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Design of Lightning Protection for Multi-Storey Buildings at the Malikussaleh University Rectorate Building

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Abstract— The Malikussaleh University Rectorate Building is a multi-storey building that is facilitated for academic and bureaucratic activities. It is necessary to safeguard against natural conditions such as lightning which may occur in the building area, including the contents of the building in the form of many electronic equipment connected to electricity such as computers, television, radio, CCTV, telephone and various other electronic equipment. Based on data received from the Meteorology, Climatology and Geophysics Agency (BMKG), 393 lightning strikes occurred in North Aceh, especially the Reuleut area, from February to May 2023. Building protection can be determined based on calculations calculated using several subclassifications of the General Installation Regulations Lightning Distribution (PUIPP). based on the level of need according to the PUIPP standard with a value of R=16, NFPA with a value of R=22, and IEC 1024-1-1 value of E= 95% with level II protection. The design of the lightning rod follows the PUIPP Standard by using a type, namely an air termination system with the brand "Kurn R-85" which has a protection radius of 85 m2. To apply an electrostatic lightning rod, simply install one lightning rod on top of the building at a height of 25 m from the ground, then connect it to ground using a 50 mm2 BC cable.

Keywords: PUIPP, Lightning rod, Grounding.

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1. Introduction

Indonesia is a country with a tropical climate, where this condition causes Indonesia to have quite high thunderstorm days based on data received from the Meteorology, Climatology and Geophysics Agency (BMKG) in May 2023. In 2023, the average area in Indonesia being struck is around over 15,000 to 60,000 times [1]. Lightning is a natural miracle that can be compared to a giant capacitor, lightning can also be considered a natural phenomenon with very high currents and voltages. Starting from the ionization process until the charge jumps from the cloud to the ground or vice versa. Lightning usually discharges its charge from the clouds to nearby objects, so lightning will most likely strike an object about 15 meters high [2], [3], [4]. Lightning can cause damage that endangers equipment and people in a room. To minimize the risk of lightning strikes, apartment buildings must have lightning protection that protects all parts of the building, including people and equipment inside [5], [6] [7].

The effects of a strike depend on the height of the building, the higher the building, the higher the loss that will be experienced if struck [8] [9]. Lightning strikes are divided into 2 types, namely direct and indirect lightning strikes. The lightning protection system is also divided into two types of protection, including internal and external lightning protection [10]. The purpose of the external protection system is to protect buildings and people from damage due to direct lightning strikes, while the purpose of internal protection is to reduce the impact of electromagnetic waves due to lightning

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currents entering the protected equipment [11], [12], [13]. The need for protection in buildings can be determined based on calculations calculated using several subclassifications from the General Regulations on Lightning Distribution Installations (PUIPP), thunder days, Ng and Nd [14].

The Malikussaleh University Rectorate Building is a multi-storey building that is facilitated for academic and bureaucratic activities. It is necessary to safeguard against natural conditions such as lightning which may occur in the building area, including the contents of the building in the form of many electronic equipment connected to electricity such as computers, television, radio, CCTV, telephone and various other electronic equipment. This equipment must be protected from lightning strikes so that it continues to function or is not damaged when the building is struck by lightning [15]. Likewise with the people inside the building so as not to cause casualties from the lightning strike [16].

Based on the phenomenon described above and after the author made observations at the Malikussaleh University Rectorate Building which is still under construction, it is necessary to install a lightning rod in the building for safety from lightning strikes. This research aims to design a lightning protection installation system that follows the general regulations for lightning distribution installations (PUIPP) based on data from planning which will later be applied to the Malikussaleh University Rectorate Building so that it can be fully protected from the danger of lightning strikes.

2. Method

The location of the research was carried out in the Electrical Engineering Department Laboratory Building and data collection in this research was taken from observations made at Malikussaleh University, precisely at the Rectorate Building located at Jln. Medan-Banda Aceh, Cot Tengku Nie, Reuleut, Muara Batu, North Aceh Regency, Aceh Province with an area of 4,277 m^2 as seen in Figure 1 below.

