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Analysis of a Grounding System In 20 Kv Distribution Transformer Line in PLTD Gayo Lues

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ABSTRACT

The main purpose of grounding is to create a low-impedance path to the earth's surface for electric waves and transient voltages. An effective grounding system will minimize these effects. The grounding system plays a very important role in the protection system. The grounding system is used as a fault current discharge path to the ground. According to its function, grounding is divided into 2, namely grounding the neutral point of the power system and grounding equipment. The neutral grounding of the power system serves as a safety system or network, while the grounding of the equipment functions as a safety against touch voltage. Measurement of the type of grounding electrode on a 20 kV distribution transformer at PT. PLN Rema Gayo Lues Area uses 2 rod electrodes with a grounding resistance value of 2 Ohms.

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1. INTRODUCTION

The use of electrical energy generally always shows increasing symptoms. This is undeniable, because electric power is a form of energy that is very profitable and very helpful for humans in carrying out their lives [1] [2]. To distribute the electricity needs from electricity producers to consumers, a network and distribution substations are needed. Based on the Standards of the State Electricity Company (SPLN), the system can be said to be effective if the voltage drop does not exceed + 5% and -10% of the nominal voltage, power losses and of the total power distributed. cause a difference in stress on the surface of the soil due to soil resistance [3] [4].

The earthing system is an important part that must be considered in ensuring the safety and reliability of the operation of the electric power system [5]. The ignition system has an influence on the safety and smooth running of the electric power system, especially in the event of disturbances related to grounding [6] . The earthing system aims to limit the voltage between the equipment and the ground to a safe condition for all operations, whether under normal conditions or when a fault occurs. An electrical equipment in order to avoid the danger of a lightning strike requires an earth resistance value of > 5 ohms, while for the ignition of electronic equipment it takes some ground resistance < 3 ohms and for grounding lightning rods or arresters < 1.75 ohms, even value devices require by 1 ohm [7] [8].

In the earthing system or can be called a grounding system, the type of soil greatly affects the good or bad of the system. This is because not all soils have good resistance values. The value of soil resistance is influenced by the structure and content in the soil. In addition, the area where the land is located also affects the value and structure of the soil content [9] [10]. To get a small ground resistance value is very difficult, because the resistance value is influenced by several factors, including the resistance of the electrode itself, the type of soil, the type of grounding electrode, temperature, humidity and electrolyte content [11].

The grounding system is part of the electric power system which has the function of grounding in the event of a voltage or overcurrent charge so as to minimize the disturbance caused. For an ideal grounding value, it must meet the requirements with an R value close to 0 or .1 Ohm [12]. The above fault voltages and currents do not flow into the ground due to equipment insulation failure and a large enough grounding resistance value. Because the grounding system is a device for limiting the voltage between tools that are not passed by electricity and between parts of these tools and the ground until a certain price is obtained [13]. So important is the grounding system to secure equipment at substations that have the function of carrying very high voltage and current loads continuously. The equipment must also be capable of withstanding fault currents, lightning impulse voltages, open-circuit impulse voltages, and lightning-cut impulse voltages within a matter of a few seconds [14] [15] [16] [17].

In a power system, the larger the line length and the magnitude of the voltage, the larger the fault current will be. Thus, if there is a ground fault, it will be even greater and the electric arc cannot be extinguished by itself, plus the symptoms of a ground arc are more prominent. The symptom of the earth arc is a process of repeated clearing and restricting of the electric arc. This is very dangerous because it can cause higher transient voltages and can damage equipment and will also endanger workers or the surrounding community because there will be touch voltage. Therefore, in a large power system (in system Y) the neutral point of the system is grounded through resistance.

Research conducted by Imam Wahyudi and friends, and research conducted by Julian Suleman the grounding system is analyzed at the July substation by analyzing how the grounding system is at the Juli substation and calculating the fault current when the system isolation failure occurs at the Maros substation and what is the value touch voltage, step voltage, and transfer voltage. In previous studies, no one has done a grounding system on the transformer line in the 20 KV distribution at PLTD Gayo Lues. then I will do research related to the grounding system by calculating the resistance to grounding by testing the type of electrode and the depth of the electrode rod. then it can determine the effect of the electrode rod on the resulting resistance value. By knowing this value, a policy can be taken that can be used as a guideline for the SPLN rules in the Gayo Lues PLTD.

The purpose of this study is to understand and determine the value of the grounding resistance in order to get a good value, so that if there is more voltage it can protect the equipment properly.

2. RESEARCH METHOD

A. Place and Time to Do Research

In compiling this final project, research data obtained at PLTD Rema Gayo Lues for 30 days starting from April 1, 2019 to April 30, 2019. Application of research locations and data collection processes carried out inventory data on the distribution of existing substations PLTD Rema Gayo Lues region . The data is intended to determine the plan to contain the transdormator distribution which will be the object of research on optimizing the distribution of transformer soil.

