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Conductor minimum safe distance analysis: Application of a 20 kV medium voltage airline (SUTM) system

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Abstract

Medium Voltage Air Line Conductor (SUTM) has a voltage of 20 kV. The SUTM network should have the criteria for electricity safety techniques, including minimum safety distances between the trees and the environment and the effectiveness of electricity distribution development. There are ten stages in the installation of the new SUTM 20 kV network. The results of the study concluded that the Conductor used in the planning of the 20 kV SUTM new network construction was AAACS - 150 mm2. The safe distance between the conductors and the conditions contained Billboards are> 0.5 meters with a minimum height difference of ± 2.5 meters. Whereas the safe distance between the conductor and the tree is ± 0.5 meters, but the Medium Voltage Network Construction Standard for Electric Power must have a height difference of > 2.5 meters. The distance between the conductor and billboards is> 0.5 meters, which does not complete the standard instructions.

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INTRODUCTION

Lately, the discussion about safe distance in Indonesia has become an observed topic in the government, especially by the Indonesian National Electric Company (PLN). In the construction of power lines or distribution projects to the community, the use of a medium voltage system as the main network is an effort to minimize the losses incurred in the construction of power lines. The community has willing it without reducing the quality of the standard voltage that must be completed under the minimum standards by PT PLN (Persero) as the main holder of the power of attorney as regulated in the Electricity Law No. 30 of 2009.

Medium Voltage Air Line (SUTM) is a Medium Voltage Network that has a voltage of 20 kV. SUTM is one of the cheapest constructions for electricity distribution at the same power (see. Fig. 1). This construction is mostly used for middle voltage air duct consumers used in Indonesia. The main characteristic of this network is the use of bare conductors supported by insulators on iron / concrete poles [1]–[3]. The use of bare conductors must be considered by many factors related to electricity safety such as the minimum safe distance that must be met by the conductor voltage of 20 kV between phases or with buildings or with plants or with human reach[4], [5].

Figure 1. Medium Voltage Air Lines (SUTM)

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Included in the group classified as SUTM is also if the conductor used is a half insulated AAAC-S (half insulated single-core) conductor. The use of this conductor does not guarantee the safety of the required touch stresses but it reduces the risk of temporary disturbances especially due to plant touch [6]. With the stipulation of the Medium Voltage Standard as the operating voltage used in Indonesia is 20 kV. The SUTM network must meet the criteria for electricity safety techniques, including minimum safety distances between the trees and the environment and the effectiveness of electricity distribution development [7].

The distribution network is spread out on a pole (in the air). The use of this conductor does not guarantee the safety of the required touch voltage but reduces the risk of temporary disturbances especially due to trees [8]–[10]. Based on those cases, this study aims to analyze the effect of safe conductor distance on new feeders to make safe distances between conductors affect the continuity of the electrical power supply and to maintain a safe distance from the conductor to the new feeder.

METHOD

The research methods that will be used in this study are (research flowchart see fig. 2):

Observation Method

The data collection method is observing directly by conducting surveys and participating in 20 kV SUTM New Network Development Planning at the Eastern Crossroad, Sumatera, Indonesia.

Literature Method

Literature data retrieval is collected by reading some literature or theories relating to the topic from previous research in the form of a thesis, reputable national and international journal articles, and all reference books.

Interview

This interview technique is conducting a question and answer with relevant parties. In this case, the researchers also used direct consultations with some technicians of PT PLN ULP Sukadana, Lampung, Indonesia.

Figure 2. Research Flowchart

RESULTS AND DISCUSSION

After taking data on PT PLN (Persero) Sukadana ULP about the Planning for the Development of the New Penyu 20 kV SUTM Development, several things must be considered in the Planning for the Development of the New Penyu 20 kV SUTM Development among them as follows [11].

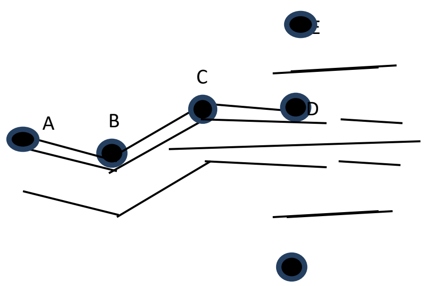
Analysis of SUTM Location Planning

The Important planning for the development of a 20 kV SUTM as a first step of building a 20 kV SUTM Network is providing direction and clarity of the Development of the Network. It aims to make all Stages of SUTM Network Development can run well, precisely, and smoothly. Development planning has also proceeded smoothly, material selection for SUTM development must be considered. The standard stamp specifications that PLN has set must be complete. Standard electric concrete pole materials is SPLN D3.19-2: 2013 for SUTM AAACS Conductors 150 mm2 SPLN 41-8: 1981 / SPLN 42-10: 1986. After the material selection has completed all the standards set by PLN, the next process is the installation of the SUTM Network [12].

In this research, a survey is done to determine the optimal route/path of network construction before it is installed[13] (see Table 1). The main criteria of the survey are:

a. Trajectory network construction sought is a straight line.
b. The land surface is chosen from one point to another which has the same height. If it is different, we will use it with the smallest difference.
c. Track / Pole location points are optimized by taking into account regional development plans/ distribution nets in the future.
d. If the network is close to other objects (buildings, trees), pay attention to the required safe distance.
e. The survey was conducted at least by 2 people for the recheck function and also equipped with survey equipment at least: Compass, meter roll and push roller.

