Communication, Navigation & Surveillance Manual

Volume V

Lightning & surge Protection and Earthing system of CNS Installations

First Edition 2006

Airports Authority of India

PREFACE

This is the Fifth Volume in the series of Seven volumes of CNS manuals prepared and maintained by CNS-OM Directorate, CHQ on behalf of Airports Authority of India for the use and guidance of its executives and staff. The topics covered under these volumes are as under:-

Volume I – Maintenance of CNS Facilities
Volume II – Communication Procedures
Volume III – Siting Criteria of CNS Facilities
Volume IV – Flight Inspection of CNS Facilities
Volume V – Lightning & Surge Protection and Earthing System of CNS Installations
Volume VI – Technical Specifications
Volume VI- Maintenance Schedules of CNS facilities

This volume contains the recommended processes, procedures and practices for protection of CNS installations and personnel from lightning strikes, surge and transient pulses which not only cause fatal damage to expensive CNS equipment but also disrupt Air Traffic Services.

The practices described in this volume if meticulously followed by Engineering (Electrical) Wing of AAI and technical maintenance personnel at Aeronautical Communication Stations will go a long way to protect the vital CNS installations from the damage caused by lightning and surges.

Views, comments and suggestions for improvement of this volume may be sent to ED CNS-OM so as to incorporate them in the next version of this volume.

Record of Amendments

No.	*Amendment Date*	*Incorporated on*	Incorporated by

Table of Contents

Chapter – 1

GENERAL

1. Title of the Document:

This document is identified as Communication, Navigation & Surveillance Manual – Vol. V (CNSM- Vol .V) "Lightning & Surge Protection and Earthing System of CNS Installations."

2. Purpose of this Document:

2.1 Purpose of this document is to provide information and guidelines for provisioning of Lightning & Surge Protection and Earthing System of CNS facilities, which are essential for the provision of safe and efficient air traffic services by Airports Authority of India. It is published for use and guidance of its CNS Maintenance personnel.

3. Responsibility for documentation, review, amendments and publication:

3.1 The General Manager (N&S), AAI, CHQ is responsible for development, review and amendments of CNS – Manuals Vol. V. He will ensure that the information and guidelines pertaining to provisioning of Lightning & Surge Protection and Earthing System of CNS facilities, as detailed in this manual are in conformity and current.

3.2 The Executive Director (CNS-OM) is responsible for the approval of documentation & Amendments and publication of CNS-Manual.

4. Effective Date:

4.1 Effective date of Manual is indicated at the foot of the page.

4.2 New edition will be indicated by the same date at the foot of the page.

5. Change History:

5.1 This is version 1 of CNS Manual Vol. V. Changes, if any, are indicated on 'Record of Amendments and corrigenda page'.

5.2 Amendments – documentation being inserted in the manual must contain headers and footers that are consistent with those given in this document.

6. Control of the manual:

6.1 Directorate of CNS-OM will control this Manual electronically through AAI web site.

7 Distribution of the Manual:

7.1 Directorate of CNS-OM may produce hard copies and control the distribution of these Copies, as deemed appropriate.

8 Master Copy:

8.1 An electronic and a hard master copy of each chapter contained in the Manual will be held and maintained by the CNS-OM Directorate.

9. Checking Currency of Manual:

9.1 A current copy of the Manual will be published on Airports Authority of India web site.

10 Enquiries

10.1 Enquiries/Clarifications should be addressed to:

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Chapter - 2

General Requirements

1. Scope

1.1 This chapter sets out guidelines for the protection of persons and property from hazards arising from exposure to lightning. The recommendations specifically cover the following applications.

(a) The protection of persons, both outdoors, where they may be at risk from the direct effects of a lightning strike, and indoors, where they may be at risk indirectly as a consequence of lightning currents being conducted into the building.

(b) The protection of a variety of buildings or structures housing CNS facilities.

(c) The protection of sensitive electronic CNS equipment (e.g. facsimile machines, modems, computers, communication systems) from over voltages resulting from a lightning strike to the building or its associated services.

1.2 The nature of lightning and the principles of lightning protection are discussed and guidance is given to assist in a determination of whether protective measures should be taken.

1.3 The standard is applicable to Lightning Protection Systems (LPSs) that comprise air terminals/Ionizers, down conductors, earth termination networks and surge protective devices (SPDs). Nothing contained within this standard neither endorses nor implies the endorsement of non-conventional LPSs that comprise special air terminals or special down conductors that claim enhanced performance or enhanced screening over other systems.

2. Introduction

2.1 Thunderstorms are natural phenomena and there are no proven devices and methods capable of preventing lightning flashes. Direct and nearby cloud-to-ground lightning discharges can be hazardous to persons, structures, installations and many other things in or on them.

2.2 Consideration should always be given to the application of lightning protection measures. Realization that it is possible to provide effective protection against lightning began with Franklin and for over a hundred years national and international manuals and standards have been developed to provide guidance on the principles and practice of lightning protection. Until about ten years ago, risk assessment was used to determine if there was a need to provide lightning protection. However, the modern approach is that of risk management, which integrates the determination of the need for protection with the selection of adequate protection measures to reduce the risk to a tolerable level. This selection takes into account both the efficiency of the measures and the cost of their provision.

2.3 The lightning protection measures include an LPS for the structure and its occupants, protection against the lightning electro-magnetic pulse (LEMP) caused by direct and nearby strikes, and transient protection (TP) of incoming services. The LPS for the structure comprises an air terminal network to intercept the lightning strike, a down conductor system to conduct the discharge current safely to earth and an earth termination network to dissipate the current into the earth. The LEMP protection includes a number of measures to protect sensitive electronic equipment such as the use of a mesh of down conductor to minimize the internal magnetic field, the selection of lightning protection zones, equipotential bonding and earthing, and the installation of Surge Protection Devices (SPDs). The TP for incoming services includes the use of isolation devices, the shielding of cables and the installation and coordination of SPDs.

3. Definitions

For the purpose of this standard, the definitions below apply .:-

Air terminal
A vertical or horizontal conductor of an LPS, positioned so as to intercept a lightning discharge, which establishes a zone of protection.

Air terminal network
A network of air terminals and interconnecting conductors, which forms the part of an LPS that is intended to intercept lightning discharges.

Early Streamer Emission (ESE) Lightning Conductor
A lighting rod equipped with a system which creates the triggering advance of the upward leader when compared with a simple rod lightning conductor in the similar conditions. The system intercepts the lightning at the highest point and de – ionize the charge developing in the clouds and offering a safe Path for the Electrical energy through down conductors.

Charge Transfer System
This system is lightning protection system and does not allow lightning to strike in the protected area. The system uses Ionizer which dissipates higher dissipation current of reverse charge in the air and reduces Electro-Static potential below the lightning potential.

