CHAPTER XXIII

PROTECTION OF TELECOM EQUIPMENTS AGAINST LIGHTNING

SECTION A

INTRODUCTION

23.1 **GENERAL**

Suitable protection arrangements shall be provided in telecom installations to protect the equipments from lightning and ensure safety of operational & maintenance staff.

23.2 **PRINCIPLES OF PROTECTION :**

The protection system shall provide a very low impedance parallel path to the ground in such a manner that discharge current due to lightning is transmitted to the earth through this path, instead of passing through the equipment.

SECTION B

COMPONENTS OF PROTECTION SYSTEM & INSTALLATION

23.3 **LIGHTNING ARRESTER :**

23.3.1 The lightning arrester shall consist of lightning spike to the earth electrode. The material and the size of the conductor shall be as given below:

MATERIAL	SIZE
G.I. WIRE	8mm dia
G.I. STRIP	20mm x 3mm

23.3.2 The lightning conductors shall be drawn in most direct possible path avoiding bends, upturn or kinks.

23.4 **EARTH TERMINATION:**

These are parts of the lightning protection system intended to distribute the discharge current into the general mass of the earth. The earth termination shall consists of suitable earth electrodes and underground conductors.

23.5 **EARTH ELECTRODE :**

23.5.1 Electrode Material & Size : Galvanised iron pipes or angles shall be used. In protected installations solid copper rod may also be used.

23.5.2 The size of the different types of electrodes shall be as under;

TYPE	SIZE
G.I.Pipe	Length >=2.5M Internal Diameter >= 38mm
G.I.ANGLE	Length > = 2.5M Cross section: : 50 mm x 50mmx5mm
Copper Rod	Length >= 2.5 M Diameter= 16mm

23.6 **INSTALLATION OF THE ELECTRODE:**

The electrodes shall have a spike at one end and a clamp at the other end for connecting earth lead. The electrodes shall be directly driven in the earth up to a depth of atleast 2.5 M. Where rock is encountered at a depth less than 2.5M, the electrode shall be driven inclined by about 30 degrees to the vertical. In hard soil, hole for the electrode may be drilled by earth auger or by manual trenching . The top of the electrode shall be about 30 cm above the ground . After inserting the electrodes, the hole shall be filled with earth properly and water should be spread to ensure good contact between electrode and filling.

23.7 **USE OF MULTIPLE ELECTRODES:**

In cases where a single electrode is not sufficient to provide the desired earth resistance, more than one electrode shall be used. The separation of the electrodes shall be about 4 M.

23.8 **CALCULATION OF THE NUMBER OF ELECTRODES:**

Approximate calculation of the number of electrodes required to get desired value of earth resistance, can be made using the guidelines given in Annexure-A

23.9 **ARTIFICIAL TREATMENT OF SOIL:**

In soils of high resistivity, even multiple earth electrode may not provide desired earth resistance. In such cases the soil should be artificially treated

with salt and charcoal in appropriate proportion. Earth pits of 600 mm dia and 2.5 M depth shall be formed by excavation and the electrode shall be placed at the centre of the pit. The pit shall be filled alternatively with layers of common salt & charcoal, each layer of about 2.5cm thick, up to a depth of about 20 cm from the ground level. The pit shall be filled several times with water, which shall be allowed to be soaked in the ground. After this treatment, the pit shall be covered with excavated earth and water shall be sprayed to ensure good electrical contact. This earth electrode should be cleaned at least once in two years or whenever it is found that the resistance is above required value by excavating the earth and the process of filling with layers of salt and charcoal to keep the earth resistance to the required level.

23.10 **BONDS:**

Bonds made of mild steel clamps with galvanised nuts & bolts shall be used to connect the lightning protection system with other metallic structures like metallic poles, water pipes etc. The bonds shall have more cross sectional area than the main lightning conductor and it shall be protected against corrosion.

23.11 **JOINTS:**

23.11.1 As far as possible joints shall be avoided in lightning conductors and underground earth conductors.

23.11.2 The joints shall be crimped, riveted, welded or soldered so as to ensure minimum electrical impedance for the surge current.

23.11.3 All joints of bimetallic elements shall be protected from corrosion by covering the joint with loaded grease or M-seal compounds.

23.12 **TESTING POINT :**

A clamp between earth termination at the electrodes and the down conductors shall be provided to facilitate isolation of the two sections & measurement of earth resistance. This joint, known as testing point, shall be made of mild steel with galvanised nuts & bolts.

23.13 **TOWER GROUND RING:**

This is the earthing system to be provided at the foot of towers used for telecom applications.
This shall consist of earth electrodes and under ground tinned bare copper conductor forming the ground ring as shown in FIG-1 & 2.

Earth electrodes shall be installed at an interval of about 4 Meter surrounding the tower foundation. Bare tinned copper conductor of 38 sq. mm shall be burried at least 2.5M below the ground level and at a distance of 0.5M from

the tower foundation. The conductor shall be soldered /clamped /welded to the electrodes to provide good electrical connection. Each leg or two diagonal legs of the tower shall be connected to the tower ground ring with 2 nos. of 6mm dia copper wire.

