am (redn) / B.L.	<i>Prasanna</i> Prasanna 31/8/12 DGM (CMD) / ER

Proforma-A for Splice loss/ dB loss Vs KM & OTDR measurements in section

Fiber No.	Km	Loss (dB)	dB/Km	OTDR EVENTS											
				Km	Km	Km	Km	Km	Km	Km	Km	Km	Km	Km	
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
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15															
16															
17															
18															
19															
20															
21															
22															
23															
24															

Signature of Railway representative

Signature of Contractor with seal

Proforma -for power Measurement:

Section:

Date:

Fibre Length:

Fiber No.	Fiber Length	dB Loss		Average	dB/Km	Remarks
		A-> B	B-> A			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
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Signature of Railway representative

Signature of Contractor with seal

Schedule-Item No.	Item	Description
Schedule-E VSS Technical specifications		
E1	Full HD (Pan /Tilt / Zoom) PTZ IP colour Camera	As per Clause No. 7.0 of RDSO Specification of IP Based Video Surveillance System Specification no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments of any Reputed Make
E2	Full HD Fixed Bullet type IP	As per Clause No. 5.4 of RDSO Specification IP Based Video Surveillance System, Specification No. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments. any Reputed Make
E3	Full HD Fixed Dome type IP	As per Clause No. 6.0 of RDSO Specification IP Based Video Surveillance System, Specification No. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments. any Reputed Make
E4	Video Management and recording Software	<p>As per Clause no. 18.1 & 18.2 of RDSO Specification of IP Based Video Surveillance System Specification No. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 3 or latest.</p> <p>VMS Software shall support minimum required cameras as mentioned in the schedule or higher per division on multiple servers (per camera basis Per camera Licence means Video Management (Viewing) and (recording) at multiple locations such as Station, RPF Post & DC Server room, Security control by same license, Zonal HQs, etc,.). Existing Integrated VMS server in Data Centre of each division shall manage, monitor, control and configure all the VMS servers provided at various locations over respective divisions in a federated architecture and multi-tenant model. The newly installed VMS at Thanas/any other locations as directed by railway engineer should be integrated with the existing VMS in the data centre. There is no provision for a separate failover or an independent integrated VMS. Necessary configuration modifications and hardware requirements shall be taken care of by the bidder.</p> <p>Video Management Software with federated cloud architecture to be provided for scalability and flexibility to support large-sized VMS installations</p> <p>Scalability: Federated cloud architecture greatly should help in designing and implementing large-sized Video management software to support an unlimited number of cameras, management servers, and big data.</p> <p>Centralized Video Surveillance: Centralized video surveillance should improve the security of the connected organizational branches/sites, provides transparency and helps in enhancing the business operations. Since operations of any connected sites can be monitored from the corporate/main office, management of the enterprise can have a complete hold on the organizational activities.</p> <p>Independent Site Monitoring: Federated cloud VMS system also allows individual sites to have complete control of their site. For incidents triggered via video analytics to be quickly responded and resolved from the local site itself, federated VMS system provides independent control of the VMS at the local sites</p> <p>Support for Multi-tenant VMS architecture: Multi-tenancy and cloud federation should go hand in hand for Cloud based Video management Software. While Multi-tenant Video management Software allows VMS infrastructure to be shared with multiple clients/sites simultaneously, federation helps in retaining the independent management of the individual sites. Multi tenancy supports shared infrastructure and monitoring costs, easy upgrades and customization, whereas federation facilitates authorized access to complete VMS System from a single location.</p> <p>Fault Tolerance: Federated cloud architecture should provide fault tolerance to the large-sized VMS system. It enables the VMS systems of the</p>

