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Study of analysis and repair of drop voltage with load breaking method at CD 125 PT. PLN UP3 Bintaro

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ABSTRACT

Electrical distribution systems at long distances and overloads can result in the amount of voltage being distributed experiencing a significant decrease with the received voltage or commonly called voltage drop. This study analyzes and repairs the voltage drop at the distribution substation owned by PT. PLN UP3 Bintaro is at the CD125 substation. The voltage drop repair is carried out using the load-breaking method. Before the CD125 substation was restored, the voltage drop in each phase was pretty considerable, exceeding 15%. After being repaired with the load rupture method, the measurement results and calculation of the voltage drop decreased to below 9%. The measurement of the voltage drop after the repair shows that the voltage is in the proper category because it is within the PLN standard (+5%, -10% of 220V).

ABSTRAK

Sistem distribusi listrik pada jarak yang jauh dan kelebihan beban dapat mengakibatkan jumlah tegangan yang disalurkan mengalami penurunan signifikan dengan tegangan yang diterima atau biasa disebut tegangan jatuh. Penelitian ini menganalisa dan melakukan perbaikan tegangan jatuh pada gardu distribusi milik PT. PLN UP3 Bintaro yaitu di gardu CD125. Perbaikan tegangan jatuh yang dilakukan dengan menggunakan metode pecah beban. Sebelum diperbaiki, hasil pengukuran dan perhitungan tegangan jatuh pada setiap fasa pada gardu CD125 cukup besar yakni di atas 15%. Setelah diperbaiki dengan metode pecah beban hasil pengukuran dan perhitungan tegangan jatuh menurun menjadi di bawah 9%. Hasil pengukuran tegangan jatuh setelah perbaikan menunjukkan bahwa tegangan berada dalam kategori layak, karena berada dalam standar PLN (+5%, -10% dari 220V).

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1. Introduction

Electrical energy is a primary need in all aspects of life so that the supply of electrical energy and its distribution system is the main thing in the context of progress and improving the quality of people's living standards. The increase in population resulted in the demand for electrical energy from year to year also continues to increase so that it can result in power losses and the voltage drop on the network also increases [1]. The distribution system is part of the electric power system to distribute electric power from bulk power sources to consumers. The electricity generated by power plants with a voltage of 11kV to 24 kV is increased in voltage at the substation through a step-up transformer to 70 kV, 150kV, 275kV, or 500kV be distributed through the transmission line. The purpose of increasing the voltage is to minimize losses due to conduction on the transmission line. From the transmission line, the voltage is lowered again to 20kV with a step-down transformer at the distribution substation, then with this voltage system, the distribution of electricity is carried out by the primary distribution system. From this distribution channel, the distribution substations take the voltage to lower the voltage with a distribution transformer into a low voltage system of 220/380 V and is a secondary distribution system. Furthermore, the voltage distribution substation will be distributed to consumers. A network that distributes electrical power over long distances results in the potential for voltage and current disturbances being lost [2].

One of the disturbances that often occur in electricity distribution lines is a voltage drop or drop voltage [1-2]. Voltage drop is the amount of voltage lost in a feeder or distribution line. This voltage drop can be caused by various factors, including the distance of the electric power distribution area from the source or supply, load imbalance, equipment age, conductor diameter, and network distribution configuration. The most frequent disturbance is caused by the length of a conductor on the medium voltage network line to the low voltage network to consumers. Voltage drop cannot be eliminated but can be reduced. Ignoring the voltage drop disturbance can decrease the reliability of the electric power system and the quality of electric power and cause damage to electronic equipment [3]. Therefore, it is necessary to analyze the voltage drop to determine the size of the voltage drop on the distribution line that occurs at PT. PLN, especially in UP3 Bintaro. If there is a voltage drop above 10%, it is necessary to repair it with various standard methods, including changing the tap changing on the transformer, changing the size of the cable area, and the load breaking method.

The principle of the tap changing method on the transformer is to increase the voltage value sent on the Medium Voltage Network (JTM) line or the Low Voltage Network (JTR) line so that the lost voltage will not cause a voltage drop phenomenon [4]. Another method is to change the size of the cross-sectional area of the cable conductor. Changing the size of the secondary distribution overhead line cable helps reduce the resistance value in the cable channel because the more significant the cable size used, the smaller the resistance value, and the opposite will happen [5]. While the load breaking method is the voltage from the consumer or customer who experiences a voltage drop will be transferred to the voltage obtained from a distribution substation to another distribution substation, provided that the voltage at the distribution substation to be moved is still in good condition, and the voltage is still at the PLN standard (220 /380 V, in the range of -10% and +5%) [6].