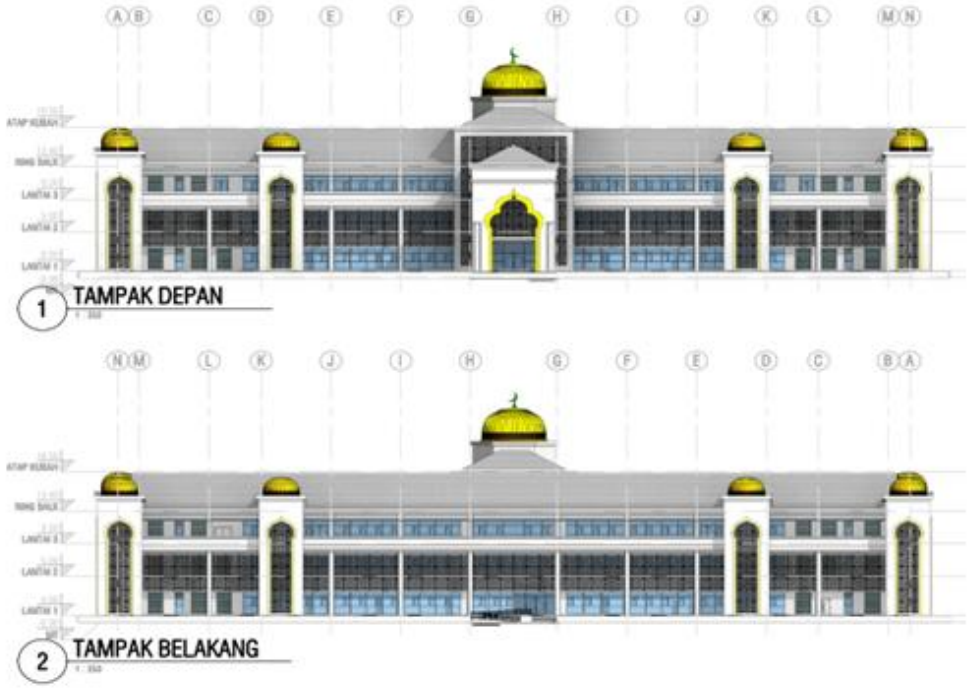


Figure 1. Layout of the Malikussaleh University rectorate building

The data in Table 1 is the specification data for the Malikussaleh University rectorate building which will be used for the purposes of this research.

Table 1. Malikussaleh University rectorate building data

Characteristics	Information
The height of the building without lightning protection and roof	13,50 m
Overall building height	18,5 m
Building area	4.277 m^2
Building Length	91 m
Building Width	47 m
Capacity	± 200 people
The outer area of the building	Land
Material characteristics	Concrete

2.1. Lightning Parameters

2.1.1. General Regulations for Lightning Protection Installation Standards (PUIPP)

A building's need for a lightning protection installation is determined by the level of risk of loss and danger that may occur if the building is struck by lightning [17]. By considering factors such as geographical location, building height, building type, as well as the value of losses that may arise due to damage, planners must ensure that the lightning protection installation is adequate to protect the building and its occupants from potential lightning hazards [18].

The approach to determining the need for lightning protection installations can be done empirically by considering indices that reflect certain factors. This is usually represented in tables showing the index values for each relevant factor, as shown in Tables 2 to 7 below. The total of these indices can then be calculated using equation 1 to determine the overall lightning protection installation requirements. Thus, this approach provides a framework for assessing the level of risk and determining the appropriate lightning protection requirements for a building [18].

$$R = A + B + C + D + E \quad (1)$$

Table 2. Index A: Hazards Based on Use and Content [18]

