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# An Analysis of Centralized Control on SB.02 Feed Recloser to Reduce the Length of Outage Hours at PT PLN (Persero) ULP Sibolga City

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| Article Info | ABSTRACT |
|---|---|
| **Keywords:**<br>Recloser,<br>disturbance detection and implementing centralized. | This study aims to analysed the effectiveness of centralized control on the SB.02 feeder recloser at PT PLN (Persero) ULP Sibolga in reducing outage duration. Outage du-ration is a key indicator in evaluating the reliability of the electricity distribution system, directly impacting service quality and customer satisfaction. Currently, the recloser on the SB.02 feeder is manually controlled, which extends the response time to disturbances and contributes to prolonged outages. By implementing centralized control on the re-closer, disturbance detection and handling times are expected to improve, resulting in reduced outage duration. The research method involves collecting data on disturbances, outage duration, and comparing outage hours before and after implementing centralized control. Testing is conducted through simulation and analysis of operational data over a specific period. The analysis results indicate that centralized control can significantly shorten recovery times, thus reducing total outage hours. In conclusion, implementing centralized control on the SB.02 feeder recloser can improve the reliability of the electric-ity distribution system at ULP Sibolga, minimizing the negative impacts of network dis-turbances on customers. The study recommends adopting centralized control on other feeders to enhance operational efficiency and service quality at PT PLN (Persero). |
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## INTRODUCTION

PT PLN (Persero) Ulp Sibolga City is one of the branches of PT PLN (Persero) Sibolga Area which serves the Sibolga area. In Ulp Sibolga City, 1 Nulec N-Series Recloser is installed which functions to provide reliability in the electricity distribution system to customers, as well as protection for SUTM equipment along the 20 KV network.

In mid-2016, there was damage to one of the parts in the recloser, which caused the reclose relay to not function. So when the Recloser senses an over current or ground fault, the Recloser immediately trips, but cannot reclose. Therefore, when a trip occurs in the Recloser, the disturbance service officer immediately goes to the Recloser to manually enter the PMT via the CLOSE button on the panel. This is considered ineffective, because the time needed to restore the 20 KV system is quite long and with the conditions in the

Sibolga Rayon, trips still often occur around 3-4 times a day. Therefore, the author takes the theme of centralized control that can be carried out on the SB.02 Feeder Recloser to help speed up recovery time at PT PLN (Persero) Ulp Sibolga City.

Recloser is an automatic device used in the power distribution system to protect the network from temporary disturbances and ensure continuity of electricity supply. At PT PLN (Persero) ULP Sibolga, the recloser on the SB.02 feeder plays an important role in minimizing disturbances and accelerating the restoration of electricity supply services.

In the electricity distribution network, disturbances such as lightning, wind, or foreign objects often cause temporary or permanent disturbances. With the presence of a recloser, the distribution system can automatically disconnect and reconnect the electricity flow after detecting a disturbance. If the disturbance is only temporary, the recloser will reconnect the electricity flow without the need for manual intervention, thereby reducing the blackout time. However, if the disturbance is permanent, the recloser system will disconnect the electricity flow until further repairs are made.

This study focuses on the analysis of centralized control on the SB.02 feeder recloser as an effort to reduce the duration of blackouts at PT PLN (Persero) ULP Sibolga. With centralized control, operators at the control center can monitor, control, and analyze the recloser in real-time. This allows for faster and more precise action in dealing with disturbances, thereby increasing the reliability of the electricity distribution system and reducing the potential negative impacts of power outages.

This research is important because delays in responding to disturbances can result in high outage hours, which have an impact on customer satisfaction and PLN's operational efficiency. The purpose of this study is to analyze the effectiveness of implementing centralized control on reclosers in reducing the length of outage hours in the PLN Sibolga operating area, as well as to identify factors that affect recloser performane under actual operational conditions.