		<p>independent sites to work efficiently even in the case of network failure. Even though the central site may not be able to access the independent sites, VMS systems of these sites can record videos and secure their premises with assigned video analytics. On resuming connection with the federated architecture, data of the local sites can be transferred to the main site for analysis.</p> <p>As per Clause no. 18.5 of RDSO Specification of IP Based Video Surveillance System Specification no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 3 or latest.</p>
E5	VAS SOFTWARE	<p>As per schedule description (Per camera License means Video analytic at multiple locations such as Station, RPF Post, Security control, Data center and zonal HQ by same license) as per clause No.18.4 RDSO Specification No RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No.3 or latest. Details of additional, optional features of Video Analytics Software (in addition to RDSO specification) are as under.</p> <ol style="list-style-type: none"> 1. AI based video analytics should be able to detect Smoke and Fire in a defined area. (Optional) 2. Auto tracking of person whereabouts while movement in Railway Premises through Video analytics in Fixed cameras. (Optional) 3. People counting. (Optional) <p>Note: Where ever required the optional features shall be configured and made available as directed by railway representative.</p>
E6	30 days storage	<p>As per RDSO Specification No. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No.3 or latest. Reputed Brand: IBM/Dell/HP or Equivalent. (Per camera License means Video recording at multiple locations such as Station, RPF Post & Security control, CCC and DC by same license). Necessary storage hardware required for all the cameras shall be provided.</p>
E7	PC Work Station	<p>As per Clause No. 11 of RDSO Specification No. RDSO/SPN/TC/65/2021 of IP Based Video Surveillance System Revision 6.0 with Amendment No.3 or latest. including 24-inch 4K UHD LED Monitors with all accessories, all required Licensed software, (like Win OS, MS Office, Antivirus-total 3 years security), RAM 64GB, 1TB SSD along with cable of Reputed make, Spike buster (minimum 5 Nos. 6A points with fuse), 600VA UPS, Make: Samsung/Dell/HP or similar or better.</p>
E8	Supply and fixing of GI pipe for fixing cameras in open area.	<p>15 Feet GI pipe of 100 mm dia 4.5m thickness of medium quality ISI no: 1230(Part 1) 1990. Having an iron base plate 10 mm thick x 30 cmx 30cm welded at the bottom of the pipe with four supports of iron bars of sizes 10 mm dia. The 3 feet pipe shall be buried in the ground and 12 feet shall be above the ground. The work includes digging of the pit on Platform, laying of cable in between poles in suitable underground GI pipes, erection of pole and filling the pit with 1:3:4 cement, concrete and sand. Final plastering should be done on the surface. The iron bracket on the top of the pole shall be provided to fix the CCTV camera, Protection cover and junction box. The work includes supply of all the materials required in this item.</p>
E9	8TB Hard disk	<p>The Storage Capacity of External Storage Device shall be as specified in Clause no. 2.8 and 12.0 of RDSO Specification of IP Based Video Surveillance System Specification no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments any Reputed Make</p>
E10	NVR	<p>As per Clause No. 10.2 of RDSO Specification of IP Based Video Surveillance System Specification no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments any Reputed Make</p>
E11	3 KVA UPS	<p>3 KVA Online UPS with 2 Hrs SMF Battery Backup. This also includes supply of one set MF battery of suitable AH capacity Rack and one set compatible</p>

