

ANALYSIS OF IMPROVEMENT OF GROUNDING RESISTANCE VALUES TO PREVENT INTERFERENCE IN THE OLD CILEGON 150KV TRANSMISSION LINE MITSUI AT PT PLN (PERSERO) ULTG SURALAYA

By

Kajat Sartono¹, Martin Djamin², Suryadi³

^{1,2,3} Program Studi Teknik Elektro, Institut Teknologi Budi Utomo, Indonesia

Email: kajat@itbu.ac.id¹, martindjamin@itbu.ac.id², suryadi@itbu.ac.id³

ABSTRACT

The electric power transmission distribution system is a system that functions to channel electric power from the generator to the main substation, or substation with other substations that are close to the load center. One of these transmission distribution systems is overhead lines or overhead line systems. Transmission lines are vulnerable to disruption due to lightning strikes. Lightning strikes on transmission lines can be identified by the presence of flash marks on plating isolator and stringset. The tower itself has a protection system against lightning strikes, namely direct grounding or a direct grounding system and a grounding at the foot of the tower. To avoid interference with transmission lines, it is necessary to ensure that the resistance value of the grounding must be within the SPLN standard limit. The aim of this research is to determine the value of grounding resistance in transmission towers as well as how to improve the value of grounding resistance if it exceeds standard limits. The data collection method is through measuring the ground resistance value periodically using an earth tester, which can then be evaluated based on the applicable standard limits. The results of this evaluation can be used as a basis for carrying out improvements to the grounding. It is hoped that this grounding repair will minimize the possibility of disruption due to lightning strikes on transmission lines so that the electric power distribution system can run smoothly and reliably serve load centers and customers.

Key words : Transmission Lines, Lightning Strikes, Grounding, Grounding Resistance Values, Grounding Repairs.

ANALISIS PENINGKATAN NILAI RESISTANSI TANAH UNTUK MENCEGAH GANGGUAN PADA GARIS TRANSMISI 150KV CILEGON LAMA MITSUI DI PT PLN (PERSERO) ULTG SURALAYA

ABSTRAK

Sistem transmisi dan distribusi tenaga listrik adalah sistem yang berfungsi untuk mengalirkan listrik dari pembangkit ke gardu induk, atau gardu induk dengan gardu induk lain yang dekat dengan pusat beban. Salah satu sistem transmisi dan distribusi ini adalah jaringan kabel udara atau sistem kabel udara. Jaringan transmisi rentan terhadap gangguan akibat sambaran petir. Gangguan akibat sambaran petir pada jaringan transmisi dapat dideteksi melalui adanya bekas sambaran pada pelat dan isolator kabel. Menara itu sendiri memiliki sistem perlindungan terhadap sambaran petir, yaitu grounding langsung atau sistem grounding langsung dan grounding di kaki menara. Untuk menghindari gangguan pada saluran transmisi, perlu

dipastikan bahwa nilai resistansi grounding harus berada dalam batas standar SPLN. Tujuan penelitian ini adalah untuk menentukan nilai resistansi grounding pada menara transmisi serta cara meningkatkan nilai resistansi jika melebihi batas standar. Metode pengumpulan data melalui pengukuran nilai resistansi grounding secara berkala menggunakan alat pengukur grounding, dapat dievaluasi berdasarkan batas standar yang berlaku. Hasil evaluasi ini dapat digunakan sebagai dasar untuk melakukan perbaikan grounding. Perbaikan grounding ini diharapkan dapat meminimalkan kemungkinan gangguan akibat sambaran petir pada saluran transmisi sehingga sistem distribusi tenaga listrik dapat beroperasi dengan lancar dan andal dalam melayani pusat beban dan pelanggan.

Kata kunci: saluran transmisi, gangguan akibat sambaran petir, grounding, nilai resistansi grounding, perbaikan grounding.

