CHAPTER VII

LINE PLANT SYSTEMS - OVERHEAD & UNDERGROUND CABLE

7.1 LINE PLANT SYSTEM - OVERHEAD

7.1.1 **SYSTEM**

7.1.1.1 TYPE OF LINES

Railway departmental telecommunication lines are usually erected / laid either as overhead or underground between railway office in railway colonies, large workshops, station yards and in the block sections along side the track.

7.1.1.2 SPARE CAPACITY

All telegraphic and telephone lines shall, as far as possible, be erected in a manner that due provisions are kept for any future extensions or extra connection which can be catered for without considerable alteration to the existing circuits or reconstruction of the entire alignment.

7.1.1.3 POWER - TELECOMMUNICATION CO- ORDINATION

a) While fixing the route of alignment and position of posts, special attention shall be paid to the provisions of Indian Electricity Act 1910. Electric Supply Act 1948. Indian Electricity Rules 1926 (revised) and Indian Telegraph Act (XIII) 1885, as amended from time to time where overhead (LT-HT) power lines and telecommunication lines exist.

b) In case of power lines belonging to a private or public utility undertaking other than the railways and its infringement on the proposed line is apprehended, the matter may be referred to the Standing Committee on Power Telecommunication Co-ordination for arbitration.

c) Where licensees have power lines already erected and it becomes necessary to put up telecommunication lines in close proximity to or across these power lines, 10 days notice in writing of the proposed erection shall be given to the licensee, as well as to the Electrical Inspector (the Electrical Inspector in case of railway power lines is the Chief Electrical Engineer of the Railway). The licensees will be required to arrange for the guards with in reasonable time, the cost of all works pertaining to guarding, additions, alterations to the existing lines to avoid interference physical or inductive shall be borne by the owner of the line, which is erected later as provided in the Indian Electricity Act.

7.1.1.4 NORMS FOR PROVIDING BOOSTER TRANSFORMERS AND RETURN

CONDUCTORS (BT/RC) IN ELECTRIFIED AREAS.

(a) The longitudinal induced voltage on DOT line due to Railway electrification shall not exceed 60 Volts under normal working conditions and 430 volts under faulty conditions.

(b) The limit of 5 Volts shall be applicable only for transverse induced voltage on DOT lines.

(c) The rail screening factor shall be 0.28 where all four (4) rails are conducting on a double track section. In all other cases this factor may be taken as 0.44.

(d) Above protection shall be provided by Railways for installation of DoT circuits prior to 17.5.94 while for future installations, DOT itself shall take necessary measures for protection.

(e) In case of urban/suburban areas where DoT local exchange circuits are provided more intensively but BT/RC have not been provided as per guidelines mentioned above, a limited provision of BT/RC at normal spacing (2.66 Kms.) may be provided in the station areas with the approval of CPM/DRM/Project Incharge.

7.1.2 SPECIFICATION AND PERFORMANCE PARAMETERS

7.1.2.1 PROTECTION FROM POWER LINE INTERFERENCE

All telecommunication lines shall be protected from physical interference from power circuits and other extraneous circuits where they exist in close proximity of the telecommunication lines or they are crossing the same. The portions likely to be interfered with by the power lines shall be protected by provision of guards between the two systems to prevent contact between the two lines, should any conductor break.

As far as communication circuits are concerned generally underground cables in busy areas are used when overhead alignments are not feasible. Cables are also used for road, track and other crossings. These cables may carry control and other communication circuits.

7.1.2.2 CROSSING OF TELECOMMUNICATION AND POWER LINES

Except in the case of electric traction circuits, the telecommunication lines shall cross below the power lines where these are generally of the heavier gauge than the telecommunication wires and possibility of breakage is less. This is also due to the fact that the telecommunication lines require more frequent attention for maintenance and are subject to frequent reconstruction. For crossing the telecommunication lines above the power lines, specific approval of each case shall be obtained from the competent authority who may be Electrical Engineer of Railways.

7.1.2.3 CLEARANCES IN WORKSHOP AND STATION AREAS

Consistent with the economic and engineering considerations, the headway should be kept as high as possible in loco sheds, workshops and other portions of the station

yards where cranes are permitted to move with their gibs up crossing should as far as possible be avoided. Where crossing cannot be avoided, cables should be used for such crossings.

7.1.2.4 LIMIT OF CROSS - ARMS IN A SINGLE POST

An alignment consisting of single posts shall not carry more than (a) 8 nos. of 2/4 - way cross - arms, or (b) 6 nos of 6 - way cross - arms, or (c) 5 nos of 8 - way cross arms. For heavy alignments up to 8 nos. of 8 - way cross arms may be used on coupled posts of approved design.

7.1.3 ERECTION AND INSTALLATION OF OVERHEAD LINES

As per policy of Board all overhead alignment system of BSNL as well as Railways should be replaced in phased manner by 2008with OFC/Quad cable systems. Therefore detailed guidelines about erection and installation of overhead lines have been excluded from this edition of Telecom Manual. However in extreme circumstances where it is required the same should be followed as detailed in old Telecom Manual (1971 edition).