Triggering Process
Physical phenomenon between the inception of the first corona and the continueos propagation of an upward leader.

Triggering Advance (ΔT)
Gain in triggering time of the upward leader of the ESE lightning conductor when compared with a simple rod lighting conductor in the same conditions and derived from the evaluation test. This is expressed in µs.

Equipotential Bonding
An electrical connection putting ground conductors and conductive parts at the same potential or a substantially equal potential.

Base conductors
Conductors placed around the perimeter of a structure near ground level interconnected to a number of earth terminations to distribute the lightning current amongst them.

Bond (bonding conductor)
A conductor intended to provide electrical connection between the LPS and other metalwork and between various metal parts of a structure or between earthing systems.

Direct lightning flash
A lightning discharge, composed of one or more strokes, that strikes the structure or its LPS directly.

Down conductor
A conductor that connects an air terminal network with an earth termination.

Earth potential rise (EPR)

The increase in electrical potential of an earthing electrode, body of soil or earthed structure, with respect to distant earth, caused by the discharge of current to the general body of earth through the impedance of that earthing electrode or structure.

Earthing conductor
The conductor by which the final connection to an earthing electrode is made.

Earthing electrodes (earth rods or ground rods)

Those portions of the earth termination that make direct low resistance electrical contact with the earth.

Earthing resistance
The resistance of the LPS to the general mass of earth, as measured from a test point.

Surge Protection Device (SPD)
A device designed limit transient surge voltages & to provide a path for the current waves. It contains at least one non-linear component.

Indirect lightning flash
A lightning discharge, composed of one or more strokes, that strikes the incoming services or the ground near the structure or near the incoming services.

Joint
A mechanical and electrical junction between two or more sections of an LPS.

Lightning flash (lightning discharge)
An electrical discharge in the atmosphere involving one or more electrically charged regions, most commonly in a cumulonimbus cloud, taking either of the following forms:-

(a) Ground flash (earth discharge): A lightning flash in which at least one lightning discharge channel reaches the ground.

(b) Cloud flash: A lightning flash in which the lightning discharge channels do not reach the earth.

Lightning protection zone (LPZ)
With respect to the lightning threat, a zone may be defined, inside of which is housed sensitive equipment. Extra protection is applied at the zone boundary to minimize the risk of damage to equipment inside the zone.

Lightning strike attachment point
The point on the ground or on a structure where the lower end of the lightning discharge channel connected with the ground or structure.

Lightning stroke
A term used to describe an individual current impulse in a complete ground flash.

Chapter - 3

Nature and Effects of Lightning

1. Purpose

1.1 Lightning strike on and around the Communication Navigation and Surveillance (CNS) installation can cause fatal damage to the expensive CNS equipment and cause disruption of air traffic services. Direct effects of lightning could result in current discharge of a magnitude of the order of 30 kA, which may cause significant risk to the personnel as well as to the equipment. The indirect effects of lightning strikes pose threat to the electrical and electronic equipment through induced voltages, surge and transient pulses.

1.2 Comprehensive Lightning and Surge Protection apart from good grounding system is essential for total protection of the equipment and personnel.

2. Introduction

2.1 Nature of Lightning

2.1.1 Lightning is one of nature's most unpredictable events. It strikes at random, damaging buildings, endangering people, corrupting data, creating expensive repairs and costly down time.

2.1.2 Thunderstorms occur under particular meteorological conditions, and partial separation of electrical charges within the thunderstorm usually results in the regions with net negative charge mainly in the lower parts of the thunderstorm, and regions with net positive charge mainly in the upper part. Lightning is an electrical discharge between differently charged regions within the clouds (cloud flash) or between a charged region, nearly always the lower negatively charged region, and earth (ground flash).

2.2 The Lightning attachment process

2.2.1 Lightning occurs as the result of unstable upper atmospheric conditions.

2.2.2 On a hot day, warm air rises from the ground is replaced by cooler air drifting down. The convection process progressively cools the rising air to form clouds, first as water droplets and then at greater heights as ice crystals. In this way, a single or multiple cloud "Cell" is formed, the top of which may reach a height of 12 Km. Charge separation within a cloud occurs because ice crystals at the top become positively charged while the water droplets at the bottom carry negative charges.

2.2.3 The distribution of these particles normally gives rise to a negative charge building up at the base of the cloud. This build-up at the cloud base gives rise to a positive build-up of charge on the ground. This build-up continuous until the voltage difference between the cloud base and the ground becomes so great that it causes a breakdown of the air's resistance, thus creating a lightning discharge.

2.2.4 The first stage of this discharge is the development of a stepped downward leader within the cloud which moves towards the ground in an approximate 50m steps and invisible to the naked eye.

2.2.5 When the stepped leader is near the ground its relatively large negative charge induces even greater amounts of positive charge on the earth beneath it, especially on the objects projecting above the earth's surface.

3. Effects of Lightning

3.1 The principal effects of a lightning discharge to an object are **electrical, thermal and mechanical.** These effects are determined by the magnitude and wave shape of the current discharged into the object and the nature of the object itself.

3.2 Electrical Effect

3.2.1 When the electrical current flows through the building or Lightning Protection System (**LPS).**The electrical potential of the building may rise to a high, usually negative, value with respect to remote earth.

3.2.2 **Earth Currents:** The lightning current produces a high potential gradient around the earthing electrode that can be dangerous to person or livestock. At the point where the lightning current enters the ground the current density is high. Hazardous earth potential gradients may be generated. Earthing electrodes should be distributed more or less symmetrically, preferably outside and around the circumference of a structure, rather than be grouped on one side. This will help to minimize earth potential gradients near the building, and tend to cause the lightning current to flow away from the building rather than underneath it.

3.2.2.1 In addition, with earth connections properly distributed, the current from a lightning flash to ground near the building will be concentrated at the outer extremities. Thus current flow underneath the building, as well as earth potential gradients, will be minimized.

3.2.3 **Side Flash:** The rate of rise of current in conjunction with inductance of the discharge path produces a voltage drop that will vary in time depending upon the current wave shape. As the point of strike on the LPS may be raised to a high potential., there is also the risk of flashover from the LPS to nearby objects. This is called a side-flash. The risk of side-flash is increased at any deeply re-entrant bend or loop in a down conductor due to the local increase in inductance. If such a flash over occurred, part of the lightning current would be discharged through internal installations with consequent risk to the occupants and fabric of the building.

3.2.3.1 If a lightning conductor system is placed on a building and there are un-bonded metal objects of considerable size nearby, there will be a tendency for side-flashing to occur between the conductors of the LPS and the un-bonded metal objects.