INTRODUCTION

The availability of sufficient and modern electricity and telecommunication equipment must be balanced with aspects of safety, comfort, and high quality and reliability. The electricity transmission distribution system as the main channel that sends electricity from the plant to customers must be considered and maintained. One of these distribution systems is overhead lines. This transmission line is very susceptible to interference due to lightning strikes. Lightning strikes are particularly dangerous for transmission systems because they can cause overvoltage and current leakage. The transmission line has a protection system against lightning strikes, one of which is a direct grounding system and grounding equipment located at the foot of the tower.

To prevent disturbances due to lightning strikes, it must be ensured that the grounding resistance value is in good condition and meets SPLN standards. Therefore, measurements are carried out regularly so that the condition of the grounding is maintained. If it is found that the resistance value of the equipment is above the SPLN standard, then it can be said that the condition of the equipment is not good. Factors that affect the resistance value of the grounding include the age of the grounding, corrosion of the joints, damage to the grounding joints, and changes in soil resistivity. With poor grounding resistance values, it is necessary to make improvements by adding and planting new electrode rods, then connecting them in parallel with the existing grounding equipment, thus forming a grid that can lower the poor grounding resistance value.

RESEARCH METHODS

1. The following research methods and instruments used in this study are:

Compare the value of the existing grounding resistance with the value of the grounding resistance after the repair by adding a new electrode rod and then connecting it in parallel with the existing grounding wire which increases due to the age factor. Then the collection of data from PT. PLN (Persero) ULTG Suralaya is carried out with direct measurements in the field so that it is easier for the author to obtain appropriate and valid data. This data collection is intended to be the basis for evaluation that will be carried out on the results of the measurements that have been carried out in the field.

2. Tools used

Ground Tester / Earth Tester is a tool used to measure the resistance value of a grounding system equipped with 3 connector holes, three measuring wires and 2 measurement electrodes as shown in Figure 1 below.



Figure 1. Earth tester parts

Figure 3.2 shows the parts of the earth tester as follows:

- | | |
|------------------|-------------------------|
| 1) LCD Display | 4) Measurement Selector |
| 2) LED Indicator | 5) Electrode Terminals |
| 3) Test Button | |

The tools and work materials used to improve the value of grounding detainees that are not in accordance with SPLN standards are:



Figure 2. Work Equipment

- | | |
|-------------------|------------------------------|
| 1. Batang Rod | 6. Hydraulic Press |
| 2. Grounding Wire | 7. Scissors/Grinder for Wire |
| 3. Skun 70 | 8. Wrench |
| 4. CCO 150/70 | 9. Wall Bolt 19 |
| 5. Elbow Iron | 10. Glove |

RESULTS AND DISCUSSION

1. Analysis of Improvement of Land Detention Value

a. Results of Calculation of Land Detention Value

1. For Tower 3

The measurement of the resistance value of the existing Tower 3 (R_1) is 3.61Ω . With wet gravel soil type conditions ($\rho = 500 \Omega\text{m}$), electrode length (L) 2 m, with an electrode rod radius of $1.539 \times 10^{-4} \text{m}^2$. First, calculating the resistance value by adding 1 electrode rod, $R_2 = 364.676 \Omega$ was obtained. It is then planned to add 2 more electrode rods, taking into consideration if:

- Electrode rod planting distance is less than depth/Length of electrode ($S < L$)
- Electrode rod planting distance greater than depth/Length of electrode ($S < L$)

For $S < L$, with $S = 1.5 \text{ m}$ and $L = 2 \text{ m}$, the value of $R_3 = 141.711 \Omega$ is obtained. If the existing electrode rod R_1 is connected in parallel with the addition of the electrode rod R_2 , & R_3 , the parallel resistance value is obtained $R_p = 3.486 \Omega$.

For $S > L$, with $S = 3$ m and $L = 2$ m, the value $R_3 = 132.534 \Omega$ is obtained. If the existing electrode rod R_1 is connected in parallel with the addition of the rod of electrodes R_2 , & R_3 , the parallel resistance value is obtained $R_p = 3.481 \Omega$.

Followed by the calculation of the addition of electrode rods if $S < L$ with varying planting depth (L).

