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Reliability Improvement Using Sectionalizer with Section Technique Method

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Abstrak

Ketidakandalan di sistem distribusi 20 kV di PT. PLN (Persero) Rayon Rumbai feeder Rusa lebih disebabkan gangguan yang terjadi. Selama tahun 2020 feeder ini tercatat mengalami ganguan yang tertinggi sebanyak 83 kali sehingga menyebabkan sistem sering mengalami pemadaman. Penelitian ini berupaya untuk mengidentifikasi dan meningkatkan keandalan sistem di feeder tersebut. Keandalan sistem dapat dihitung dan dianalisis lebih terperinci dengan Metode Section Tehnique. Metode ini dapat mengidentifikasi keandalan dengan memecah sistem menjadi beberapa bagian sehingga dapat diketahui keandalan tiap tiap bagiannya. Peningkatan keandalan dilakukan dengan menambahkan sectionalizer pada sistem yang memiliki keandalan yang rendah, terdapat dua skenario yang dijalankan dalam menempatkan sectionalizer ini dengan tepat untuk menghasilkan keandalan yang lebih baik. Hasil perhitungan keandalan setiap bagian sistem menggunakan metode Section Technique ini telah didapatkan, nilai rata rata tiap indeks keandalannya adalah SAIFI 11,231 (f/customer.yr), SAIDI 30,55 (hr/customer.yr), CAIDI 11,015 (hr/customer interruption). Hasil perhitungan indeks ini belum memenuhi standar SPLN 68-2 1986 SAIFI 3,2 (f/customer.yr) dan SAIDI 21,9 (hr/customer.yr). Peningkatan keandalan dilakukan dengan implementasi sectionilizer pada penyulang dan diperoleh indeks keandalan dengan nilai SAIFI 9,8185 (f/customer.yr), SAIDI 27,5292 (hr/customer.yr) dan CAIDI 11,223 (hr/customer interruption) dengan persentase peningkatan SAIFI sebesar 10,4 %, SAIDI sebesar 8,8% dan CAIDI 0,37% . Dengan penambahan sectionilizer sangat membantu dalam meningkatkan keandalan, walaupun masih belum memenuhi nilai standar yang diharapkan.

Kata kunci: *keandalan, SAIFI, SAIDI, CAIDI, metode Section Technique , sectionilizer*

Abstract

Unreliability in the 20 kV distribution system at PT. PLN (Persero) Rayon Rumbai feeder Rusa is more caused by disturbances that occur. During 2020 this feeder was recorded to experience the highest disturbance of 83 times, causing the system to experience frequent blackouts. This study seeks to identify and improve the reliability of the system in the feeder. The reliability of the system can be calculated and analyzed in more detail with the Section Tehnique method. This method can identify reliability by breaking the system into several sections so that the reliability of each section can be known. The increase in reliability is done by adding a sectionalizer to a system that has low reliability, there are two scenarios that are carried out in placing this sectionalizer correctly to produce better reliability. The results of the calculation of the reliability of each section of the system using the Section Technique method have been obtained, the average value of each reliability index is SAIFI 11.231 (f/customer.yr), SAIDI 30.55 (hr/customer.yr), CAIDI 11.015 (hr/customer interruption). The results of this index calculation do not meet the standards of SPLN 68-2 1986 with SAIFI 3.2 (f/customer.yr) and SAIDI 21.9 (hr/customer.yr). The reliability improvement was carried out by implementing sectionilizer on the feeder and the reliability index was obtained with SAIFI values 9.8185 (f/customer.yr), SAIDI 27.5292 (hr/customer.yr) and CAIDI 11.223 (hr/customer interruption) with an increase in SAIFI percentage. by 10.4%, SAIDI 8.8% and CAIDI 0.37%. With the addition of a sectionilizer, it is very helpful in increasing reliability, although it still does not meet the expected standard values.

Keywords*: reliability, SAIFI, SAIDI, CAIDI, Section Technique Method, sectionilizer.*

1. Introduction

In today's developing world, the need for electrical energy sources plays an important role in improving people's lives. Electrical energy is a source of energy which can indirectly prosper human life and besides that electrical energy can encourage economic growth at this

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time. The greater the level of welfare of a person's needs, the greater the use of electrical energy in people's lives [1] [2]. PT. PLN, as one of the state-owned enterprises (BUMN) industrial company, has the authority to generate electricity and is obliged to distribute electricity. Along with the passage of time the community's need for electrical power is always increasing, then PT. PLN is obliged to provide satisfactory electricity services to all its consumers [2].