		MCBs complete with cover & fixing materials, one earth leakage circuit breaker arrangement. Make:Exide/Amaron/Tata green or better
E12	Layer 2 Switch, Minimum 8+2 Port Manageable	As per Clause No. 14.0 (iii) field switches of RDSO Specification of IP Based Video Surveillance System Specification no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments any Reputed Make
E13	12F FDMS	<p>The FMS should be confirming to RDSO specification No. RDSO/SPN/TC/37/2020 or latest. However, the FMS should have the following:</p> <p>It should be mountable in standard 19" rack and of slider type. There should be an arrangement of termination of 48/24/12/6 No of fibers. It should be supplied with 48/24/12/6 Nos. of pigtails of respective type of connector of minimum 1.5 meters length. Colour coded pigtails (µn tight jacket) shall be provided for easy identification.</p> <p>The FMS should be supplied with arrangement of required Nos. of adapters. The adapters shall be fixed in such a way that these shall be easily accessible protecting the eye from direct exposure to laser.</p> <p>There should be a nos. of trays or as per site requirement for the provision of termination of the fibres & sufficient space for routing of the fibres in the trays. Trays shall be numbered bottom to top (tray no. 1 is lower most).</p> <p>Pigtails shall follow tray numbering.</p> <p>Pigtails shall be labelled through colour coding/ferruling.</p> <p>Adaptors shall be numbered Bottom to Top or Left to Right in ascending order.</p> <p>All adaptors shall be provided with dust protection caps.</p> <p>Important Do's and Don'ts about the operation of the FMS shall be clearly indicated at a convenient place on the FMS.</p> <p>Insertion Loss: ≤ 0.3 dB or less</p> <p>Return Loss: ≤ 45 dB or less</p> <p>The FMS shall be manufactured as per latest state of art technology.</p> <p>The FMS shall be protected against the entry of dust and insects, rodents etc. Body should be of MS steel; powder coating painting (min.70 micrometres thickness) shall be provided with rust resistance paint.</p> <p>Marking: The marking on the system shall be indelible and following minimum information shall be provided by way of engraving or Laser printing method:</p> <p>"SWR" should be written on each FMS to be visible from front.</p> <p>Manufacturer's name & date/ year of production.</p> <p>Model No./Batch No./ Serial No.</p> <p>Capacity i.e. No. of cables and the fibres.</p> <p>Identification details/ cables/ Fiber/ labelling facility.</p> <p>Preferred type of connector is SC/APC for all connectors.</p>
E14	Blowing & Drawing ofc	Blowing & drawing of OFC 24F/12F/6F, Switchboard telecom cable, CAT-6 and Power Cable (including crimping and termination of copper cables) through PVC Conduit/GI/DWC/HDPE Pipe. OFC should normally be blown through the ducts by blowing through machines; drawing may be adopted in short lengths as decided by the site engineer.
E15	6U Cabinet	Supply and fixing of outdoor 6U cabinet (IP65 or better) with locking facility, suitable for housing one 8-port switch, fdms, 150 AH tubular battery, solar charging controller, NVR, DC-DC converters with adequate free space for air flow. The cabinet should be fixed in the outdoor pole. Necessary power adapter and all accessories required for this work shall be supplied by the contractor.
B16	9U RACK	Supply and Installation of 19" 9U Rack Wall/Pole Mount ,with all accessories Like Electrical fitting, Fan Tray, Patch Panel, Cable Manager, PDU .

Schedule-D IP-MPLS Technical specifications		
D1	LER (Label Edge Router)	As per clause No. D of Implementation of IP-MPLS Technology for unified communication backbone on Indian Railway of RDSO Specification STT/TAN/IP-MPLS/2020 Ver 3.0 with Amendment No.1 Make: Reputed Brand. Model supplied shall be the latest one and new one and should have service support upto 8 years.
D3	16 port E1Card	The 16-port E1 card must align with the comprehensive router standard RDSO/SPN/TC/84/2008 Rev.0 and comply with Indian Railways of RDSO Specification STT/TAN/IP-MPLS/2020 Ver 3.0 with Amendment No.1
D4	2 x 10G Adapter	The make of the modules shall be the same as that of above LER/LSR Routers to ensure reliable functioning and the same shall be supplied With all the accessories.
D5	8 x 1G Adapter	
D6	10G SFP+Module	<p>The make of the modules shall be the same as that of above LER/LSR to ensure reliable functioning and the same shall be supplied with all the Accessories. Specifications are given below</p> <ul style="list-style-type: none"> • SFP modules should comply with multi-source agreement (MSA), enabling compatibility with other vendors' equipment. • Should support 40 km optical distance (1550/1310 nm). • Should have LC type connector or as per field requirement. • Should work on single mode dual fiber. • Should have 10 Gigabit Ethernet capacities on single mode fiber. • Should support DDMI/DOM features & should be of OEM/Reputed Make. Option should be available for SFP+/XFP • Should be having valid ISO 9000 & ISO 14000 certification on the date of opening of bid. • Should have CE and FCC regulatory compliances. • Operating Temperature of the SFP Should be mini 0 to 65 °C (23 to 149°F)
D7	Single Mode 1 G SFP-BX (10 Kms)	<p>The make of the modules shall be the same as that of above LER/LSR to ensure reliable functioning and the same shall be supplied with all the Accessories. Specifications are given below</p> <ul style="list-style-type: none"> • SFP modules should comply with multi-source agreement (MSA), enabling compatibility with other vendors' equipment. • Should support 10 km optical distance on single fiber • Should have an LC type connector or as per site requirement • Should provide in Pair (BX U & D). One Switch should have BXU other should be BXD • Should have 1 Gigabit Ethernet capacity on single mode fiber. • Should support DDMI/DOM features & should be of OEM/Reputed Make. Option should be available for SFP+/XFP • OEM should be having valid ISO 9000 & ISO 14000 certification on the date of opening of bid. • Should have CE and FCC regulatory compliances. • Operating Temperature of the SFP Should be mini 0 to 65 °C (23 to 149 °F) • SFPs should be bidirectional single Fiber.