7.1.4 MAINTENANCE SHEDULE FOR OVERHEAD ALIGNMENT

7.1.4.1 MAINTENANCE

a) The inspector shall give due consideration to preventive maintenance during their routine maintenance rounds and shall impress upon the linemen, maintainers and other staff the importance of preventive maintenance.

b) While attending breakdowns or doing restoration work, minor repairs and replacements shall be simultaneously attended to in the vicinity of the breakdown to prevent future interruptions.

c) The general standard of maintenance of telecommunication lines shall be such that the line losses are kept within the limits prescribed in the Annexure A

d) The line staff shall continuously watch the line plant in order to strengthen vulnerable spots and thus prevent failures.

e) All repairs and replacement shall be carried out in accordance with the practices mentioned earlier and specified material shall only be used except in case of emergencies.

f) Repairs or replacements shall be done in such a manner that interruption to other circuits on the alignments are avoided or at least kept to the minimum.

g) Where lines of departments other than railways exist close to departmental alignments, necessary precautions shall be taken to avoid any entanglement of wires with the other alignments while repairs or replacements are in progress.

h) Line diagram and pole diagrams in the form of map for all main alignment and branches shall be maintained up-to-date in the office of the DSTE / ASTE and the telecommunication supervisors.

i) All linemen maintainers and JEs shall also be supplied with up to date line diagrams for the respective beats and sections.

7.1.4.2 OVER HEAD LINES

7.1.4.2.1 INSPECTION

a) Detailed inspection of all the component parts of an alignment are absolutely essential for maintaining satisfactory communication service.

b) The inspection shall be carried out at all levels right from the foot patrol khalasi to the telecommunication supervisor incharge, at prescribed intervals.

c) Those alignments or circuits which are subject to frequent and long duration interruption, as may be evident from the periodical interruption reports, shall be inspected by the DSTE/ ASTE as and when required.

d) During the course of inspection of a line, each pole, guy, tie bar, cross-arm U bolt, insulator with stalk, jumpers and wire joints shall be inspected to determine whether they have adequate strength and are otherwise fit to remain in service. The life of a rail post or other components may be greatly shortened by careless inspection.

e) The lines maintained by the P&T will be inspected by the maintainers of that department. However, officers and inspectors should observe the general conditions of the alignments while travelling in the train or trolley and whenever any defect is noticed, these should be intimated to the concerned officials.

7.1.4.2.2 INSPECTION OF POLES

a) Each pole shall be visually examined from all sides from the ground to the top for evidence of corrosion, cracks and other defects which may seriously affect the strength of the post.

b) Each pole shall be inspected below the ground line at suitable intervals to ensure that the buried parts are not corroded.

7.1.4.2.3 CROSS – ARMS

a) While inspecting cross-arms, it shall be carefully observed that these are not corroded and are in perfect alignments securely fixed to the rail post.

b) It shall also be checked that the nuts on the U bolts are not loose and the bolts are not twisted.

7.1.4.2.4 INSULATORS WITH STALK

a) Broken or damaged insulators and twisted or bent stalks should immediately be replaced.

b) The insulators should always be kept clean.

7.1.4.2.5 JUMPERS AND WIRE JOINTS

a) Wire joints shall be carefully inspected for looseness and inadequate or dry soldering.

b) Jumpers shall be checked for their slackness and for proper clearance from the conductors.

7.1.4.2.6 GUYS AND STAYS

a) While inspecting the guys, their tightness shall be checked.

b) Guy anchors shall be inspected for any corrosion or other deterioration in their condition affecting their strength.

c) Stay wire shall be examined to check that there are no broken strands.

d) Threaded portion of nuts of the straining screws shall be inspected to see that they are not damaged.

7.1.4.2.7 OTHER ITEMS FOR INSPECTION

In addition to the above, the following require particular attention of linemen/Inspectors during the course of inspection:

a) Headway at railway and road crossing

b) Termination arrangements

c) Posts getting out of alignment due to sinking or being bent over.

d) Power line crossing guards

e) Insulators off brackets.

f) Bird nests on insulators

g) Too much sag in conductors

h) Inadequate separation between wires

i) Cloth pieces, kite strings, tree branches, creepers, vegetation, etc., on wire.

7.1.4.2.8 FREQUENCY OF INSPECTION

a) The roster of the linemen/maintainers should preferably be prepared in such a manner to enable him to attend to the remotest part of the alignment in his beat at least once a week. This frequency may be relaxed to once a fortnight in the case of

less important circuits.

b) The JE/SE incharge of a section should preferably inspect all the main and branch alignment in his section at least once a month.

c) The SSE shall carry out the inspection of all sections under him at least once in 3 months.

