Measurement of ground clearance : Ground clearance of the conductor should be checked periodically at least once in 5 years as this may change due to developments enroute or due to excessive setting of sag during first 2 years of stringing. If ground clearance of the conductor is found not in conformity with the I.B. rules, retensioning of the lines has to be done after taking shutdown.

Pole to pole inspection : Other points which need checking are given below :

(a) Looseness of binding
(b) Broken strands of conductor
(c) Unequal sagging
(d) Slipping of conductors from the clamps.
(e) Broken or burnt strands of the jumpers.

The following corrective measures should be taken :

(a) Slipped conductors or broken/burnt strands of the jumpers should be replaced.
(b) Repair of loose binding should be done.
(c) Check for loose connections and signs of over-heating at the point of jumper connections. Take necessary corrective action to rectify.
(d) Check for crowding or jumping of wires and jumpers at the tee-off point, adjust if necessary.

Checking for general conditions of other line accessories such as parallel grove clamps, jointing sleeves and other fitting may be done. Re-adjust and replace where necessary.

Stays/Guys and its Accessories : All the time of inspection, the following points shall be examined

(a) Loose or over-tensioned guys.

(b) Broken or chipped stay insulators.
(c) Absence of wind guys in the fields.
(d) Missing of earthing arrangements for the stay.
(c) Rusting of stay wires.
(f) Corrosion of stay rods.
(g) Condition of the stay anchoring.

Whenever necessary, the defects noticed in the above places should be attended to immediately.

Other Fixtures : Other line fixtures such as, phase plate, number plates, danger plates, anti-climbing devices.and earth bounds should be checked and replaced if necessary.

Lightning Arresters : During the periodical inspection, the lightning arresters enroute should be checked for any damaged or broken porcelain and for any external indication of fused or sparked over arresters. Whenever any repair or maintenance is being carried out after taking lines shutdown opportunity should be utilized for checking up the line and earth connections for their tightness, damages if, any found, should be rectified.

33 kV cable and boxes : During the inspection, whether the cables and cable boxes are supported properly will have to be checked. Also any damaged insulator bushing or leakage of compound from the box should be checked up and arrangement for replacement or tapping up with the compound should be made. During the shutdown, the connections from the bushing terminal to the overhead line, earthing of the cable and also the overall condition of the cable and cable box and joint will have to be checked.

Earthing system : The earthing connections of supports and metal fittings shall be periodically checked for their size tightness and proper contact.

Periodicity of inspection

Designation of staff	**Routine inspection**
1. Inspector / JE	Once in a fortnight.
2. Assistant Engineer	Twice in a year
3. XEN	Once in a year (specially) the section where the reported faults are frequent.

Pre-monsoon periodical special inspection

1. Inspector
2. A.E. } Annual

Special inspection after each interruption

Inspector / JE — To find out the exact cause of the fault and rectify.

Night patrolling

Inspector / JE — Once in six months

Maintenance Schedule for EHV Transmission Line

S.No.	Work to be carried out	Periodicity	Action required if inspection shows unsatisfactory conditions
1.	Checking of hot spots along the lines at location of conductor joints and clamping points	Once in three months	Immediate repair of very hot joints. other hot joints should be repaired at the earliest opportunity.
2.	Clearance of right of way jungle growths etc.	Once a month during rainy seasons.	Jungle growths should be immediately cleared to maintain the requisite right of way.
3.	Checking of insulators, vibration dampers etc.	Once in 3 months	Damaged insulators should be replaced by hot line techniques immediately. Polluted insulators should be washed. Similarly, damaged vibration dampers must also be replaced. In absence of hot line technique reports be done during shut down.
4.	Missing members on towers and conditions of foundations.	Once in 3 months	Missing members on tower structures should be replaced immediately. For foundations, if water logging/erosion and such other defects are noticed dewatering/making of necessary embankments and repair work must be carried out soon after heavy rains/storm.
5.	Tower earthing	Once in 6 months	Take suitable action if the earthing resistance is high.

