Jurnal Teknologi Elekterika, 2025, Volume 22 (1): 78-83 **e-ISSN 2656-0143**

LIGHTNING PROTECTION SYSTEM FOR THE MAIN POWER HOUSE BUILDING SULTAN HASANUDDIN AIRPORT DEVELOPMENT PROJECT

Dimas Yudha Ari Pratama [1], Purwito[2] Agus Salim[3]
[1,2,3] Department of Electrical Engineering D4 Electrical Engineering, Politeknik Negeri Ujung Pandang
email: dimasyudha.aripratama@gmail.com[1] purwito@poliupg.ac.id[2]
agussalim16081967@gmail.com[3]

Abstract — Lightning, often called lightning, is a natural phenomenon that is common during the rainy season. Lightning appears as a flash of bright light followed by a rumbling sound called thunder. This phenomenon occurs due to the potential difference between clouds and the earth or between clouds, with negative charges in clouds being released towards the earth to achieve equilibrium. This process creates lightning and lightning sounds. This phenomenon is more common in the rainy season because of the high moisture content in the air which lowers the insulation power, making it easier for electric current to flow. The danger of lightning can cause damage to buildings, and power grids, and fatalities.

This research was conducted at PT Wijaya Karya (Persero) Tbk., at the Sultan Hasanuddin Airport Development Project, Maros Regency, South Sulawesi. The research procedure begins by asking permission from the company's management, followed by data collection from the Production, Engineering, and QC teams. Data collection is carried out through literature studies, field observations, interviews with related teams, and documentation. The data obtained will be analyzed to determine the lightning protection system and earth resistance measurement at the Main Power House Building. The calculation includes the density of the lightning strike, the area of the protection area, and the frequency of the strike. The determination of the need for a protection system is carried out based on the results of the calculation, and if necessary, the protection efficiency will be calculated using the rolling ball method.

From the calculation results, the minimum protection value in the rolling ball method is 9.7 meters with a maximum protection of 20 meters. In the results of the measurement of the grounding resistance for lightning rods, the following results were obtained (1.42 Ohms; 0.92 Ohms; 0.15 Ohms; 1.61 Ohms). The result does not exceed the limit of 5 Ohms.

Keywords: Lightning Rod, Main Power House Building, Grounding Prisoner

I. INTRODUCTION

As is well known, Indonesia has a tropical climate where the level of thunder days is high every year. Many locations are prone to lightning in Indonesia, especially in the Makassar area and its surroundings. As in the journal "Analysis of Lightning Rod System on BTS". The journal researches lightning protection systems as protection in a building. The use of protection systems has been known for a long time. However, the traditional protection system is only a protector from fire hazards, while the overvoltage or overcurrent still cannot be fully absorbed by this traditional lightning rod. Along with the advancement of technology, the level of damage caused by lightning strikes is also greater.

Lightning strikes at long distances are already capable of damaging strong current electrical systems and weak current electrical systems. Therefore, the creation of a grounding control box is also needed to eliminate potential differences such as the discharge of excess electrical charge by flowing it to the ground, an example of a journal that researches grounding is "Feasibility Study of Grounding System in Electrical Installation of the Faculty of Tarbiyah and Teacher Training Building UIN AR-RANIRY Banda Aceh".

Judging from the many benefits obtained by the application of the principle of protection to protect electrical equipment and electronic devices such as in the Main Power House Building. Therefore, the implementation of this research activity will be analyzed for protection systems that can protect devices or safety in lightning strikes both directly and indirectly. Based on the description above, the author will hereby discuss the "Lightning Protection System for the Main Power House Building of the Sultan Hasanuddin Airport Development Project".

II. RESEARCH METHODOLOGY

2.1 Place and Time of Research

This activity was carried out at PT Wijaya Karya (Persero) Tbk. which is located at Jalan Poros Bandara Baru, Baji Mangngai, Mandai District, Maros Regency, South Sulawesi 90552 at the Sultan Hasanuddin Airport Development Project. This activity will be carried out from March 2024 to June 2024.

2.2 Activity Procedure

This research procedure lasts for four months from March to June 2024 at PT Wijaya Karya (Persero) Tbk. The beginning of this activity is to ask for permission from the Management of

PT Wijaya Karya. After getting permission from the Management, the next step is to take the necessary data together with the Production (Implementer), Engineering and QC, so that they can be held accountable.

The data that has been obtained is then processed as needed in the formulation of the problem. The formulation is like the lightning rod system needed to protect the Main Power House Building and the grounding system on the lightning rod. Figure 2.1 shows a flowchart of the procedure for the activities to be carried out until the results and conclusions are obtained.