Use and Contents	Index A
Normal buildings that do not need to be secured either structurally or in contents.	– 10
Buildings and their contents are rarely used, such as rice fields, towers or iron poles.	0
Buildings with everyday equipment, for example houses, small industrial factories, train stations.	1
Very important buildings, for example water towers, government offices.	2
Buildings with lots of people such as cinemas, places of worship, schools, shopping centers and important monuments.	3
Gas, oil, petrol and hospital installations.	5
Buildings that are explosive and may present uncontrolled environmental hazards, e.g. nuclear power plant.	15

Table 3. Hazard Index Based on Building Construction [18]

Building construction	Index B
The entire building is made of metal and easily conducts electricity.	0
Concrete or reinforced steel frame buildings with metal roofs.	1
A building of reinforced concrete structure with a metal frame and a non-metal roof.	2
Wooden building with non-metal roof.	3

Table 4. Index C: Hazard Based on Building Height [18]

Building height up to ... (m)	Index C
6	0
12	2
17	3
25	4

Building height up to ... (m)	Index C
35	5
50	6
70	7
100	8
140	9
200	10

Table 5. Index D: Hazard Based on Building Situation [18]

Building Situation	Index D
On a flat surface at any height.	0
In the foothills up to % of the hill height or up to 1000 meters in the mountains.	1
At the top of a mountain or on a mountain that is more than 1000 meters high.	2

Table 6. Hazard Index Based on the Effect of Thunder Days [18]

Thunder Day/Year	Index E
2	0
3	1
6	2
8	3
16	4
32	5
64	6
128	7
256	8

By paying attention to the conditions at the location where the risk will be assessed, the next step is to add up the relevant indices to get an estimate of the level of danger faced by the building. Below, a table of Lightning Strike Hazard Estimates Based on PUIPP is presented as a reference for assessing this risk. By using this table, you can get an idea of the level of danger and protection that must be applied to the building.

Table 7. Lightning Strike Hazard Estimate Index Based on PUIPP [18]

R		Hazard Estimates	Safety
Under	11	Ignore	Not needed
Together with	11	Small	Not needed
	12	Intermediate	Recommended
	13	It's a bit big	Recommended
	14	Large	Highly recommended
More	14	Very large	Must be installed

2.1.2. Standard IEC 1024-1-1 (Standard Internasional Electronical Comission 1024-1-1)

The The IEC 1024-1-1 standard (International Standard Electronical Commission 1024-1-1) is based on the protection level of lightning protection systems based on the local direct lightning frequency (Nd) and the permitted annual local lightning frequency (Nc). The annual average level of lightning strikes to the ground or lightning strikes at the position where the structure is located is expressed [19] in equation 2 as follows:

$$\text{Ng} = \frac{0{,}04\ \text{Td}^{1.26}}{\text{tahun}}$$

$$\text{Nd} = \frac{\text{Ng.Ae.}10^{-6}}{\text{tahun}} \qquad (2)$$

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

The coverage area is the earth's surface, which is considered to be the structures directly affected by lightning every year. The protected area is the area around the building up to 2h, where h is the height of the building. Installing a lightning protection system in a building requires or does not require a decision using the following Nc and Nd calculations [20]:

$$E \geq 1 - \frac{Nd}{Nc} \quad (3)$$

Table 8. Lightning Protection System Efficiency, Peak Current Parameters and Air Termination Placement Based on IEC 62305-1 Standard Protection Level [19]

Protection Level	SPP Efficiency (E)	Probability of Peak Current	Peak Current (kA)	h(m)	20	30	45	60	Mesh Width (m)
				R(m)	α^0	α^0	α^0	α^0	
I	0,98	0,99	3	20	20	25	-	-	5
II	0,95	0,97	5	30	30	35	25	-	10
III	0,9	0,91	10	45	45	45	35	25	15
IV	0,8	0,84	16	60	60	55	45	35	20