23.14 **EXTERNAL GROUND RING** :

The external ground ring is the earthing system surrounding the plinth of the building, housing telecom equipment. This shall be constructed in the same manner as tower ground ring . The layout is shown in Fig 1.

23.15 **INTERNAL GROUND RING**

This is the earthing arrangement to be provided inside the equipment room. This shall consist of earth bus bar(25 mm x 5mm copper flat or 38mm sq. bare tinned copper conductor) installed surrounding the equipment room 0.5m below the ceiling or 0.5 M above the floor level. The layout is shown in Fig. 2.

23.16 **SINGLE EARTH SYSTEM:**

The telecom installations shall use single earth system in which the different earth connections from equipments, towers, DC power supply, metallic structures etc. shall be interconnected to each other through low resistance earthing conductors. This method is recommended to keep all the points to be earthed at approximately same potential level in order to reduce the possibility of side flash & subsequent damages.

SECTION C

PROTECTION ARRANGEMENT AT AC MAINS SUPPLY

23.17 AC MAINS EARTHING SYSTEM :

The A.C. mains earthing system shall be as per the rules and regulation issued by local power supply agency.

23.18 **TERMINATION OF OVERHEAD POWER LINES**:

If mains supply is provided through overhead lines, the over head lines shall be terminated about 100M away from the building of sensitive telecom installation such as telephone exchange, radio relay or optical fibre installations.

23.19 **CONNECTION FROM LOW VOLTAGE MAINS** :

Connection for low voltage mains shall be drawn through underground cable. The power cable sheath must be fully insulated from the earthing network of the telecom equipments.

23.20 **SEPARATION BETWEEN MAINS EARTH & TELECOM EARTH**

The protective earth of telecom system shall not be connected to the earth of mains power supply system. A minimum distance of 10 M is desirable.

23.21 **PROTECTION ARRANGEMENT ACROSS AC MAINS SUPPLY TO TELECOM INSTALLATIONS:**

Low voltage lightning discharger of nominal rating of 650V shall be provided across the 230 V mains power supply as shown in Fig 1 & 2. In case of high tension supply (11KV or above) are terminated near the telecom installation, suitable pole mounted high voltage arrester shall be provided.

SECTION D

PROTECTION ARRANGEMENT ACROSS DC POWER SUPPLY

23.22 **PROTECTION AT DC POWER SUPPLY :**

Suitable protection arrangement consisting of avalanche diode and L-C network shall be provided at the DC power supply point at the power distribution board and in heavy lightning prone areas, at the input terminals of the equipment. The rating of the diode shall be at least 20% above the nominal supply voltage.

SECTION E

PROTECTION OF UNDERGROUND CABLE

23.23 **PROTECTION AT SUBSCRIBER PREMISES:**

In heavy lightning prone areas, the under ground cable shall be terminated with line protector arrangement consisting of gas discharge (GD) tubes & MOVR. The specification of the protection arrangement is given in Annexure-B.

23.24 **PROTECTION AT CABLE JUNCTION /TERMINATION BOXES**:

The metallic sheath or armour of the cable shall be earthed. In the cable termination/junction box, the sheath should be connected to the metallic body of the box which shall be earthed. In non metallic boxes a separate provision shall be made to earth the cable sheath.

23.25 **PROTECTION AT TRANSMISSION/SWITCHING END:**

The metallic sheath shall be earthed and protective device as mentioned in Para 23.23 above shall be provided for each pair including unused pairs.

23.26 **PROTECTION AT TRANSITION POINT BETWEEN OVERHEAD LINES & UNDERGROUND CABLE**

If the distance of the overhead lines drawn from the cable termination box exceeds 500 meters, protection arrangement consisting of GD tube & MOVR shall be provided for each pair of the conductor including unused pairs & the common earth point shall be connected to earth electrodes.

SECTION F

PROTECTION FOR CIRCUITS ON OVERHEAD WIRES

23.27 The protection arrangements similar to those of underground cable shall be provided. Every tenth pole of the overhead alignment shall be provided with earthed lightning arrestor to reduce the intensity of discharge current along the overhead line.

SECTION G

PROTECTION ARRANGEMENTS IN MICROWAVE, UHF & TRAIN RADIO STATIONS

23.28 **PROTECTION ARRANGEMENTS FOR RADIO STATIONS**

The lightning surges in microwave, UHF & train radio stations may get entry into the equipment through any of the following paths-

- Tower, waveguide or radio frequency coaxial cable
- AC mains power supply
-Over head telephones wires or underground telecommunications cables.

Adequate protection arrangement shall be provided in each case to protect the equipment from damages.

23.29 **RISK INDEX :**

The degree of protection required and the protection devices necessary to be installed shall be based on the RISK INDEX of the particular location. A method for calculation of the risk index is given in Annexure-C.

23.30 **PROTECTION ARRANGEMENT OF RADIO TOWERS:**

23.30.1 **PROVISION OF TOWER GROUND RING:**

Tower ground ring as mentioned in para 23.13 shall be provided for all towers.

