

A Simple Evaluation of the Lightning Protection System at the Class III Airport Management Unit of Sugimanuru Based on SNI 03-7015 and PUIL 2011

Ria Abina Sianipar, Muhammad Erpandi Dalimunthe, Rahmaniar

Abstract

This study presents an evaluation of the lightning protection system installed at the terminal building of Sugimanuru Airport. The lightning protection system plays an essential role in protecting electrical facilities and aviation security facilities from operational disturbances, electronic equipment damage, and potential hazards caused by lightning strikes. The objective of this research is to assess the compliance of the existing lightning protection system with the requirements of SNI 03-7015 and PUIL 2011 standards. A descriptive-evaluative method based on field observations and technical document analysis is employed. The evaluation parameters include air terminals, down conductors, and grounding systems. The data used in this study consist of existing lightning protection installation conditions, relevant technical documents, and lightning strike density (Ng) data obtained from the Meteorology, Climatology, and Geophysics Agency (BMKG). The results of this study are expected to provide an overview of the adequacy of the current lightning protection system and serve as a technical basis for recommendations to enhance safety and operational reliability at Sugimanuru Airport.

Keywords: Lightning Protection System, Grounding, SNI 03-7015, PUIL 2011, Airport

Ria Abina Sianipar¹

¹Electrical Engineering Study Program, Universitas Pembangunan Panca Budi, Indonesia e-mail : riaabina18@gmail.com¹

Muhammad Erpandi Dalimunthe², Rahmaniar³

^{2,3}Departement of Electrical Engineering, Universitas Pembangunan Panca Budi, Indonesia e-mail: erpandi@dosen.pancabudi.ac.id², rahmaniar4n01@gmail.com³

2nd International Conference on Islamic Community Studies (ICICS)

Theme: History of Malay Civilisation and Islamic Human Capacity and Halal Hub in the Globalization Era

<https://proceeding.pancabudi.ac.id/index.php/ICIE/index>

Introduction

The development of air transportation infrastructure in Indonesia requires improvements in reliable operational security and safety systems, including the reliability of electrical systems and lightning protection as an integral part of airport facility safety. As vital infrastructure, airports operate numerous electronic devices and communication systems that are sensitive to overvoltage surges, making them highly vulnerable to lightning effects.

Indonesia is located in a tropical climate zone with a high frequency of lightning occurrences throughout the year. Based on data from the BMKG Geophysics Station in Kendari (Letter No. e.T/GF.01.01/015/KKDI/X/2025), West Muna Regency, including the Sugimanuru Airport area, is categorized as having a high lightning strike density ($N_g > 15$ strikes/km²/year). This condition indicates that the lightning risk in the region is significant, especially for main buildings such as the passenger terminal.

The terminal building of UPBU Class III Sugimanuru has been equipped with a conventional external lightning protection system consisting of air terminals (finials), down conductors, and a grounding system. However, a comprehensive technical evaluation of its compliance with national standards has not yet been carried out. An evaluation is required to ensure that the lightning protection system effectively conducts lightning current to earth and supports the principles of Safety and Compliance established by the Directorate General of Civil Aviation (DGCA).

Therefore, this research evaluates the lightning protection system at the terminal building of UPBU Class III Sugimanuru in a technical and systematic manner, referring to SNI 03-70152004 and PUIL 2011, while considering the local lightning strike density conditions.

Literature Review 2.1. Lightning

Lightning is a natural phenomenon in the form of a very high-voltage electrical discharge that occurs due to an electric potential difference between clouds, between a cloud and the earth's surface, or between clouds and the ground. This discharge produces a large impulse current with a very short duration, which can cause disturbances and damage to electrical systems and electronic equipment. In public-service buildings with continuous operation, such as airport terminals, lightning strikes may disrupt operations, damage electrical and electronic equipment, and increase safety risks. Therefore, a reliable lightning protection system is needed to control and conduct lightning energy so that it does not directly affect the building and internal installations.