B. Method of collecting data

The types of data needed in this data collection are:

1. Collecting grounding measurement data in the grounding system of the Distribution Substation of the Rema Gayo Lues PLTD customer service unit.
2. Measuring the earthing of the 20kV distribution transformer at the Rema Gayo Lues PLTD customer service unit.
3. Type of soil around the PLTD Rema Gayo Lues customer service unit.

4. The type of grounding electrode used for grounding.
5. Earthing measurement results.
6. Field study is a method for collecting data and collecting data directly from the object, where data collection is done by going into the field.
   a. Observation is a method by observing directly to get accurate data regarding the title of this final project.
   b. Asking directly to the supervisor in order to collect data so that the data obtained is as desired.

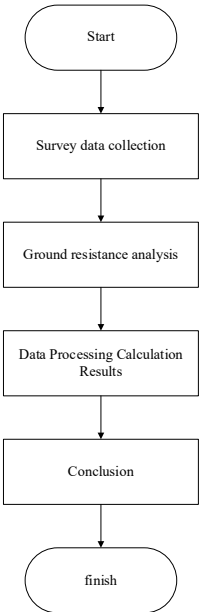

Figure 1. Research flow chart

C. Earthing Ground Measurement

The measurement of grounding resistance aims to determine the resistance between iron or copper plates planted in the ground which is used to protect electrical equipment against lightning and short circuit disturbances. Thus the plate must be planted so that it gets the smallest resistance to the surrounding soil [18]. To measure the grounding resistance, an Earth Resistance Tester is used [10].

D. Measuring Circuit

In the series of soil resistivity measurements, it can be determined using two rod electrodes connected to the Earth Resistance Tester, as shown in Figure 2 below:

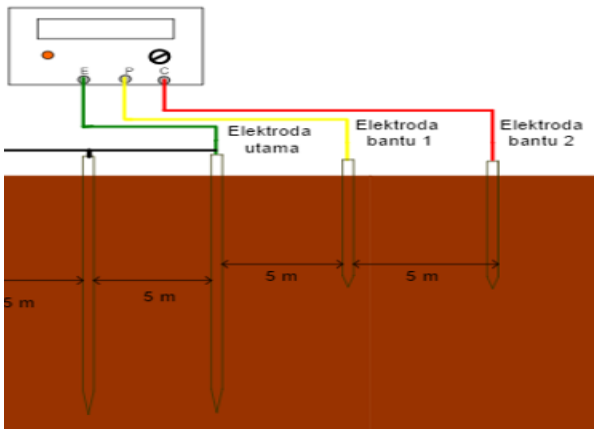

Figure 2. Circuit for measuring ground resistance using an earth resistance tool

E. Equipment used

The equipment used in carrying out these measurements to obtain the desired results include:

1. Ground grinding (earth resistance tester)

earth tester for measuring ground resistance. This earth tester has 3 inputs, the first is a black or green cable that is connected to the main electrode, the second is a yellow cable that is connected to the auxiliary electrode 1 and the third is a red wire that is connected to the auxiliary electrode 2, this earth tester is also equipped with several ranges [19]. prisoners, can be seen in Figure 3 below.

Figure 3. Earth Tester

2. Electrode

Figure 4. Rod Electrodes

3. Solid Copper Cable

Solid copper cable serves to connect the main electrode 1 and main electrode 2.

4. Hammer

This hammer is useful when using a grounding rod system, useful for implanting rod electrodes into the ground and also useful for removing electrodes that have been plugged into the ground [20]. can be seen in Figure 5 below.

Figure 5. Hammer

3. RESULTS AND DISCUSSION

In this chapter, the results of the research obtained during conducting research in the field are described. the results of this study get different resistance values - different electrode values, in

order to get a better resistance value with two electrodes in parallel. to get the measurement results, the resistance value can be obtained which can be seen as table 1.

Table 1. Land holding value

No	Electrode depth	R1 Ω	R2 Ω	R1/R2 Ω
1	20	32	31	15,74
2	40	28	27	13,74
3	60	20	20	10
4	80	16	17	8,24
5	100	14	13	5,72
6	200	8	7	3,75

To find out the results of measuring the value of soil resistance manually, it can be searched with the following formula:

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

Depth 20 cm

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

$$\frac{1}{Rt} = \frac{1}{32} + \frac{1}{31}$$

$$= \frac{32+31}{32 \text{ x } 31}$$

$$\frac{1}{Rt} = \frac{63}{992}$$

$$\text{Rt} = \frac{992}{63} = 15{,}74\ \Omega$$

The calculation is carried out to find the value of the resistance determined by using the above formula. The formula is solved according to the depth of the rod. The solution was carried out with 6 trials with each different depth. The results of the grounding settlement can be seen in the table above. From table 1. it can be explained the differences that occur in each resistance R1 and R2 and the resistance in parallel, where changes occur for each difference in the value of the depth of the electrode rod. the depth of the electrode is planted into the ground and the depth is measured using a meter and resistance measurement is carried out using an eart tester. From the results of the data obtained, the deeper the electrode rod is planted into the ground, the smaller the resistance value produced. each electrode rod is added to a depth of 20 m, the difference in value from the resistance is 3 – 5 **Ω**.