7.1.4.2.9 INSPECTION REPORTS

All SSE/SE shall prepare exhaustive inspection reports giving due consideration to all the details mentioned above and shall submit the same to their superiors indicating the remedial action proposed to be taken against each item. An Inspection report register should be maintained in DSTE /ASTE's office and a periodical review of the compliance of the proposed remedial actions must be made at suitable intervals.

7.1.4.2.10 TROLLIES

Where departmental alignments are situated in big railway yards or along the track in the section, push trollies or motor trollies may be used for inspection and material trollies, for carrying materials to site, subject to trolley rules in force.

7.1.4.2.11 LINE FAILURES, OVERHEAD LINES

7.1.4.2.11.1 PRECAUTIONS

Necessary action has to be taken to avoid failures as stated below:

a) Bird nests form constant source of nuisance and extra care should be taken in the crow nesting season.

b) Branches over-hanging or leaning towards the alignment should be removed.

c) Flaws, kinks, etc., in wires usually results from careless handling of the wires. These should be removed as and when noticed. Wire having too many joints in the same span should be replaced.

d) In the event of the fire occurring in the close proximity of a line of copper conductor, a piece should be removed from the exposed section and tested to see whether it has been annealed. If so, all wires shall be replaced to prevent failures.

e) Wires in railway yard tend to rust and corrode as they are exposed to smoke. These spots require frequent inspection and replacement.

7.1.4.2.11.2 FAULT LOCATION

a) When a fault occurs on the line and the communication service is completely

suspended or rendered unsatisfactory immediate steps to restore the communication shall be taken. To clear fault and to restore the communication, it is very essential to know the type and probable location of the fault. Following are the type of faults that generally occur on a telecommunication system.

i) Partial earth and total earth on one or both the conductors of a circuit.

ii) Dead short between two conductors of the same circuit or between conductors of different circuits.

iii) Intermittent contact faults.

iv) Foreign contact fault.

b) Once it is ascertained that it is a line fault, the test room maintainer will alert the lineman in the vicinity of the faulty section describing the nature of the fault and the probable location by telephone, if possible and by telegram.

c) The lineman shall immediately proceed by the quickest available route and mode of conveyance to the location given and cover the line between points indicated.

d) They should take with them their complete tool kit and reasonable quantity of spare parts and stores consistent with the nature of fault and the strength of available staff.

e) If the source of trouble is not discovered by inspecting from running train, the lineman shall foot patrol the section examining all suspicious spots more closely keeping in touch with the test room and giving necessary tests.

f) The controller in case of fault on control lines, and maintainer - in- charge of the test room shall give all necessary assistance to the line staff and co-operate in localising the fault and giving the necessary test. Whenever feasible, the controller will also arrange out-of -course stoppage of the first available train for lineman to proceed to the location of the fault.

g) Once the fault has been located and extent of damage ascertained, the lineman will take necessary remedial action, keeping the test room fully informed.

h) He should also place the demand for spare parts and material required.

i) The maintainer in the test room, controller and the line staff at site shall fully co-operate in conducting the necessary interim tests to restore communication within the shortest possible period.

j) The lineman shall make all repairs and replacements in a prescribed manner using only specified materials as far as practicable.

7.1.4.2.12 LINEMAN PATROLLING

The lineman before leaving his headquarters station shall advise the test room about his destination, where he may be contacted if required.

7.1.4.2.13 GENERAL BREAK-DOWN

In case of a general break down due to storm or heavy rains, maintainer in the section shall immediately endeavour to ascertain the nature and location of damage and then intimate the test room immediately. After having notified the SSE/SE/JE incharge, maintainer shall proceed to the site of break-down taking the section lineman for assistance.

7.1.4.2.14 SPARE STORES

a) In addition to tools, requisite quantities of spare stores shall be stocked with each lineman who is required to move out when called upon by the maintainer in the test room.
b) The actual quantities of different spare stores to be stocked with the JE/SE and lineman shall be determined from the quarterly and annual consumption of various spares in a particular section or alignment.
c) The recommended quantities of spare stores to be stocked with the lineman have been given in Annexure –B
d) To enable the lineman to attend to routine faults and make minor repairs to restore communication quickly, the tools and plants detailed in Annexure-C may be supplied to them in quantities as considered necessary.
e) In addition to the tools supplied to the line staff, adequate stocks of tools and equipment shall be maintained at the headquarters by the JE/SEs, for the use of their gangs to enable them to readily tackle major break-downs or heavy replacements. The recommended quantities of various tools to be stocked with the JE/SE have been detailed in Annexure-D

7.1.4.3 LINE INTERRUPTION REPORTS - OVERHEAD LINES

7.1.4.3.1 PROCEDURE

a) The efficiency of the maintenance of lines and the necessity for special attention being paid to any particular section which may be subjected to long interruption is to some extent determined by the line interruption reports of the concerned section.

b) These reports shall be prepared monthly by all the maintainers for their respective beats and submitted to their JE/SE incharge who will reconcile them with the test room log register.

c) After reconciliation, the Inspector shall compile a consolidated interruption report circuit wise in the same form as the control room log book and submit to the DSTE/ASTE.