3.2.3.2 To prevent damage from side-flash, interconnecting conductors should be provided at all places where side-flashes are likely to occur. This is referred to as equipotential bonding, although complete equalization of potential is never achieved. As the currents required to equalize potentials are considerably less than the full lightning current, conductors of relatively small cross-section are adequate for this purpose.

3.2.4 Potential (voltage) Differences

3.2.4.1 The impedance of the earth termination network to the rapidly changing lightning current influences the potential rise of the LPS. This in turn affects the risk both of side-flashing within the structure to be protected, and of dangerous potential gradients in the ground adjacent to earth termination network. The potential gradient around the earth termination network, on the other hand, depends on the physical arrangement of the earthing electrodes and the soil resistivity.

3.3 Thermal Effect

3.3.1 The amount of energy deposited in any object carrying current may be calculated by multiplying the action integral by the electrical resistance of the object. From this, the temperature rise may be calculated. It should be noted however that the resistance of most objects other than metallic conductors, e.g. wood, masonry or earth, is very non-linear for the large currents associated with lightning. It should also be noted that passage of lightning currents through moist resistive materials such as masonry, or wood can convert the moisture to high-pressure steam, causing the material to explode or shatter.

3.3.2 The thermal effect of a lightning discharge is confined to the temperature rise of the conductor through which the lightning current is discharged. Although the amplitude of a lightning current may be high, it's duration is so short that the thermal effect on an LPS, or on the metallic parts of a structure where this is included in the LPS, is usually negligible. This ignores the fusing or welding effects that occur locally consequent upon the rupture of a conductor that was previously damaged or was of inadequate cross-section. In practice the cross-sectional area of a normal lightning conductor is determined primarily by mechanical and secondarily by thermal considerations.

3.4 Mechanical Effect

3.4.1 At the point of attachment of a lightning discharge channel to a thin metal surface, a hole may be melted in the surface. In this case, some thermal energy will be deposited directly in the metal from the hot plasma of the lightning discharge channel, as well as the thermal energy caused by the passage of the current through the metal. The size of the hole melted in the sheet depends on the material, the thickness of the sheet, and the charge delivered. For example, a moderately severe lightning flash delivering a charge of 70 Coulomb would melt a hole about 100mm^2 in area in a sheet of galvanized iron 0.38 mm thick.

Chapter - 4

Elements of Lightning and Surge Protection System

1. Purpose of Protection

1.1 The purpose of lightning protection is to protect persons, buildings and their contents, or structures in general, from the effects of lightning, there being no evidence for believing that any form of protection can prevent lightning strikes.

1.2 The lightning / surge protection system should provide adequate protection to:-

a) Entire Building with CNS system installed over it;
b) Power supply system of CNS facility;
c) Remote telephone data and signal lines and RF cable for CNS facility.

2. Lightning Protection

2.1 Lightning strikes the earth, on average, sixty times per minute. The tallest structures in cities across the world are regularly struck by lightning. All exposed communications towers and masts are vulnerable to a direct strike. Many of the worlds historic and heritage rated buildings are most at risk because of early construction methods and a lack of sophisticated fire protection systems.

2.2 Some suffer physical damages, with most paying the price through damage to equipment caused by induced transients on service wiring running inside or entering the structure. Engineers, designers, consultants and managers have a responsibility to provide a safe environment for employees, patrons and microelectronic computer and communication systems.

3. Protection Strategy

3.1 The design principles and installation practices to be followed for lightning protection system have to ensure a co-ordinated approach for protection of personnel and critical assets. A three stage integrated strategy given below is essential. This strategy is recommended by all international lightning protection standards.

3.1.1 Direct strike protection system for the structure of the building (area lightning protection): It is designed to intercept the lightning discharge before it strikes the building and safely conducts the energy to earth. The air terminals, down conductors and earthing system are fundamental components within a structural lightning protection system.

3.1.2 Equipotential bonding of all earthing system: Lightning is a natural phenomenon – 50% of all lightning strikes involve a current flow grater than 30,000 amps. With such extreme current level, lightning need not directly strike power or data lines to cause problems. The electro-magnetic field radiated by the discharge current couples into nearby cabling, thereby inducing over-voltages (surges) along these conductors. As the current spreads into the ground, it produces extreme changes into potential at different earth points, e.g. consider the 30,000 amps of current flowing into an earthing system with a measured resistance of 5 ohms. The potential rise of the earthing system (EPR) at this point would be 150,000 volts. These differences in earth potential create damaging over voltages and resulting current flows along conductors, eventually causing a breakdown of components within sensitive equipments. This problem is particularly severe when equipment is connected to more than one separate or remote earth.

To minimize the influence of EPR it is essential that all local earths are equipotentially bonded to the lightning protection earthing system.

3.1.3 Transient and Surge protection: All incoming power, data, communications, signal and control cables from remote locations that connect to critical equipment, must have surge protection equipment fitted to clamp the damaging over voltage to a local earth point.

3.2 Without implementing all the three stages of protection strategy mentioned above, complete protection cannot be guaranteed.

4 Elements of direct lightning protection system: In AAI following types of direct lightning protection is used:-

- Early Streamer Emission (ESE) System
- Charge Transfer System

4.1 ESE (Early Streamer Emission) System: ESE system offers the best solutions for interception of lightning strike at the highest point. The ESE Air Terminal would be mounted on a rod / mast 2-5 meters above the highest point of the structures / building to be protected and would provide protection against direct lightning strikes over large area up to 60 meters radius around it by de- ionizing the charges developing in the clouds and offering a safe path for the electrical energy through down-conductors.

Following are the components of ESE :-

4.1.1 Air Terminals: To protect the area of building or structure, there is a need of lightning arrestors to be installed at the highest point of the structure of the building to be protected. To minimize the effect of lightning, the lightning arrestor should be able to capture the lightning and safely conduct the electrical energy to ground.

The conventional Franklin Rod technology is not sufficient to provide adequate protection to sensitive equipment, buildings, structures and safety to personnel.

4.1.2 Principle of Air Terminals working: The ESE lightning conductors Air Terminals gathers energy from the naturally offering ambient field, which builds up considerably as much as several thousand volts per meter – when a storm approaches. The lower series of energy collecting electrodes allows electrical energy to be restored within the triggering device. Just before the lightning strikes, there is a sudden and rapid increase in the electrical field around and this is detected by the Air Terminal. This information is sent to the electrical triggering device, which in turn, releases the stored energy in the form of ionization at the tip of terminal.