## Literature Review

### Distribution System Protection

The distribution network functions to distribute electric power from the main substation to customers through a 20 KV medium voltage network, which is then converted to a low voltage of 220 V through the distribution substation. Because of this function, reliability is very important and for that the distribution network needs to be equipped with safety devices. There are three functions of the security system in the distribution network (Sarimun, 2014):

1. Prevent or limit damage to the network and its equipment due to electrical disturbances.
2. Maintaining public safety from the effects of electrical disturbances
3. Improving the continuity of electricity services to consumers

A good security system must be able to:

1. Coordinate with other security systems in GI
2. Protects equipment from further damage due to disruptions
3. Limiting the possibility of accidents

4. Quickly eliminate outages due to disruptions
5. Limiting the blackout area due to interference
6. Reduces the frequency of permanent outages due to disturbances

Requirements that must be met by safety devices or safety systems (Pusdiklat, 2014):

1. Sensitivity (sensitivity)
   A safety device is tasked with securing a particular device or part of an electrical power system, including within its safety range is the safety area. The task of a safety device is to detect disturbances that occur in its safety area. It must be sensitive enough to detect with a minimum value and if necessary, trip the PMT or fuse to separate the disturbed part from the healthy part.
2. Selectivity (accuracy)
   The selectivity of security is the quality of precision in securing the open parts of a system so that disturbances are kept to a minimum. If this can be achieved, such security is called selective security.
3. Reliability
   Under normal circumstances the safety should not work, but it must be able to work when needed. The safety should not work wrong, so the arrangement of safety devices must be reliable. The reliability of safety depends on the design, workmanship and maintenance.
4. Speed. (Speed)
   The faster the safety measures work, the less damage can be reduced but also the greater the likelihood of the consequences caused by the disruption spreading.

**Types of Distribution System Disturbances**

Medium voltage and low voltage overhead lines with exposed wires (SUTM and bare SUTR) are the lines that are most vulnerable to external disturbances, namely disturbances caused by outside the system itself, such as:

1. touch of tree,
2. disturbances due to wild animals, such as snakes, monkeys, birds, bats etc.
3. lightning strike disruption
4. disturbance due to insulator leakage, Lightning Arrester failure

Interference due to tree contact is the most frequently reported cause of disruption to electricity distribution services in all PLN service units as a result of the large number of trees growing around the SUTM network, both those belonging to the general public and the City/Regional Government Parks Department.

In addition, other causal factors are animals such as birds, bats and snakes in some places there are also kite strings reported as one of the causes of disruption of electricity services. These types of disturbances can be categorized as temporary disturbances, meaning that these disturbances can disappear by themselves when operating distribution safety devices such as automatic reclosers (Reclosers) or Sectionalizers or even these disturbances can disappear by themselves because tree branches or bamboo trees are lifted again due to gusts of wind. Disruptions to electricity services that cannot disappear by themselves are categorized as permanent disturbances.

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Examples of disturbances that are categorized as permanent disturbances are broken wires, disturbances due to leaking insulators, failure of lightning arresters, etc. Of all the causes of disturbances in the distribution system, short circuit disturbances in the distribution system are divided into (Sarimun, 2011):

1. 3 phase short circuit fault
2. Phase short circuit
3. Single phase short circuit to ground
4. Two phase short circuit to ground
5. 3 phase short circuit to ground

These three types of short circuit faults produce fault currents of different magnitudes. Almost every short circuit fault, whether 3 phase, 2 phase or 1 phase to the ground, still passes through a fault resistance value formed by arching (R arc) or by contact resistance (tree branches). But in short circuit analysis, the calculation of short circuit fault current is always assumed that the fault resistance = 0 (zero). The short circuit fault current is calculated using the OHM'S LAW formula, namely:

$$I = \frac{V}{Z} \qquad \text{.........................................................(1)}$$

Where :
I = Current flowing through Impedance Z (Ampere)
V = Source voltage (Volt)
Z= Network impedance is the equivalent value of all impedances in the network starting from the voltage source to the fault point (Ohm)

By knowing the magnitude of the source voltage and the impedance value of each network component and its configuration in the system, the magnitude of the short circuit fault current can be calculated using the formula above. Furthermore, the fault current flowing in each network component can also be calculated with the help of the formula above. What distinguishes between 3-phase, 2-phase and 1-phase short circuit faults to ground is impedance.

**Lightning Arrester**

Lightning arrester is a safety device that protects the network and its equipment from abnormal overvoltages that occur due to lightning strikes (flash over) and switching surges in a network (Pusdiklat, 2014). This lightning arrester provides a greater opportunity for abnormal overvoltages to be passed to the ground before this safety device damages network equipment such as transformers and isolators. Therefore, lightning arresters are devices that are sensitive to voltage, so their use must be adjusted to the system voltage.

This surge protection device functions to protect electrical power system equipment by limiting incoming overvoltage surges and channeling them to the ground. Due to its function, the Arrester must be able to withstand a system voltage of 50 Hz for a limited time and must be able to pass the surge current to the ground without being damaged. The Arrester acts as a shortcut around the insulation. The Arrester forms an

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easy path for lightning currents to pass through, so that high overvoltages do not occur on the equipment.