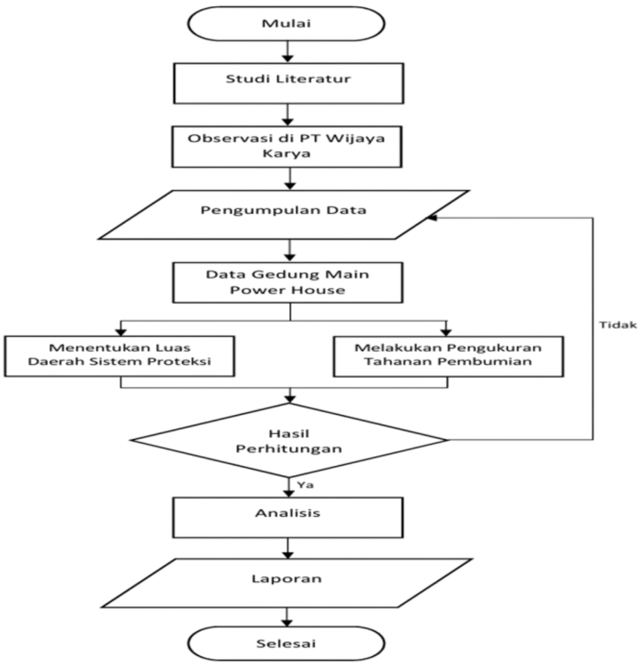

Figure 2.1 Activity Procedure Flow Diagram

2.3 Data Collection Techniques

The data collection method used in this thesis about the Lightning Protection System of the Main Power House Building of the Sultan Hasanuddin Airport Development Project is a literature study, observation, interview and documentation method.

1. Literature Studies

The author conducts a literature study to find theories that are relevant to the problems found. Searches are carried out from various sources such as books, archives, journals, internet articles and others. So that the information obtained from this study can be used as a reference or reference.

2. Observation

The author made observations in the field where the researcher conducted the research, in this case the research place will be carried out in the Main Power House Building to find out the real condition of the object discussed and obtain data that supports the planning of writing this thesis.

3. Interview

The author collects data by giving questions to the Production Team, Engineering Team and QC Team at PT Wijaya Karya (Persero) Tbk. when researching to obtain more accurate knowledge and knowledge.

4. Documentation

The author conducts the process of collecting data through documentation as evidence and documents that can help complete this thesis. The data taken is in the form of secondary data. This secondary data collection was obtained from PT Wijaya Karya (Persero) Tbk.

2.4 Data Analysis Techniques

The data obtained or successfully collected during the research process on the data of the Main Power House Building, the area of the lightning protection system and the measurement of grounding resistance will be processed to produce conclusions that can be reached.

III. RESULTS AND DISCUSSION

3.1 Detailed Building Data and Lightning Rods

3.1.1 Building Details

Length (m)	Width (m)	Height (m)	Area(m^2)
60	27	5	1620

3.1.2 Lightning Rod Details

a. Length : 1000 or 1 meter
b. Type : Aluminium
c. Lightning rod diameter : 0,59 inchi

3.2 Grounding System Details (Grounding)

The grounding system functions to channel and distribute lightning currents into the ground. In spreading lightning current to the ground without causing dangerous overvoltages, the shape and dimensions of the grounding system are very important.

The grounding system data found in the Main Power House Building area at Sultan Hasanuddin Airport, is as follows:

a. Length of copper rod : 1,8 meter
b. Depth : Minimum 6 meters

c. Number : 4 sticks

3.3 Determination of Lightning Protection Needs

Determination of the need for lightning protection in an area is calculated using thunderstorm day data, building size data, protection area, local direct strike frequency (Nd), and annual strike frequency, by first calculating the strike density to the ground (Ng).

3.3.1 Thunder Day of Maros Regency

Months	Thunder Day of Maros Regency			
	2019	2020	2021	2022
JANUARI	28	23	8	14
FEBRUARI	28	17	8	15
MARET	28	16	22	19
APRIL	29	17	19	13
MEI	31	17	1	24
JUNI	25	3	10	23
JULI	10	7	10	25
AGUSTUS	8	9	12	13
SEPTEMBER	1	9	15	12
OKTOBER	7	20	21	31
NOVEMBER	16	20	25	27
DESEMBER	29	20	14	31
TOTAL THUNDER DAYS	240	178	165	247