Patrolling proforma

The overhead lines should be inspected as proforma given below :

1. Name of the feeder.
2. Nature of inspection with location numbers and length in km.
3. Time and date of inspection.

Underground Cables

Types of Faults in Cables

The faults which are most likely to occur in cables are :

1. **Ground faults :** When the insulation of the cable gets damaged, the current starts flowing from line to earth, such faults are called ground or earth faults.

2. **Short circuit faults :** When the insulation between two cables or between two lines of same cable gets damaged, the current starts flowing from one cable to another or from one core to another core of a multicore cable directly; such faults are called short circuit faults.

3. **Open circuit faults :** When the conductor of a cable is broken or joint is pulled out there is no current in the cable open circuit faults.

First the nature of fault is determined and then the point of faults is located. For determination of nature of faults, the insulation resistance of each core to ground and

between cores is measured with the help of a megger. To low value of insulation resistance between any core and earth indicator the ground fault whereas the low value of insulation resistance, between two cores (with far ends of cable isolated from load) indicates short-circuit fault.

For determining of open circuit fault, the far end of the cable is earthed (on the far ends of the cable are interconnected) an ammeter is inserted in series with the cable and low voltage supply is given the cable and earth or cables. Zero deflection in ammeter indicates open circuit fault.

Location of Faults

There are various methods of locating the point of fault :

1. Ground fault of a single cable : Ground fault of a single cable can be located by Blavier's test.

This test is performed with the aid of a low voltage supply and either an ammeter or voltmeter or a bridge network. In this test resistance between end of the cable T_1 and earth is measured first with the far end T_2 isolated from earth and then with the far end T_2 earthed. Let the two readings be R_1 and R_2 respectively. If r_1 and r_2 are the conductor resistances of the lengths of cable "far end" to fault and test end to fault respectively and r is the resistance fault of earth, then

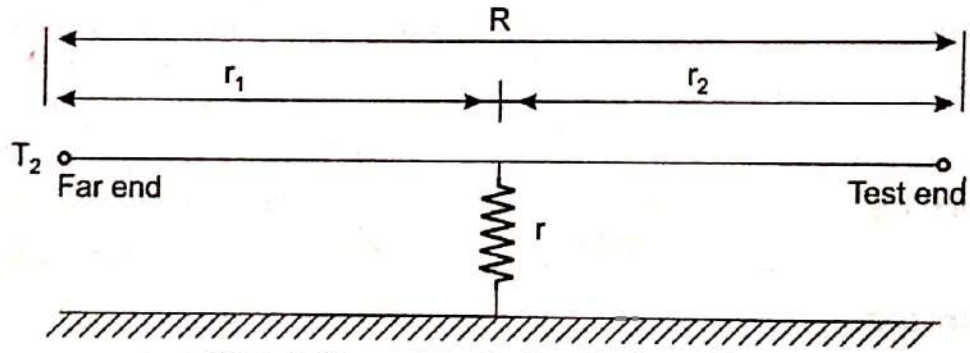

Fig 6.5. Ground fault of a single cable.

$$R_1 = r_2 + r \qquad \text{...(i)}$$

and

$$R_2 = \frac{1}{\frac{1}{r} + \frac{1}{r_1}} + r_2 = \frac{rr_1}{r + r_1} + r_2 \qquad \text{...(ii)}$$

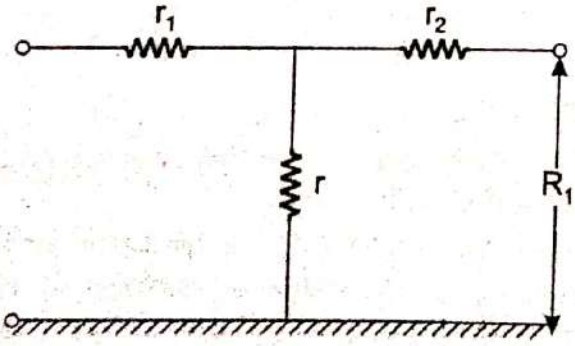

Fig 6.6.