4.1.3 Design Considerations for Air Terminals:-

- Provide air terminals to protect the most vulnerable parts (points and corners);
- Use the roller sphere method (RSM) to check if the less vulnerable parts (edges) are protected and, if not, add more terminals to protect them;
- Check if the least vulnerable (such as flat surfaces) are protected and, if not, add more terminals.
- If a strip conductor is used, it shall be directly on the part it is to protect;
- If a vertical rod is used, its length shall not be < 500mm, and it shall preferably be mounted on the part it is to protect or within 1m or half its length, which ever is the smallest. The maximum allowable length of a rod terminal is 6m.
- If a structure has horizontal or gently sloping upper parts that are essentially cylindrical or oval in shape, then the edges are the vulnerable parts and shall be protected by air terminals. If strip conductor is used, it shall be run along the edge(s). If vertical rods are used, there shall be minimum of two evenly spaced terminals.

4.1.4 Down Conductors: The function of a down conductor is to provide a low impedance path, from air termination network to earth termination network, to allow the lightning current to be safely conducted to earth.

4.1.4.1 International standards advocate the use of various types of down conductors. A combination of strip and rod conductors, reinforcing bars, structural steel stanchions, etc. can be used as all or part of the down conductor system – provided they are appropriately connected to the air and earth termination networks, and are known to offer good electrical conductivity. The international codes such as BS6651 suggest that there is no advantage in "shielded" co-axial cable as down conductors. In fact this is thought to be the disadvantage that potentials upto hundreds of kilo – volts can occur between the inner and outer conductor (Shield) at the top of the down conductor so triggering a side flash.

4.1.4.2 The number of down conductors should be two if the height of the building / structure is higher than 10 meters or the horizontal length of the down conductor is more than its vertical length. As a standard practice 2 Nos. of 70 Sq mm PVC insulated flexible copper cable is used as down conductors.

4.1.5 Design Considerations for down conductors :-

- On any structure 10m in height, there shall be at least two down conductors, each terminated on an earth termination.
- For any structure whose perimeter exceeds 20m, the spacing between down conductors shall not exceed 20m.
- A down conductor shall be connected directly below an air terminal used to protect the most vulnerable parts;
- If an air terminal is on an exposed roof corner, its down conductor will also act as continuation of the air terminal to protect the vertical edge below it, as is required for tall structures.

4.2 Charge Transfer System: Charge Transfer System is lightning Prevention System and does not allow lightning to strike in the protected area. Since there will be no lightning strike in the protected area, which, implies, there will be no secondary effect of lightning like EMP, ground transient etc. on sensitive equipments.

4.2.1 Design Principle: Charge Transfer System consists of following:-

(a) Ionizer: Ionizer is made of high grade Stainless Steel (Usually 304/316) wires having multiple of thousands pins with sufficient gap between each other, which are mounted on a large horizontal surface at the highest point of the sites. These pins dissipate the charge as there will be sufficient electro-static potential between cloud and the ground (possibility of lightning). These multiple pins create much bigger charge corona as compared to lightning rod and neutralizes downward leader approaching towards it. In the process, lightning strike is eliminated in the protected area.

Size of the ionizer depends upon site location, area of installation and surroundings. These pins are installed at highest point and are highly effective and cut in a special shape and size, so it sends charge more effectively by reducing the electrostatic potential below the lightening potential, which helps in stopping the other upward streamer from the facility. Since there is no other competitive path for lightning collection and ionizer is having large charge corona to stop down, the system offers lightning protection for the facility. Ionizer is connected with earthing and earth bonding through up (down) conductor.

System may be tested over a long period to confirm reduction in electro-static potential (approximately 1.5 KV/m) in the covered area as compared to outside coverage area.

(b) Up/Down conductor: Up / Down conductor (Copper Cable, Strip etc.) is connected between the Ionizer pins and earthing. Up/Down conductor must be made of copper strip of at least 70 Sq.mm size.

4.2.3 Design Considerations for Air Terminals

- Provide air terminals to protect the most vulnerable parts (points and corners);
- Use the roller sphere method (RSM) to check if the less vulnerable parts (edges) are protected and, if not, add more terminals to protect them;
- Check if the least vulnerable (such as flat surfaces) are protected and, if not, add more terminals.
- If a strip conductor is used, it shall be directly on the part it is to protect;
- If a vertical rod is used, its length shall not be < 500mm, and it shall preferably be mounted on the part it is to protect or within 1m or half its length, which ever is the smallest. The maximum allowable length of a rod terminal is 6m.
- If a structure has horizontal or gently sloping upper parts that are essentially cylindrical or oval in shape, then the edges are the vulnerable parts and shall be protected by air terminals. If strip conductor is used, it shall be run along the edge(s). If vertical rods are used, there shall be minimum of two evenly spaced terminals.

4.2.4 Down Conductors: The function of a down conductor is to provide a low impedance path, from air termination network to earth termination network, to allow the lightning current to be safely conducted to earth.

4.2.4.1 International standards advocate the use of various types of down conductors. A combination of strip and rod conductors, reinforcing bars, structural steel stanchions, etc. can be used as all or part of the down conductor system – provided they are appropriately connected to the air and earth termination networks, and are known to offer good electrical conductivity. The international codes such as BS6651 suggest that there is no advantage in "shielded" co-axial cable as down conductors. In fact this is thought to be the disadvantage that potentials upto hundreds of kilo – volts can occur between the inner and outer conductor (Shield) at the top of the down conductor so triggering a side flash.

4.2.4.2 The number of down conductors should be two if the height of the building / structure is higher than 10 meters or the horizontal length of the down conductor is more than its vertical length. As a standard practice 2 Nos. of 70 Sq mm PVC insulated flexible copper cable is used as down conductors.

4.2.5 Design Considerations for down conductors:-

- On any structure 10m in height, there shall be at least two down conductors, each terminated on an earth termination.
- For any structure whose perimeter exceeds 20m, the spacing between down conductors shall not exceed 20m.
- A down conductor shall be connected directly below an air terminal used to protect the most vulnerable parts;
- If an air terminal is on an exposed roof corner, its down conductor will also act as continuation of the air terminal to protect the vertical edge below it, as is required for tall structures.

4.3 Earthing System: The earthing network is responsible for safely dissipating the lightning current to ground. A low impedance connection to earth is a fundamental requirement for an effective lightning protection system and the efficient operation of surge protection device. The earth resistance of an earthy pit is depending on certain criteria like soil resistivity, moisture content, temperature etc. Conventional earthing method using charcoal and salt with GI metal components are prone to corrosion and damage of earth pit in a very short span of time, hence it is recommended to use either stainless steel or copper along with chemicals earth enhancing compound which can reduce soil receptivity and absorb moisture from the surrounding soil.