Good reliability of the electrical energy system is characterized by the system being able to distribute electrical energy in full with satisfactory quality. The increasing demand for electrical energy at this time, the continuous electrical power must be able to meet these needs. Supply must continue to be maintained, distribution in the network should run smoothly. Distribution of electrical power to consumers through the distribution system should have quality, continuity and the availability of good electrical energy services to customers. A reliability of this system can be seen from the extent to which it can supply electricity continuously from year to year to customers [3]. But in reality the problem of system unreliability still occurs, this is a fundamental problem. With the increasing demand from the community from year to year and accompanied by the increasing demand for electricity, the continuity of the supply of electrical energy often experiences problems, causing system blackouts. The reliability of the distribution system can increase, it is necessary to calculate the reliability of the distribution system. The reliability value can be calculated by calculating the reliability index [4].

The Section Technique method is one of the methods used to calculate the value of a distribution system reliability, this method makes it easier to calculate the reliability index by breaking the network structure and dividing it into several sections. The calculation results of each section are added up and become the final result. The calculation of the Section Technique method uses the failure rate, sustained failure rate. This method has the advantage of dividing the system into smaller parts, so that errors can be minimized and the time needed for repairs can be shorter [5].

The problem of unreliability also occurs at PT. PLN (Persero) Rayon Rumbai on Tuna, Sungakai, Meranti, Damar, Libra, Kijang, Rusa, Kuda, Kelinci, and Anoa feeders. The ten feeders have different amounts of interference. The Tuna feeder experienced 0 disturbance the Sungkai feeder experienced 29 disturbances, the Meranti feeder experienced 31 disturbances, the Damar feeder experienced 23 disturbances, the Libra feeder experienced 4 disturbances, the Kijang feeder experienced 14 disturbances, the Rusa feeder experienced 83 disturbances, the Kuda feeder experienced 37 disturbances, the Kelinci feeder experienced 19 disturbances, and feeder Anoa had 7 disturbances [7]. Based on the Central Statistics Agency, it is stated that the Rumbai area has always experienced an increase in population from year to year with a total population of 73,748, with the increasing number of residents, the distribution of electrical energy is expected to be distributed continuously [8].

Based on the disturbance data obtained from PT. PLN (Persero) Rayon Rumbai, Researchers took the Deer feeder which has the highest disturbance, which is 83 times experiencing disturbances which often have an impact on system blackouts. This feeder also has the largest number of subscribers and the longest channel among other channels supplied from the New Garuda Sakti Substation. So far the results of Saifi and Saidi's scores from PT. PLN (Persero) Rayon Rumbai has unreliable results and exceeds the standard limit of SPLN 68-2 in 1986. So far PT. PLN (Persero) Rayon Rumbai has tried to improve reliability, namely by reducing or minimizing the number of disturbances that occur such as carrying out distribution network maintenance but disturbances still occur. Previous research has never evaluated and calculated the value of reliability per feeder PT. PLN (Persero) Rayon Rumbai. Related to this problem, the researcher will evaluate the reliability index of the Rusa feeder by using the Section Technique method and simulating the addition and placement of the best Sectionalizer.

Sectionalizer or Automatic Section Switch (SSO) is used as a safety section or current safety in medium voltage networks. The working principle is related to source side protection (such as recloser). Sectionilizer is a backup protection tool. The addition of this sectionalizer can increase reliability [9]. The Sectionalizer function isolates the SUTM section that is experiencing interference automatically and becomes a circuit breaker device to separate the main line into several sections, so that when a permanent disturbance occurs, the area of the fault network that experiences blackouts can be limited as small as possible [10].