2.1.3. Standard NFPA 780 (Standard National Fire Protection Association 780)

The NFPA 780 standard (National Fire Protection Association Standard 780) adopts a similar approach to PUIPP in assessing lightning risk. This approach involves the summation of several indices that reflect the condition of the building location, and the summation result is then divided by an index that reflects the level of lightning activity in the area, which is referred to as the isokeraunic level. Thus, the NFPA 780 standard provides a structured method for evaluating lightning risk and determining the appropriate level of protection for buildings based on site conditions and local levels of lightning activity [21], mathematically it can be written in equation 4 below [19]:

$$R = \frac{A+B+C+D+E}{F} \quad (4)$$

Table 9. Index A Type of Structure [19]

Type of structure	Index A
Residential buildings less than 456 m^2.	1
Residential building over 456 m^2.	2
Residential, factory or office buildings with a height of no more than 15 m.	
1. The area is less than 2323 meters.	3
2. The area is more than 2323 meters.	5
Residential, office or factory buildings with a height of 15-23 m.	4
Residential, office or factory buildings with a height of 23-46 m.	5
Office or factory buildings with a height of more than 46 m.	8
State offices, fire departments, police stations, fire departments, water companies..	7
hangars	7
Power plants and telephone exchanges.	8
Air towers and cooling towers..	8
Libraries, museums and historical buildings..	8
Farm building	9
Recreation place	9
Buildings with lots of people such as schools, places of worship, cinemas, sports stadiums.	9
Thin and tall structures such as chimneys, towers and lighthouses.	10
Hospitals, nursing homes, and nursing homes.	10
Buildings where chemicals are produced and stored..	10

Table 10. Index B Type of Construction [19]

Structural Framework	Roof Type	Indeks B
Not metal	Wood.	5
	Asphalt, tar or tile mixture.	3
	Separate metal.	4
	Electrically connected metal.	1
Wood	Wood.	5
	Asphalt, tar or tile mixture.	3
	Separate metal.	4
	Electrically connected metal..	2
Reinforced concrete	Wood.	5
	Asphalt, tar or tile mixture.	3
	Separate metal.	4
	Electrically connected metal.	2
Steel frame	Wood.	4
	Asphalt, tar or tile mixture.	3
	Separate metal.	3
	Electrically connected metal.	1

Table 11. Index C Building Locations [19]

Building Location	Index C
Buildings in higher building areas.	
A small building with an area of less than 929 m2.	1
A small building with an area of just over 929 m2.	2
Buildings in lower buildings.	
A small building with an area of less than 929 m2.	4
A small building with an area of just over 929 m2.	5
The structure extends 15.2 m above the ground.	7
Extends over 15.2 m above the ground.	10

Table 12. Index D Topographic [19]

Location	Indeks D
Tanah rata.	1
On a hill position.	2
Up the hill.	4
Top of the mountain.	5

Table 13. Index E Use and Contents of Buildings [19]

Building Use and Contents	Index E
Non-flammable material.	1
Home furniture.	2
Ordinary complement.	2
Pet	3
There were only a few people in the building (<50 people).	4
Flammable materials.	5
The building holds less than 50 people.	6
Valuable equipment and assets.	7
Public services such as fire departments and police stations.	8
Explosive gas or liquid.	8

Building Use and Contents	Index E
Sensitive operating devices.	9
Historical objects.	10
Explosives and their materials.	10

Table 14. Index F Isokeraunic Level[19]

Isokeraunic Levels	Index F
0 – 5	9
6 – 10	8
11 – 20	7
21 – 30	6
31 – 40	5
41 – 50	4
51 – 60	3
61 – 70	2
Over 70	1

Hazard estimates using formulas and based on the determining indices, a hazard estimate will be obtained according to the lightning risk assessment based on NFPA 780 as the following table:

Table 15. Estimated Lightning Strike Hazard Based on NPFA 780 [19]

R	Safety
0 – 2	No need
2 – 3	Recommended
3 – 4	Recommended
4 – 7	Highly recommended
Over 7	Very important

2.2. Research Design and Procedures

The research process was carried out in the Malikussaleh University Rectorate Building. The lightning protection system design process begins with the Literature Study step. At this initial stage, various literature sources are studied to gain a comprehensive understanding of the concepts and needs of lightning protection systems. After that, the next step is Problem Identification, where specific problems and building protection needs are identified based on the results of the literature study. This process aims to establish clear and directed design goals.