D8	10/100/1000 Base-T Copper Ethernet Transceiver SFP Module	The make of the modules shall be the same as that of above LER to Ensure reliable functioning and the same shall be supplied with all the accessories.
D9	Ethernet Surge Protector.	As per clause No. 5 of RDSO Specification of surge protection device for protection of telecom equipments Specification No. RDSO/ SPN/ TC/98/2011 Revision 0 or latest.
D10	Layer 3, 24 Port Managed Switch	As per clause No. 5 of Lan switches of RDSO Specification No.RDSO/SPN/TC/83/2020 Revision 2.1 Note:-Switch Supplied should be of Latest Model of Reputed Brand and should have service Support upto completion of Codal life
D11	4 Port Gateway	As per Clause No.10 of RDSO Specification of VoIP Based Train Control Communication System Specification No. RDSO/ SPN/ TC/ 99/ 2012 Rev.3 or latest.
D12	Control IP Telephone	As per Clause No.8.2 of RDSO Specification of VoIP Based Train Control Communication System Specification No. RDSO/ SPN/ TC/ 99/ 2012 Rev.3 or latest.
D13	SIP Based Medium IP Phone	As per Clause No.9 of RDSO Specification of VoIP Based Train Control Communication System Specification No. RDSO/ SPN/ TC/ 99/ 2012 Rev.3 or latest.

Schedule-C FOIS Technical specifications

C1	FOIS Router (02 100/1000 Mbps LAN/08x2 Mbps WAN (8 Nos. G.703 interface)	As per Router RDSO specification No. RDSO/SPN/TC/84/2008 Rev. 0.0 or latest suitable for FOIS
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C2	6 U rack	S N	Specification	Description
		1	Type	Closed Telecom Rack Wall/Pole mounted
		2	Dimension	350 mm (Height) x 600 mm (Width) x 600 mm (Depth)
		3	Mounting	Rack should have Wall/Channel/Beam Mounting with heavy brackets and fasteners of required shape and size as per site condition. It shall be insulated from the wall/channel/beam/shelter through insulators
		4	Front Door	Rack should have front door tough and transparent glass fitted on MS/CRCA sheet on sides with lock and key
		5	Rear Door	MS/CRCA door plain having ventilation holes bottom side with dust filters
		6	Top Bottom &	Rack top and bottom should be MS/CRCA steel made with cable entry provision with glands at both sides

		7	Fan Module	Compact fan module of 90 CFM working on 230VAC, 2 nos. with each rack properly fitted at top of rack
		8	Earthing Provision	Rack should have earthing provision
		9	Cable Manager	1 No. horizontal and 1 No. vertical cable manager with cable loops to be provided with each rack
		10	Power Distribution Unit (PDU)	PDU is of 6 sockets of branded make with 6 Amp MCB
		11	Modem Tray	The rack should be fitted with one modem tray 19". Back side of the rack should be closed with a removable panel
		12	Painting	The good quality powder coating light grey in colour shall be used for painting of the rack
		13	Marking & Certification	"INDIAN RAILWAYS LOGO along with Year" in bold and easily recognizable fonts should be written at the front top of the rack preferably in black or blue colour. OEM should have a valid ISO 9001 certification on the date of opening of bid
		14	Standards & Protection	Rack should be minimum IP54 certified. Rack should also comply with EIA 310/DIN 41494 standards