Many researchers have conducted studies on the analysis and improvement of voltage drop, including [7] repairing the voltage drop on the feeder B KB 31P Setia Budi, Jakarta. The use of the load-breaking method in [7] shows that the percentage of lost stress decreases until it matches the applicable tolerance limit standard. Furthermore, the study [8] to improve the voltage drop was also carried out to change the tap changing on the transformer with the Quantum Differential Evolution (QDE) method. The repair method can minimize the voltage drop in the form of a decrease in power losses from 21.76 kW to 19.16 kW. [9] Performing a comprehensive measure replacement as one of the voltage drop corrections has also been reported. ETAP 12.6.0 simulation in [9] shows that with this method, replacing the cross-sectional area of the conductor from 70 mm2 to 150 mm2 with the same line length results in a 0.345% drop in voltage drop from the previous voltage drop. This study focuses on analyzing and repairing voltage drops using the load-breaking method at the CD125 substation, especially for customers of PT. PLN Customer Service Implementation Unit (UP3) Bintaro. The primary purpose of this study is to reduce the voltage drop to meet the tolerance standards that have been set so that the service of PT PLN as a distributor of electricity voltage becomes more effective and efficient. At the same time, the public as consumers benefits from the level of durability of the use of electronic equipment.

2. Research Methodology

2.1. Alkaline Extraction of Seaweed

The method used in data processing is descriptive analysis and calculations based on theory. This method aims to determine the magnitude of the voltage drop or voltage drop that occurs in the low voltage network (JTR) at PT PLN UP3 Bintaro. The object of this research is the CD125 substation, which indicates that a voltage drop that exceeds the tolerance limit occurs. CD125 substation is one of the substations of PT. PLN UP3 Bintaro which is located at Pondok Safari Indah 2, South Tangerang. This substation gets its electrical energy supply from the Petukangan substation (GI) under the name of the water pass feeder. The CD125 substation is a type of concrete distribution substation and uses a step-down transformer which functions to reduce the voltage from 20 kV to a voltage of 220/380 V. To find out how much voltage falls on the CD125 substation. It is necessary to measure the voltage at the sending end and the receiving end for further calculation by the equation as follows:

$$|\Delta V| = |\Delta V_s| - |\Delta V_r| \,. \tag{1}$$

Where,

$|\Delta V|$: The difference between the voltage sent and the voltage received
$|\Delta V_s|$: The transmitting voltage
$|\Delta V_r|$: The received voltage

$$\%V = \frac{\Delta V}{\Delta V_s} \times 100\% \,. \tag{1}$$

Where,

$\%V$: Percentage of voltage drop
ΔV : The difference between the transmitting voltage and the received voltage
ΔV_s : The transmitting voltage

Equation (1) is used to determine the lost voltage, namely the difference between the sending end voltage and the received end voltage. In comparison, equation (2) compares the difference between the magnitude of the sensing voltage and the voltage received with the amount of voltage sent to determine the percentage of the voltage drop. Based on SPLN Number 1 of 1995 regarding everyday stresses, the allowable stress tolerance limit is a minimum of 5% and a maximum of 10% of the everyday stress [10]. If the results exceed these standards, it is necessary to repair to reduce the voltage drop. The method of resolving or repairing the voltage drop performed on CD125 in this study is the load-breaking method. Repair using this method is a method where the voltage from consumers or customers who experience a voltage drop will be transferred to the voltage obtained from a distribution substation to another distribution substation, provided that the voltage at the distribution substation to be moved is still in good condition, and the voltage is still at PLN standards 220/380 V, in the range of -10% and +5%). If the load to be transferred to the new distribution substation causes the voltage at the distribution substation to experience a voltage drop, this cannot be done, and we will look for other distribution substations that still have good voltage conditions.

In this study, the load-breaking method used is by transferring the end voltage load to the customer at CD 125 to the distribution substation CD338 [11]. The CD338 substation gets the same supply as the CD125 substation from GI Petukangan. The type of substation from CD338 is a portal substation and uses a switching/protection configuration that has been assembled as a Ring Main Unit (RMU). The location of the CD338 substation on Jl. Panti Asuhan, West Jurangmangu, South Tangerang. The load transfer is carried out because the end voltage at the consumer of the CD125 substation has experienced a voltage drop. The voltage received is below the PLN standard (< 198 V).

