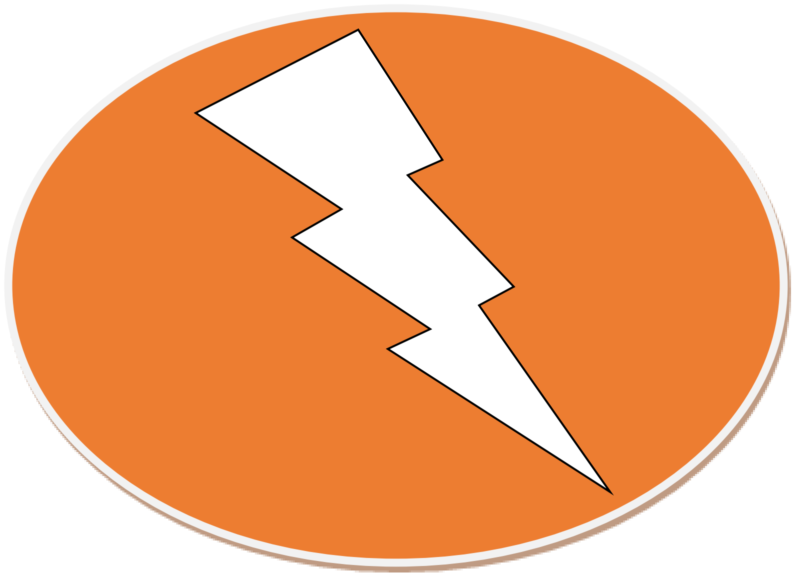
# Community Handbook for Lightning Protection in Makawanpur District



*Submitted to*

ETSC-Nepal,

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*By*

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## Acronyms

| | |
|---|---|
| CBO | community based organization |
| CSO | Civil society organizations |
| ESE | Early streamer emission |
| ETSC | Educational Training Service Centre |
| IEC | Importer-Exporter Code (a key business identification number mandatory for export from India or Import to India). |
| NEA | Nepal Electricity Authority |
| LPS | Ligtning protection system |
| SPD | Surge Protective Devices |

## Introduction: Lightning an emerging major disaster

Recent studies confirm that lightning is emerging as the major potential threat to the human lives, livestock, communication system, transmission system, physical properties particularly electronic and electrical appliances etc. In order to mitigate the hazardous impact of lightning a multi-sectoral and multi-dimensional approach is required. The purpose of awareness and training program on protection against lightning is to protect structures and it occupants such as people within them, power systems, electronics, and other infrastructures from damage by lightning strike as well as by electrical surges that may accompany lightning strikes.

Lightning is the most spectacular and most common atmospheric activity that occurs ubiquitously on our planet. It has become a major threat to the human and physical property and kills over 24000 people every globally. With advent of technology and growing usage of the electronic gadgets the threat has been further escalating.

Lightning is a huge atmospheric electrical discharge that takes place between two regions of the clouds or between the clouds and ground. A huge current flows during the electrical discharge having a magnitude of 30,000 Amperes on the average and up to 300,000 Amperes in some occasions. Such a huge current, heats up the atmospheric air to a temperature of about 30000 Degree Celsius. The large current and resulting temperature pose the threat to living beings and structures. The electronic equipments

*Figure 1 Nepal is among high risk zone from lightning hazard*

are very susceptible to the sudden rise of voltage in the atmosphere called surge, and hence get damaged even with the lightning strikes occurring a few kilometers away.

Although, lightning has been a threat to the human beings since the time immemorial, the protection against lightning hazards begun in the modern era only after Benjamin Franklin’s experiment in 1752. The nature of lightning discharge was understood after the two famous experiments namely Sentry box experiment and kite experiment. However, much of the science of lightning was understood during the latter part of 20th century and accordingly protective measures. However, with the advancement of technology and excessive usage of electrical and electronic appliances, the threat has further escalated necessitating the need of advanced protective measures. Despite all the technological advancement, the status of protective measures in the developing countries is rather miserable and Nepal is not any exception. At a time when the developed countries have been strictly adhering with the code for lightning protection incorporated in their building codes, many of the developing countries are still unaware of such a code or standard.

Nepal is now in the stage of rapid urbanization, with many new constructions are coming up. In the new construction, it will be much convenient to implement the code. The country has adopted federal set up of governing system with seven provinces and 753 local units. The federal government is expected to play a pivotal role in the mitigation all kinds of disaster risk engaging the local and provincial governments and involving other humanitarian and development agencies, private sector, academia and civil society.

This booklet is designed to serve the purpose of guiding community technicians who need a simple handbook for conducting training as well as reading resource materials to learn. At this initial stage, the booklet has been launched on trial basis. In subsequent stages, it will be revied, developed and refined upon receiving feedbacks so that it is widely used for reducing various risks of lightnings.