d) These interruption reports form a valuable record in summarising the maintenance work carried out during a particular period and the resulting efficiency of circuit maintained during the period. The reports shall be suitably interpolated in the shape

of efficiency graphs for each circuit affording a visual indication of the efficiency of various circuits during the previous month. The monthly graphs from which inference can be taken to plan the renewal and strengthening programme for weak and vulnerable alignments in the division. However, if the monthly interruption reports of a particular section indicate persistent long duration failures, a detailed cause analysis may be implemented by the DSTE or /ASTE and if considered necessary, he may enhance the frequency of inspection at various level and also the frequency of submission of reports from monthly to fortnightly.

e) The respect of circuits maintained by the P&T, the reconciliation of the reports shall be done monthly with the respective Engineering Supervisor by the Telecommunication Supervisor and with the respective Divisional Engineer Telegraphs by the DSTE /ASTE. The circuit efficiency figures will be calculated on the basis of circuit hour lost due to interruptions for each circuit and graphs for efficiency shall be maintained in the office of the DSTE/ASTE and Telecommunication Supervisor. The efficiency of the circuits will further be discussed in a quarterly meeting between the Post Master General / Director Telegraphs of the P&T Circle and the CSTE/Dy. CSTE of the Railway.

7.2 LINE PLANT (UNDERGROUND CABLE)

7.2.1 SYSTEM

7.2.1.1 UNDERGROUND CABLES

As far as communication circuits are concerned generally underground cables in busy areas are used when overhead alignments are not feasible. Cables are also used for road, track and other crossings. These cables may carry control and other communication circuits.

7.2.2 SPECIFICATION & PERFORMANCE PARAMETERS

7.2.2.1 TYPES OF CABLES

The following types of underground cables are generally used for various telecommunication circuits as indicated.

a) Cable Quad 0.9 mm conductor dia as per IRS specification. These are 4/6 quad polythene insulated jelly filled cable and used for control circuits and block interfaces.

b) Multi pair PIJF cable as per IRS specification. These are generally used for branch cables branching off from the main cable or for outdoor subscriber or extension circuit.

c) Cable Switch Board/Tip of sizes 0.5 mm / 0.6 mm conductor dia as per IRS/TEC specification. These are generally used for indoor applications such as distribution to various telephone subscribers in a same building, MDF to exchange wiring etc.

d) Earlier a type of cable containing paper as well as polythene insulated copper quads were used in RE area. This is now obsolete but old installations are still in use. Such cable system will be described in separate chapter.

7.2.2.2 SIZES OF CABLES

The different sizes of cables to be used for various telecommunication circuits are detailed in the following table:

a) OUTDOOR UNDER GROUND

i)

Sizes of conductor	Circuit
0.5 mm cond Dia PIJF or 1.83 kg/km (6.5 lb/mile)	Subscriber's connection up to 5 kms.
0.63 mm cond. Dia. PIJF or 2.81 kg/km (10 lb/mile)	Subscriber's connections not exceeding 10 km.
0.9 mm cond. Dia. PIJF or 5.65 kg/km (20 lb/mile)	Tie lines, control circuits and long distance trunk circuits.

ii) INDOOR

0.5 mm ATC Switch Board / Tip 1.76 kg/km	Local subscriber's connection in a building, exchange to MDF wiring etc.
0.6 mm ATC Switch Board / Tip 2.52 kg/km	Trunk connections etc.

b) The size of the telephone exchange cables, shall be specified in a manner indicating the number of pairs, dia of conductor, armoured or unarmoured as illustrated below:

50 pair, 0.63 mm cond. dia armoured polythene insulated polythene sheathed jelly filled telephone cable as per IRS : TC-41/1990.

7.2.2.3 TESTING CABLE BEFORE LAYING

a) Before the cable is laid, it shall be tested for insulation and continuity of the cores.

b) Bedding and armouring shall also be inspected to see that there has been no damage during transit or in storage.

7.2.2.4 vi) LAYING OUT THE CABLE

a) For laying out cables, the cable drums shall be mounted on cable-wheels.

b) The drum on the wheel shall be brought to one end of the trench and the end of the cable freed and put into the trench.

c) The cable-wheels shall then be drawn along the road or track.

d) A party of labours shall follow the drum and guide the cable from the road into the trench carefully so that the cable is not damaged or bent unduly.

e) In case where the wheels are not available, the drum shall be mounted on an axle at one end of the trench and cable paid out and carried by labourers.

f) In no case, shall the drum be rolled off on to the road for laying the cable and the cable dragged on the ground for laying purposes.

7.2.2.5 v) GENERAL

a) While excavating earth for trenches or making other pits necessary for installation of cable junction boxes in between the tracks or in close vicinity of the track the Permanent Way Inspector or his representative shall be present.

b) Trenches running parallel to the track shall be filled up and rammed properly before sunset on each working day whenever required. Special care, in this regard shall be taken during the monsoon season and in alluvial soil.

c) Whenever a road-crossing or rail-crossing is encountered in busy areas where expansion is definitely anticipated and also digging of trenches will cause serious interruption to traffic, it will be advisable to lay one or more spare length of cables of sufficient length for future jointing so that re-opening the trenches will not be necessary.

d) Where earthen-ware pipes or trenches are used, additional trenches may be kept ready for future expansion.

