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Planning Management To Improve The Value Of The Lightning Protection Grounding System At The Ccr Building At Sultan Syarif Kasim II International Airport Pekanbaru

Muhammad Caesar Akbar[1], Tri Dina Agustina Panjaitan[2]
[1,2]Politeknik Penerbangan Medan

ABSTRACT

Sultan Syarif Kasim II International Airport Pekanbaru is equipped with an Airfield Lighting System (ALS) just like airports in general. ALS is a visual landing aid that functions to assist and serve aircraft during takeoff, landing and taxiing so that they can move efficiently and safely. The ALS is supplied by CCR (Constant Current Regulator). CCR is a constant current power supply used to supply ALS equipment. The CCR building at Sultan Syarif Kasim II International Airport Pekanbaru is also equipped with a lightning rod with an electrostatic type which is intended to be able to flow lightning currents directly to the ground and not hit the building and not damage the electronic equipment in the CCR building. But in November there was a damage to the CCR module of the PAPI lamp so that the CCR could not operate. This is due to a strong lightning strike that results in a "Local Bus Down Error" on the CCR of the PAPI lamp. The factor that affected the occurrence of the event was the poor quality of the lightning rod grounding system in the building where the value of the lightning rod grounding system was 5.7Ω, the value had exceeded the 2011 PUIL rules where the value of a good grounding system was <5Ω, so improvements were needed to the value of the lightning rod grounding system in the building in accordance with the 2011 PUIL rules.

Keyword : Constant Current Regulator; PAPI; Lightning Rod; Grounding System

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Corresponding Author:
Muhammad Caesar Akbar,
Politeknik Penerbangan Medan
Jl. Penerbangan No.85, Medan, Indonesia.
Email : mhdcaesar@poltekbangmedan.ac.id

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1. INTRODUCTION

Sultan Syarif Kasim II International Airport (SSK) Pekanbaru is an airport with historical relics from the independence era against the Dutch and Japanese colonizers. This airport is located in the province of Riau, Marpoyan Damai District, Pekanbaru City. At Sultan Syarif Kasim II Airport, Pekanbaru is equipped with a CCR (Constant Current Regulator) which is used as a constant current power supply to supply Airfield Lighting System equipment. The CCR is located in a building equipped with lightning rods used to protect the building and electronic equipment from lightning strikes. Lightning rods consist of air termination, lightning conductors, and grounding systems.

1. Air Termination

Air termination is a part of the lightning protection system that is specifically designed to catch lightning strikes. Lightning rods are placed in such a way that they are able to catch all lightning strikes without hitting any part of a building, building or protected area. Lightning rods are usually made tapered at the ends because electrical charges are easily collected. The type of material that is usually used is metal electrodes installed vertically or horizontally which are installed at the highest point in the protected area. This is so that the lightning rod can catch or absorb all lightning strikes without hitting anything in the protection zone of the air terminal.

2. Lightning Conductor (Down Conductor)

The lightning conductor functions to channel the lightning current that hits the air termination (water termination) which will then be forwarded to the grounding or grounding. The selection of the number and position of the conductors should take into account the fact that, if the lightning current is divided in several conductors, the risk of sideways jumps and electromagnetic interference in the building is reduced.

3. Grounding

Grounding of a system is the establishment of an electrically connected connection to the ground of the system, so that lightning can flow to the ground electrically from the system, so that lightning can flow to the ground without causing dangerous overvoltage. The shape and size of the grounding system is important. However, the grounding resistance is sought to be less than 5Ω (Ria, 2009), because direct or indirect strikes from lightning can not only damage equipment and kill living things, but can also damage electronic components in important installations.

The lightning rod in the CCR building of Sultan Syarif Kasim II Airport Pekanbaru has a grounding system value of 5.7Ω which has exceeded the maximum limit of the prisoner value according to the 2011 PUIL rules. This caused the CCR to be struck by lightning and unable to operate. So with this problem, the researcher planned to improve the value of the lightning rod grounding system as a protection for the CCR building and the electronic equipment in it.

The grounding system is a conductive relationship system that connects systems, equipment bodies and installations with the earth or soil so that they can secure humans from electric shocks and secure devices that use electricity as a power source from power surges, lightning strikes, and others.

A lightning rod grounding system (Grounding System) is a series of installations and embedded in the ground that functions to release lightning current into the earth or discharge excess current in electrical installations and can also discharge induction in electric current.

The level of reliability of a grounding is in the conductivity value of the metal to the soil that is directly related to the soil or the metal is embedded. The more conductive the soil is to metal objects, the better. The grounding feasibility of the lightning rod must be able to obtain a maximum dispersion resistance or resistance value of 5Ω). (PUIL 2011).