SWR Sor 2025 Technical specifications

SWR Sor 2025 Chapter 21 Item No.43	Portable Maintenance Terminal	As per Clause 8.7 & 8.9 of RDSO Specification of VoIP Based Train Control Communication System Specification No. RDSO/ SPN/ TC/ 99/ 2012 Rev.2 or latest. The specs includes i7 Processor, 16GB RAM, 1TB SSD, MS Office with latest license version, Windows OS with latest version & Anti-Virus with Three Year licences, USB to Serial cable, Monitor size 14/15.6 inch or better. Shall be of reputed brand with all client software loaded.
SWR Sor 2025 Chapter 21 Item No.23	CAT-6 Patch Cord 5 mtrs	UTP CAT6 Cable, Cable jacket low Smoke zero halogen(LSZH), conductor dia 23AWG, confirming to ANSI/TIA/EIA-568-C or latest. Make. D-Link or equivalent.
SWR Sor 2025 Chapter 21 Item No.20	24F FDMS 19" Rack Mount	<ul style="list-style-type: none"> It should be mountable in standard 19" rack and of slider type. There should be an arrangement of termination of 48/24/12/6 Nos. of fibers (as per SOR). It should be supplied with 48/24/12/6 Nos. of pigtails of respective type of connector of minimum 3 meter length. Colour coded pigtails (µn tight jacket) shall be provided for easy identification. The FMS should be supplied with arrangement of required Nos. of adapters (as per SOR). The adaptors shall be fixed in such a way that these shall be easily accessible protecting the eye from direct exposure to laser. There should be a nos. of trays or as per site requirement for the

		<p>provision of termination of the fibre's & sufficient space for routing of the fibers in the trays.</p> <ul style="list-style-type: none"> • Trays shall be numbered bottom to top (tray no. 1 is lower most). • Pigtailed shall follow tray numbering. • Pigtailed shall be labelled through colour coding/ferruling. • Adaptors shall be numbered Bottom to Top or Left to Right in ascending order. • All adaptors shall be provided with dust protection caps. • All adaptors shall be provided with dust protection caps. • Important Do's and Don'ts about the operation of the FMS shall be clearly indicated at a convenient place on the FMS. • Insertion Loss: ≤ 0.3 dB or less • Return Loss: ≤ 45 dB or less • The FMS shall be manufactured as per latest state of art technology. • The FMS shall be protected against the entry of dust and insects, rodent's etc. • Body should be of MS steel; powder coating painting (min. 70 micro meter thickness) shall be provided with rust resistance paint. • The Fiber termination shall be tested and the test Report (Soft Copy) shall be submitted to the site Engineer in soft copy for records. Each fiber shall be properly marked with necessary ferrules/tags.
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Note:

1. To ensure security of VSS (Camera & Software) from vulnerabilities & breaches and discourage false undertaking from OEMs, security auditing and testing of equipment including source code of camera and software shall be carried out from **STQC** (Ministry of Electronics & Information Technology) or any other Government Agency from the list of **CERT-In** empanelled Information Security Auditing Organization. In order to ensure security of network and other IT equipment of VSS system, before bulk supply and installation, purchaser should ensure that security auditing and testing at the time of POC (Proof of Concept) as well as at the time of completion of project are conducted or as specified by the purchaser. In case any security breach is found in the system at any stage including at POC level, immediate strict penal action is to be initiated by the purchaser. (As per Clause No. 3.0 of RDSO Specification of IP Based Video Surveillance System Spec no. RDSO/SPN/TC/65/2021 Revision 6.0 with Amendment No. 1, 2 and 3 or latest with all amendments)
2. CCTVs must integrate seamlessly with the existing VSS infrastructure of the division, including VMS servers and video analytics hardware.