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2. Research Method

This research was conducted on a 20 kV feeder, the PT. PLN (PERSERO) Rayon Rumbai Rusa feeder. The feeder gets its electrical power supply from the power transformer unit 1 of the New Garuda Sakti 60 MVA substation. The secondary data used in this study include channel, interference, and the number of subscriber data. The steps carried out in this study are described as follows

2.1 Section Technique Methode

The Section Technique Method in its calculation divides a network into several sections and makes it easier to simulate. By using this method, it can be seen which areas of the network need to be improved reliability. Either through maintenance or system automation [1]. The division of the section on the Deer feeder is described as follows

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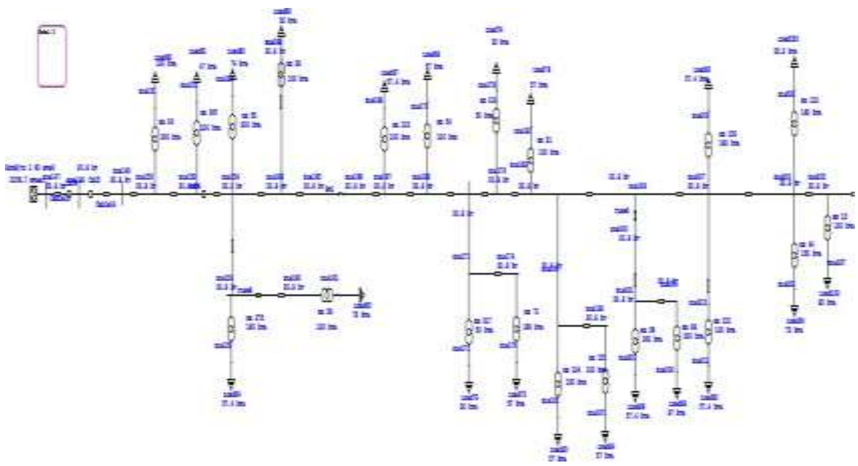