Next, data collection is carried out which includes measuring and recording important data such as building dimensions (height, width and length of the building roof), ground resistance values, and frequency of lightning strikes to the ground (Ng). This data is then processed in the Data Processing stage to calculate protection needs, including protection level (LPL), lightning current (I), risk (Rs), and radiation (Nd). The results of this calculation are then verified with applicable standards, such as PUIL or IEC. If the results do not comply with the standards, then the data and calculations need to be adjusted until they meet the specified criteria.

After the data and calculations are declared according to standards, the next stage is Protection System Design. At this stage, the lightning protection system is designed in detail, including determining the type and location of protection devices such as lightning rods and grounding systems. After the design is complete, Analysis and Conclusions are carried out to ensure that the design is effective and meets protection needs. If all stages have been completed properly and the design is considered optimal, then the design process is declared complete and the lightning protection system is ready to be implemented.

This research was carried out using the rolling ball method, following PUIPP, NFPA, and IEC standards, and utilizing a Kurn R-85 type lightning rod. This differs from previous studies, which only discussed the rolling ball method with PUIPP and SNI standards and used Thomas[22] type lightning

rods. Meanwhile, in this study, by combining NFPA and IEC standards, and utilizing Kurn R85 type lightning rods, it can increase the effectiveness of protection.

3. Result and Discussion

3.1. Grounding Measurement Data

Grounding measurements were carried out at 3 different locations around the Rectorate Building. The three points are the front yard (Point A), the back yard (Point B) and the parking lot (Point C). The results of grounding measurements can be seen in Table 16 as follows:

Table 16. Grounding Measurement Results

No	Location Point	Ground Resistance
1.	Point A Backyard	22 ohm
2.	Point B Front Page	38 ohm
3.	Point C Parking Lot	40 ohm



Figure 2. Measurement of the grounding of the backyard, front yard and parking area

3.2. Protection Needs

3.2.1. Based on General Regulations for Lightning Protection Installation (PUIPP)

Determining a building's need for lightning protection is based on the General Regulations on Lightning Protection Installations (PUIPP), namely all data results that have been obtained on building characteristics, and also the number of days of thunder or lightning strikes at the building location.:

Index A: The use and contents of a building that is occupied by many people, and is included in learning facilities (schools) with an index value of 3 (according to Table 2)

Index B: The building construction is built with reinforced concrete construction with a metal roof having an index value of 1 (according to Table 3)

Index C: The height of the new Rectorate building to be built is around 18.5 meters with an index value of 4 (according to Table 4)

Index D: The situation of buildings built on flat land at all heights has an index value of 0 (according to Table 5)

Index E: Lightning strike data was taken in the 2023 period at the Meteorology, Climatology and Geophysics Agency (BMKG) Malikussaleh, North Aceh at the Lightning Strike Data Location: Bukit Indah Campus, with coordination point 5.20550,97.06430 and the calculation radius for lightning strikes is 10 km from the coordination point. From the known lightning strike data above, the number of days of thunder at building locations with a radius of 10 km totaled 393 strikes, with an index value of 8 (according to Table 6)

So the estimated lightning strike hazard index (R) is obtained as follows with equation 5 below:

$$R = \text{index}\,(A + B + C + D + E)$$
$$R = 3 + 1 + 4 + 0 + 8 \quad (5)$$
$$R = 16$$

Where R = 16, so that the installation of a lightning protection system in the Rectorate building according to Table 7 Table 7is very necessary and highly recommended, to reduce the possibility of a

lightning strike accident later if the building is struck by lightning.