Table 1. Survey activities and location of pole points

No	Order of Activities	Description of Activities
1	Determination of the direction points of the track 	Determine the starting points of the survey with the initially estimated distance of +/- 50 m and their indications with the initial stakes. Between one point and another is a straight line. Also, pay attention to the height of the ground and the estimated pole to be installed. Put a mark on the sketch, for example between B and C the ground level is very low, or point C is lower than B. This data is important for the selection of different pole lengths.
2	Track Distance Measurement	Measure the distance between the important points and divide them into intermediate points, with the distance for the SUTM network between 40 m and 50 m. For distances exceeding provisions, poles with a strength of> 200 and 11 meters are used
3	Measurement of network path angles	Use the compass to measure the angle of the important point. This angle measurement is important for the selection of suitable pile construction.
4	Final Pegging	After the initial measurement activity is completed, evaluate and adjust the distance between the initial stakes as an optimal survey result.

Evaluate survey results and prepare final survey data:

1. Draw a path, in the form of lines with angles and turns at scale.
2. Pictures and notes of the geographical conditions of the network path location.
3. Note the environmental conditions of the network path location that must be considered for construction planning and implementation.

Insulation Testing

Insulation Resistance Test is conducted to determine the condition of the insulation for the safe operation of the next tool in electrical equipment. The test should be carried out regularly (periodically). Then, to obtain a graph to show the condition of the equipment isolation from time to time, the rate of damage can be known and can be sudden prevention damage to the tool [14].

From the results of insulation resistance testing, the degradation of values obtained from the test results based on PUIL 2000 standard shows here:

1. Swelling, cracking, separation, discoloration as an indication of aging due to heat (thermal);
2. The emergence of contamination on the surface of the coil and the connection surface;
3. The occurrence of abrasion or things caused by other mechanical stresses;
4. Evidence of partial discharges (partial discharge)
5. The existence of loose bolts, bending, etc.
6. Shaking of the coil support/vibration due to mechanical vibrations/ (usually on the buffer and coil support on the transformer).

Table 2. Test voltage rating

Equipment Voltage Rating To Be Tested (x)	Voltage Applied to Testing Insulation Resistance
< 1000 V	500 V
1000 - 2500 V	500 V - 1000 V
2501 V - 5000 V	1000 V - 2500 V
5001 V - 12000 V	2500V - 5000 V
>12000 V	5000 V - 10000 V

Source: Phase to Phase and Phase to Ground Testing

Voltage test

Voltage testing is needed to ensure electrical devices do not experience leakage currents which results in a loss of some of the power used and guaranteed safety in their use. The results of the analysis of site planning, isolation testing, and stress tests found three criteria for SUTM network installation. These criteria are obtained based on different geographical or regional conditions:

1. **The distance between the conductor and billboards (see fig. 3)**

   Safe distance for conditions where there are buildings around or public facilities such as billboards is not possible for a 150 mm^2 AAACS cable to be pulled. By considering the Standard from PLN in the Construction of Medium Voltage Electric Power Networks to make a safe distance for the conductor to the building is> 0.5 meters with a height difference of ± 2.5 meters. Due to the existence of billboards, SUTM will be disturbed if the distance is too close. This disturbance can cause an electrical short circuit. It is because the frame of the billboard is made from conductive material[15], [16].

Figure 3. The distance between conductors and billboards.

2. The distance between the electric concrete pole and the tree (see fig. 4)

Safe distance for conditions where there are trees is not possible for a 150 mm2 AAACS cable to be pulled. According to the PLN's construction, the Standard for the Construction of Medium Voltage Electric Power Networks is safe when the distance of the conductor to the building is> 0.5 meters with a height difference of ± 2.5 meters [17], [18]. Due to the presence of trees, this makes SUTM will be disturbed if the tree continues growing tall and the distance becomes too close [19]. This disturbance can result in electrical short-circuiting or interruption of the flow of the wire due to the fall of the tree due to natural disasters or the tree is getting older.

Figure 4. The distance between poles and trees.

CONCLUSION

From the results of the Study of the Minimum Safe Distance Analysis of the 20 kV SUTM Conductor System Planning of the New PLN ULP Sukadana Network Development. The following conclusions can be obtained:

1. The distance between the conductor and billboards is> 0.5 meters, which does not complete the standard instructions. According to PLN Book, 5 (2010) Standard for Construction of Medium Voltage Electric Power Networks the safe distance of conductors to buildings is> 2.5 meters.
2. The Distance between 12 meters of electric concrete poles with trees, taller trees does not complete the standard installation construction according to PLN Book 5 (2010) about Standard Construction of Medium Voltage Electric Power Networks. The safe distance of a conductor with a Tree is> 2.5 meters.

SUGGESTION

Before carrying out the work, the safe distance for planting grow is sterilized beforehand so that the installation of the network is better and more effective. For the distance between the conductor and billboards, TM Bayonet type V construction is added so that the network is higher and to fulfills the standard construction for a safe installation distance> 2.5 meters.

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