2.2. Lightning Protection System

A lightning protection system (LPS) is designed to protect buildings, electrical installations, and electronic equipment from the effects of lightning strikes, both direct and indirect. The system provides a controlled conductive path for lightning current to be safely transferred to earth, thereby preventing damage to the building structure and the electrical system. In general, an external LPS consists of air terminals, down conductors, and a grounding system. The air terminal functions as the strike interception point and is installed at the highest part of the structure. The down conductor provides a path to conduct the current to the grounding system, while the grounding system dissipates the current into the soil to reduce dangerous touch and step voltages.

2.3. Protection Angle Method

The protection angle method is commonly applied in the planning and evaluation of lightning protection systems to determine the protected zone of an air terminal. This method is based on the assumption that lightning tends to strike the highest object in an area. The protected region is determined by drawing an imaginary line from the tip of the air terminal at a specified angle relative to the roof surface. Areas within this angle are considered protected from direct

lightning strikes. The protection angle depends on the air terminal height and the selected protection level according to applicable standards. This method is widely used for existing buildings because it is simple and does not require complex calculations.

2.4. Grounding System

The grounding system is a critical part of an LPS because it conducts and dissipates lightning current into the soil. A good grounding system should have a low earth resistance value so that lightning current can be transferred effectively without causing hazardous touch and step voltages. Earth resistance is influenced by soil type, electrode depth and configuration, conductor cross-sectional area, and soil moisture. For high-risk and high-importance facilities such as airports, the grounding system must be carefully evaluated to ensure compliance with safety and electrical reliability requirements.

2.5. Lightning Protection Standards

The design, installation, and evaluation of lightning protection systems should follow applicable standards to ensure an adequate level of protection. In Indonesia, commonly referenced standards include SNI 03-7015 for lightning protection systems and the General Requirements for Electrical Installations (PUIL) 2011. SNI 03-7015 provides fundamental principles, protection methods, component placement, and evaluation criteria. PUIL 2011 specifies electrical safety requirements, particularly grounding and overvoltage protection. By referring to both standards, the lightning protection system is expected to provide optimal and safe protection.

Research Methodology

This research was conducted at the terminal building of Sugimanuru Airport. The object of study was the external lightning protection system, which includes air terminals, down conductors, and the grounding system. The method used was descriptive-evaluative with qualitative and quantitative approaches.

The research stages began with a literature study to obtain theoretical foundations and standard requirements for lightning protection systems. Field data were then collected regarding the building conditions and the existing lightning protection installation. Ground resistance measurements were carried out by the electrical unit using appropriate measuring instruments to assess compliance with the limit values specified by the standards.

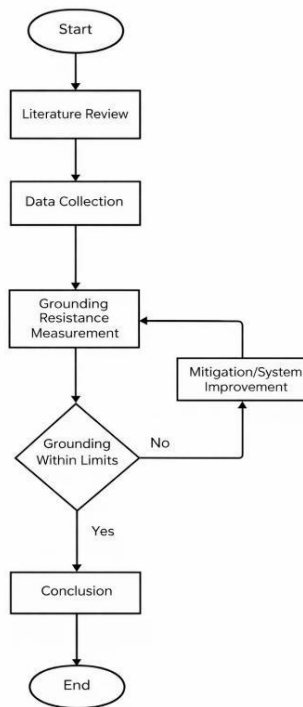


Figure 1. Research Methodology Flowchart Results



Figure 2. Sugimanuru Airport Terminal Building

The lightning protection system installed at the Sugimanuru Airport terminal building is a conventional external LPS consisting of air terminals (finials), down conductors, and a grounding system. The down conductor used is a BC 50 copper conductor, which functions to safely conduct lightning current from the air terminal to the grounding system.

The terminal building has an approximate length of 72 m, a width of 26 m, and a building height of 12 m, with a total floor area of 1,872 m². Air terminals (finials) with a height of approximately 2 m above the roof surface are installed on the roof. These building dimensions and the finial height form the basis for the protection zone analysis using the protection angle method. A total of 12 finials are installed on the roof and distributed evenly along the building geometry.