3.2.2. Based on NFPA

Based on the NFPA Standard in Indonesia, the amount required to install a protection system against lightning strikes in a building is determined by adding up the indices that represent the condition of the location where the structure is located..

Index A:	Buildings with lots of people such as schools, places of worship, cinemas, sports stadiums with an index value of 9 (according to Table 9)
Index B:	Reinforced concrete, roof tiles have an index value of 3 (according to Table 10)
Index C:	Buildings in higher building areas, A small building with an area of more than 929 m2 has an index value of 2 (according to Table 11)
Index D:	Flat land has an index value of 1 (according to Table 12)
Index E:	Valuable equipment and assets, has an index of 7 (according to Table 13)
Index F:	More than 70, has an index of 1 (according to Table 14)

So the index that represents the isokeraunic level is obtained as follows with the following equation 6:

$$\begin{aligned} R &= \frac{A+B+C+D+E}{F} \\ R &= \frac{9+3+2+1+7}{1} \\ R &= 22 \end{aligned} \tag{6}$$

Where R/isokeraunic level=22, which is at index F=6 (based on Table 14 and Table 15), so installing a lightning protection system in the Rectorate building is very important to reduce the possibility of a lightning strike accident later if the building is struck by lightning.

3.2.3. Based on IEC 1024-1-1

The use of the IEC 1024-1-1 standard provides a calculation method using data on thunder days, building/area size data, protection area, local direct strike frequency (Nd), and annual strike frequency (Nc) permitted on structures, by first calculating ground strike density (Ng). The density of lightning strikes to the ground (Ng) is influenced by the average number of thunder days per year (Td) in the area. Because it is located in a lowland area, the average number of thunder days per year is 393 (obtained from BMKG data) and the level of lightning vulnerability is high..

So the density of lightning strikes to the ground (Ng) can be calculated using equation 7:

$$\begin{aligned} Ng &= 4 \times 10^{-2} \times Td^{1,26} \\ Ng &= 4 \times 10^{-2} \times 393^{1.26} \\ Ng &= 74.3 \text{ Strikes Per km}^2 \text{ per year} \end{aligned} \tag{7}$$

Then the Ae value can be calculated using the following equation 8 from the data obtained in Table 1:

$$\begin{aligned} Ae &= ab + 6h(a+b) + 9\pi \times h^2 \\ Ae &= 91 \times 47 + 6(18,5)(91+47) + 9 \times 3,14 \times 18,5^2 \\ Ae &= 4.277 + 111(138) + 28,26 \times 342,25 \\ Ae &= 4.277 + 15.318 + 9.671,985 \\ Ae &= 29.266,985 \text{ m}^2 \end{aligned} \tag{8}$$

Meanwhile, to calculate the average number of direct lightning strike frequencies per year (Nd) you can find the following equation 9:

$$\begin{aligned} Nd &= Ng \times Ae \times 10^{-6} \\ Nd &= 74,30 \times 29.266,985 \times 10^{-6} \\ Nd &= 2.174 \text{ Lightning strike} \end{aligned} \tag{9}$$

The local annual lightning strike frequency (Nc is known to be 10-1) is permitted. Determining the level of protection in a building based on Nd and Nc calculations is carried out as follows:

If Nd ≤ Nc there is no need for a lightning protection system.

If Nd > Nc a lightning protection system is required.

Because in the calculations Nd and Nc are obtained, the efficiency value is based on equation 10:

$$E \geq 1 - \frac{N_c}{N_d}$$
$$E \geq 1 - \frac{10^{-1}}{2.1745} \quad (10)$$
$$E \geq 0{,}95$$
$$E \geq 95\ \%$$

Thus the E value of 95% is at protection level II with an efficiency value between 90% - 95% according to Table 8.