2. For Tower 4

The measurement of the grounding resistance value of the existing Tower 4 (R_1) is 15.94Ω . With the condition of clay and field soil type ($\rho = 100 \Omega\text{m}$), the electrode length (L) is 2 m, with the radius of the electrode rod is $1.539 \times 10^{-4} \text{m}^2$. First, calculating the resistance value by adding 1 electrode rod, $R_2 = 72.926 \Omega$ was obtained. Then it is planned to add 2 more electrode rods, considering if:

- Electrode rod planting distance is less than depth/Length of electrode ($S < L$)
- Electrode rod planting distance greater than depth/Length of electrode ($S < L$)

For $S < L$, with $S = 1.5$ m and $L = 2$ m, the value of $R_3 = 28.342 \Omega$ is obtained. If the existing electrode rod R_1 is connected in parallel with the addition of the electrode rod R_2 , & R_3 , the parallel resistance value is obtained $R_p = 8.949 \Omega$.

For $S > L$, with $S = 3$ m and $L = 2$ m, the value $R_3 = 26.507 \Omega$ is obtained. If the existing electrode rod R_1 is connected in parallel with the addition of the electrode rod R_2 , & R_3 , the parallel resistance value is obtained $R_p = 8.759 \Omega$.

Followed by the calculation of the addition of electrode rods if $S < L$ with varying planting depth (L).

3. For Tower 5

The measurement of the existing Tower 5 grounding resistance value (R_1) is 11.58Ω . With wet sand type conditions ($\rho = 200 \Omega\text{m}$), electrode length (L) 2 m, with an electrode rod radius of $1.539 \times 10^{-4} \text{m}^2$. First, calculating the resistance value by adding 1 electrode rod, $R_2 = 116.396 \Omega$ was obtained. It is then planned to add 2 more electrode rods, taking into consideration if:

- Electrode rod planting distance is less than depth/Length of electrode ($S < L$)
- Electrode rod planting distance greater than depth/Length of electrode ($S < L$)

For $S < L$, with $S = 1.5$ m and $L = 2$ m, the value $R_3 = 56.684 \Omega$ is obtained. If the existing electrode rod R1 is connected in parallel with the addition of the electrode rod R2, & R3, the parallel resistance value is obtained $R_p = 9.02 \Omega$.

For $S > L$, with $S = 3$ m and $L = 2$ m, the value $R_3 = 53.013 \Omega$ is obtained. If the existing electrode rod R1 is connected in parallel with the addition of the electrode rod R2, & R3, the parallel resistance value is obtained $R_p = 8.787 \Omega$.

Followed by the calculation of the addition of electrode rods if $S < L$ with varying planting depth (L).

b. Comparing the Calculation Results with the Results of Measuring the Soil Resistance Value

From the various calculations of the addition of electrode rods in the previous sub-chapter, it can be seen that adding 1 or 2 electrode rods varies in the calculation formula, and also the distance to the depth of electrode rod planting is also a consideration in calculating the resistance value of the electrode rod. So the most feasible calculation of the addition of the electrode rod is if the electrode rod planting distance should be smaller than the electrode rod planting depth ($S < L$). Because if the electrode rods are connected in parallel and the farther the planting distance will be, the greater the resistance value of the tower legs because it is affected by the resistance of the length of the grounding wire connecting the 3 electrode rods.

1) Tower 3



Figure 3. Tower 3 Landfill Detention Measurement Results

2) Tower 4



Figure 4. Tower 4 Landfill Detention Measurement Results

3) Tower 5



Figure 5. Tower 5 Landfill Detention Measurement Results

From the results of the measurement and calculation of the resistance value in Tower 5, for example, it shows different results where the resistance value of the measurement results shows a value of 2.13 Ω , while the resistance value of the calculation shows a value of 3.41 Ω . From the data, the results of the measurement and calculation of the earth resistance value can be said to be different because the calculation of the earth resistance value is based on the assumption of ideal soil conditions, such as standard soil moisture and dryness. However, in practice, the soil conditions at the measurement location can vary, and each layer of soil

contour is different, for example, the soil surface layer corresponds to the type of soil we include in the calculation, but in the field it turns out that there is a difference in the soil contour in each layer if the deeper the planting of the grounding electrode rod is planted. This variation can lead to a difference in the measured resistance value.