Figure 1. Section 1 Rusa Feeder Circuit

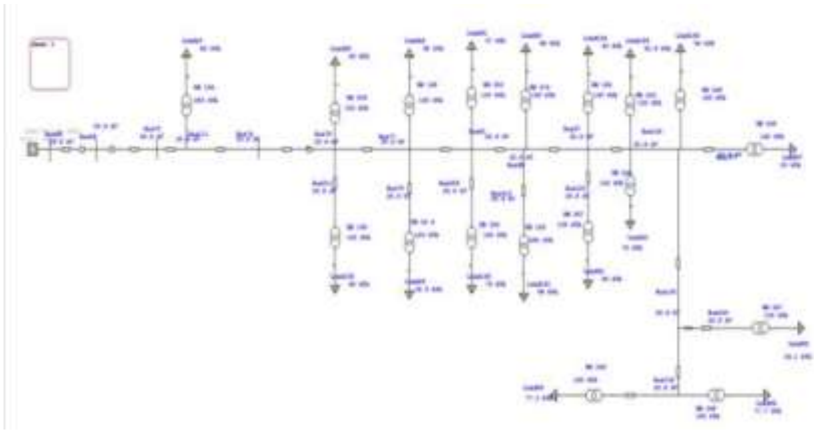

Figure 2. Section 2 Rusa Feeder Circuit

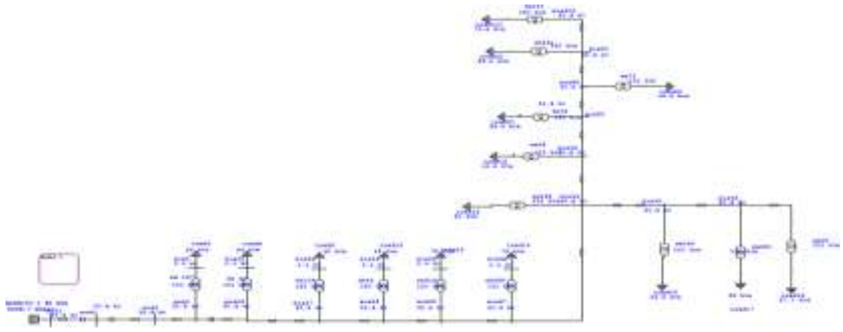

Figure 3. Section 3 Rusa Feeder Circuit

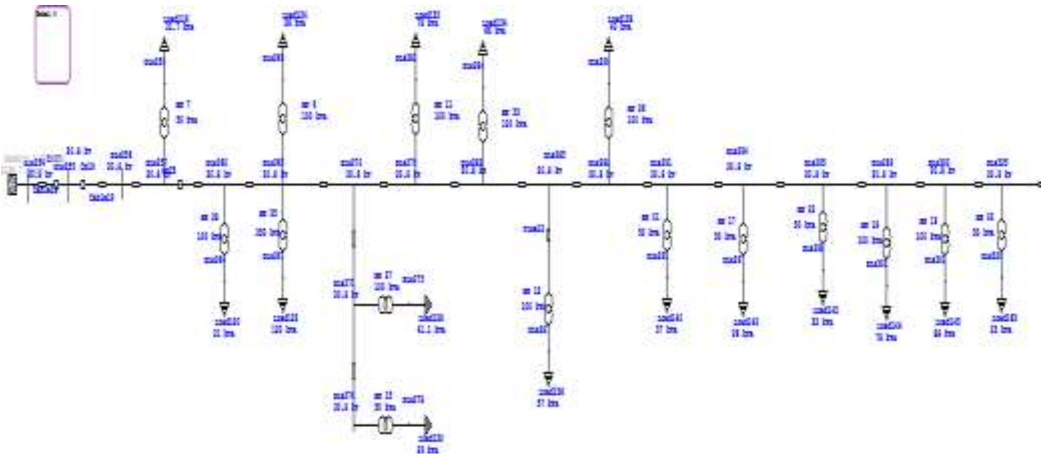

Figure 4. Section 4 Rusa Feeder Circuit

2.2. Sectionilizer Addition

The next step is to do a simulation with the help of ETAP Software, on the 4 feeder sections above which include simulation of the existing conditions before and after the addition and placement of the sectionilizer. Sectionilizers are generally installed at the branch and for the placement of this Sectionilizer installed after the recloser because if it is not installed after the recloser, the Sectionilizer only functions as an ordinary switch [9].

2.3. Reliability Index

The reliability index is calculated as the load point index, the system index in section or as a whole. The indexes are [11]:

a. The failure rate at each load point is the sum of the failure rates for all affected equipment at the load point.

$$\lambda LP = \sum i = k\ \lambda i \quad (1)$$

in the formula (1) λ is the failure rate, K = Length of the channel affected by the Load Point

b. UiP load point unavailability is the length or average annual duration of disturbance for the ULP load point, along with the following equation

$$UiP = \sum i\ \lambda i \,.\, r \quad (2)$$

There are three types of reliability index of the Section Technique method which are calculated, namely SAIDI, SAIFI, and CAIDI [11].

a. SAIFI (*System Average Interruption Frequency Index*)

The SAIFI index is the average number of failures that occur per customer served one year

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$$SAIFI = \frac{\sum NLP\ x\ \lambda LP}{\sum N} \quad (3)$$

∑NLP is the number of subscribers at the load point, ∑N is the number of subscribers to the system, and λ LP is the frequency of interruptions at the load point.

b. SAIDI (*System Average Interruption Duration Index*)

The SAIDI index is the average failure value of the duration of failure that occurs for each consumer every year

$$SAIDI = \frac{\sum NLP\ x\ \mathrm{U}LP}{\sum N} \quad (4)$$

ULP is the duration of the disturbance at the load point

c. CAIDI (*Customer Average Interruption Duration Index*).

The CAIDI index is an average consumer disorder that occurs every year

$$CAIDI = \frac{SAIDI}{SAIFI} \quad (5)$$

3. Results and Analysis

3.1. Reliability value

Table 1. Frequency of Failure Rate (λ) and Duration Failure Rate (u)

Section	Load Point	Failure Rate (SPLN) 68-2 1986	Length of the channel (km)	λ (*fault/year)*	r (*hour)* (SPLN) 68-2 1986	U (*hour/year*)
1	LP 01 -15	0,2	13	2,6	3	7,8
2	LP 16 – LP46	0,2	23	4,6	3	13,8
3	LP 47 – LP65	0,2	7	1,4	3	4,2
4	LP66 – LP 89	0,2	10	2	3	6

Table 2. Amount λ (*fault/year)* and U (*hour/year*) on the Rusa Feeder Section

Feeder Rusa	λ(*fault/year)*	U (*hour/year*)
Section 1	2,6	7,8
Section 2	4,6	13,8
Section 3	1,4	4,2
Section 4	2	6
Total	10,6	31,8