3. Results and Discussion

3.1. Initial Treatment

Voltage drop analysis is carried out by measuring the difference between the transmitted and received end voltages. Furthermore, by using equation (1), the difference and drop in voltage drop are known. To find out how significant the percentage of the voltage drop, the calculation is continued by using equation (2). The results of these measurements and calculations are presented in Table 1. Table 1 shows the measurement results and calculation of the voltage drop at the CD125 substation to the consumer before breaking the load. The table shows that the voltage on the TR rack (Low Voltage) and the receiver's end has decreased or a significant difference. The measurement results also show that the voltage received by the receiver experiences a voltage drop caused by the large number of consumers who use electricity around and are end customers of the CD125 substation [12].

The magnitude of the voltage drop above 15% in each phase at the CD125 substation shows that the customer receives a voltage value less than the PLN norm of 198 V. (-10 percent, 220V). This voltage drop exceeds the tolerance limit set, so it is necessary to repair the voltage drop using the load-breaking method. After the voltage drop is corrected by the load rupture method at the CD338 substation, the measurement and calculation process between the TR voltage and the receiving voltage is carried out using the same two equations. This measurement and recalculation aim to determine whether the repair with the load rupture method to the CD338 substation has succeeded in reducing or reducing the voltage drop to the standard tolerance limit that has been determined. The results of measurements and calculations after repair are presented in Table 2.

Table 1. Percentage of voltage drop

Substation code	Phase	Low voltage (V)	End voltage (V)	Voltage difference (V)	Voltage drop (%)
CD125	R – N	229	170	59	25.8
	S – N	226	190	36	15.9
	T – N	220	181	39	17.7

Table 2. Percentage of voltage drop after load breaking

Substation code	Phase	Low voltage (V)	End voltage (V)	Voltage difference (V)	Voltage drop (%)
CD125	R – N	229	209	20	8.7
	S – N	226	215	11	4.9
	T – N	220	213	7	3.2

Based on Table 2, after the voltage is repaired by the load breaking method at the CD338 substation, the end voltage or the voltage received by the customer experiences a low decrease. Furthermore, Table 2 shows that the voltage drop in each substation phase is less than 9%, with the lowest end voltage being 209 V and the most significant variance being 20 V. With a maximum voltage reduction of 8.7%, the voltage loss remains within the normal PLN range of -10% to +5% of 220 V. Based on these facts, it can be stated that the load-breaking strategy was successful in reaching the standards set.

Despite the fact that the voltage drop has been repaired, there is still a discrepancy between the voltage from the TR rack and the end voltage received by the customer. Even so, the magnitude of the voltage drop that occurs is smaller than before it was repaired. The percentage value after the end stress is repaired a percentage value below 10%, and it can be interpreted that the end stress is in good condition. There is still a voltage loss due to various factors, including when voltage and current flow through the conductor cable, there will be obstacles in the conductor cable which, of course, is very dependent on the value, cross-sectional area, type, and quality of initial resistance [13].

Table 3. Comparison of the percentage of voltage drop before and after repair

Substation code	Phase	Voltage drop (%)	
		Before load-breaking	After load-breaking
CD125	R – N	25.8	8.7
	S – N	15.9	4.9
	T – N	17.7	3.2

Table 3 compares the percentage of the voltage drop between before and after the repair using the load breaking method. Based on these data, it shows that the use of the load breaking method can reduce the percentage of the voltage drop, which is quite significant, so it can be concluded that the load breaking method is quite effective in reducing the lost stress and can meet the acceptable drop tolerance standards [14-15].

4. Conclusions

Based on the analysis and repair of the voltage drop using the load breaking method, it was concluded that there was a significant difference between the voltage sent by the CD125 substation and the voltage received by the consumer after measurements and calculations were made by the researchers. The voltage drop across all phases is below 198V. The percentage drop in the received voltage is more than 15% of the transmitted voltage. Because the voltage drop has exceeded the standard tolerance limits that have been determined, it is necessary to repair the voltage drop in this case by using the load breaking method. Subsequently, the voltage drop was corrected using the load-breaking method at the CD338 substation. From the results of this improvement, the voltage drop across all phases is above 198V. The percentage drop in the received voltage is less than 9% of the transmitted voltage. Based on the data, it can be concluded that the load breaking method is one method that is quite effective in reducing the lost voltage and can meet the voltage drop tolerance standard set by PLN standards.

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