# Objectives

General objective of this booklet is to help reducing risks of lightning hazards in some of the most vulnerable community households, public buildings and infrastructures by systematic approach of planning, education and capacity building of the stakeholders.

The specific objectives include familiarizing municipality officials, elected local leaders, community workers and technicians on the scientific techniques for protecting buildings, occupants and equipment from lightning hazards and ultimately to mitigate loss of lives and property due to lightning hazards. Upon completion of full participation of the training to be launched in the days ahead, the participants are expected to:

- Understand the basics of lightning and transients, lightning threats to humans and structures, lightning safety issues for humans and livestock, and the mechanism of lightning injuries.
- Identify the basic lightning safety measures to raise awareness in their society.
- Design lightning protection systems for various structures to safeguard

the occupants.

- Compute risk assessments by applying the various parameters for designing appropriate protection systems.
- Describe the levels of threat and levels of protection needed according to the sensitivity of the structure and the occupants

*Figure 2: A lightning incident near Kathmandu, Nepal*

# SECTION 1

## Resource materials on lightning risks and protection measures

### Risks, types and prevelances of lightning

Lightning is the phenomenon which accompanies the discharge of atmospheric charges from cloud to cloud or from cloud to earth. As lightning seeks the path of the least resistance, it naturally tends to follow the shortest way between cloud and earth, such as buildings or towering projections. As illustrated positive electrical charges gather in the clouds and negative charges gather in the ground. When the attraction between these two charges are strong enough they come together in the form of lightning.

Lightning arrester equipment, properly manufactured and installed, dissipates the charges. In temperate climates a large majority of lightning is negative downwards lightning, as the negatively-charged cloud-base discharges to the ground.

- The most important parameters are the following :
- Amplitude
- Rise time
- Decay time
- Current variation rate (di/dt)
- Polarity
- Charge
- Specific energy
- Number of strikes per discharge.
- The first three parameters are independent in terms of statistics .
  The expected effects of the characteristic lightning parameters are as follows:
- Optical effects
- Acoustical effects
- Electro-chemical effects
- Thermal effects
- Electro-dynamic effects
- Electro-magnetic radiation

Lightnings have no specific path to reach the ground. As a result, lightning presents several hazards to our houses, commercial buildings and human beings. Therefore, safety measures, e.g. lightning arresting rods must be installed at all places, properties or systems in the ground such as building, house or a tree. This also includes any electrical equipment like phone, cable, electricity lines, the water or gas pipes, or in case of a steel-framed building the whole structure itself. These are the most commonly used paths utilized by the lightning to reach the ground.

Before implementing a lightning protection system, it’s important to understand the risks associated with lightning. Three types of lightning risks that can cause injury or facility downtime.

Step potential: An indirect lightning strike that is potentially lethal. Step potential refers to the ground current that occurs when the lightning strike dissipates into the earth, which can be transmitted into a person in the area of the strike.

Touch potential: A direct lightning strike that is captured and carried by a metallic object, which a person comes into contact with directly. Commonly occurs in fences and support towers.

Side flashing: During a lightning flash, the rapid rate of current rise can cause down conductors or natural objects to flashover to a nearby person or object.

While no system can completely ward off the lightning risks above, proper protection systems can help safeguard your facility, personnel and electronic devices.

## Lightning risks over Nepal and in Makawanpur

Lightning has emerged as one of the deadliest disasters in Nepal with thunder strikes claiming dozens of lives every year. On an average 100 people die every year due to lightning strikes. According to the Nepal Emergency Operation Centre, lightning killed 67 people and injured 397 between April 14, 2018 and April 9, 2019. Lightning killed 94 people in 2019 alone. The distribution of events shows that the number of lightning events is increasing year by year. The distribution of lightning events and deaths varies within the country; however, there are some districts with repeated lightning fatality events.

*Figure 3: Makawanpur District with palikas*

The Chure and Mahabharat Hill ranges are highly vulnerable to lightning incidents, which mostly occur during pre-monsoon period when a large amount of atmospheric water vapor coming from the Indian Ocean and a large orographic lifting of this moist air take place on the southern fronts of the Chure and Mahabharat hills. The seven years data between 2011/12 and 2018/19 has recorded 773 deaths and 1,695 injuries due to thunder strikes, making it the second deadliest catastrophe in the country only after the 2015 earthquake that had killed nearly 9,000 people. In that period, other disasters like landslides and flood, which often get more attention from the government for preparedness and response, claimed 730 and 665 lives respectively.