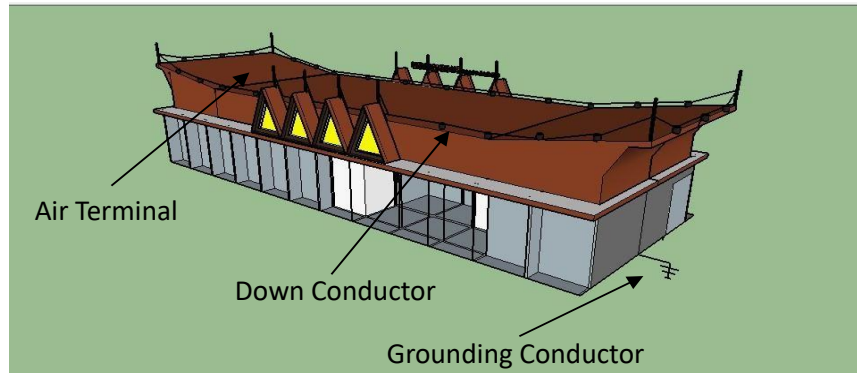


Figure 3. Lightning Protection Installation on the Sugimanuru Airport Terminal Building

Ground resistance measurements of the lightning protection grounding system were performed using a Kyoritsu digital earth tester, type KEW 4105A. Measurements were taken under two different environmental conditions, namely the dry season and the rainy season, to observe grounding performance under soil moisture variations.

Table 1. Ground resistance measurement results of the lightning protection system

No	Measurement Condition	Ground Resistance (Ω)
1	Dry season	1.47
2	Rainy season	0.95

Based on Table 1, the ground resistance value is 1.47 Ω in the dry season and 0.95 Ω in the rainy season. Both values are below the maximum limit recommended by SNI 03-7015 and PUIL 2011, which is $\leq 5 \Omega$. The difference in ground resistance is influenced by soil moisture; wetter soil generally has better conductivity.

Protection zone analysis was carried out using the protection angle method with a protection angle of 60° . The finial height above the roof surface was measured as 2 m. The basic equation of the protection angle method is:

$$r = h \times \tan(\alpha)$$

where:

r = horizontal protection radius (m) h =
finial height above the roof surface (m) α =
protection angle ($^\circ$)

Substituting the values:

$$h = 2 \text{ m } \alpha = 60^\circ \\ \tan(60^\circ) = 1.732$$

Thus, the horizontal protection radius is:

$$r = 2 \times 1.732 = 3.46 \text{ m}$$

Based on the calculation, the horizontal protection radius for a single finial with a height of 2 m at a 60° angle is approximately 3.46 m. With 12 finials distributed on the roof, the protection zones overlap, indicating that the roof area is covered within the protection zone of the lightning protection system.

Table 2. Protection radius calculation results using the protection angle method

Parameter	Symbol	Value	Unit
Finial height	h	2	m

Protection angle	α	60	°
Protection radius	$r = h \times \tan \alpha$	3.46	m

Conclusion

Based on the evaluation of the external lightning protection system at the terminal building of UPBU Class III Sugimanuru, the following conclusions can be drawn:

1. The installed lightning protection system is a conventional external LPS consisting of air terminals, a down conductor using BC 50 copper conductor, and a grounding system.
2. Ground resistance measurements showed 1.47Ω during the dry season and 0.95Ω during the rainy season, both below the maximum limit required by SNI 03-7015 and PUIL 2011 ($\leq 5 \Omega$).
3. Protection zone analysis using a 60° protection angle and a finial height of 2 m produced a horizontal protection radius of approximately 3.46 m.
4. Based on the calculations and finial configuration, the roof area of the terminal building is within the protected zone of the lightning protection system.
5. Overall, the lightning protection system at the Sugimanuru Airport terminal building meets the basic requirements and is considered to function properly.

Recommendations:

1. Periodic inspection and maintenance should be carried out on all lightning protection components, particularly air terminals, down conductors, and the grounding system, to keep the system performance optimal.
2. Periodic ground resistance measurements under different environmental conditions are recommended to ensure that the resistance remains within the required limits.
3. Future studies may be expanded by considering other lightning protection methods or by analyzing the protection level based on local lightning characteristics at Sugimanuru Airport.

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