Lightning rod grounding systems can be made in 3 forms, including:

a.Single Grounding Rod

Single grounding system is a lightning rod that only consists of one point of anchoring the discharge rod or ground rod in the ground with a certain depth (for example 6 meters). For areas that have conductive soil characteristics, it is usually easy to obtain a soil dispersion resistance below 5Ω with one lightning rod ground rod.

b.Paralel Grounding Rod

If the lightning rod single grounding rod system still gets poor results (resistance value > 5Ω), then it is necessary to add a ground rod to the ground and connect it with a BC/BCC cable. The addition of a lightning rod ground rod can also be planted horizontally with a certain depth, can surround the building to form a ring or chicken claw. These two techniques can be applied simultaneously with a reference spread/resistance resistance of less than 5Ω after measurement with the Earth Ground Tester

c.Multi Grounding System

Namely using copper plates planted in the ground, if it is found that the soil conditions have the following characteristics:

- Dry or deep groundwater
- Little metal content
- Alkaline (calcareous)
- Sand and porous

So the technique used is to replace the soil with soil that has the property of storing water or soil that contains salt minerals that can transmit electricity properly. For example: clay, humus soil, then the ground rod is plugged in the area of the metal point and in the range of connecting cables between the ground rods.

According to SNI 0225:2011 PUIL 2011, the value of soil type resistance is as follows:

Table 1. Soil Type Resistance Value

Soil Type	**Soil Type Resistance Ω-m**
Tanah Rawa	30
Clay and Farmland	100
Wet Sand	200
Wet Gravel	500
Dry Sand and Gravel	1000
Tanah Bebatu	3000

To achieve the prisoner value, not all areas can be fulfilled because there are several aspects that affect it, namely:

a. Moisture content, if the groundwater is shallow/rainy, then the distribution resistance value is easy to obtain because the soil contains enough water or even excess, so that the soil conductivity will be better.

b. Minerals/salts, the mineral content of the soil greatly affects the dispersion resistance/resistance because: the more metallic and mineral it is, the easier it is for the soil to conduct electricity. The coastal area mostly meets the characteristic of high mineral and salt content, so the soil around the coast will be much easier to obtain low soil resistance.

c. The degree of acidity, the more acidic (low PH or PH 7) the soil, the more difficult it is for electric current to conduct. Characteristics of soils with high PH: usually light-colored, e.g. Limestone Hill.

d. The texture of the soil, for areas with a sandy and porous texture (porous) will be difficult to get good dispersion resistance because this type of soil, water and minerals will easily drift away and the soil will dry out easily

2. RESEARCH METHOD

After observation, it was seen that the form of the lightning rod grounding system in the CCR building at Sultan Syarif Kasim II Pekanbaru Airport used a single grounding system and consisted of 1 box control, and after measurements were made on the grounding system, it was found that the resistance value was 5.7Ω, the value had exceeded the maximum limit of the grounding system value, so to be able to reduce the value of the detention was planned by adding a grounding system and then parallel with the existing grounding system. The data collection technique was carried out using literature study, observation, measurement, and interview methods. The literature study method is carried out by studying and exploring the theoretical aspects regarding the installation of lightning rod grounding systems taken from books and from research that has been carried out by other parties with the aim of serving as a theoretical basis in this writing, and also knowing the standards used according to PUIL 2011. The observation method is carried out by direct observation of an object to be evaluated. With the observation method, the author can produce an image of the object to be evaluated and a planning image to be carried out on the object. Furthermore, the measurement method is carried out to obtain value data from the lightning rod grounding system. Then the interview method is carried out to collect data by asking about the object to be evaluated to the party concerned, in addition to asking other parties who understand the object being evaluated and the problems related to the object.

The initial stage is to make observations on the grounding system to be evaluated which includes the current conditions that occur in the grounding system and find out the type of materials currently used. Furthermore, measurements are made on the grounding system to find out the value of the grounding system and the data will be used in the calculation of planning to improve the value of the grounding system. Literature studies are carried out to obtain references related to the formulations and standards used to find out and determine the conductor materials to be used.

Next, data analysis was carried out. Calculation analysis was carried out using the data obtained based on the measurements made to determine the value of the grounding system according to the standards based on PUIL 2011, which is a maximum of 5Ω. Because this planning aims to reduce the value of the grounding system, the calculation formula used is:

$$\frac{1}{Rtotal} = \frac{1}{R1} + \frac{1}{R2} \dots + \frac{1}{RN}$$

With:

Rtot = Prisoner [Ω]

3. RESULTS AND DISCUSSION

After observation, it was found that the lightning rod grounding system in the CCR (Constant Current Regulator) building of Sultan Syarif Kasim II Airport Pekanbaru currently uses a single grounding system and consists of 1 control box which has a resistance value of 5.7Ω. The value has exceeded the maximum limit of the grounding value, so to be able to reduce the value of the prisoner, planning is carried out by adding new grounding and then parallel it with the existing one. Parallel grounding is actually almost similar to single grounding, but with the addition of electrodes or commonly called ground rods to release current into the ground. The distance between the electrodes if using a rod electrode is twice the length of the electrode used. A parallel grounding system is used if the single grounding system still gets poor results (resistance value >5 Ω).