23.30.2 **PROVISION OF LIGHTNING SPIKE :**

Lightning spike as mentioned in para 23.3 shall be provided for all towers, on the top of the tower.

23.30.3 **PROTECTION FOR TOWERS SITUATED ON GROUND :**

In case of towers erected directly on ground the lower legs act as down conductors & no separate lightning conductor from lightning spike to earth is necessary. Each tower leg shall be connected to the tower ground ring by 2 no. of 14mm dia copper wire.

23.30.4 **PROTECTION FOR TOWERS ON THE TOP OF BUILDING**:

The tower legs shall be connected to lightning conductors which shall be drawn along the building wall and connected to the earth termination at ground. At least two number of such conductors shall be drawn. The earth termination shall be constructed in the same manner as the tower ground ring.

23.31 **PROTECTION ARRANGEMENTS OF RADIO RELAY STATIONS WITH HIGH RISK INDEX ;**

The protection arrangement as given in Fig-1 shall be taken for stations with risk index 80 or more. The arrangement shall consist of the following:

(a) TOWER GROUND RING;
(b) EXTERNAL GROUND RING;
(c) INTERNAL GROUND RING;

23.31. The tower ground ring shall be connected at two places to the external

1 ground ring with 6mm dia bare tinned copper conductor laid in underground trenches.

23.31.2 The waveguide run shall be connected to the tower metal structure at the top and the bottom. The waveguide portion inside the building shall be connected to the tower ground by 6mm dia copper wire.

23.31.3 The external metallic sheath of RE coaxial cable shall be earthed in the same manner as in case of waveguide.

23.31.4 Following shall be connected to the internal ground ring:

(a) The battery charger positive terminal, earth terminals of microwave/UHF/train radio/Optical fibre equipments, Multiplexing equipments.

(b) The earth terminal of lightning ARRESTER & MOVRs provided in the DC circuits.

(c) All conduits , battery trays, battery chargers, cable trays, jumper wire cable trays.
(d) All incidental metal objects such as ducts, distribution frame, metal door frames etc.
For all these connections 4mm dia copper or 6mm dia copper clad steel wire shall be used.

23.31.5 Each rack /equipment shall have separate earth connection to the internal ground ring.

23.31.6 The internal ground ring is to be bonded to the external ground at 4 corners of the building with 6 mm copper wire.

23.32 **PROTECTION SCHEME FOR RADIO STATIONS WITH LOW RISK INDEX**:

Protection arrangement as per Fig 2 shall be provided.

23.32.1 The protection arrangement shall consist of :
(a) TOWER GROUND RING
(b) INTERNAL GROUND RING

The internal ground ring shall be connected to the tower ground ring by 6MM dia copper at minimum two places.

23.32.2 Following shall be connected to the internal ground ring

(a) Battery charger positive.
(b) Ground terminal of the microwave radio & multiplexing equipment.

(c) Ground terminal of lighting arrestors across the charger.
(d) Ground terminal of GD tube & MOVR.

23.32.3 The waveguide portion inside the building near the branching filter shall be connected to the tower ground ring with 6mm copper wire. The waveguide support ladder shall be connected to tower ring.

23.32.4 The waveguide shall be connected to tower structure at the top and the bottom.

SECTION H

PROTECTION ARRANGEMENT FOR TELEPHONE EXCHANGES

23.33 The protection system of telephone exchanges shall be similar to the radio relay station excepting that no tower earth is required. Suitable protection arrangement with fuse, GD tube and MOVR shall be provided.

23.33.1 **EARTHING REQUIREMENT:**

External ground ring similar to the radio relay stations shall be provided for telephone exchanges.

23.33.2 Three stage system consisting of fuse, GD tube and MOVR shall be provided in the line side of the electronic telephone exchanges. However, for exchanges where above protections are inbuilt in the design of MFG and line cards, no separate protection is required.

23.33.3 Lighting protection arrangement as described in para 23.22 shall be provided across DC supply voltage at the power distribution board.

23.33.4 Metallic structures, chassis, racks etc. shall be connected to the external earth in the same manner as in radio relay stations.

SECTION I

INSPECTION & TESTING

23.34 The complete protection arrangement should be inspected and tested by ASTE/DSTE/Sr.DSTE to ensure that the work has been completed in a satisfactory manner and the material and components used conform to the standard.

23.35 Routine inspection of the installation, particularly the earth resistance shall be taken twice a year by the SE/SSE incharge of the station and Earth connections of all installation should be checked thoroughly two months in advance of every monsoon season and remedial measures should be taken well in advance of monsoon.

23.36 A log book shall be kept in which details of the measurement and inspection should be recorded for scrutiny by higher officials.

ANNEXURE-A

Para 23.8

CALCULATION OF EARTH RESISTANCE & NUMBER OF ELECTRODES

The approximate earth resistance of the rod/pipe electrodes can be calculated by the following formulae.

R= 0.75 X o/L if 25< L/d < 100

= o/L if 100 < L/d < 600

= 1.2 o/L if 600 < L/d < 300

where o = Resistivity of earth in Ohm.M
L= Length of the electrode in M.
d= Diameter of the electrode in M.