*Figure 4 All pictures from Makawanpur: (Clockwise from the top left) Scar on a wooden pillar after lightning struck that left one person killed and several more injured during dinner in the evening. Local people reported that majority of lightning incidents take place on electricity lines (top right). The house of the victim family (bottom left). Lightning safety awareness on progress (bottom right)*

In the year 2019, a total of 2884 people were affected, with loss of USD 110,982, and the fatality number was the highest (94) in reported lightning events since 1971. The long-term analysis of this hazard is very scanty in Nepal. The study ((Adhikari, 2021) shows that the overall countrywide lightning fatality rate of the entire period is 1.77 per million per year. District lightning fatality rates range from 0.10 to 4.83 per million people per year. Between 1971 to 2019, there were a total of 2501 reports of lightning fatality in which 1927 people lost their lives and 20 569 people were affected. The increase in lightning fatality events in recent years might be due to the internet access and other measures of information gathering that result in lightning fatality reports reaching agencies collecting information. The high and low concentrations of loss and damage are mainly due to geographic distribution, population density, and economic activities.

Makawanpur is among the top five districts of Nepal with high risk of lightning fatalities and losses. The other includes Jhapa, Morang, Udayapur and Rupandehi. This is mainly because of its high exposure due to geographical setting and lack of risk reduction measures in the majority of housing and settlments. In the months of August and September of 2014, lightning incidents killed twelve people and injured 30 others in Makawanpur District. These incidents occurred in various parts of the district, mainly in Hatiya, Harnamadi, Chhatiwan, Dhiyal, Shikharpur, Thingan, Betini, Phaparbari, Raigaun, Gadhi and Aambhanjyang where people were highly terrified by increasing frequencies of lightning strikes (Kathmandu Post, 2014/09/21).

A survey of lightning incidents in Makawanpur reveals that majority of deaths and injuries occurred in rural households were through sudden surge of high current and sparks along the electrical lines. The electricity lines were observed without adequate safety measures such as installation of earthing system and unisulated wire along the distribution lines. Additionally, the households were found without lightning safety defices such as earthing and lightning arrestor rods.

## Basic measures for protection from lightning

The main function of the lightning protection system installed on the existing building is to capture a lightning strike and then conduct the discharge current safely to the ground. Taking the fact into consideration that there are up to 100 lightning discharges to the ground every second throughout the world, it is always possible that a lightning strike hits the place which is particulary close and important to you. The lightning protection system exists to intercept an atmospheric discharge in order to safely convey its current to the ground. Lightning is formed as a result of processes occurring in the storm clouds. When air masses, ice crystals, water vapour drift and interact, then electrical charges are generated. There are two types of storms (depending on the way how they are formed):

- Heat storms-formed as a result of strong heating and drifting upwards of the bottom air masses.
- Frontal storms-caused by the impact of a front of cold air on a warm moist air mass which is lifted above the advancing cold front.

In a typical storm cloud, the positive charges are concentrated in the upper part, whereas the negative charges build up at the base of the cloud. A further charge growth causes an escalation of the electric field intensity until it exceeds the critical value. A cloud-to-ground discharge proceeds towards the ground (small upward discharge can also be initiated from elevated ground points and this kind of discharge is called a ground-to-cloud discharge) or towards the neighbouring cloud, which is called cloud-to-cloud discharge. Sound and visual effects of a lightning discharge are preceded by an invisible initiated process. A high negative cloud potential (of the order of 108 V) is conveyed towards the ground by the downward leader, with the relatively small decline of potential in its channel. When one of the upward leaders comes into contact with the downward leader, a conductive path of ionized air is created allowing a powerful current to flow equalizing the potential difference between the cloud and the ground. In general, lightning installations are divided into: conventional and active ones.

| Know the major devices used for lightning protection | |
|---|---|
| Air Terminals | Also known as air rods are placed at the top of the building. They attract lighting and draw it safely to the ground. |
| Down Conductors | Also known simply as cables. You attach them so electrical flow leaves the air terminal and travels down the down-conductor towards the final protection device. |
| Ground Rods | Ground rods, or rods, are the final protection device in a lightning protection system. You attach it to the down-conductor and insert it into the ground so the electricity can escape harmlessly into the earth. |
| Surge Arrestors and Protectors | Surge arrestors or surge protectors protect electronic equipment within a structure from sudden surges of electricity. They do not provide complete protection in a lightning strike but may help protect plugged-in devices from surges caused by a lightning strike. |

*Figure 5 Four major devices for lightning safety*

Lightning hazards to the structure can be averted by providing best conducting path to the lightning current preventing it to flow through the structure. Lightning protection system thus protects a building or structure by providing an alternative path to the lightning current. LPS is divided into two types 1) external protection system 2) Internal protection system. The major components of external LPS are a) Air terminal system 2) Down conductor system and 3) Earth terminal system. Each component has equally important role in protecting a structure and therefore care should be taken on each component. The internal protection system is essential in order to prevent electronic/electrical equipments and fire that may get ignited by the indirect lightning strikes. The internal LPS comprises of Surge Protective Devices and equipotential bonding.