3.1. Plate Electrodes

by calculating the value of the plate electrode is done using the formula below. the formula used is to calculate the resistance value and the total R value. The data needed to calculate the plate electrode value are power, constant, and the length of the electrode depth as shown in the Table 2. below.

$$R = \frac{\rho}{4{,}1\ L}\left(1 + 1{,}84\frac{b}{t}\right)$$

$$R = \frac{3000}{4{,}1.20}\left(1 + 1{,}84\frac{18}{20}\right)$$

$$R = \frac{3000}{82}(1 + 1{,}656)$$

$$R = 37{,}5(2{,}656)$$

$$R = 99{,}6\ \ \Omega$$

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

$$\frac{1}{Rt} = \frac{1}{99,6} + \frac{1}{99,6}$$

$$\frac{1}{Rt} = \frac{199,2}{9.920,16}$$

$$\frac{1}{Rt} = \frac{9.920,16}{199,2}$$

$$\mathrm{Rt} = 49,8\ \Omega$$

The formula is carried out with 6 calculations according to the data at the calculated electrode depth. The calculation results can be seen in the table 2. below

Table 2. Plat Electrodes

No	Electrode depth	R Ω	Rt Ω
1	20	99,6	49,8
2	40	67,05	3,55
3	60	56,7	2,83
4	80	41,15	2,05
5	100	48,68	2,43
6	200	42,61	2,12

After calculating the resistance on the electrode plate using a comparison of the depth of the electrode rod. From the results obtained, it can be explained that the deeper the electrode rod, the smaller the resistance value of R and the value of the resistance at Rt. This value is obtained by measuring using an earth tester. the difference that occurs in each test varies according to the reading of the tool used.

3.2. Tape Electrodes

by calculating the value of the tape electrode is done using the formula below. the formula used is to calculate the resistance value and the total R value. The data needed to calculate the plate electrode value are power, constant, and the length of the electrode depth as shown in the Table 3. below.

$$R = \frac{\rho}{\pi L}\left[\mathrm{Ln} + \frac{2L}{d}\right]$$

$$R = \frac{\rho}{\pi L}\left[\mathrm{Ln} + \frac{2L}{d}\right]$$

$$R = \frac{3000}{62,8}\left[\mathrm{Ln} + \frac{40}{30}\right]$$

$$R = 47,7[\mathrm{Ln}1,333]$$

$$R = 13,71\Omega$$

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

$$\frac{1}{Rt} = \frac{1}{13,71} + \frac{1}{13,71}$$

$$\frac{1}{Rt} = \frac{13,71 + 13,71}{13,71\ X\ 13,71}$$

$$\frac{1}{Rt} = \frac{27,42}{187,96}$$

$$\frac{1}{Rt} = \frac{187,96}{27,42}$$

$$Rt = 7,67\ \Omega$$

Table 3. Tape Electrodes

No	Electrode depth	R Ω	Rt Ω
1	20	13,71	7,67
2	40	23,42	8,50
3	60	22,06	11,02
4	800	19,98	9,98
5	100	17,54	8,76
6	200	5,7	2,86

After calculating the resistance on the electrode band using a comparison of the depth of the electrode rod. from the results obtained it can be explained that the effect of the depth of the electrode rod is very dependent on the results of the resistance value, the results of the resistance value show that the value varies according to the electrode band. the resistance values of R and Rt are different where at a depth of 20m the resistance values of R and Rt are different, the deeper the electrode band, the smaller the resistance value. So, the relationship between the depth of the electrode rod and the resistance value is very influential.

4. CONCLUSION

From the data that the authors obtained by measuring the value of the grounding resistance, and processing the data with the calculation method. Then the result table of measurement values can be seen in the table 3 above. and the results obtained are as expected, so here we know that the deeper the electrodes are installed and the more electrodes there are, the better the ground resistance value will be and if the electrode depth is not maximal then the ground resistance value is not as expected. And if that happens, it will greatly affect the transformer. So here we have to pay attention to the value of the ground resistance so that the transformer is protected from voltage drops.

Based on the description of all research data analysis that the author has done, it can be concluded as follows:

1. Neutral grounding of the power system serves as a safety system or network. The wider the distance between the two electrodes, the smaller the value of the grounding resistance.
2. It can be seen that if the value of the grounding resistance is more than 5 ohms, it will affect the transformer.

Based on the results of the research that has been concluded, it is recommended to plant several parallel rod electrodes with a deep depth and wide distance to get a small earth resistance value. For further research, it is better to try to analyze the effect of the depth of the rod electrode on the value of the earth resistance in various types of soil.

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