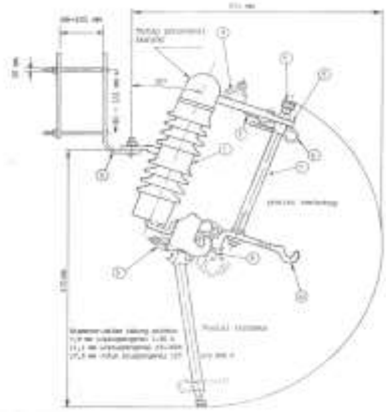

**Figure 2.** Lightning Arrester

**Fuse Cut Out (FCO)**

Distribution transformers are usually connected to the line or phase through a fuse cut out. The fuse cut out contains a fuse element that will automatically fuse and disconnect the transformer from the line to prevent damage from overload. The fuse cut out can also disconnect the phase from the transformer when a fault occurs in the transformer. Not only does it prevent the expansion of damage to the damaged transformer, but it can also prevent disruption of the primary supply that can affect other transformers and customers supplied from the same feeder. The construction of this fuse cut out is much simpler when compared to the circuit breaker found in the sub-station. However, this fuse cut out has the same capability as the previous load breaker. This fuse cut out can only disconnect one network wire channel in one tool. If a three-phase line breaker is needed, three fuse cut outs are needed.

**Figure 3.** Fuse Cut Out (FCO) Construction

**Load Break Switch (LBS)**

Load Break Switch (LBS) or load breaker switch functions as a breaker or connector for 20 kV electrical installations. The load breaker can be operated under load and is installed on the incoming or outgoing cable of the distribution grade. The process of disconnecting or releasing the network can be seen with the naked eye. This load breaker switch cannot work automatically when a disturbance occurs, it is opened or closed only to manipulate the load.

**Figure 4.** Load Break Switch

**Sectionalizer**

SSO or Auto Sectionalizer is a protection device that automatically separates the faulty part of a distribution system. Usually used in conjunction with a backup recloser or breaker, the sectionalizer cannot break the fault current. This device can only calculate the operation of the backup device when a fault occurs. After the disconnection operation occurs and when the backup device opens, the sectionalizer will open, separating the faulty area. This allows the backup recloser to close again and return electricity to the undisturbed area.

**Figure 5.** Sectionalizer

## METHOD

This study employs a quantitative descriptive method to analyze the effectiveness of centralized control on the SB.02 feeder recloser in reducing outage duration at PT PLN (Persero) ULP Sibolga. The research steps are as follows: A literature review is conducted to understand the fundamental concepts of reclosers, centralized control systems, and the factors influencing outage duration in power distribution systems. Sources include relevant scientific journals, books, and technical reports.

Primary and secondary data are collected to assess the performance of the SB.02 feeder recloser. Collected data includes:

a. Recloser Operational Data: Records of fault occurrences, outage duration, and recloser operation frequency before and after implementing centralized control.
b. Outage Data: Information on outage duration, types of faults (temporary or permanent), and recovery time.

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c. Technical and Infrastructure Data: Configuration of the recloser system, feeder conditions, and architecture of the centralized control network.

The data collected is analyzed using a quantitative approach. Methods of analysis include:

a. Descriptive Statistical Analysis: Used to identify patterns and trends in outage data and to evaluate recloser system performance before and after implementing centralized control.
b. Pre- and Post-Implementation Comparison: Calculating the average outage duration before and after implementing the centralized control system to determine the impact of centralized control on reducing outage time.
c. Centralized Control Effectiveness Analysis: Analyzing the effectiveness of the centralized control system in responding to faults more quickly than manual or decentralized control systems.

Validity and reliability tests are conducted to ensure the accuracy and dependability of the data used in this research. The results of the data analysis are evaluated and discussed to answer research questions on the effectiveness of centralized control for the SB.02 feeder recloser. The discussion also covers factors influencing centralized control performance in the context of power distribution at ULP Sibolga..

Based on the analysis results, conclusions will be drawn regarding the effectiveness of centralized control on reclosers in reducing outage duration. Recommendations for optimizing centralized control systems and potential applications in other PT PLN (Persero) distribution networks will be provided.