In general, a lightning protection system must perform the following in order to be considered effective:

- Intercept lightning flashes
- Conduct the lightning current to the earth
- Dissipate the current to the earth
- Create an equipotential bond to prevent potential differences between the system, structure and internal circuits

Furthermore, a lightning protection system is categorized into two parts. The first is the external lightning protection system, which intercepts, conducts and dissipates the lightning flash to the earth. Second, the internal system that prevents flash over within the structure using equipotential bonding. Also note that while lightning protection systems are generally implemented via a network of bonded air terminals and down conductors, alternative systems that capture the strike and conduct the discharge through an insulated conductor to the ground are available.

For external LPS the following three different methods are used,

- Air Rod
- Mesh Method
- Early Streamer Emission Lightning Rods

Conventional lightning systems are based on the protection of a structure by making an installation of horizontal or vertical air terminals which are connected to the earth with the help of downconductors. By means of the procedure described below, it is possible to decide according to the chosen protection level whether the lightning protection is required or not. On the ground of our observations and experiences gained in this field, we recommend to install the lightning protection on the structure regardless of the existance of a strike hazard level.

The selection of the protection level allows to minimize the risk of damage to people as well as complex and sophisticated equipment and structures. The higher the efficiency of a lightning conductor is, the lower the risk of damages caused by lightning strikes will become. A protection level selection depends on the kind of building, its structure and value.

Table: List of the effectiveness of lightning conductor with corresponding protection levels.

| Protection Level | Effectiveness of lightning conductor E |
|---|---|
| I | 0.98 |
| II | 0.95 |
| III | 0.90 |
| IV | 0.80 |

The Zones of protection can be determined by the “Cone of Protection” and “Rolling Sphere” methods. The “Cone of Protection” rule consists of placing the protected structure in the zone of protection of high vertical air terminal.

| | |
|---|---|
| Air terminals and accessories (left). Air terminal bases (right) |  |
| Connectors and fittings (left). Thro assemblies and accessories (right) |  |
| Condoctors and accessories (left). Surge protection (right) |   |
| Lightning warning system (left) and Exothermic molds for lightning conductors (right) |  |

*Figure 6: Samples of lightling protection equipment*

The objective of an external lightning protection system is to control the lightning strike point and provide the lightning current with a path to earth avoiding damage to the structure such as early streamer emission air terminals[1]. Operation of early streamer emission air terminals is based on the electric characteristics of lightning formation. Lightning begins with a down-conductor which spreads in any direction. Once it approaches the objects on the ground, any of them can be struck. The main feature of Early Streamer Emission (ESE) air terminals is the generation of the continuous upward leader before any other object within its protected area. The standards define this characteristic using a parameter called advance time ($\Delta T$): ”Difference expressed in microseconds between the emission time of an early streamer emission air terminal and a simple rod air terminal measured in a laboratory under the conditions defined in the reference standard.” This advance time determines the protection radius of each air terminal. If the triggering occurs earlier, then the distance at which the downward leader is intercepted increases, thus avoiding a lightning strike in a wider area. The advance

[1] https://at3w.com/upload/ficheros/guide-ese-installation.pdf

time must be measured in a high voltage laboratory, following the test procedure described in the ESE lightning protection regulations.

Before a lightning strike hits, lonization leads to an increase of the electric field around the top of the rod and the lightning current is lead from the rod to the ground. According to table 1, the protected area connects the level of protection according to the protective angle, the length of the rod, the height of the rod above the surface to be protected. Air Rods are used for the mesh method and stretched technique.

This is done by connecting the Air Rods to the down conductors, while the building is covered by a mesh with down conductors. In this system the protection stage result the distance of down conductors fixings are determined according to these distances conductors are fixed.

In the Roof system of Mesh Metod, Specially Air Terminals are used on conductors crossing points on firing roofs. On f i re resistant roofs (metal roofs etc) It is not needed to use air terminals (IEC 62305)

Protection Levels According to Height and α Angles

| **AIR ROD AND MESH METHOD PROCESSING CRITERIA ACCORDING TO PROTECTION LEVEL** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Protection Level** | **Air Rod** | **Height (m)** | | | | **cage (m)** | **Down conductor distance (m)** |
| | | 20 | 30 | 45 | 60 | | |
| I | α angles | 25 | * | * | * | 5×5 | 10 |
| II | | 35 | 25 | * | * | 10×10 | 15 |
| III | | 45 | 35 | 25 | * | 15×15 | 20 |
| IV | | 55 | 45 | 35 | 25 | 20×20 | 25 |

## Available technologies and practices for lightning protections

In light of growing risks of lightning on buildings, homes and human settlements, a range of designs and devices are available in the global markets. However, only few and traditional one are available in Nepal unless there is a global call for quotation is issued. Nevertheless, traditionally used technologies such as copper wire and plates for earthing and air rods or lightning terminals of various ranges are available locally.

### *Interception*

1. The radius of protection offered by an ESE lightning conductor depends on its height (h) in relation to the area to be protected, its triggering advance ΔT and the protection level.