4.3.1 Design Considerations for Earth Terminations :-

A good earth connection should possess the following characteristics:

- Low electrical resistance with the electrode and the earth. The lower the earth electrode resistance the more likely the lightning or fault current will choose to flow down that path in preference to any other, allowing the current to be conducted safely to and dissipated in the earth.
- Good corrosion resistance. The choice of electrode for the earth electrode and its connection is of vital importance. It will be buried in soil for many years so has to be totally dependable.
- Ability to carry high currents repeatedly.
- Ability to perform the above functions for a minimum period of **ten** years.
- There shall be equipotential bonding at ground level for all metallic surfaces.
- At least two down conductors are required for all but small structures, which means that there shall always be at least two earth terminations

4.3.2 Bonding of Earthing System: If different earthing systems are not bonded, they are exposed to damage due transients / surges caused by difference in earth potential. Since earth system is directly related with the moisture holding capability, chemical composition and temperature of the soil, the conventional earthing systems do not provide good clean earth especially in dry and rocky areas.

It is, therefore, recommended that:

- different earthing systems are bonded to reduce the earth resistance of overall system as the resistance of each earth system is added in parallel, reducing the overall earth resistance
- earth enhancing compounds should also be used for improving the earthing characteristic of the soil.
- Transient earth bonding units in between electrical and communication earth should be used so that both the earth are separate during normal conditions and connects together during surge arrivals.

4.4 Surge Protection Equipment: The earth potential rise (EPR) from a direct lightning strike can not be avoided. Neither can the induced surge caused by a nearby strike, storms and accidents bringing down power lines, electrical power grid disturbances or large electrical machinery switching on and off.

4.4.1 As the microprocessor based equipment in today's global village becomes less and less tolerant to surges on power, data and signal lines, our critical computer, control and communication system become more vulnerable.

4.4.2 To avoid equipment damage system down time, the correct surge protection equipment must be installed in the right location and in the proper manner. International standards now clearly recommend these devices must be fitted to all incoming services that offer an entry path for a transient of over voltage.

4.4.3 To achieve the above, under mentioned two stage design must be implemented

- “Base” level production using surge diverters should be mounted at the point of entry to the site / building and
- “Computer” grade protection using power filters installed at the most important and sensitive equipment.

This design enables a maintenance person to pin point which item is sensitive to a disturbance of critical to the sites / operations and protect it with an appropriate device, whilst ignoring other more robust or less important equipment.

4.4.4 To rely on a single stage of surge diverters at the point of entry to provide adequate protection for all equipment within the building is unwise. Their performance depends heavily on the quality of the installation and lengths of leads to earth. Essential equipment may be subjected to voltages far in excess of their withstand capabilities on a regular basis.

Chapter -5

Devices For Surge and Transient Protection

1 Introduction

1.1 Transient over voltage caused by the secondary effect of lightning strikes (either between clouds or to ground) from a kilometer, or more away. Although they last only thousandths or millionths of a second, transient over voltage can devastate modern electronic system by disrupting system operation, loss of data, software corruption, degrading equipment components and circuitry, shortening equipment lifetime and increasing failures.

1.2 A major cause of equipment breakdown has been traced to earth voltage differentials. The past practice of forced separation of power and telephone earths has allowed significant potentials to occur inside equipment. Many communications sites including large exchanges have wide range of equipment performing a variety of services. Over the past decade, the use of solid state communications equipment has increased dramatically. As a consequence, the vulnerability to damage caused by surges and transients have also increased as discrete components, circuits and power supplies become extremely sensitive to smaller and smaller amounts of energy. The net result for an organization can be costly repairs or replacements and increased maintenance bills.

1.3 The only proven method of reducing the effect of lightning strikes and surges is to adopt a strategy that best suits the industry, the network or the equipment requiring protection. All recognized international lightning protection standards recommend an integrated and effective earthing system that is combined with a coordinated approach to over voltage protection on all incoming services.

1.4 Effective transient over voltage protection can prevent: lost or destroy of data, equipment damage, repair work-especially costly for remote or unmanned installations deterioration or spoilage of work in progress, loss of essential service-fire alarm, security system, building management system, health and safety hazards caused by system instability, fire risks and electric shock hazards.

2 Protective Devices:

2.1 General Considerations:

Protective devices against surge and transients fall into the following categories:-

1. Gas Discharge Devices
2. Varistors
3. Solid State Devices

2.2 Gas discharge devices:

These devices usually consist of glass or ceramic tubes filled with an inert gas sealed at each end with a metal electrode. They have breakdown voltages in the range 70V to 15KV with surge current ratings up to 60 KA. The strike time and firing voltage of these device is dependant on the rate of increase of voltage. Typical strike times are in the range 10 ns to 500ns. Unlike most other devices, gas discharge devices conduct at a much lower voltage than their firing voltage. This conduction voltage is typically below 30 V.

Gas discharge devices are available in both two electrode and three electrode configurations. The latter provide a means of clamping a pair of wires to earth regardless of which conductor was subjected to the over voltage.

2.3 Varistors:

These devices are voltage dependent resistors. The earlier forms of varistors were constructed from carbon or silicon carbide but most modern devices are made from metal oxide and are known as metal oxide varistors (MOVs).
The resistance of varistors drops significantly when the voltage exceeds a limit thus clamping the voltage near the limit. Varistor are used on circuits operating at voltages between 10 V and 1 KV. They can handle surges up to several kilo amperes and respond in tens of nanoseconds. Because the performance of MOVs deteriorates with repeated operation, it is usual to allow a high safety margin in the selection of the device rating in lightning prone areas. Alternatively, facilities should be provided to give an indication of device failure

2.4 Solid State Devices:

These devices consist of special zener diodes which exhibit voltage limiting characteristics. The breakdown voltages of such device are typically in the range 5V to 200V. They have current ratings up to several hundred amperes and response times of the order of 10 pico seconds. These devices are expensive compared to other protection devices.

3 Applications of protective devices:

3.1 Power and Signal Lines:

3.1.1 With any signal or power transmission system employing two lines and a separate protection earth, two types of transients can occur. The first type appears as a difference between the two lines, independent of their potential differences to earth; this is known as a differential mode transient (also called transverse mode or normal mode).

3.1.2 The second type appears as a transient between each line and the earth, and is known as a common mode transient (sometimes called a longitudinal transient). This mode is that commonly experienced by twisted pair circuits as each wire is equally exposed to the transient voltage source.

3.1.3 The use of two non-earthed lines is common. The AC mains use the active and neutral lines to supply power, with an accompanying earth line for protection. Telephone lines use two wires over which the signal is transmitted, with neither line tied to earth. RS-422 signaling for computer data uses two lines for each data channel, which is known as balanced-pair signaling.