7.2.2.6 CABLE TERMINATION

a) Cables can be terminated in any of the following methods:

i) Cable - heading.

ii) Pot - heading.

iii) FRP DP Box.

iv) Direct termination.

v) Krone type DP Box or similar

b) Cable heading shall be used for long distance circuits, viz., telegraph and telephone

trunk circuits and is also preferred for adoption in case of composite cables.

c) For local telephone cables and other short distance circuits which are likely to be affected by moisture, pot-heading with approved type cable termination boxes shall be used.

d) PIJF cable of various sizes shall be terminated through FRP DP Box.

e) Cable which are not affected by moisture may be terminated directly.

7.2.2.7 JOINTING OF PIJF CABLE

i) PIJF cable armoured/unarmoured are jointed with thermo shrinking technique.

ii) The jointing material is readily available in the form of a jointing kit. For different sizes of cable (No. of pairs and cond. dia.) the kits are different e.g. TSF-1, TSF-2 etc. For quad cable the kit is also different (reinforced type).

iii) For details of jointing kit and jointing procedure RDSO's code of practice for PIJF using thermo shrinking technique may be adopted.

iv) The screen and armour of copper cables to be jointed shall be made through with suitable wires. This is essential to get the specified reduction factor in association with its earthing at stations. This should be done first to avoid any electric shock due to induction.

v) The copper cable screen and armour shall be earthed with a low value earth (<1Ω) at stations to achieve the specified screening factor.

vi) In case of armoured optic fibre cable jointing (splicing) the armour shall neither be made through (continuous) nor it shall be earthed.

7.2.3 SYSTEM REQUIREMENTS

7.2.3.1 PLANNING

a) While planning for cabling on a route, the number of conductors and sizes required depending upon the type of circuits required should be first determined.

b) It will be generally desirable to leave 10% or more conductors spare for all cables carrying 5 or more pairs of conductors for future expansions.

c) Only after deciding the size and the number of conductors in the different type of cables to be used on a route, the actual route for taking the cables should be decided upon.

d) This should be done by walking along the track and deciding upon the best location for the cable route.

e) The desired route should be shown clearly on a route plan showing the actual

alignment of track giving offsets from permanent way or permanent structures. The diagram should indicate the various road and track crossings, crossing with power cable, water and sewage mains and other points of importance. It is preferable to chart the route on a route plan on which the existing routes of power cables etc., are shown.

f) After the route has been decided upon, the convenient points for distribution should be chosen.

g) The local distribution may be done either by aerial wires or smaller size cables.

h) The cable shall be laid at least 2 m away from the nearest track, and at the same time, it shall be ensured that it is separated by the least 1 m from the nearest power cable.

i) Cable markers shall be provided all along the road at minimum interval of 180 m. These should also be provided to indicate important points like water and sewage mains, power cable, crossings, angles, etc.

j) Paper or polythene insulated polythene sheathed jelly filled telephone cables may be used for communication circuits.

k) These may be laid underground in trenches. The cable shall be at least 0.6 m below the surface of the ground. The trench shall be sufficiently wide to accommodate troughs wherever used.

l) In telephone cables, electro-static and electro-magnetic induction between different pairs of conductors shall be minimised by a lead or aluminium sheath and by the provision of twisted pairs.

m) In case of paper core unit twin cables, the pairs shall be twisted together.

n) In 'Quad' type of cables, conductors diagonally opposite shall form one circuit.

7.2.3.2 METHODS OF LAYING CABLE

7.2.3.2.1 TYPES

Cables shall be laid using one of the following methods, viz., laying direct in the trench, drawing through ducts and laying solid. The choice of the method depends upon the type of the cable to be laid, the nature of the cable route, initial outlay, and future expansions, and economy in maintenance charges.

7.2.3.2.2 DIRECT - IN - THE - TRENCH METHOD

a) For direct laying, the bottom surface of the trench is made free of corrosive elements and the cable is laid on the bedding of the soft earth of the trench.

b) Where the bottom surface is rough, a 12.5 cm layer of sand shall be used as bedding.

7.2.3.2.3 DRAWING THE CABLES THROUGH DUCTS

a) RCC or earthen-ware ducts are used for laying the cable.

b) The ducts may have suitable covers.

c) Whenever the cable is laid in the duct,, there shall be sufficient holes at the bottom of the duct for draining away of any water that may collect.

d) When using ducts for taking cables, these are kept close to the surface of the ground so that the cover can be removed easily without digging earth.

e) Even though the initial cost of this type of cabling is quite high, it has one important advantage that additional cables can be laid easily by just opening the cover of the duct and laying the additional cable. This avoids digging of the ground and re-opening the trenches for adding extra cables.

f) The one disadvantage in this method is that duct alignments have to be as straight as possible for facilitating laying operations. This may not be feasible in some areas.