2. The air terminal must be installed at least 2 metres higher than any other element within its radius of protection

*Down Conductors*

3. Each air terminal must be earthed using two down-conductors located outside the structure. They will preferably be on different external walls of the building.

4. Each down-conductor should be installed such that its routing is as straight as possible and takes the shortest path to earth without sharp bends or upward sections. Care should also be taken to avoid crossing or running conductors in close proximity to electrical cables. When external routing is impracticable, the down-conductor may be internally routed. However, this is not recommended as it reduces the effectiveness of the lightning protection system, makes maintenance difficult and increases the risk of voltage surges.

5. The number of down-conductor fixings is determined by considering 3 clips per metre as a reference.

6. Down-conductors should have a cross-section of at least 50 mm2. Since lightning current needs to be driven, flat conductors (tape) are preferable to round conductors as they have a larger exterior surface area for the same amount of material. Tin-plated copper is recommended due to its physical, mechanical and electrical characteristics (conductivity, malleability, corrosion resistance and so on)

7. Down-conductors should be protected by installing guard tubes up to a height of 2 m above the ground level.

8. The installation of a lightning event counter over the guard tube is recommended in order to carry out verification and maintenance operations which are essential for any lightning protection system.

9. It is recommended that the downconductor be kept at a distance of at least 5 metres from the external gas pipes.

*Earthing*

10. Each down-conductor must have an earth termination system. Earth termination systems should be located outside the building, except where this is absolutely impossible.

11. The resistance of the earth termination system measured by conventional means must be lower than 10 Ω, when separated from other conductive elements. Connection with the earth termination system must be made directly at the bottom of each down-conductor, using a device that allows the disconnection of the earth electrode and should be placed inside an inspection pit marked with the earth symbol.

12. The inductance of the earth termination system must be as low as possible. The recommended arrangement is vertical electrodes forming a triangle with a minimum total length of 6 m. The vertical electrodes must be bonded with a conductor buried 50 cm deep and separated at a greater distance than their length.

13. The use of a soil conductivity improver is recommended in high resistivity ground.

14. All earth termination systems should be bonded together and to the general earthing system of the building.

15. It is recommended to use a spark gap to connect the lightning earth termination system to the general earth system, as well as the lightning air terminal mast to any aerials.

16. All elements of the lightning rod earth termination system must always be at least 5 m from any buried metal or electrical pipes.

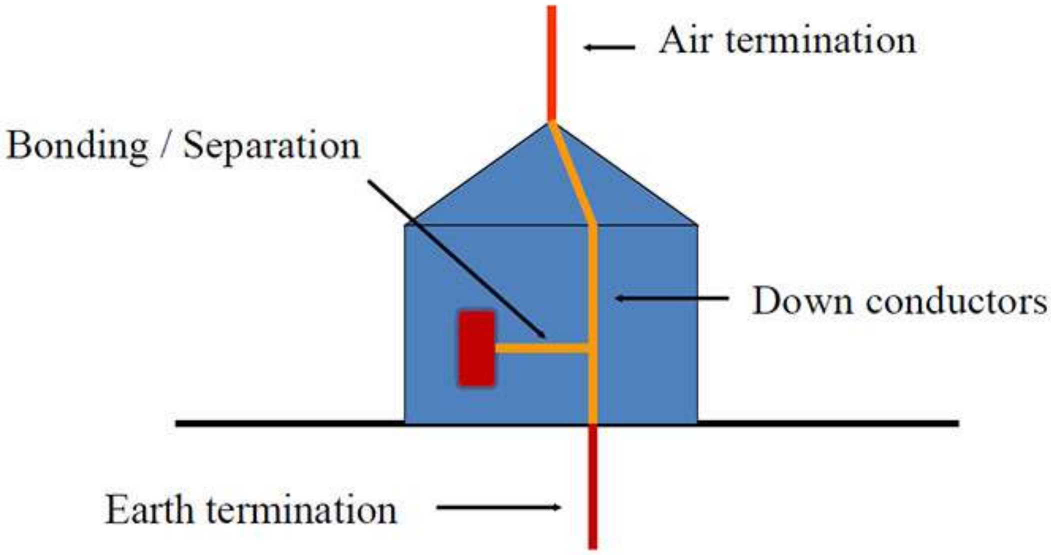


*Figure 7: Schematic diagram for Protection Against Lightning Hazard.*

Recently the Alternative Energy Promotion Centre of Government of Nepal procurred light protection system through a public quotation for its Dhading based Solar PV Project in Benighat (Rorang Rural Municipality). The required technological specifications and risk assessment may offer a good practice example for community and public officials for procuring such system. To this purpose, Vertical air terminals was installed separately for power house and solar panel structure in mini-grids whereas individual air terminals was installed for solar lift irrigation system and solar micro industrial hub system separately. Prior to this, the earth resistance in power house area of mini grids, saw and grinding mill and water lifting system were measured as follows: i. Chotesh Solar Mini Grid: 226 ohm, ii. Thundrung Solar Mini Grid: 225 ohm, iii. Bangburti Solar Mini Grid: 88 ohm, iv. Solar Saw and Grinding Mill: 138 ohm, v. Solar Water Lifting System: 39 ohm. Since the earth resistance were much higher than required, revamping of earthing system was also, recommended. In addition to this, an equipotential bonding will be created using bus bar by connecting earth termination (terminals from earth electrode) with AC/DC SPDs. Accordingly, lightning protection system was installed in all 5 sites to ensure the protection against direct lightning strikes with the following details.