## RESULT

### Single line Diagram (SLD) of SB.02 Feeder

The SB.02 feeder is supplied from the Sibolga substation with a power of 10 MVA. This feeder has 41 load points in the form of distribution transformers with a total of 7583 customers, 1 Load Break Switch (LBS) and consists of 60 Lines with a channel length of 30.540 Km and the SB.02 Feeder consists of 2 Sections. The following Single Line Diagram (SLD) of the SB.02 feeder is shown in Figure 6.

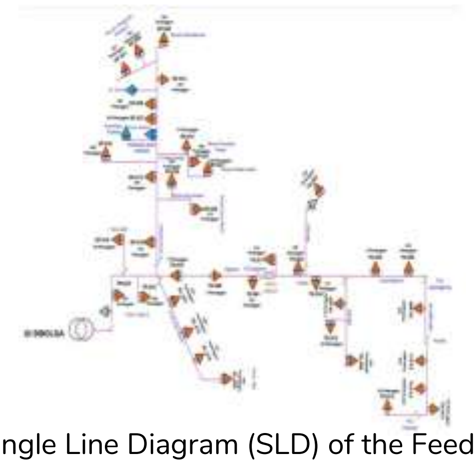

**Figure 6.** Single Line Diagram (SLD) of the Feeder SB.02

**Equipment Reliability Data**

Equipment reliability data on the Single Line Diagram (SLD) System according to PLN standards is shown in Table 1.

**Table 1.** PLN Standard Equipment Reliability Data

| Component | Failure Rate (Disorder/Year/ km) | *Repair Time* (O'clock) | *Switching Time*(O'clock) |
|---|---|---|---|
| Distribution Transformer | 0.005 | 10 | 0.15 |
| *Circuit Breaker* | 0.004 | 10 | 0.15 |
| *Sectionalizer* | 0.003 | 10 | 0.15 |
| Air Duct | 0.2 | 3 | 0.15 |
| Channel Cable | 0.7 | 10 | 0.15 |

**Calculation of Reliability of Section Method**

The first step in analyzing with this method is to divide the feeder structure into 2 parts. This division is based on the placement of sectionalizers in the feeder network. Distribution of feeder structures in the form of Substation Data and number of customers as can be seen in Table 2.

**Table 2.** Substation Data and Number of Customers

| No. | Substation | Number of Customers |
|---|---|---|
| 1 | PN.30 | 342 |
| 2 | SP.18 | 78 |
| 3 | Kindergarten 18 | 302 |
| 4 | SP.19 | 178 |
| 5 | SP.13 | 145 |
| 6 | SP.38 | 257 |
| 7 | SP.39 | 312 |
| 8 | SP.42 | 420 |
| 9 | SP.15 | 14 |
| 10 | SP.27 | 356 |
| 11 | SP.41 | 89 |
| 12 | Tapteng Flats | 1 |
| 13 | Tapteng Police Station | 1 |
| 14 | SP.37 | 54 |
| 15 | SP.28 | 287 |
| 16 | Samsat Office | 1 |
| 17 | SP.14 | 233 |
| 18 | SP.29 | 432 |
| 19 | SP.21 | 401 |
| 20 | SP.40 | 235 |

| No. | Substation | Number of Customers |
|---|---|---|
| 21 | KL.21 | 312 |
| 22 | KL.13 | 248 |
| 23 | KL.19 | 157 |
| 24 | KL.25 | 434 |
| 25 | Kindergarten 10 | 5 |
| 26 | TK.8 | 4 |
| 27 | Kindergarten 1 | 167 |
| | **TOTAL** | 5465 |

The next step is to calculate the value and U of each equipment included in the calculation of each section. Based on the calculation, the λ value of section 1 equipment is 2.372 disturbances/year and the U value of section 1 equipment is 7.199 hours/year. Next, calculate the SAIFI and SAIDI reliability index. Take one example of SAIFI and SAIDI calculation at load point 1.

**SAIFI Calculation**

$$SAIFI\ (TB1) = \frac{\sum \lambda TB \times NTB1}{\sum Nsection\ 1}$$
$$= \frac{2{,}372 \times 342}{5465}$$
$$= 0{,}1484\ Kali/tahun$$

**SAIDI Calculation**

$$SAIDI\ (TB1) = \frac{\sum UTB \times NTB1}{\sum Nsection\ 1}$$
$$= \frac{7{,}199 \times 342}{5465}$$
$$= 0{,}4505\ Jam/tahun$$

For the calculation of load points 2 and so on, the same method is used. After obtaining the overall value of the SAIFI and SAIDI reliability indices, the total sum is carried out. The reliability index value in section 1 can be seen in Table 3.