7.2.3.2.4 LAYING SOLID

a) For laying solid, a trough is made in an excavated trench and the cable is laid in the trough.

b) Molten bituminous compound or asphalt or similar materials of approved type is poured in to fill the trough completely.

c) It is then lined with bricks on the top after the compound is set.

d) Care is taken to hold the cable in the trough on wooden pieces, so that the cable is entirely surrounded by the molten material.

e) This type of laying is very expensive but can be justified only in cases where the soil is chemically detrimental due to electrolytic corrosion, or in other similar conditions.

7.2.4 MAINTENANCE SCHEDULE

7.2.4.1 TESTING CABLES

7.2.4.1.1 TESTING

a) Cables shall be tested after each joint is made to facilitate tracing of a fault during the course of jointing.

b) On discovery of a fault, the last joint must be opened out and defect rectified.

c) The wires in the cable must be tested for the following:

i) Continuity
ii) Absence of crossed pair
iii) Absence of contacts
iv) Insulation resistance.

7.2.4.1.2 PROCEDURE

a) To facilitate testing, every wire at the starting end shall be twisted with its mate to form a loop in each pair, each twist being insulated from other pairs by means of paper sleeves.

b) The end shall be dried and enclosed in a lead cap which shall be soldered or wiped to the lead sheathing of the cable.

c) The tests shall be conducted from the other end of the cable.

d) The exposed wires at the other end shall be duty protected with paraffin wax coating to avoid moisture entering the cable when the lead sheath is removed.

e) The layers of the cable shall be separated with cotton thread or twine to keep the wires in their proper places, so that the position of faulty wire or pair may be easily ascertained.

f) After the test is over, the end shall be cut, sealed and terminated, if necessary.

g) In case it is desired to maintain the end for further tests, it may be suitably protected.

7.2.4.1.3 TESTING FOR CONTINUITY, ABSENCE OF CROSSED PAIR AND ABSENCE OF CONTACTS

a) The following procedure may be adopted:

i) The testing end, a GPO detector No.2 and a battery comprising of three dry cells are used for the tests.

ii) All conductors should be bunched together and then earthed through the lead-sheathing of the cable with a soft bare copper wire and connected to the positive end of the testing battery.

iii) Negative of the battery should be connected to the negative of the detector.

iv) Now any of the wires from the bunch may be separated and when touched with a lead connected to the 5V positive terminal of the detector, if should give a deflection indicating continuity.

v) Disconnect the mate of the wire under test from the bunch and this deflection should disappear proving the absence of crosses and contacts.

vi) If any of the wire shows the cross of contact, they should be earthed again to trace wires with which they are crossed or are in contact.

vii) Each pair of conductors should be tested in the above manner before jointing the next length.

b) Where the test proves that wires have been cross jointed, the joints shall be opened and the fault rectified to avoid crosstalk. Recrossing in the next jointing does not clear the fault.

7.2.4.1.4 TESTING FOR INSULATION

a) The insulation test shall be taken on half of the pairs of the cable bunched together, the other half being earthed to the lead sheathing. The second half shall than be tested in a similar manner with the first half earthed.

b) The test shall be carried out with a megger before connecting it to the terminal equipments.

7.2.4.1.5 TESTING AFTER LAYING

a) Cable shall be tested immediately after the laying, jointing and terminations are complete. All wires in the cables shall be tested for the following:

i) Continuity

ii) Absence of crossed conductor

iii) Absence of contacts

iv) Insulation resistance

v) Absence of contacts between wires forming a pair (short circuit)

7.2.4.1.6 PROCEDURE

a) The first three tests in Para 7.2.4.1.5 (a) shall be carried out as prescribed in Para 7.2.4.1.3.

b) Test (iv) and (v) of Para 7.2.4.1.5 (a) shall be taken at the same time in the manner as prescribed below:

i) The distant end of the cable shall be prepared for tests in the same manner as prescribed in Para 7.2.4.1.3.

ii) At the testing end, two separate bunches of conductors shall be made, each bunch comprising of one wire from each pair.

iii) These wires should be segregated on the basis of colour code of the paper or cotton tape for the purpose of forming separate bunches.

iv) One bunch is then earthed and the other is tested with a megger in the manner prescribed in Para 7.2.4.1.4.

v) Where the cable consists of a large number of conductors, more than two bunches may be formed to obtain readable deflection on the megger.

v) Each bunch shall be tested in turn while the remaining wires shall remain earthed.

c) The method in Para (b) above gives insulation resistance per km applying the following formula:

$$\text{Megohms/km} = \frac{\text{No. of wires tested X Deflection (Megs) X Length in metres}}{1000}$$

The insulation resistance per Km shall not be less than 625 megohms at 16 degree C. Insulation at 16 degree C may be found out by the formula:

Insulation at 16 degree C= Insulation at T degree C X 1.04(T-16)X9/5

d) If a contact between the wires forming a pair exists, it will be shown by the megger registering a dead earth. In this case, each pair shall be tested individually until the faulty pair is found.