### *I. Air Termination System*

1. 8mm Aluminum Solid Round Conductor meeting the requirements of IEC 62305 and IEC 62561-2

2. Suitable Stainless Steel cross connector for 8 mm round Aluminum conductor meeting the requirement of IEC - 62305.

3. 2m Aluminum Vertical Air terminal of diameter 8 mm with Complete Support of Wall Clamp meeting the requirement of IEC 62305, and tested for Electrical, Mechanical and Chemical as per IEC 62561.

4. Conductor holder for fixing 8 mm Aluminum conductor on the frame of the solar panel meeting the requirement of IEC – 62305.

### *II. Down Conductor System*

1. Conductor holder for fixing 8 mm Aluminum down conductor on the wall meeting requirements of IEC – 62305.

2. Test Joint with enclosure suitable connector for 8 mm round Al. conductor & 10 mm round copper coated conductor meeting requirement of IEC - 62305.

3. 10 mm copper bonded Round steel solid Conductor for earthing meeting requirements of IEC 62305 and IEC 62561-2.

4. Conductor holder for fixing wall down conductor after test joint for holding 10 mm copper bonded Round steel solid Conductor meeting requirement of IEC – 62305.

### *III. Earthing System*

1. Maintenance Free Copper coated Earth rod of 3 m length having a diameter of 25 mm with a copper coating thickness of 250 microns, tested for Dimension, Marking, Tensile Strength, and Salt mist, coating thickness, Electrical resistivity test before and after corrosion test as per IEC 62561

2. Earth enhancing (maintenance free) mineral compound tested for leaching and TCLP as per IEC 62561. Universal Clamp made up of stainless steel for terminating cable/flat conductor. Heavy duty Chamber Inspection Pit made up of plastic material and stainless steel bus bar for connecting the earth termination and the down conductor as well as earth terminal of the AC/ DC system via SPDs meeting the requirement as per IEC 62305.

## Quality assessment of lightning protection technologies

Addressing the lightning safety issues needs assessment of the risk and quality of the materials to design an effective lightning protection system. Adulteration of the non-standard products is abundant in the global market and the developing nations are more prone to receive such products. Nepal is not an exception of such vulnerable countries owing to the fact that we do not have a proper code to control such fraudulent products. So, while adopting the Lightning protection system it is very likely that consumers may get easily deceived by the proponents and vendors of such products.

Mitigation of deleterious effects of lightning hazards and electrical faults requires short term and long term approaches involving multispectral and multidimensional aspects. Enlisted below are the short term and long term approaches:

a. Short-Term Approach 1. Raising awareness in the public, particularly addressing the vulnerable community/society by: - Organizing seminars for school teachers in the rural areas. - Distributing pamphlets and posters on safety messages. - Playing awareness videos and PSA through national and local media. - Demonstrate drills, engaging teachers and students. - Install Lightning protection system on a few school buildings as per IEC and use them as model structures. 2. Training engineers on the scientific methods of installation of lightning protection system and electrical safety. 3. Organizing seminar for the representatives of local authorities to apprise them about safe shelters. 4. Organizing awareness program for Hospital managements both on lightning protection and electrical safety issues.

b. Long-term Approach: 1. Standardisation of quality control policy for lightning systems and materials by DUBC. 2. Capacitating of regulatory agency to monitor quality of equipment being imported, produced and supply in a systematic and transparent mechanism. 3. Establishment of quality testing lab for lightning protection equipment and designs.

# SECTION 2[2]

## *Training on understanding of risks and installations of lightning protection*

## Training participants

The participants of the training program will be the elected officials and officials involved in planning and technical aspects of palika(s), concern officials of building safety protocols and compliance divisions, electricians, housing contractors and media. A typical list of participants will look like (but not be limited to) as follows:

- Mayors and deputy mayors of rural and urban municipalities
- Ward chairpersons and members
- Planning officers/engineers, other technical staff, and building safety focal point
- Representatives from Electrical and electronic goods and service associations
- Electrical safety conccern official of NEA
- Representative of Department of Housing and Physcial Planning
- Local Media persons
- Engineers and technical persons engaged in development work both from government and private sectors
- Representatives from Local Humanitarian Organizations
- Policy/decision makers (e.g. members of Parliament)
- Faculty from academic institutions
- Journalists working with local and national media organizations