3.3. System planning

3.3.1. Selection of Lightning Arrester

The area of the protection area or protection zone for the lightning distributor that will be installed is calculated using the rolling ball method. The peak current (I) can be found using the equation, where the R value is 30 m in accordance with level I protection requirements:

$$R(m) = I^{0.75}$$
$$I = \sqrt[0.75]{30}$$
$$I = \sqrt[0.75]{30}$$
$$I = 93.22\ \text{kA}$$

So, the peak current is 93.22 kA.

$$ds = 10 \times I^{0.65}$$
$$ds = 10 \times 93.22^{0.65}$$
$$ds = 190.6\ \text{m}$$

So, the lightning strike distance (ds) is 190.6m.

$$Rs = \sqrt{h(2ds - h)}$$
$$Rs = \sqrt{18.5(2(190.6) - 18.5)}$$
$$Rs = \sqrt{18.5(381.2 - 18.5)}$$
$$Rs = \sqrt{6.709{,}95}$$
$$Rs = 81.91\ \text{m}$$

So, the length of the protection radius is 81.91m.

The radius of protection by a lightning rod can be calculated using equation 11 as follows:

$$A = \pi . Rs^2$$
$$A = 3.14 \times (81.91)^2 \quad (11)$$
$$A = 21.067\ m^2$$

So, the area of the protection radius is 21,067m^2

Based on the calculation results, the protection radius (R) = 81.91 m and the area of the protection radius (A) = 21,067 m^2. In selecting the type of lightning rod, the author recommends installing an air termination system or an electrostatic lightning rod with the brand "Kurn R-85" which has a protection radius of 85 m, which means the coverage area is + 22,600 m^2.

3.3.2. Distribution Conductor

Before the lightning rod is installed, it is a good idea to pay attention to the distribution conductor which must comply with standards, so that the distribution conductor will be able to accommodate the current flowing to the ground. To calculate the cross-sectional area of the distribution conductor, use the following equation:

$$A = I \sqrt{\frac{8.5 \times 10^{-6} S}{\log 10\left(\frac{T}{274} + 1\right)}} = 12{,}604\ mm^2$$

Where: I = 93.22 kA
T = 1000 ^{0}C
S = 0,01 sec

The safe cross-sectional area value of the conductor is 12.604 mm2. In this case the author

recommends installing a conductor cable with a cross-sectional area of this value, namely a BC cable/special grounding cable of 50 mm^2 so that it can be ensured that the installed conductor is able to withstand the current flowing to the ground.

3.3.3. Ground Resistance

Ground resistance is very important in designing lightning protection systems. Based on Table 2, this research uses electrode rods with a length of 1 m, a cross-sectional area of 70 mm2 and a rod radius of 0.0047 m. The measurement of ground resistance from the three specified points still does not meet PUIL 2014 standards where ground resistance must be below 5 ohms. Therefore, the author's solution is to increase the length of the rod or electrode rod to 10 m for points A and B and 15 m for point C, then it can be calculated again using the equation as follows.