7.2.4.1.7 ROUTINE TESTS

a) Underground cables shall be tested once every year with a megger for insulation only and the results of tests shall be submitted to DSTE/ASTE.

b) Apart from the testing to be performed during laying and after laying the cables, routine tests shall also be conducted on the cables to ensure that the cable is in good condition. This will provide data to decide as to when a cable has served its life and to replace the same in time, to avoid complete breakdown.

c) All spare pairs in a cable shall be tested periodically once a year to ensure that they are in good condition. This will help in using the same pairs whenever a working pair has been faulty and the circuit carried by it has to be transferred to one of the spare pairs.

7.2.4.2 MAINTENANCE AND INSPECTION - CABLES

7.2.4.2.1 MAINTENANCE

a) Underground cable installations when laid strictly in accordance with the recommended practice will hardly need any maintenance throughout their anticipated span of life. As far as the buried portion of the cable is concerned, no repairs are generally possible except in cases where moisture or water has entered the cable and is detected before it has damaged the insulation.

b) All cable termination devices, pillar boxes, cable heads and glands shall be kept clean and dry.

c) These parts shall be frequently inspected and any tendency for moisture or water leak shall be immediately attended to.

d) Where humidity is high, particular care shall be taken regarding the condition of the cable heads, pillar boxes etc., and those may be dried by charcoal fire or anhydrous gas as and when required taking necessary precautions against fire hazards.

e) All cables shall be tested periodically to enable timely action being taken and prevent breakdowns.

f) No digging operations by other departments shall be carried out close to the cable route without prior notice to the Telecommunication Inspector who will take necessary precautions to protect the cable from damage.

7.2.4.3 CABLE FAULTS

7.2.4.3.1 TYPE

i) Low insulation in one limb or both

ii) Open/break in one limb or both

iii) Short/Earth

iv) Multiple faults

v) Faults with foreign potential

7.2.4.3.2 LOCALISATION OF FAULTS

Various type of cable fault locators available generally works on the following principle:
- Potential distribution method
- Pulse reflection (ECHO) method

The detailed guide lines for locating cable faults issued by RDSO may be adopted.

7.2.4.3.3 RECTIFICATION OF FAULTS

After localisation of faults, the defective portion of cable may be replaced by healthy piece of cable with proper joints as laid down in 7.2.2.8 and 7.2.2.10.

ANNEXURE A
Para 7.1.4.1(c)
LIMITS OF LOSSES ON TELEPHONE LINES

1. Subscribers lines

Type of exchange	Transmission standards exchange voltage	Maximum permissible loop resistance of subscriber's line in ohms
Magneto	00	375
CB Manual	40 V	375
Auto	24 V	325
Auto	40 V	450
Auto	48 V or 50 V	600

The maximum loop resistance of 375 ohms for Magneto and semi-CB exchange is permissible with local batteries of not less than 2V with a maximum internal resistance of 6 ohms. For subscriber's line with loop resistance of 375 to 450 ohms local battery should have 3 cells of not less than 3V with internal resistance not exceeding 3 ohms.

2. Junction lines

		Maximum loop resistance
a)	Junction lines connecting two local exchange of any type	350 ohms
b)	Junction lines from trunk exchange to local exchange of any type	350 ohms
c)	Junction line plus subscriber line from local exchange in (b) if the latter is connected to a second local exchange.	300 ohms

NOTE:

It will be observed that the standard for 1 and 2 are stated in terms of permissible maximum loop resistance instead of being given as limits of transmission loss in decibels. This is to allow for losses which occur due to the conditions of operation of subscriber's instruments and not line loss only.

3 Trunk lines

Maximum permissible transmission loss is 8.7 dB at 800 Hz including repeating coils main lines (connecting main trunk centres).

Maximum permissible loss at 800 Hz for secondary lines (connecting small exchanges of RAX to trunk centres) is 10 dB

4 Non-exchange connection (applicable in railway control circuits) ---- 25 dB.

5 The overall transmission loss from one subscriber to another in any part of a telephone system shall not exceed 32 dB.

When trunk and junctions from part of a telephone system, they shall be so arranged that the built-up circuit over which conversation is to take place shall not exceed 28 dB. An allowance of one decibel must be made for each magneto exchange included in the built-up circuit and 1.5 decibel for each CB exchange.