[2] This section is subject to revision to suit with specific needs of the participants e.g. technicians, planning, community workers and elected officials. Useful information for planning may also be rawn from https://app.adpc.net/wp-content/uploads/2021/02/APP_PAL202001_0.pdf

## Training contents and time allocation

The training is designed for three to five days depending on the nature and needs of the participants. Sessions consist of theoretical and practical contents including group works and fieldwork. The sessions can be standalone or merged depending on the situation, needs and availability of the resources. Session experts may prepare PowerPoint slides and conduct sessions using various tools of presentation followed by active discussions. The experts will be encouraged to make the sessions interactive as far as possible. Since the participants are from diverse background such as planners, implementers, and community members having limited technical knowledge, technical terms, jargons and academic/theoretical contents will be kept to a minimum, and the focus will be on practical aspects to make as simple as possible.

## Teaching Methodologies

The following methodologies will be used for conducting the course:

- Interactive lectures and presentations
- Video/animation exhibition
- Group discussion/presentations
- Outdoor activity for hands on training
- Table top exercise
- Role play

## Session plan overview

| Sessions | Details |
|---|---|
| Session 1: | Opening, introduction and objectives of the training |
| Session 2: | Lightning as a major disaster: Losses of life and properties at local, national and global scales |
| Session 3: | Understanding lightning- Situation of its formation, risks of ground strike and ESE |
| Session 4: | Assessment of lightning risks in Makawanpur |
| Session 5: | Basics measures for protection from lightnings |
| Session 6: | Available technologies and practices |
| Session 7: | Quality assessment of devices and conductors. |
| Session 8: | Observe and estimate the installation cost of air terminations |
| Session 9: | Observe and estimate installation cost of earth terminations |
| Session 10: | Observe and estimate costs of down conductors and bonding |
| Session 11: | Evaluation and closing |

## Session 1: Opening, introduction and objectives of the training

*Learning objectives:*

At the end of the session, participants will be able to:

- Explain the objectives of the training
- Introduce the participations and facilitators to each other
- Discuss participant expectations
- Unite on the training objectives and program of activities
- Set climate for smooth functioning of rest of training sessions with technical arrangements such as schedule, formation of host team, house rules, etc.

## Session 2: Lightning as a major disaster: Losses of life and properties at local, national and global scales

*Learning objectives:*

At the end of the session, participants will be able to:

- Explain the data of losses of lives, injuries and property damages due to lightning.
- Explain lightning prone areas.
- Understand that lightning is nothing but an electrical discharge.
- Understand the cause of physical damage.
- Understand the extent of lightning threats in Nepal.

## Session 3: Understanding lightning- situation of its formation, risks of ground strike and ESE

*Learning objectives:*

**At the end of the session, participants will be able to:**

- Explain the cause of lightning hazards
- Distinguish between direct and indirect effects of lightning
- Explain the cause of injuries and damage
- Identify high risk and low risk zones

## Session 4: Assessment of lightning risks in Makawanpur

*Learning objectives:*

**At the end of the session, participants will be able to:**

- Explain the geography, climate, season and areas with lightning risks
- Share the causes behind the high casualties of lightning in various areas
- Importance of internal protection system
- Lightning surges
- Identify very sensitive public buildings
- Recommend the level of protection needed

## Session 5: Basic measures for lightning protection

*Learning objectives:*

At the end of the session, participants will be able to:

- Explain the basic steps for protection from lightning.
- Identify safe and unsafe areas of lightning incidents
- Give examples of safe and unsafe places of lightning
- Explain the basic principles on protection of structure against lightning.
- Differentiate between the earthing of electrical supply and earthing of lightning protection.
- Surge protective devices and their applications

## Session 6: Available lighting protection technologies and practices

*Learning objectives*

At the end of session, participants will be able to:

- Name major equipment used for protection of lightning
- Share the limitations of technologies
- Explain the various components of lightning protection and their role.
- Explain the various types of earthing and techniques for improving earth resistance.
- Describe the function of surge protective devices and their role in protecting equipment inside a building.

## Session 7: Quality and cost assessment of devices and conductors.

*Learning objectives:*

**At the end of the session, participants will be able to:**

- Explain steps to assess quality of devices and system
- Suggest options to reduce risks of lightning with and without applications of devices.
- Explain the types of devices required for reducing the risk of a structure
- Estimate costs various types of lightning protection devices and associated quality.
- 

## Session 8: Observe and estimate costs of air termination systems (out door)

*Learning objectives:*

At the end of the session, participants will be able to:

- Observe and identify two or more types of air terminations systems.
- Estimate the quantity and costs of equipment used
- Assess level of risks reduction and recommend improvement

## Session 9: Observe and estimate costs of earth termination systems (out door)

*Learning objectives:*

At the end of the session, participants will be able to:

- Observe and identify two or more types of earth terminations systems.
- Estimate the quantity and costs of equipment used
- Assess level of risks reduction and recommend improvement

## Session 10: Observe and estimate costs of down conductors and bonding separation (out door)

*Learning objectives:*

At the end of the session, participants will be able to:

- Observe and identify two or more types of down conductors.
- Estimate the quantity and costs of equipment used
- Assess level of risks reduction and recommend improvement

## Session 11: Evaulations and closing

*Learning objectives*

- Offer views of what was highly useful and suggest where improvement needed.