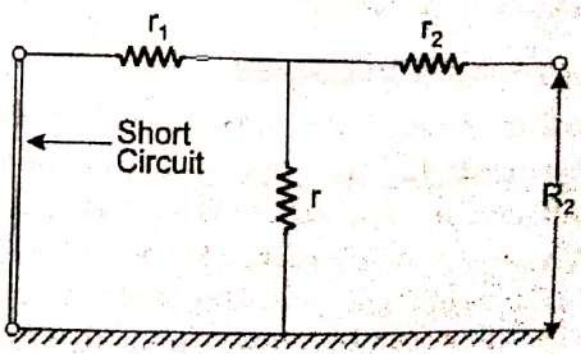

Fig 6.7.

The total resistance of the conductor

$$R = r_1 + r_2 \qquad \text{...(iii)}$$

By solving the above three equations we can get the values of r_1, r_2 and r.

If the total length of cable is L metre, the length of cable between far end and fault is L_1 metres, length of cable between test end and fault is L_2 metres and cross-section of conductor is uniform, then

$$\frac{L_1}{L_2} = \frac{r_1}{r_2}$$

and

$$\frac{L_1 + L_2}{L_2} = \frac{r_1 + r_2}{r_2}$$

or,

$$L_2 = L\frac{r_2}{r_1 + r_2} \qquad (L = L_1 + L_2)$$

Thus, the distance of faults from test end can be determined.

Loop Tests

These tests are performed for the location of either an earth fault or a short-circuit fault in underground cables provided that a sound cable runs along with the grounded cable or a short-circuited cable. In these tests resistance of fault does not effect the results obtained except when the resistance of fault is very high. There are two loop tests usually used and are known as Murray loop and Varley loop tests. These tests employ the principle of Wheatstone bridge.

1. **Murray loop test :** The connection diagram to locate earth fault and short-circuit faults by Murray loop test method are shown in Fig. 6.8 and 6.9 respectively. As already said, Wheatstone bridge principle is used in these tests.

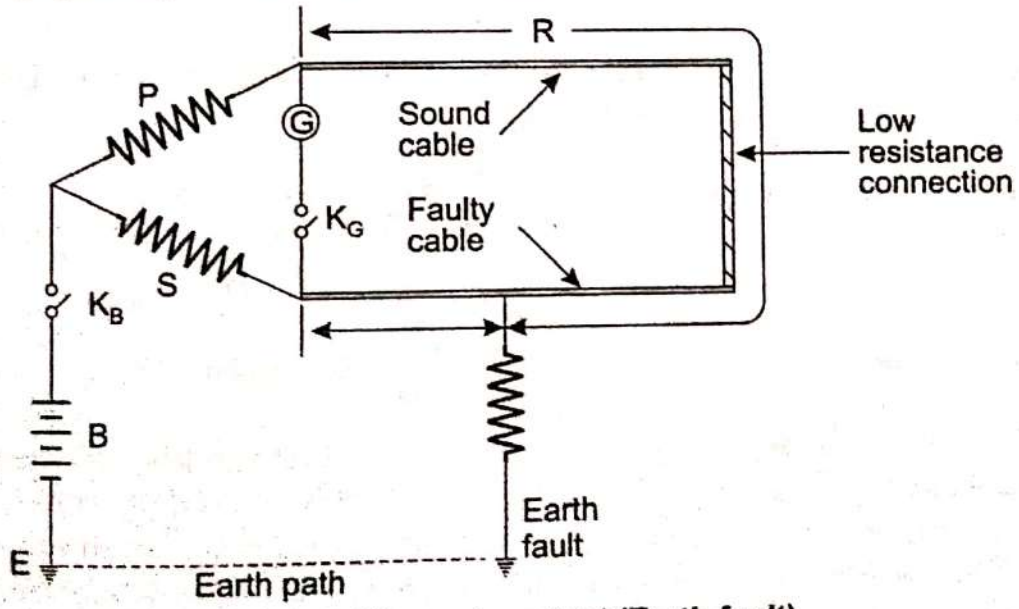

Fig 6.8. Murray loop test (Earth fault)

P and Q are the two ratio arms consisting of step resistors or slide wire, G is galvanometer, B is a battery, K_1 is a battery key and K_G is galvanometer key.

The fault cable connected to a second cable through low resistance link at far end bridge is balanced by adjusting the resistance of ratio arms P and Q until the galvanometer indicates zero.