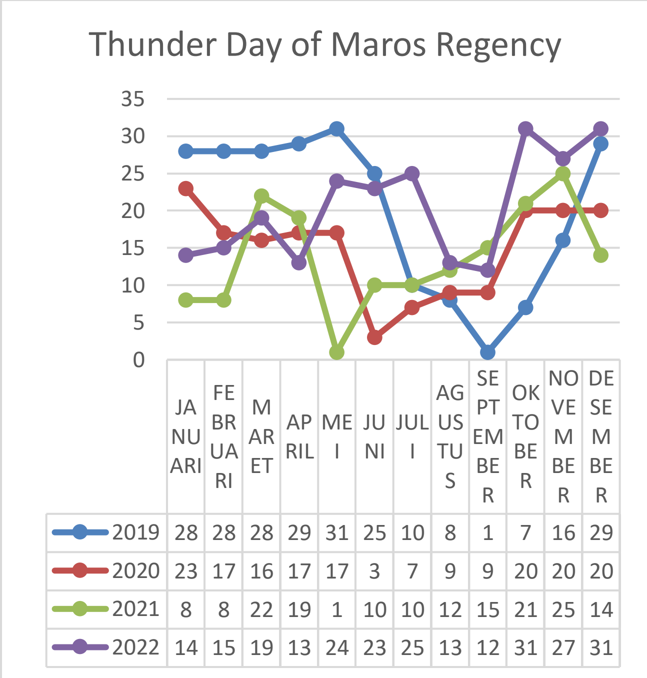

Figure 3.1 Graph of Thunder Day in Maros Regency

The density of lightning strikes to the ground (Ng) is affected by the thunder day in the area. The number of thunder days in Maros Regency is around 165 thunder days (Source: BMKG Gowa Class II Geophysics Station).

Then the lightning strike density to the ground (Ng) can be calculated by equation 2:

$$Ng = 4 \cdot 10^{-2} \cdot T_d^{1{,}26} \ldots\ldots 2$$

$$Ng = 4 \cdot 10^{-2} \cdot 165^{1{,}26}$$

Ng = 24,89 Lightning strikes km^2 per year

Meanwhile, the area of the ground surface that is considered to have an annual direct hit frequency can be calculated by equation 3, as follows:

$$Ae = ab + 6h(a+b) + 9\pi h^2 \ldots\ldots 3$$

$$Ae = (60 \times 27) + 6 \times 5\ (60 + 27) + (9 \times 3{,}14 \times 5^2)$$

$$Ae = 1.620 + 30\ (87) + 706{,}5$$

$$Ae = 1.620 + 2.610 + 706{,}5$$

$$Ae = 4.936{,}5\ m^2$$

Meanwhile, to calculate the average number of direct lightning strike frequencies per year (Nd), it can be found with the following equation 4:

Nd = Ng x Ae x 10^{-6}……………………………….4

Nd = 24,89 x 4.936,5 x 10^{-6}

Nd = 122.869,5 x 10^{-6}

Nd = 0,122869485

Nd = 0,12 Lightning strikes per year

Information:

a = Length of the building (m)

b = Building width (m)

h = Building height (m)

Td = Average thunder days per year

Ng = Density of lightning strikes to the ground (strikes/km^2 /year)

Ae = Area that still has a lightning strike number of Nd ((km^2)

Nd = Frequency of direct lightning strikes per year

Nc = Fixed (10^{-1})

The annual lightning strike frequency (Nc is known to be worth 10^{-1}) is allowed. The determination of the level of protection in buildings based on the calculation of Nd and Nc is carried out as follows:

a. If Nd ≤ Nc does not need a lightning protection system.
b. If Nd > Nc a lightning protection system is required.

3.3.2 Lightning Protection System Efficiency

Protection Level	Lightning Protection System Efficiency	R(m)
I	0,98	20
II	0,95	30
III	0,90	45
IV	0,80	60

Information :

E < 0%, no need for a lightning protection system

0% < E ≤ 80%, requires a protection system, is at protection level IV

80% < E ≤ 90%, requires a protection system, is at protection level III

90% < E ≤ 95%, requires a protection system, is at protection level II

95% < E ≤ 98%, requires a protection system, is at protection level I

Since the value of Nd is greater than that of Nc, the value of efficiency can be calculated by equation 5:

$E \geq 1 - \frac{Nc}{Nd}$…………………………………………..5

$E \geq 1 - \frac{10^{-1}}{0,12}$

E ≥ 1 – 0.83

E ≥ 0,17

E ≥ 0,17 (17%)

Information :

E = Efficiency of lightning protection system

Nd = Frequency of direct lightning strikes per year

Nc = Allowable local annual lightning strike frequency (10^{-1})