## Annex 1: Pre/Post Test

Code:…………………………………………….

1. Nepal is ranked in the world in terms of lightning risks.

   a. High   b. Medium   c.Low   d. None

2. Is lightning a threat to us?

   Yes ………………  No ………………

3. On average over the past ten years in Nepal the number of people killed annually due to lightning is

   a. 10
   b. 50
   c. 100
   d. Above 100

4. Lightning is a natural phenomenon.

   True ………………False ………………

5. During lightning people are more vulnerable if they are Inside

   a. Home/house   b. Outside ………………

6. We can swim during a storm with lightning strikes

   True ………………   False ………………

7. Can we protect infrastructure using proper lightning protection devices from lightning strikes?

   Yes ………………   No ………………

8. What should we do while outside home/house/building during lightning season?

   a. Stay away from big trees
   b. Do not walk in a water stagnant area
   c. If possible, stand in between and below high-tension electric poles
   d. All of above

9. What should we do to reduce casualties from lightning strikes?

a. Include LPS in the Building Code and ensure its strong enforcement
b. Mainstream PaL in academic curricula at all levels
c. Mass scale public awareness on PaL
d. All of above

10. Makawanpur is among the high risk districts from lightning. Why
a. Industrial zone
b. Rich forest area
c. Dense population
d. Geographic and climatic conditions

## Annex 2: Training on Protection against Lightning

**Training Evaluation** [Date: // ] **Location /Venue**

| Instructions: Please tick your level of agreement with the statements listed below | Strongly Agree | Agree | Disagree | Strongly Disagree | Not relevant to this event |
|---|---|---|---|---|---|
| **1. The objectives of the training were met.** | | | | | |
| **2. The facilitators were good communicators.** | | | | | |
| **3. The course materials were relevant to my work.** | | | | | |
| **4. The facilitators were well prepared and able to answer any questions.** | | | | | |
| **5. The pace and time allocation of the course was appropriate to the content and attendees.** | | | | | |
| **6. The material was presented in an organized manner.** | | | | | |
| **7. I would be interested in attending a follow-up and advanced workshop.** | | | | | |
| **8. The exercises/role play were helpful and relevant.** | | | | | |
| **9. The venue was appropriate for the event.** | | | | | |
| **10. Course support team was helpful and provided timely information to facilitate my participation in the training.** | | | | | |

In your opinion, the level of this training was a) Introductory, b) Intermediate, or c) Advanced. (please circle your response)

11. Facilitators Rating

Please rate the facilitators in reference their knowledge, facilitation skills and responsiveness

| | | Excellent | Very good | Good | Average | Poor |
|---|---|---|---|---|---|---|
| **Name of facilitator** | His/her knowledge in the subject area is… | | | | | |
| | His/her facilitation skills are… | | | | | |
| | His/her ability to espect participants' views is… | | | | | |
| **Name of facilitator** | His/her knowledge in the subject area is… | | | | | |
| | His/her facilitation skills are… | | | | | |
| | His/her ability to respect participants' views is… | | | | | |
| **Name of facilitator** | His/her knowledge in the subject area is… | | | | | |
| | His/her facilitation skills are… | | | | | |
| | His/her ability to respect participants' views is… | | | | | |
| **Name of facilitator** | His/her knowledge in the subject area is… | | | | | |
| | His/her facilitation skills are… | | | | | |
| | **His/her ability to respect participants' views is…** | | | | | |

12. Please list the three most useful takeaways from the course.

1.

2.

3.

13. Please list the three least useful sessions/materials in the training

1.

2.

3.

14. Are there any other topics that you would like to be offered training in?

15. Would you recommend this course to your colleagues/friends?

Yes
No
Why?

16. Would you recommend this course to your colleagues/friends?
Yes
No
Why?

## Annex 3: Template for Training Report

**Training on lightning risks and protections**

[Venue] [Date]

1. Introduction
2. Training objectives
3. Profile of participants and facilitators
4. Proceeding (Information based on each session)
    - Topics covered in each session
    - Key issues raised by the participants
    - Summary/takeaway of the group exercises (for each sessions)
    - Desk-top Simulation exercise:
    - Scenario for the exercise
    - Materials used
    - Key observations
    - Lessons
5. Results of the Pre and Post tests
6. Results from the training evaluation
7. Conclusion (including key outcomes from the training)
8. Recommendations and learnings
9. Pictures with captions
10. Annexes (for report):
    - Operational Plan from Participants
    - Schedule
    - List of participants