Assuming a value of 'o'=40, L=2.5M , d = 38 mm
the value of R comes out to be = 12 ohms.

Thus with one electrode the earth resistance is 12 ohms.

If the desired earth resistance is equal to R(d), the no. of electrodes required to achieve the above resistance can be approximately calculated by R(d) = (1.5/N) x R where,

R= Resistance of single electrode
N= No. of electrodes installed in parallel at a distance of 3 to 4 M interval.

Thus to get earth resistance of 1 ohm the total no. of electrodes required N= 1.5 x 12= 18

The representative values of soil resistivity in various parts of India are given for ready reference.

Representative values of soil resistivity in various parts of India

S. No.	Locality	Type of soil	Order of resistivity in ohm meter	Remarks
1	**2**	**3**	**4**	**5**
1	Kakarepar, Surat Distt. Gujarat	Clayay black soil	6-23	Underlying bedrock Deccan trap
2	Taptee Valley	Alluviium	6-24	-do-
3	Narmada Valley	Alluvium	4-11	Underlying bedrock-sand stones, shale and limestones, Deccan trap, and geneises.

4	Purna Valley(Deogaon)	Agricultural	3-6	Underlying bedrock Deccan trap.
5	Dhond, Bombay	Alluvium	6-40	-do
6	Bijapur Distt. Mysore State	(a) black cotton soil (b) Moorm	2-10 10-50	-do-
7	Carimenapenta, Nellore Distt., Andhra Pradesh.	Alluvium(Highly clayey)	2	Underlying bedrock geniuses.
8	Kartee	(a) Alluvium (b) Alluvium	3-5 9-21	Underlying bedrock sand-stone, trap or geniuses.
9	Delhi (a)Najafgarh	(a) Alluvium(dry, sandy soil) (b) Loamy to Clayey soil) alluvium(Saline)	75-170 38-50 1.5-9	-do- -do- -do-
	(b)Chhatarpur	Dry Soil	36-109	Underlying bedrock quartzites
10	Korba, M.P.	(a) Moist Clay (b) Alluvium soil	2-3 10-20	Underlying bedrock sand-stones or shale.
11	Cossipur, Calcutta.	Alluvium	25(Approx)	----------
12	Bhagalpur Bihar	(a) Alluvium (b) Top Soil	9-14 24-46	Underlying bedrock traps, sand -stones or gneisses.
13	Kerala(Trivendrum Distt)	Leteritic Clay	2-5	Underlying bedrock leterite charnockite or ghanites.
14	Bharatpur	Sandy, loam(saline)	6-14	------
15	Kalyadi, Mysore.	Alluvium	60-150	Underlying bedrock gneisses.
16	Kolar Gold fields	Sandy surface	45-185	-do-
17	Wajrakarur, Andhra Pradesh	Alluvium	50-150	-do-
18	Koyna, Satara Distt.	Lateritic	800-1200(dry)	Underlying bed-rock sand-laterite or trap.
19	Kutch-kandla	(a) Alluvium(clayey) (b) Alluvium(Sandy)	4-50 60-200	Underlying bedrock sand-stone, shale or trap. -do-
20	Villupuram Madras	Clayey sands	11	Underlying bedrock-granite.
21	Ambaji, Banaskantha, Gujarat.	Alluvium	170	Underlying bedrock-sand-stones and gneisses.
22		(a) Alluvium	2-5	Underlying bedrock sand-

		stones and gneisses.
		-do-
	(b) Lateritic soil	300 (approx)

Note: The soil resistivities are subject to wide seasonal variation as they depend very much on the moisture content.

ANNEXURE – B
Para23.23

PROTECTION ARRANGEMENT FOR SUBSCRIBERS LINES

General Specification :

i) Response Time - < 1 micro sec.

ii) Protection level - ~ 22 V

iii) Discharge current -- > 10 KA

iv) Insulation resistance -- > 10^{8} Ohms

v) Capacitance -- ~ 3 pf

vi) Series resistance --- 20 Ohms

Specification of Gas Arrestor : (Discharge Tube)

i) DC spark over voltage - 300 - 500 V.

ii) Impulse spark over voltage (1 KV/micro sec.) 800V

(iii) Nominal impulse discharge current - 10 KA
(8/20 micro Sec. wave)

(iv) Insulation resistance at (100 VDC) - 10^{10} Ohms

(v) Capacitance -- 2.5 pf

Specification of MOVR :

i) Protection level voltage - 22 V
ii) Surge current at (8/20 micro sec. wave) -- upto 50 amps.
iii) Average power dissipation -- 0.02 W
iv) Insulation resistance -- > 100 M.Ohms.
v) Capacitance -- ~ 2 pf

ANNEXURE - C

CALCULATION OF RISK INDEX BASED ON VARIOUS FACTORS AFFECTING RISK OF LIGHTNING AND CONSEQUENTIAL DAMAGE

1 **Usage of Structure:**

If the structure is generally occupied by a large number of people , the consequential damage could be quite high. In case of radio relay installations, since they can be treated as places occupied by a limited number of people and having a tall outdoor metallic structure, the value of the index is 4.