a. Grounding resistance at Point A

$$Rp = \frac{\rho}{2\pi L}[\ln\frac{4L}{\alpha} - 1]$$

$$Rp = \frac{22}{2 \times 3{,}14 \times 10}[\ln\frac{4(10)}{0{,}0047} - 1]$$

$$Rp = \frac{22}{62{,}8}[9{,}049 - 1]$$

$$Rp = 0{,}353(8{,}049)$$

$$Rp = 2{,}481\Omega$$

b. Grounding resistance at Point B

$$Rp = \frac{\rho}{2\pi L}[\ln\frac{4L}{\alpha} - 1]$$

$$Rp = \frac{38}{2 \times 3{,}14 \times 1}[\ln\frac{4(10)}{0{,}0047} - 1]$$

$$Rp = \frac{38}{62{,}8}[9{,}049 - 1]$$

$$Rp = 0{,}6051(8{,}049)$$

$$Rp = 4{,}87\ \Omega$$

c. Grounding resistance at Point C

$$Rp = \frac{\rho}{2\pi L}[\ln\frac{4L}{\alpha} - 1]$$

$$Rp = \frac{40}{2 \times 3{,}14 \times 15}[\ln\frac{4(15)}{0{,}0047} - 1]$$

$$Rp = \frac{40}{94{,}2}[9{,}4545 - 1]$$

$$Rp = 0{,}4246(8{,}4545)$$

$$Rp = 3{,}589\ \Omega$$

Berdasarkan perbaikan nilai tahanan pentanahan untuk ketiGa titik tersebut sudah sesuai dengan standart PUIL 2014 dimana nilai tahanan pentanahan sudah dibawah 5 ohm.

3.3.4. Application of Lightning Protection

The design of the lightning rod for the Malikussaleh University rectorate building uses an electrostatic lightning rod with the Kurn R-85 brand. Where electrostatic lightning rods are chosen because they are easier to apply and can meet the need for protection against lightning strikes. The protection radius of the electrostatic lightning rod can be seen in Figure 3 as follows:



Figure 3. Kurn R-85 Lightning Protection and its Protection Radius

To apply an electrostatic lightning rod, only one electrostatic lightning rod is installed on top of the building at a height of 25 m above the ground. Then it is connected to grounding using a 50 mm2 BC cable as shown in Figure 4 below:

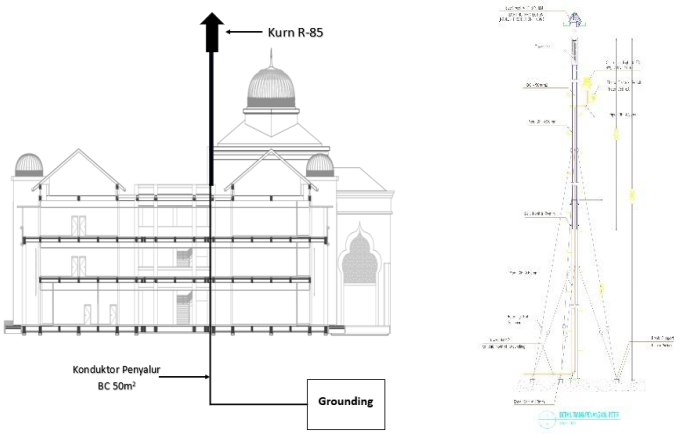


Figure 4. Lightning Arrester Installation Sketch and Specifications

Based on the lightning protection design that has been made, according to PUIPP, NFPA and IEC standards, the Malikussaleh University rectorate building is sufficient to protect the entire building. For grounding calculations, there are several locations, namely the back yard (A), front yard (B) and parking yard (C), where these three points meet PUIL 2014 standards, where the soil resistance value is below 5 ohms.

4. Conclusion

Based on this research, the conclusion obtained is that the Malikussaleh University Rectorate Building has met standards based on the level of need according to PUIPP standards with a value of R=16, NFPA with a value of R=22, and IEC 1024-1-1 value of E= 95% with level II protection. There are several stages, namely determining the need for lightning protection according to PUIPP, NFPA and IEC standards. Next, determine a suitable lightning rod based on your needs and determine good grounding according to the PUIL 2014 standard. The grounding calculation at the rear yard, front yard and parking area meets PUIL 2014 standards, namely with a resistance value of less than 5 ohms. The design of the lightning rod follows the PUIPP Standard by using a type, namely an air termination system with the brand "Kurn R-85" which has a protection radius of 85 m2. To apply an electrostatic lightning rod, simply install one lightning rod on top of the building at a height of 25 m from the ground, then connect it to ground using a 50 mm2 BC cable. Based on the results of research at the Malikussaleh University Rectorate Building, the lightning rod chosen can protect the entire existing building.

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