Circuit shall be designed so that equivalent length of the circuits in terms of loss dues not exceed:

Subscriber loop to exchange of all types	4.5 dB
Trunk between two trunk exchanges	12.00 dB
Junctions between two exchanges	4.5 dB

6. Table of transmission equivalents of instruments and exchange

a) Apparatus connected in shunt across telephone circuit:

	dB
Bell magneto 1,000 ohms	0.461
Bell magneto 1,000 ohms in service with 2 mF condenser	0.461
Coil bridging 600 ohms	0.922
Coil bridging 1,000 ohms	0.461
Coil bridging 600+600 ohms	0.461
Coil retardation 1,000 ohms	0.461
Indicators (tubular type) 100 ohms	0.461
Coil repeating 4006 –A	0.692
Coil repeating VTR Gd.	0.300
Coil repeating AT 4128-2	0.326
a) Trunk exchange cord circuit	0.462 to 0.922
c) Magneto exchange cord circuit	0.462 to 0.922
d) Junction line cord circuits	0.22

These assume that the operator is not listening in on the line. With ordinary cord circuits and the operator's key thrown to speak the loss will increase from 0.922 dB to 4.61 dB, unless provision is made for a high efficiency monitoring circuit on the trunk exchange cord circuits, in which case the operators can listen in without

causing in large losses which occurs when the 'speak' key is thrown.

ANNEXURE B
Para 7.1.4.2.14(d)
TOOLS AND EQUIPMENT FOR LINEMAN/MAINTAINER

1.	Axe-load handle	4 Nos.
2.	Pick axe	2 Nos.
3.	Sickle	4 Nos.
4.	Crow bar	6 Nos.
5.	Pan mortar	6 Nos.
6.	Shovels	6 Nos.
7.	Rope manila 30m, 2.5 cm	1 No.
8.	Rope manila for block tackles 15m, 1.25 cm	2 Nos.
9.	Tackles block large	2 sets.
10.	Ladders 6m	1 Each
11.	Line grips	2 Sets
12.	Carrying hooks 1 m	4 Nos.
13.	Soldering iron large	2 Nos.
14.	Soldering iron small	2 Nos.
15.	Blow torch	1 No.
16.	Chisel cold 2 cm	2 Nos.
17.	Chisel cold 2.5 cm	2 Nos.
18.	Hammer 2.5 kg	2 Nos.
19.	Shears pruning	2 Nos.
20.	Hand saw	1 No.
21.	Wrenches double ended of sizes 1.25 cm to 3 cm	2 Sets.
22.	Crescent adjustable wrench 20 cm	2 Sets.
23.	Adjustable wrench 30 cm	2 Sets.
24.	B J tool	1 Set.
25.	Pliers diagonal 15 cm x 20 cm	2 Nos.
26.	Pliers side cutting 15 cm	1 No.
27.	Pliers long nose 20 cm	1 No.
28.	Pliers insulated 30 cm	2 Nos.
29.	Ratchets and tongs of sizes	2 Nos.
30.	Tape measuring 15/50 m	2 Nos.
31.	Gloves	2 Pairs
32.	Goggles	2 Nos.
33.	Brushes of sizes-paint	2 Sets.
34.	Lantern	2 Nos.
35.	Straps safety	2 Nos.
36	Straps	2 Nos.
37.	Tools boxes	1 No.
38.	Bag tools	2 Nos.
39.	Portable phones	2 Nos.
40.	Detector GPO	1 No.
41.	Dynamometer	1 No.
42.	Hand compression tool for ACSR	1 No.
43.	Sleeve twister for ACSR wires	2 Nos.

44.	PIJF jointing kit.	2 Nos.

ANNEXURE C
Para 7.1.4.2.14(e)
TOOLS AND EQUIPMENT FOR JE/SEs

1.	Rope manila 60m, 5 cm	3 Nos.
2.	Rope manila 15m, 2.5 cm	6 Nos.
3.	Wrench small 1m, 1.25 cm	2 Nos.
4.	Wrench small 1m, 1.25 cm	2 Nos.
5.	Forge portable	1 No.
6.	Forge large	1 No.
7.	Brace ratchet medium	1 No.
8.	Hammer 1 Kg	2 Nos.
9.	Chain saw	1 No.
10.	Knife clasp 20 cm	2 No.
11.	Files flat 30 cm	2 No.
12.	Files round 30 cm	2 Nos.
13.	File half round 30 cm	2 No.
14.	File triangular 30 cm	1 No.
15.	Tape steel 30 cm	1 No.
16.	Steel square	1.No.
17.	Plumb	1 No.
18.	Spirit level	2 Nos.
19.	Trowel	2 Nos.
20.	Banner flanges	2 Nos.
21.	Tent small	1 No.
22.	Dynamometer	1 No.

ANNEXURE D
Para 7.1.4.2.14(c)
SPARE STORES WITH LINEMAN/MAINTAINER

Stock of the following spare parts and quantities shown against each of them is recommended to be retained with each of the lineman/maintainer:

1.	Line wires	1 Km length of each gauge of wire used in circuits.
2.	Binding wires	Wire sufficient for 12 bindings
3	Wire tapes	6 nos. of each gauge in use
4.	Insulators	50 nos. each size
5.	Stalks	6 nos.
6.	Solder	1 Kg
7.	Sleeves for joints	6 of each size
8.	PIJF cable jointing materials	6 of each size.