2 **Type of construction:**

A steel framed building is self-protecting against lightning while brick buildings require greater degree of protection. In case of Radio Relay installations:-

((i)) For reinforced concrete building with any roof other than metal- index is 2.
(ii) For Brick , plain concrete or masonary with any roof other than metal or thatch- the index is 4.
(iii) Reinforced concrete with metal roof - 7
(iv) Brick, plain concrete, masonary with metal roofing the index is - 8.

3 **Contents or consequential effects:**

If the installation contains equipment, damage to which will seriously disrupt normal working, then such an installation requires a higher level of protection. In case of radio relay installations, the value of the index is 6.

4 **Degree of Isolation:**

In closely built-up towns and cities, the lightning hazard is not as great as in the open country. For radio relay installations, the index value is
(i)).. for structures located in a large area of structures of trees of the same or greater height, for example in a large town or forest-2.

ii) for structures located in an area with few other structures or trees of similar height-5.

iii) for structures completely isolated or exceeding at least twice the height of surrounding structures or trees- 10.

iv) For radio relay stations with no motorable approach roads to the top and attendant difficulties in transporting equipment and reaching the station after sun-set, an index value of 10 is to be added to the values at (i) to (iii) above,

(v) For radio relay stations situated on rocky soil where it is difficult to get a good earth connection an index value of 10 is to be added to the values of (i) to (iv) above.

5 **Type of Terrain:**

An installation in a hilly or mountainous area is more susceptible to damage than a building in plains and flat terrain. In case of radio-relay installations;

I) situated on flat terrain at any level - index value is 2.
ii) Hill terrain - index value is 6.
iii) Mountainous terrain between 500 m to 1000 m- index value is 8.

iv) Mountainous terrain above 1000m - index value is 10.

6 **Height of Structures**

Taller structures are subject to greater hazards, than smaller structures and therefore lightning protection is more desirable in tall structures. In case of Radio Relay installations, since the height of the tower is the deciding factor, the following index values are to be adopted:-

Height of Structures(Height of tower, or height of building + tower in metres where tower is mounted on the building)

Exceeding	**Not exceeding**	**Value of Index**
-	10 metres	2
10 metres	15 "	4
15 "	20 "	5
20 "	25 "	8
25 "	30 "	11
30 "	35 "	16
35 "	40 "	19
40 "	45 "	22
45 "	55 "	30
55 "	60 "	32
60 "	70 "	35
70 "	80 "	37
80 "	90 "	39

90	"	100	"	40

Structures higher than 55m require protection in all cases.

7 **Lightning Prevalence:**

Isokaraunic level (IKL) refers to the number of thunders storm days in a year at a particular place: the map at **Appendix B** shows the Average IKL in different parts of the country". The risk of lightning strike increases with the IKL but the severity of lightning storms , as distinguished from their frequency of occurrence is much greater in some locations than in others. Hence the need for protection at certain places may not be in direct proportion to IKL. The value of the index as a function of IKL is as under:-

Number of thunderstorms days per year

Exceeding	Not exceeding	Value of index.
-------	5	4
5	10	8
11	15	13
16	20	18
21	-----	21

Examples of Index Figure Calculations:

a) Secunderabad Station S.C.Rly(situated in crowded areas)

	Factor	Category	Risk Index
1	Usage of structure	Occupied by limited number of people	4
2	Types of construction	RCC with tower on top	7
3	Contents of conse-quential effects.	Communication network of Indian Railways	6
4	Degree of Isolation	Height exceeds twice the height of surrounding structures.	10
5	Type of terrain	Flat terrain	2
6	Height of structure	60m(Tower and Building)	32
7	IKL	28	21

Index Figure= 4+7+6+10+2+32+21-= 82

b) Peddagutta (situated on an isolated hill) S.C.Rly

1	Usage of structure	Same as above (in a)	4
2	Type of construction	RCC Building with tower on top	7

3	Contents	Same as above (in a)	6
4	Degree of isolation	On an isolated hill	10+10+10
5	Type of Terrain	Mountainous terrain between 500 to 1000m.	8
6	Height of structure	10-15m(Building tower)	4
7	IKL	43(Approx.)	21
	Index figure	=80	

c) Ongole - SC Rly (along the East Coast)

1	Usage of Structure	Same as above (in a)	4
2	Type of construction	RCC building with other than metallic roof	2
3	Contents	Same as above (in a)	6
4	Degree of Isolation	Height exceeding twice the surround structure	10
5	Type of Terrain	Hill terrain	6
6	Height of structure	Height of tower is 90m	39
7	IKL	25	21
	Index figure:	88	

d) New Delhi- N.Rly(situated in crowded area)

1	`Usage of structure	Same as above (in a)	4
2	Type of construction	RCC building with other than metallic roof.	2
3	Contents	Same as above (in a)	6
4	Degree of Isolation	Located in the midst of structure of comparable height	2
5	Type of Terrain	Flat terrain	2
6	Height of structure	Height of tower(50m)	30
7	IKL	38	21