3.1.4 When protective equipment is connected to such lines, both differential and common mode transients must be suppressed. Placing a protective device across the two signaling lines alone is not sufficient. The high potentials to earth created by common mode transients can cause insulation breakdown and arc-over, and can damage electronic components. The use of opto isolators for signaling lines does not necessarily eliminate this problem. Opto-isolators suitable for printed board mounting are rated as high as 5000V isolation between input and output but transients caused by lightning can easily exceed this value resulting in breakdown of the isolator, with transients 'punching through' and damaging subsequently circuitry. However, special purpose fibre optic opto-isolators are available with significantly higher isolation ratings.

3.1.5 Protection against transients is best achieved by the provision of voltage clamping or diversion devices between the lines, and between the lines and the earth. These will shunt common mode transients to earth before they are allowed to reach breakdown potentials.

3.1.6 When used to protect equipment the gas discharge device will normally handle the largest amount of energy with solid state devices handling the least amount of energy. Robust equipment such as electromechanical equipment is normally protected by the addition of only gas discharge devices while sensitive electronic equipment may require all three types of device in combination. Much modern equipment already has the varistor and solid state devices incorporated in its design and only the high energy gas discharge device and its isolation important to match the protection device to the equipment.

3.1.7 Gas discharge devices are generally not suited to the protection of main supplied AC equipment because of the fold back nature of their operation. Metal oxide varistors (MOVs) are normally used in mains protection circuits where they provide essential clamping against both differential and common mode transients.

3.1.8 These MOVs are usually specified to initiate clamping at an effective r.m.s. voltage of 275V. However, high-current surges may still produce peak voltages exceeding 1200 V within rating of the device. Equipment may be subjected to rates of rise of thousands of volts per microsecond prior to the clamping device becoming effective.

3.1.9 A primary surge diverter shall be provided on the mains power entry point. It shall be connected between each phase and neutral. It should be wired to minimize the additional voltages added to that of the diverter due to inductive effect in the connecting lead. The MOVs should be made of single bock of 100 kA at 8/20 μ-second surge rating. The MOV should have separate monitoring / sensing circuits with LED. The MOV used should be protected with a thermal fuse which should open in case of MOVs temperature rise due to an over-voltage situation. A neutral to earth protection single block MOV of 40 kA should be fitted in each diverter. The surge diverter should dynamically track the incoming waveform on continuous basis, providing a let through voltage that tracks supply waveform, not an absolute value.

3.1.10 Surge diverters fitted at the point of entry can clamp the transients to a predetermined voltage level, however, high current surges may still produce peak voltages prior to clamping. Hence it is essential to install a multistage series filter to condition the residual transient and to reduce the high rate of voltage rise observed immediately prior to clamping.

3.1.11 These filters should have the following:-

a. The filter should be installed after the surge diverter and in from critical equipment power supply and should protect sensitive equipment installed in the technical building against the damaging effects of lightning power transients and RF interference.

b. The filter should have 3 stage protection, the first stage should consists of metal oxide Varistor connected between each phase and neutral to absorb transverse mode surges generated by load switching and other power system disturbances. These MOVs in conjunction with MOV between neutral and ground should absorb common mode surges caused by lightning induced disturbances or power system earth faults.

c. The second stage of the filter should consist of inductors and capacitors. The LC section low pass filter components should further attenuate surge voltages already clamped by the first stage MOVs. In addition to this the filter should attenuate noise and power system harmonics and should be designed to attenuate both transverse and common mode noise.

d. The third stage of protection should consist of MOVs connected across the load side of the filter in a similar configuration as stage 1. These MOVs should provide further stage of protection and safeguard the filter's integrity and in addition to this, this stage should provide suppression of any surges generated by load side connected equipment.

3.1.12 It is important to note that radio frequency interference filters may not be suitable for power circuit protection. Transient current levels may cause inductor saturation which will degrade the filter action.

4 Standards and Recommended Practices

The following standards are recommended for surge and transient protection for the equipment used in Airports Authority of India.

4.1 Surge protection for the mains power supply: Surge protectors of proper rating are to be installed at switchboards; distribution boards and the building power entry point. Two stage protections are suggested.

4.1.1First Stage Protection is to be provided at power entry point.

4.1.1.1Rating of lightning current arrestor to be connected between phase & neutral

a) Impulse current >= 100 KA, 8/20 µs
b) Rated voltage >= 330 V
c) Voltage protection level < 0.6 KV

4.1.1.2 Rating of lightning current arrestor to be connected between neutral & earth

a) Impulse current >= 50 KA, 8/20 µs
b) Rated voltage >= 270 V
c) Voltage protection level < 0.6 KV

4.1.2 Second Stage Protection: This protection to be provided at UPS panel and input to the Communication or Instrumentation equipments. The protection device should be a combination of MOV, LC MOV devices. All in-circuit MOV should have associated thermal fuse to isolate the circuit in the event of failure of MOV. The MOV should also have indication system for identifying failed MOV. Following are the specs.

4.1.2.1 MOV type connected between phase to neutral and neutral to earth in co-ordination with the first stage protection.

a) Nominal discharge current >= 40 KA 8/20 µs
b) Maximum discharge current >= 40 KA
c) Maximum rated operating voltage >= 320 V AC
d) Voltage protection level < 0.3 KV

4.1.2.2 LC filter: The LC filter will consist of inductor and capacitor. This filter should

a) Attenuate surge voltage to limit output peak surge to less than 300 V.
b) Attenuate noise and power system harmonics by 30 dB.
c) Full load voltage drop due to filter should not exceed 3 Volts.

4.2 Comprehensive telephone, data and signal line protection: All remote lines, data lines, telephone lines, signaling circuits, Computer LANs, coaxial antenna feeders and low current power supplies should be protected. Suitable protection is to be provided at local as well as remote end of the cables. The cables for the purpose may be divided in following categories as under:

	Protection required for	Nominal operating voltage or power	Impulse discharge current	Commonly used Connector	Frequency of operation
1.	Telephone/ Fax/ Modem cable	140-180 V	5 KA 8/20 µs	RJ-11, Crone type connector	DC
2.	Multi-pair remote lines	15 – 50 V	10 KA 8/20 µs	Crone type connectors	DC
3.	Computer networks cables	15 V DC	350 A 8/20 µs	RJ-45, Cat 5, Cat 10/100	DC
4.	Data communication lines	15 V DC	5 KA 8/20 µs	RS232 RS485	DC
5.	HF/UHF/VHF co-axial cables	250-3000 W	20 KA 8/20 µs	N type & BNC connectors	1.5 MHz-400 MHz
6.	HF/UHF/VHF co-axial cables	50-375W	20 KA 8/20 µs	N type and UHF connectors	125 MHz-1000 MHz
7.	Microwave co-axial cables	100 W	50 KA 8/20 µs	N type connectors	1.7 GHz – 2.0 GHz
8.	Microwave co-axial cables	100 W	50 KA 8/20 µs	N type connectors	2.1 GHz – 2.6 GHz

Fast response devices e.g. Gas filled arrestors (GDTs) or MOVs or Avalanche diodes or combination of them may be used, which is suitable for the aforesaid type of cable/connector.