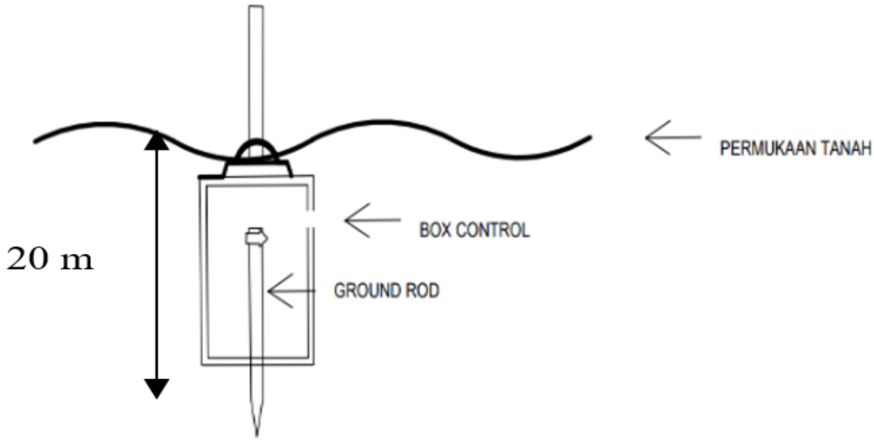

Figure 1. Current Condition of Lightning Grounding System

Figure 2. Lightning Arresting Grounding System Measurement

Because the grounding value of the lightning rod in the CCR building is very large, a ground rod is added to the ground and connected in parallel with the existing one. The following are the stages of parallel grounding planning to improve the grounding value of lightning rods in CCR buildings:

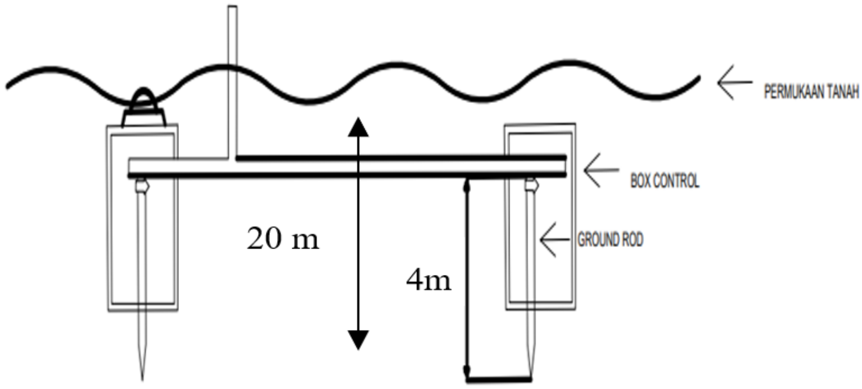

Figure 3. Planning the Desired Grounding System

1) Location Selection
In the initial stage of the work, the point where the ground rod will be planted is determined. In planting ground rods, it is tried at a point that is easy to plant / not collide with stones or gravel. If at the time of planting the ground rod is still hitting hard gravel or stones, then it can be moved to the side point. The distance between the electrodes is at least twice the length of the electrode used. In this planning, the distance between the boxes is 8 m.

2) Material Selection
The best ground rod is a solid pipe made of copper. Besides being a strong conductor, copper does not rust easily. The ground rod used in this planning uses a copper rod with a diameter of 5/8 Inch = 15.89 mm along 4 m. These electrodes are often used as materials that conduct the distribution of lightning currents to the ground.

3) Ground Rod Planting
•Perform drilling at the location where the ground rod will be implanted
•To facilitate the drilling process, it can be helped by using water watering at that point so that the soil becomes soft. Drilling is carried out as deep as 20 m in an effort to get a prisoner value that meets the conditions, and then planting a ground rod into it.
•Before planting the ground rod, dig the soil from the point where the existing grounding is to the new grounding point. Next, connect a 50 mm2 BC cable with a length of ± 24 m from one point to another and then connect the cable using a clamp, then the grounding between one and the other has been connected. Next, lay the cable on the excavation path that has been made.

4) Measurement of Grounding Resistance
Measure soil resistance using the Earth Tester. If the soil resistance is still above 5Ω, then make or add more grounding next to it and parallel it with the existing grounding so that the resistance or soil resistance decreases according to the standard is less than 5Ω. If the measurement results show less than 5Ω, then fill the soil on the grounding cable connection path.