Index Figure: 67

e) Bilaspur- S.E.Railway

1	Usage of structure	Same as above (in a)	4
2	Type of construction	RCC building without metal roofing	2
3	Contents	Same as above (in a)	6
4	Degree of Isolation	Exceeds double the height of structures surrounding	10
5	Type of terrain	Flat terrain	2
6	Height of structure	Ht. of tower 90m	39
7	IKL	34(approx)	21
	Risk Index=	84	

f) Surat- W.Rly(along the West coast)

1	Usage of structure	Same as above (in a)	4
2	Type of construction	RCC building without metal roofs	2
3	Contents	Same as above(in a)	6
4	Degree of isolation	Exceeds double the height of the surrounding structures	10
5	Type of Terrain	Flat	2
6	Height of structure	Height of tower (50m)	30
7	IKL		4

Risk Index: 58

g) Uruli (Central Railway)

1	Usage of structure	Same as above (in a)	4
2	Type of construction:	RCC building without metal proof	2
3	Contents	Same as above (in a)	6
4	Degree of Isolation	exceeds double the height of surrounding structures.	10+10
5	Type of Terrain	Hill terrain	6
6	Height of structure	50m tower	30
7	IKL	21	

Risk Index : 89

ISO XERAUNIC DATA
(Reproduced from IS 2309-1969)

S.No.	Name of Place	Annual Thunderstrom days
1	Gilgit	7
2	Skardu	5
3	Gulmarg	53
4	Srinagar	54
5	Dras	3
6	Kargil	2
7	Leh	3
8	Jammu	26
9	Dharamshala	13
10	Amritsar	49
11.	Pathankot	4
12.	Mandi	46
13	Ludhiana	12
14	Simla	40
15	Patiala	26
16	Ambala	9
17	Hissar	27
18	Delhi	39
19	Bikaner	10

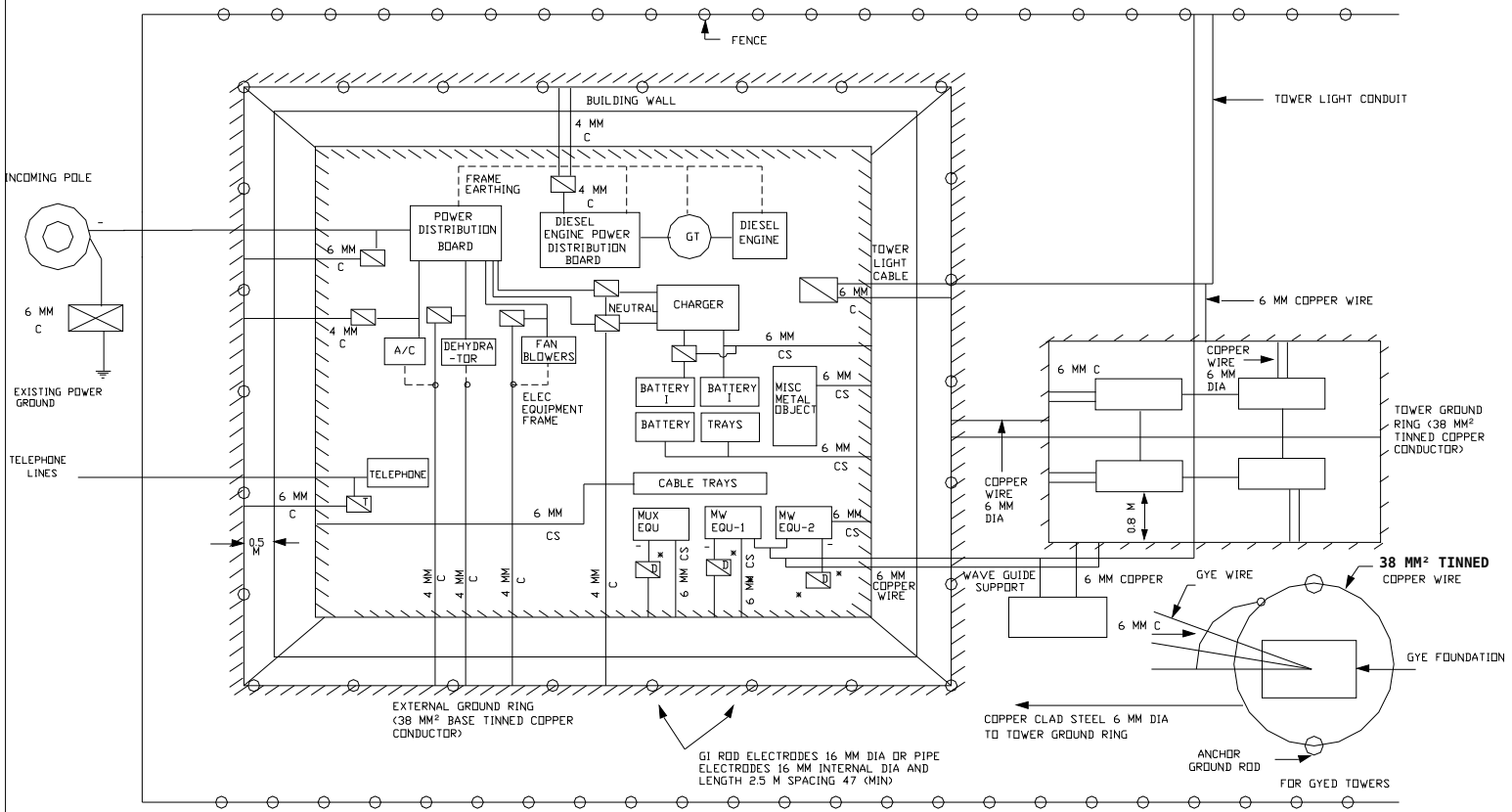
20	Phalodi	14
21	Sikar	17
22	Barmer	12
23	Jodhpur	23
24	Ajmer	26
25	Jaipur	39
26	Kankroli	36
27	Mount Abu	5
28	Udaipur	38
29	Neemuch	28
30	Kota	27
31	Jallawar	40
32	Mussorie	61
33	Roorkee	74
34	Najibabad	36
35	Mukteshwar	53
36	Meerut	-
37	Bareilly	34
38	Aligarh	30
39	Agra	25
40	Mainpuri	23
41	Baharaich	31`
42	Gonda	22
43	Lucknow	18
44	Kanpur	26
45	Fatehpur	24
46	Jhansi	20
47	Allahabad	51
48	Varanasi	51
49	Azamgarh	1
50	Gorakhpur	11
51	Kathmandu	74
52	Motihari	38
53	Darbhanga	10
54	Patna	33
55	Gaya	38
56	Daltonganj	73
57	Hazaribagh	73
58	Ranchi	34
59	Chaibasa	70
60	Jamshedpur	66
61	Purnea	52
62	Sabour	76
63	Dumka	63
64	Darjeeling	28
65	Jalpaiguri	68
66	Malda	59