Table 1. Results of Measurement & Calculation of Tower Grounding Resistance Value

No.	Tower	Hasil Pengukuran (Ω)		
		Sebelum Perbaikan	Hasil Perhitungan	Setelah Perbaikan
1	3	3,81	3,486	1,67
2	4	15,94	8,949	1,44
3	5	11,58	9,02	2,13

2. Measurement of Gap Arching Horn

The following is an example of the measurement of the Gap Arching Horn on T.4 PHT Cilegon Lama – Mitsui.

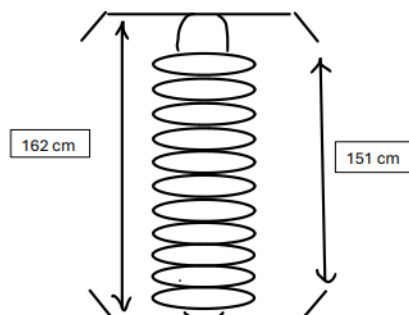


Figure 6 Gap Arching Horn Measurement

Results

The calculation of the Gap Arching Horn can be known by the following formula.

$$Gap (\%) = \frac{\text{Panjang Isolator}}{\text{Panjang Gap}} \times 100\%$$

$$Gap (\%) = \frac{151 \text{ cm}}{162 \text{ cm}} \times 100\%$$

$$Gap (\%) = 93,2 \%$$

So the Gap Arching Horn meets the criteria for optimal distance for lightning protection against the insulator.

3. Lightning Shelter Angle Measurement

The following is an example of the measurement of the Lightning Protection Angle at T.4 PHT Cilegon Lama – Mitsui.

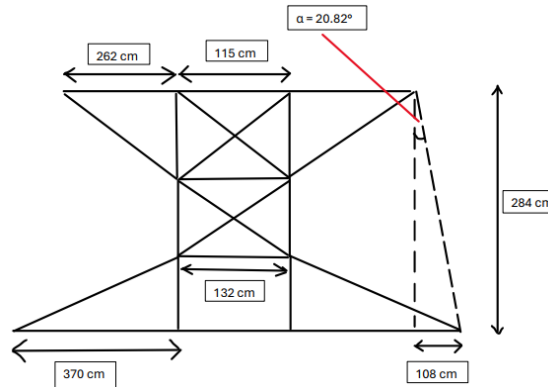
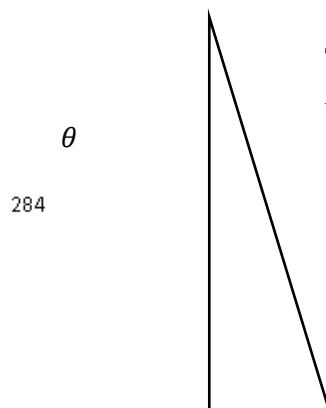


Figure 7. Lightning Shelter Angle Measurement Results



The calculation of the angle of protection against lightning can be determined by :

$$\theta = \tan^{-1} \left(\frac{108}{284} \right)$$

$$\theta = 20,82^\circ$$

So the protected angle at Tower 4 PHT Cilegon Lama – Mitsui, does not meet SPLN standards that are less than . This is one of the possible causes of disturbances due to lightning strikes.¹⁵

CONCLUSION

1. To prevent disturbances due to lightning strikes on the transmission line, there are several things that must be considered:
 - a. Soil Resistance Value
 - b. Accessories Completeness (One of which is the Arching Horn)
 - c. Lightning Shelter Angle on Tower

2. The improvement of the grounding resistance value is carried out by adding new electrode rods by connecting the new electrode rods with the existing grounding system in parallel. A good detention value is one that meets SPLN standards.
3. The calculation of the grounding resistance value is carried out in several ways, namely the addition of electrode rods if $S < L$ and $S > L$. Based on the experiment of adding various different electrode rod planting depths, the grounding resistance value that is close to the SPLN standard is with the formula for calculating the resistance value if $S > L$. However, due to the limitation of tower land, the experiment was carried out with $S < L$ with a varying depth (L) until it meets the SPLN standard.

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