**Table 3.** Section 1 Reliability Index

| Load Point | SAIFI (Times/Year) | SAIDI (Hour/Year) |
|---|---|---|
| TB1 (PN30) | 0.1484 | 0.4505 |
| TB2 (SP18) | 0.0339 | 0.1028 |
| TB3 (TK18) | 0.1311 | 0.3978 |
| TB4 (SP19) | 0.0773 | 0.2345 |
| TB5 (SP13) | 0.0629 | 0.1910 |
| TB6 (SP38) | 0.1115 | 0.3386 |
| TB7 (SP39) | 0.1354 | 0.4110 |
| TB8 (SP42) | 0.1823 | 0.5533 |
| TB9 (SP15) | 0.0061 | 0.0184 |
| TB10 (SP27) | 0.1545 | 0.4690 |
| TB11 (SP41) | 0.0386 | 0.1172 |

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| Load Point | SAIFI (Times/Year) | SAIDI (Hour/Year) |
|---|---|---|
| TB12 (Rusunawa Tapteng) | 0.0004 | 0.0013 |
| TB13 (Police Station) Tapteng) | 0.0004 | 0.0013 |
| TB14 (SP37) | 0.0234 | 0.0711 |
| TB15 (28) | 0.1246 | 0.3781 |
| TB16 (Office) Samsat) | 0.0004 | 0.0013 |
| TB17 (SP14) | 0.1011 | 0.3069 |
| Total | 2.37 | 7.20 |

Based on Table 3 above, it can be explained that the SAIFI and SAIDI values obtained in section 1 are SAIFI 2.37 times/year while for SAIDI 7.20 hours/year and for the CAIDI index is a comparison between the results of the SAIDI and SAIFI indices so that the CAIDI value obtained is 3.04 hours/disruption. For the calculation of load points 29 and so on, the same method is used. After obtaining the overall value of the SAIFI and SAIDI reliability indices, the total sum is carried out.

**Comparison of Reliability Index Between Section Technique Method and Failure Mode Effect Analysis with PLN Standards**

From the results of the reliability analysis and calculations that have been carried out using both the Section Technique and Failure Mode Effect Analysis (FMEA) methods, the results of the SAIFI, SAIDI and CAIDI indices can be compared seen in Table 4.

**Table 4.** Comparison of Reliability Index values between Section Technique Methodsand FMEA with SPLN

| Reliability Index | Method | | |
|---|---|---|---|
| | *Section Technique* | FMEA | SPLN 68:2:1986 |
| SAIFI (Times/Year) | 5.53 | 6.12 | 3.2 |
| SAIDI (Hour/Year) | 16.74 | 18.44 | 21.09 |
| CAIDI (Clock/Interruption) | 6.06 | 3.01 | 6.59 |

Based on the table above, the reliability index SAIFI on the SB.02 feeder using the Section Technique method exceeded the PLN 68:2:1986 standard by 76.96%, while The SAIFI reliability index value using the FMEA method exceeds the PLN 68:2:1986 standard by 95.84%. For the SAIDI and CAIDI reliability index values using the Section Technique and FMEA methods, they have met the PLN 68:2:1986 standard. The following reliability index comparison diagram is shown in Figure 4.

**Figure 4.** Reliability Index Comparison Diagram

## CONCLUSION

Based on the analysis and evaluation of the recloser's performance on Feeder SB.02 at PT PLN (Persero) ULP Sibolga Kota, the following conclusions can be drawn: The implementation of recloser control through the adjustment of protection characteristics (time-current characteristic) and the configuration of the auto-reclosing function proved effective in reducing the duration and frequency of power outages. The multi-shot auto-reclose function successfully restored most temporary faults (such as those caused by rain, tree branches, or animals) automatically, minimizing the need for manual intervention and accelerating the network recovery process. After optimizing the control system, the total outage duration decreased by approximately 64%, from around 14 hours to about 5 hours over a six-month period, and the fault frequency was reduced by approximately 50%. The network reliability indices, namely SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index), showed a significant decrease, reflecting improved quality of service for customers. The integration of recloser monitoring via SCADA contributed to faster fault detection and response, strengthening the distribution system's resilience under various operational conditions. Thus, the implementation of automatic control and precise protection settings on the recloser of Feeder SB.02 has been proven to significantly enhance the reliability of the power distribution system and reduce outage hours in the service area of PT PLN (Persero) ULP Sibolga Kota.

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