3.3.3 Air Termination Placement in accordance with Protection Level

Protection Level	h (m)	20	30	45	60	Mesh Width (m)
	R (m)	α^o	α^o	α^o	α^o	
I	20	25	-	-	-	5
II	30	35	25	-	-	10
III	45	45	35	25	-	15
IV	60	55	45	35	25	20

Based on the data, the height of the Main Power House building is 5 meters and the length of the air termination is 1.8 meters, based on the lightning protection system installed with a conventional lightning rod type on the roof of the Main Power House building, the protection radius can be calculated with equation 7, as follows:

r = α x h…………………………………………7

$= \tan 55^{o} \times 6{,}8$

$= 9{,}7$ meters

From the data obtained, the minimum protection radius for the installation of lightning rods with conventional lightning rods is 9.7 meters. Based on table 4.4, the maximum protection radius is 20 meters.

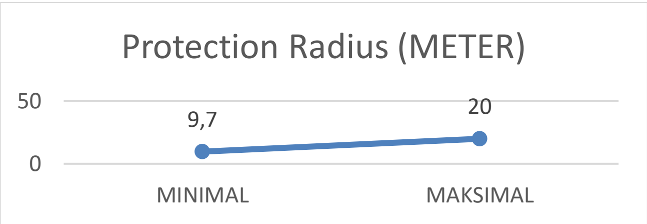

Figure 3.2 Lightning Protection Radius of Rolling Ball

The formula for calculating the protection radius (protection zone) of the lightning rod is based on the height and level of protection required. In the calculation of the lightning rod protection radius used is rolling ball protection, which can be calculated by equation 6, as follows:

$$R = \sqrt{2\,.\,h\,(d-h)} \qquad \ldots\ldots 6$$

Dimana :

R = Protection radius (meters)

h = Lightning rod height from ground level (meters)

d = Lightning strike distance (the level of protection determined by the SNI standard)

The d value is based on the level of protection, as follows:

a. Protection level I (Efficiency 98%): d = 20 meters

b. Protection level II (Efficiency 95%): d = 30 meters

c. Protection level III (Efficiency 90%): d = 45 meters

d. Protection level IV (80% efficiency): d = 60 meters

From this equation, we can calculate the protection value or protection zone used in the rolling ball method with protection level IV, as follows:

$$R = \sqrt{2\,.\,6{,}8\,(60-6{,}8)}$$

$$R = \sqrt{2\,.\,6{,}8\,.\,53.2}$$

R = 26,89 meters or 26890 mm

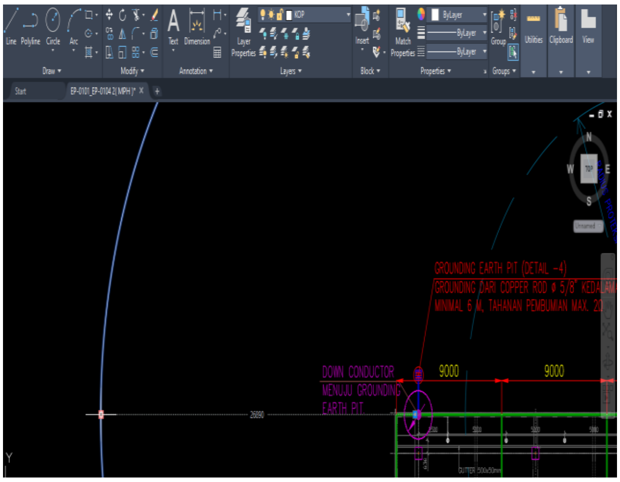

Figure 3.3 Protection Zone via AutoCAD

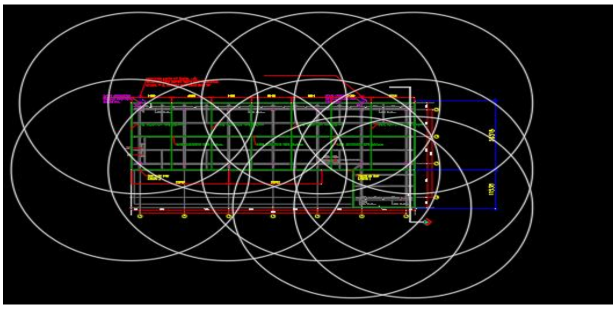

Figure 3.4 Overall Protection Zone

3.4 *Grounding System*

The grounding electrode for the lightning rod grounding system used is a rod electrode type electrode. The material of the grounding electrode is copper. The grounding electrode is installed at a depth of 6 meters under the control basin with a size of 25.6 x 7 x 15.8 cm in as many as 4 control basins. On the roof of the Main Power House building, the most crowded 13 Air Terminals are connected using Down Conductors in parallel. In this case, the control body can handle more than one Air Terminal or lightning rod.