5) Calculation of Grounding Resistance
The following is the calculation of the value of grounding resistance according to the dwight formula:
R= ρ/2ΠL (ln4L/a-1)
With:

$$R = \frac{\rho}{2\Pi L}\ (\ln\frac{4L}{a} - 1)$$

With:

ρ = Soil type resistance (Ω-m)

L = Depth of electrode (m)

a = Electrode cross-sectional fingers or ground pegs (m)

R= Resistance of the electrode or peg to the ground (ohms)

In this planning, an electrode length of 4 m with a diameter of 15.89 m is used. Furthermore, in accordance with SNI 0225:2011 PUIL 2011, the soil type resistance is 30Ω. By entering all of these quantities in the formula above, R resistance will be produced, the following is the calculation for one grounding rod in one well if it has not been connected in parallel with the existing lightning rod grounding, namely:

$$R = \frac{\rho}{2\Pi L} (\ln\frac{4L}{a} - 1)$$

$$R = \frac{30}{2.3,14.20} (\ln\frac{4.20}{7,9 \ x \ 10^{-3}} - 1)$$

$$= (\ln \frac{4.20}{7,9 \ x \ 10^{-3}})$$

$$= (\ln \frac{80x \ 1000}{7,9})$$

$$= \ln\frac{80000}{7,9}$$

= ln = ln 10,126.5 = 9,22

$$R = \frac{30}{2.3,14.20} (9,22\text{- }1)$$

$$R = \frac{30}{125,6} (8,22)$$

$$R = \frac{246,6}{125,6} = 1,96\Omega$$

Table 2. Results of Calculation of the Value of Grounding Prisoners

No.	Value	
	Depth (m)	Calculation Result (Ω)
1.	20	1,96
2.	25	1,61
3.	30	1,37
4.	35	1,19
5.	40	1,06

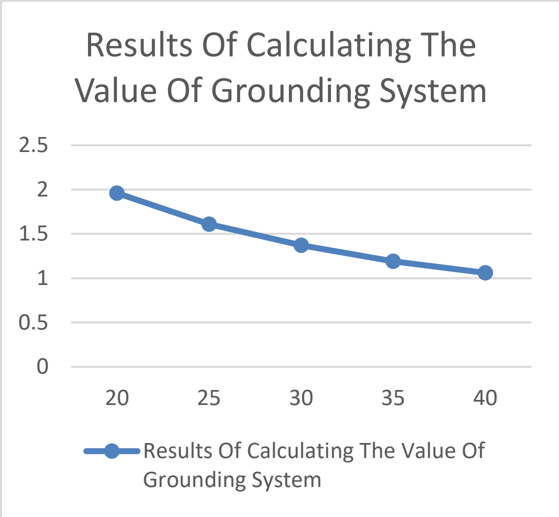

Figure 4. Graph of Grounding System Value Calculation Results

Based on the table and graph above, it appears that there is a decrease in the value of grounding resistance with each decrease in depth. In this planning, an example is the use of swamp soil media as a ground rod planting place. By using this swamp soil medium, the calculation results are obtained as in table 3, that at the planting depth of 20 m ground rod gets a grounding resistance value of 1.96Ω. The deeper it will have, the lower the grounding resistance value. Up to a depth of 40 m, the grounding resistance will have a value of 1.06Ω. For other types of soil, the value of ρ can be used which is adjusted to the type of soil used to insert the electrode.
With an additional resistance value of 1.9Ω, after being connected to the existing grounding system, the total resistance value will be obtained, namely:

$$\frac{1}{Rtotal} = \frac{1}{R1} + \frac{1}{R2}$$

$$\frac{1}{Rtotal} = \frac{1}{5{,}7} + \frac{1}{1{,}96}$$

$$\frac{1}{Rtotal} = \frac{1{,}96+5{,}7}{11{,}172}$$

$$\frac{1}{Rtotal} = \frac{7{,}66}{11{,}172}$$

$$Rtotal = \frac{11{,}172}{7{,}66} = 1{,}4\Omega$$

Based on the calculation above, a total resistance value of 1.4Ω was obtained and this value met the requirements for the grounding value for lightning rods in the CCR building containing electronic equipment according to PUIL 2011. So the lightning rod grounding in the CCR building already has a very good value and can function optimally.

4. CONCLUSION

From the discussion that has been carried out, it can be concluded that the current grounding value or grounding of lightning rods is 5.7Ω, the value exceeds the maximum grounding value limit according to PUIL 2011, which is 5Ω. The reduction of the resistance of the grounding system or grounding of the lightning rod is carried out by adding a new lightning rod grounding system that is then parallel to the existing one.

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