67	Asansol	71
68	Burdwan	39
69	Khargpur	76
70	Calcutta	70
71	Sagar Island	41
72	Dhubri	8
73	Tejpur	27
74	Dibrugarh	98
75	Sibsagar	103
76	Shillong	75
77	Cherrapunji	49
78	Silchar	33
79	Kohima	34
80	Imphal	49
81	Deesa	7
82	Dwarka	5
83	Jamna Nagar	8
84	Rajkot	12
85	Ahmedabad	11
86	Dohad	17
87	Porbundar	3
88	Varaval	3
89	Bhavnagar	11
90	Baroda	8
91	Surat	4
92	Gwalior	53
93	Guna	33
94	Nowgong	59
95	Satna	41
96	Sagar	36
97	Bhopal	44
98	Jabalpur	50
99	Umaria	37
100	Ambikapur	29
101	Indore	34
102	Hoshangabad	37
103	Pachmarhi	30
104	Seoni	51
105	Pendaiah	56
106	Raipur	34
107	Chindawara	27
108	Kanker	37
109	Jagdalpur	35
110	Balasore	81
111	Chandbali	75
112	Angul	81
113	Bhubaneshwar	46

114	Puri	33
115	Gopalpur	34
116	Jharsuguda	85
117	Sambalpur	67
118	Titlagarh	24
119	Rajgangpur	1
120	Dhahanu	1
121	Nasik	17
122	Maligaon	13
123	Akola	20
124	Amraoti	32
125	Nagpur	45
126	Gonda	10
127	Aurangabad	34
128	Bombay	16
129	Aligarh	12
130	Ahmadnagar	10
131	Parbhani	32
132	Pune	22
133	Mahabaleshwar	14
134	Ratnagiri	6
135	Sholapur	23
136	Miraj	25
137	Vengurla	39
138	Najibabad	36
139	Hanamkonda	43
140	Hyderabad	28
141	Khammam	26
142	Kalingapatnam	20
143	Vishakhapatnam	46
144	Rentichintala	42
145	Masulipatnam	20
146	Ongole	25
147	Kurnool	29
148	Anantapur	22
149	Nellore	18
150	Bidar	15
151	Gulbarga	34
152	Bijapur	9
153	Belgaum	31
154	Raichur	17
155	Gadag	21
156	Bellary	22
157	Karwar	27
158	Honawar	5
159	Chikalthana	24
160	Mangalore	36

161	Hassan	26
162	Bangalore	46
163	Mysore	44
164	Kozhikode	39
165		
166	Cochin	69
167	Allopey	51
168	Trivandrum	68
169	Vellore	25
170	Madras	47
171	Cotacamud	24
`172	Salem	69
173	Cuddalore	37
174	Coimbatore	40
175	Tiruchirapalli	41
176	Nagapattinam	15
177	Kodikanal	82
178	Madurai	39
179	Pambam	5
180	Tuticorin	14
181	Cape Comorin	68
182	Port Blair	62
183	Car Nicobar	18
184	Minicoy	20

LIGHTENING PROTECTION SCHEME FOR INSTALLATIONS WITH "RISK - INDEX" GREATER THAN 80



NOTE:-

1) SHARP BENDS TO BE AVOIDED IN EARTH LEADS AND THEIR LENGTH IS TO BE KEPT TO THE MINIMUM.