Chapter - 6

Earthing Electrodes and Measurement of Earth Impedance

1 General

1.1 Function of an earthing electrode:

The function of an earthing electrode is to provide an electrical connection to thegeneral mass of earth. The characteristic primarily determining the effectiveness of an earthing electrode or group of interconnected earthing electrodes (earth termination network) is the impedance that it provides between the earth termination network and the general mass of earth.

1.2 Factors influencing earth impedance:

1.2.1 The impedance of the earth termination network to lightning currents varies with time and the magnitude of the current, and is dependent on:

(a) The resistance and surge impedance of the earthing electrode and the connecting conductors;

(b) The contact resistance between the earthing electrode and the surrounding soil;

(c) The resistivity of the soil surrounding the earthing electrode; and

(d) The of soil ionization.

The resistance of the metallic conductors in the earth termination network can generally be neglected.

1.2.2 In addition there are often fortuitous paths to earth, e.g. via bonded electricity reticulation low voltage neutrals. These can mask the earthing electrode impedance by paralleling other routes of high surge impedance but low d.c. or low – frequency impedance to earth. It is essential to utilize measurement techniques, referred to later, to discriminate between these conditions.

1.3 Measures for reducing earth impedance:

1.3.1 Lightning current is considered to be a high frequency phenomenon with current rise times in the order of 10^{10} amperes per second (10 GA/s). In these circumstances, an earth termination network can best be regarded as a 'leaky' transmission line. Each conductor has resistance, inductance and capacitance to earth and leakage through non-insulated contact. An examination of earthing conductors using transmission line equations will show that the impedance of the earth termination network is lowered by the following:

(a) The use of flat strip rather than circular conductors. This increases surface area, reduces high-frequency resistance due to skin effect, increases both capacitive coupling and the earth contact area for a given cross-section of conductor.

(b) The use of a centre point feed to create the effect of two parallel connected transmission lines is also effective. This concept can be further enhanced by using several radial conductors emanating from the injection point.

(c) The use of short-length multiple conductors for example up to 30 m, is preferred over long buried systems.

1.3.2 In areas of low to moderate soil resistivity, vertical earthing electrodes will, for an earthing electrode of given dimensions, usually be more effective in providing a low surge impedance.

1.3.3 When trench (horizontal) earthing electrodes are installed, the initial surge impedance of two or more electrically paralleled wires or strips, radiating symmetrically from a central connection point, will be < the equivalent length laid as one single unit. However, the multiplied earthing electrode will be of higher d.c. or low-frequency resistance due to electric field interaction between the individual earthing electrode segments near the central connection point. The optimum surge performance for a single horizontal earthing electrode will usually be achieved when the downconductor attaches to its midpoint.

1.3.4 The contact resistance between the earthing electrode and the soil can be up to about 10 percent of the total resistance of the earth termination network. This resistance may be reduced by ionization and arc-over in the soil in contact with the earthing electrode. The major part of the earth resistance of an earthing electrode arises from the resistance of the earth in the immediate vicinity of the earthing electrode. The value of this resistance depends upon the shape, size, and position of the earthing electrode and the resistivity, moisture content and degree of ionization of the soil in the vicinity of the earthing electrode. The ratio of resistance at peak impulse current to resistance at low current depends on the number and arrangement of the electrodes, the peak current and soil resistivity.

1.4 Resistivity of Soil:

1.4.1 Soil resistivity is another term for the specific resistance of soil. It is usually expressed in ohms meters (symbol Ω.m), i.e. the resistance in ohms between opposite faces of a cube of soil having sides 1 m long.

1.4.2 The resistivity of the soil depends on its chemical and mechanical composition, moisture content and temperature. In view of this there is a very large variation in resistivity between different types of soils and with different moisture contents. This is illustrated in Tables 1 and 2.

Note: Earthing electrodes should not be located near brick kilns or other installations where the soil can be dried out by the operating temperatures involved.

Table 1
Resistivity values for various materials

Material	Resistivity Ω m	
	Typical	Usual limits
Salt sea water	0.2	0.15 to 0.25
Estuarine water	0.5	0.2 to 5.0
Artesian water	4.0	2.0 to 4.0
Damp black inland soil	8.0	5 to 100
Damp clay	10.0	2.0 to 12.0
Inland lake water, reservoirs	20.0	10.0 to 500.0
River Banks, alluvium	25.0	10.0 to 100.0
Clay / sand mixture	30.0	20.0 to 200.0
River water (upstream)	40.0	30.0 to 200.0
Concrete	100.0	40.0 to 1000.0
Dry inland soil	100.0	20.0 to 1000.0
Moraine gravel	2000.0	1000.0 to 10000.0
Coal	2000.0	1000.0 to 5000.0
Secondary rock	3000.0	1000.0 to 50000.0
Sand	3000.0	1000.0 to 10000.0
Solid volcanic rock	20000.0	1000.0 to 50,000.0
Ice	100000.0	10000.0 to 100000.0

Table 2

Variation of Soil resisrivity with moisture content

Moisture content (percent by weight)	Typical value of resistivity Ω.m	
	Clay mixed with sand	sand
0.0	10000000	-
2.5	1500	3000000
5.0	430	50000
10.0	185	2100
15.0	105	630
20.0	63	290
30.0	42	-

1.5 Artificial reduction of soil resistivity:

1.5.1 Chemical additives can be used to reduce soil resistivity. These additives generally take the form of fully ionizable salts such as sulphates, chlorides or nitrates. Such chemical additives should not be used indiscriminately as;

(a) The benefit that they provide will lessen with time due to leaching through the soil; and

(b) They may increase the rate of corrosion of the earthing electrode material.

Some of the chemical additives are also objectionable from an environmental viewpoint.

1.5.2 A bland backfill material such as calcium or sodium bentonite clay, or montmorillonite with finely ground gypsum will reduce resistivity for a considerable period in high resistivity soils, maintain some moisture adjacent to the earth termination network, and provide a uniform and non-corrosive environment for the earthing electrodes.

1.5.3 Additional Measures:

When the high soil resistivity makes it impossible to achieve earth terminationsystem resistance lower than 10 Ω using the standard protective measures, the following additional measures may be used:

- add natural material with a lower resistivity around the earth conductors;
- add earth rods to the crow's feet or to the stakes already installed;
- augment the number of earth termination systems and interconnect them;
- apply a treatment which reduces the impedance and features high current draining capacity;
- when all the above measures are adopted and a resistance value of < 10 Ω can not be obtained, it can be considered that the earth termination system provides acceptable lightning current draining when it consists of a buried termination system at least 100m long, assuming that each vertical or horizontal element is not more than 20m long.