3.4.1 Efisiensi Sistem Proteksi Petir

No	Location	Grounding Box	Grounding Resistance Value
1	Main Power House	AS D : 2	1,42
2	Main Power House	AS E : 4	0,92
3	Main Power House	AS A : 4	0,15
4	Main Power House	AS G : 3	1,61

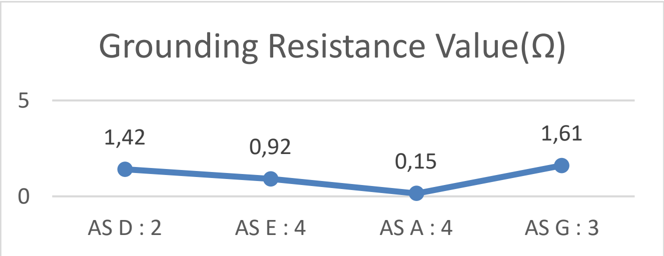

Figure 3.5 Grounding Resistance Value (Ω)

IV. CONCLUSIONS

Based on the discussion of the Lightning Protection System for the Main Power House Building of the Sultan Hasanuddin Airport Development Project, the following conclusions can be drawn:

1. Main Power House building with a height of 5 meters requires a lightning rod system with a value of Nd = 0.12 lightning strikes per year. With a tuition value = 0% - 80% (based on calculations, the value obtained is 17%), the Main Power House Building requires a minimum tuition level level IV. The distance (radius) of lightning rod protection to the surrounding area with rolling ball analysis is 9.7 meters, using conventional lightning rods, while the maximum distance (radius) for lightning rod protection based on SNI 2004: 7015 is 20 meters at the SPP level IV protection level.
2. The grounding resistance in the Main Power House Building has 4 grounding boxes with a value below 5 Ohms. So the Main Power House Building has met the 2020 PUIL standard with a standard value of no more than 5 Ohms.

REFERENCES

[1] Agus Falentigo, Irvan. "Evaluation of Lightning Distribution Installation at PT Pertamina (Persero) Marketing Unit III Padalarang Depot. Bandung, 2009.

[2] Agusthinus S. Sampeallo, Evtaleny R. Mauboy, Yeremias M. Moron, 2020. Planning of Electrostatic Lightning Distribution System with Faraday's Cage Method at the Kupang State Finance Building. Nusa Cendana University Kupang. NTT.

[3] Ahmad Zubari, 2012. The process of lightning occurs.

[4] Dimas Pangestu Danar P, Mayda Waruni Kasrani, A. Asni B, 2023. Designing an External Protection System for Lightning Distributors at the PT. Bukaka Main Technique Balikpapan. University of Balikpapan. Balikpapan.

[5] Era Krisna, 2013. Definition of Lightning.

[6] Fajar Endang Taryana. 2017. Types of Electrodes and Their Installation.

[7] Febriani Syafran Putri, Eddy Hamdani 2017. Evaluation of Lightning Protection System on the Tower of PT Sampoerna Telekomunikasi Indonesia (CERIA) Pekanbaru: Journal of Jom FTEKNIK Volume 4 No. 1.

[8] Happy Aprilia, 2022. The Rolling Ball Method for the Analysis of the Design of the Lightning Protection System of the Lecture Building of the Kalimantan Institute of Technology. Kalimantan Institute of Technology. Balikpapan.

[9] Herlaswandi Harahap, 2017. Lightning Catcher Protection System Using the Franklin Method at the Medan Religious Education and Training Center Building. University of Muhammadiyah North Sumatra. Terrain.

[10] Mafdal Mahmud, 2022. Feasibility Study of Grounding System in Electrical Installation G

[11] Meyditri Luden, Harnyatris. (2003). Study on the Effect of Lightning on Electronic Equipment in Buildings and Their Security. Surabaya: Petra Christian University.

[12] Permata, D., & Purwasih N. 2009. The Effect of Lightning Strikes on the Protection System in BTS Towers (Base Transceiver Station). Journal of Engineering and Technology of Elektro.

[13] Pusa, Widhya P, 2009. Evaluation of the lightning protection system at the Base Transceiver Station (BTS). Tangerang: UI Thesis.

[14] Zaki Mulyadi, Ifkar Usrah, Asep Andang, 2023. Planning of Lightning Protection System at Sakti Lodaya Stadium, Cisayong District, Tasikmalaya Regency. Tasikmalaya. Siliwangi University.