2) HIGH VOLTAGE ARRISTAR AC 11 KV POLE MOUNTED (TO BE PROVIDED WHERE APPLICABLE FOR MW STATIONS)

3) 230 V AC

4) T — LOW VOLTAGE TELEPHONES ARRISTER, 60 V AC

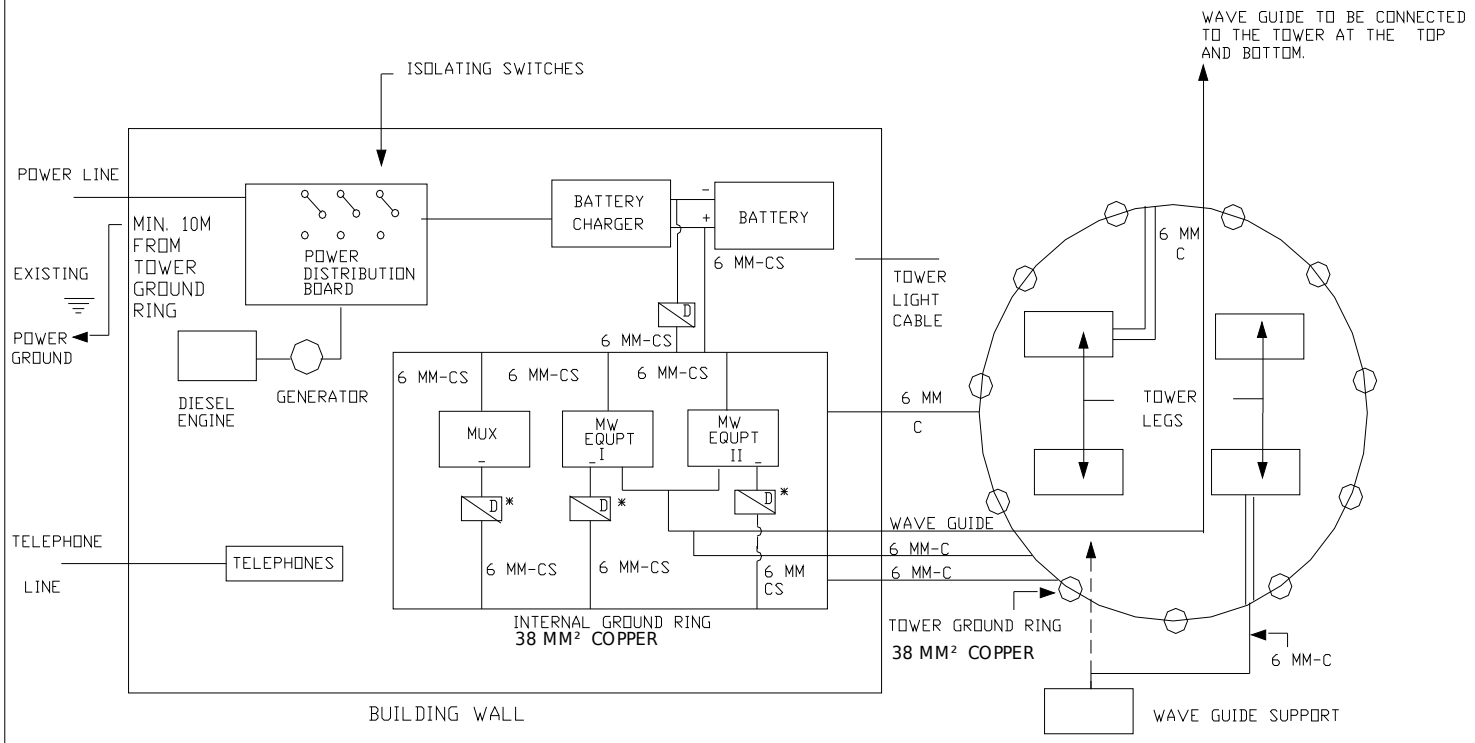
5) D — LOW VOLTAGE DC ARRESTERS ACROSS RADIO AND MUX EQUIPMENTS 24 V OR 36 V DC

6) C - COPPER WIRE
CS - COPPER CLAD STEEL WIRE

7) * REQUIRED IN CASE OF CHARGE-DISCHARGE CYCLE OF WORKING

FIG - 1

LIGHTENING PROTECTION SCHEME FOR INSTALLATIONS WITH "RISK - INDEX' LESS THAN 80



NOTE :-

1. SHARP BENDS TO BE AVOIDED IN EARTH LEADS AND THEIR LENGTH IS TO BE KEPTTO THE MINIMUM.
2. IN CASE OF GYE TOWER, EACH GYE ANCHOR TO BE CONNECTED TO TOWER GROUND RING.

D DC LIGHTNING ARRESTER 24V OR 36V DC * REQUIRED IN CASE OF CHARGE DISCHARGE CYCLE OF WORKING.

C - COPPER WIRE

CS - COPPER CLAD STEEL

FIG - 2