2 Measurement of Earth Resistivity

2.1 Need for the measurement of Resistivity:

The resistivity of the soil varies within extremely wide limits, between 1 and 10,000 Ω-metres. The resistivity of the soil is found to be non-uniform at many station sites. To design the most economical and technically sound grounding system for large installations, it is necessary to obtain accurate data on soil resistivity and on its variation. Resistivity measurements at the site help in designing a good earthing system. The resistivity of the earth varies over a wide range depending on its moisture content. It is therefore, advisable to conduct earth resistivity tests during the dry season in order to get conservative results.

2.2 Test Locations:

In the evaluation of the earth resistivity of sub stations and generating stations, at least eight test directions should be chosen from the centre of the station to cover the whole site. This number shall be increased for very large station sites and for sites where, the test results obtained at various locations show a significant difference, indicating variations in soil formation.

In case of transmission lines, the measurements shall be taken along the direction of the line throughout the length approximately once in every 4 kilometers.

2.3 Principle of Tests:

2.3.1 Wenner's four electrode method is recommended for these types of field investigations. In this method, four electrodes are driven into the earth along a straight line at equal intervals. A current I is passed through the two outer electrodes and the earth as shown in figure below and the voltage difference V observed between the two inner electrodes. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to the field. Consequently, the resistivity will be proportional to the ratio of the voltage to current.

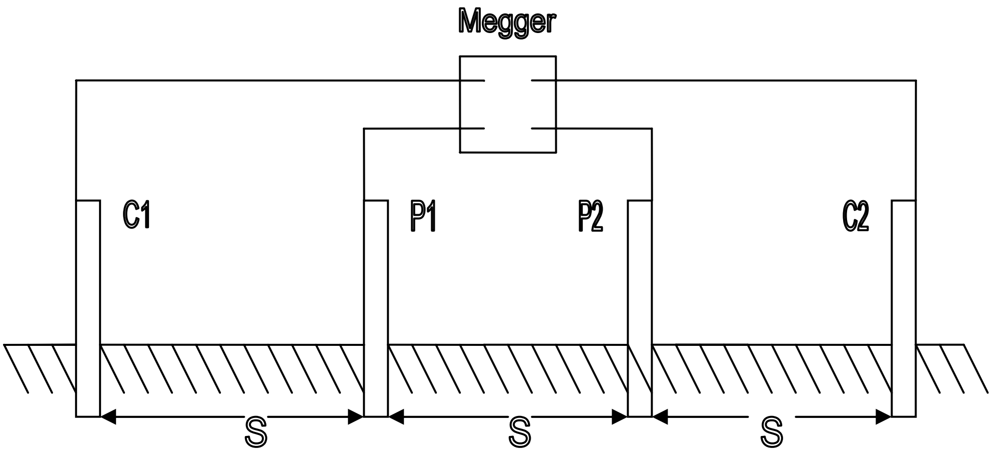
If the depth of burial of the electrodes in the ground is negligible compared to the spacing between the electrodes, then

$\rho = 2\pi SV / I$

Earth testers 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 Fig 1. When using such a megger, the resistivity may be evaluated from the modified equation as given below.

$\rho = 2\pi \times SR$

Where
ρ = resistivity in ohm – meters
S = distance between successive electrode in meters
R = megger reading in ohms.



C1, C2 Current Electrodes
P1, P2 Potential Electrodes

Fig. 1 Measurement of Earth Resistivity

Chapter -7

Maintenance Procedures of Lightning Protection System

1. **Responsibility Of Maintenance**

1.1. The maintenance of Lightning and Surge Protection System, for the CNS installations and equipment installed in **Terminal Building and/or Technical Block** shall be looked after by the Engineering wing.

1.2. Maintenance of Lightning and Surge Protection System for the CNS installations located inside **operational area and around airport** (Radar, LLZ, GP, DVOR, OM, MM and NDB), shall be looked after by the CNS personnel.

1.3. Earthing system of CNS facility at all places will be maintained by CNS personnel.

2. **Maintenance Checks For Lightning Protection System**

Following checks should be carried out at regular interval – **once every quarter**:

2.1 Inspection of Air Terminal

2.1.1 Physical inspection of air terminal and functionality checks with air terminal test meter.

2.2 Inspection of Down-conductors

2.2.1 Check for corrosion

2.2.2 Continuity testing by continuity tester, across all types of conductors in lightning protection and grounding system. The resistance should be **less than 0.5 ohms**.

2.2.3 The down conductors are routed, located and electrically bonded as required.

2.3 Periodic Check for earthing system:

2.3.1 Earth resistance will be checked at the **interval of 3 months** with the standard process of measurement (Three point method) and recorded. If the measured value is beyond specified standards, corrective action must be taken.

2.3.1.1 Earth termination systems are interconnected. Where a conductor is totally hidden, its electrical continuity should be tested.

2.3.2 In case specified standards of earth resistance are not met, ground conductivity may be improved by

2.3.2.1 Refilling of earth pit with electrolytic compound for electrolytic grounding system where provided.

2.3.2.2 Recharging of earth pits in case conventional grounding system is installed.
2.3.2.3 Physical inspection of connection between ground rod and down conductor near grounding system for corrosion, bad contacts followed by corrective action.

2.4 Inspection of Surge Protection devices:

2.4.1 All surge protection devices should be checked at an interval of 3 months for their functionality.

2.4.2 Indications provided with surge protection system should be monitored and recorded on daily basis.

2.4.3 Faulty devices should be replaced.

2.5 Special Inspection:

In the event of occurrence of major lightning strike around the Terminal building and other CNS facility as observed or monitored on the strike record counter, all the aforesaid inspection should be carried out and if need be, the corrective measures to be taken immediately so that LPS is maintained in its optimal effectiveness.

3. Inspection Regarding Modifications / Repairs of the Protected Structures

While carrying out the periodic maintenance particular attention should be paid, besides earthing and corrosion, to alteration or extensions to the structure that may affect the LPS. Examples of such alterations or extensions are:-

a) Change in the use of building.
b) Installation of fuel oil storage tank.
c) Erection of radio aerials
d) Installation or alteration to electrical, telecommunications or computing facilities within or closely connected to the building.

4. Records

The following records should be kept on site, or by the person responsible for the upkeep of the installation:

a) Scale drawings showing the nature, dimensions and position of all components parts of the LPS.
b) The nature of the soil and any special earthing arrangements.
c) Date and particulars of salting, if used.
d) Test conditions, date and results.
e) Alterations, additions or repairs to the system.
f) The name and contact details of the persons responsible for the installation or for its upkeep.

******End of CNS Vol. V*****