The table above is the result of the calculation of the frequency of the failure rate (λ) of the length of failure for each section. where the results obtained for each section are different. The value of the frequency of the failure rate (λ) the highest duration of failure (u) is found in section 2, namely the value of (fault/year) of 4.6 and U (hour/year) of 13.8 and for the results of the frequency of the failure rate (λ) The lowest duration of failure (u) is found in section 3, namely the value of (fault/year) of 1.4 and U (hour/year) of 4.2. The frequency value of Failure Rate (λ) and duration of failure (u) is very influential in determining an unreliability in the distribution network system which in section 2 has a channel length of 23 km while section 3 has a channel length of 7 km. The shorter the channel in the distribution network, the smaller the failure rate frequency (λ) and the duration of failure (u). Meanwhile, the longer the feeder channel, the greater the failure rate frequency (λ) and the duration of failure (u). The total results from the frequency value of the Failure Rate (λ) the duration of failure (u) is getting smaller, namely (fault/year) of 10.6 and U (hour/year) of 31.8.

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3.2. Reliability Index with Section Technique Method

Table 3. Rusa Feeder Reliability Index

Rusa Feeder	SAIFI	SAIDI	CAIDI
SECTION 1	2.593	7.795	3,006
SECTION 2	4.589	12.576	2,740
SECTION 3	1.39	4.194	3,017
SECTION 4	2.659	5.99	2,252
TOTAL	11.231	30.55	11,015

Table 3 shows that the highest reliability index on the Rusa feeder is found in section 2 of SAIFI of 4,589 and SAIDI of 12,576 and the lowest occurs in section 3 of SAIFI of 1.39 and SAIDI of 12,576. The total result of SAIFI reliability index calculation is 11.231 (f/customer.yr) and SAIDI is 30.55 (hr/customer.yr) and Caidi is 11.015 (hr/customer interruption). These results indicate that the Deer feeder is still experiencing unreliability. The standard of reliability index in an electric power distribution system SPLN 68-2 1986 SAIFI is 3.2 times/customer/year while SAIDI is 21.9 hours/customer/year.

3.3. Reliability Index Simulation Results with Section Technique Method

Table 4. Simulation Results of Deer Feeder Reliability Index

Rusa Feeder	SAIFI	SAIDI	CAIDI
SECTION 1	2,4610	7.5374	3,063
SECTION 2	4,5348	12,4631	2,748
SECTION 3	1,3415	4,0044	2,985
SECTION 4	2,5042	5,9732	2,385
TOTAL	10,841	29,942	11,181

After simulating the ETAP 12,6.0 software, the reliability index of the Deer feeder is obtained, namely SAIFI = 10,841 (f/customer.yr), SAIDI = 29,942 (hr/costumer.yr), and CAIDI = 11,181 (hr/customer interruption) . Based on the results of calculations and simulations, it is found that the reliability index value of the Rusa feeder still does not meet the standardization. Regarding the problem of unreliability in the Rusa feeder, it is necessary to improve the reliability of the feeder so that the system meets PLN standards. Efforts to add additional protective devices in the form of sectionalizers can be used as sectional safety or current safety in medium voltage networks. The working principle is related to source side protection (such as recloser or PBO). sectionilizer is a backup protection device Sectionalizer isolates SUTM sections that experience interference automatically and becomes a circuit breaker device to separate the main line into several sections, so that when a permanent disturbance occurs, the area of the fault network that experiences blackouts can be limited as small as possible.

3.4. Reliability Index Simulation Results with Addition of Sectionalizer

The sectionalizer is placed after recloser installation, this placement is placed at the branch after RB 265 section 1, after loading RB 57 section 2, at the branch after RB 25 section 3, and at the branch after MN 02 section 4 as shown in the following figure:

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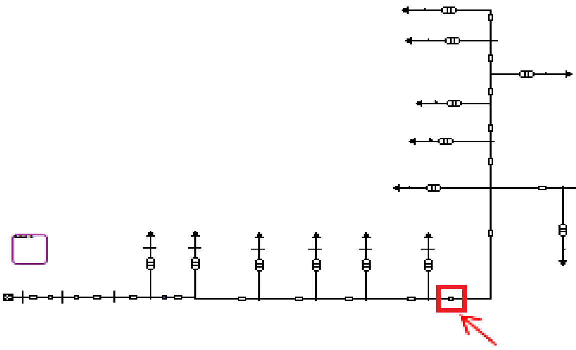

Figure 5. Section 1 Placement of Sectionalizer

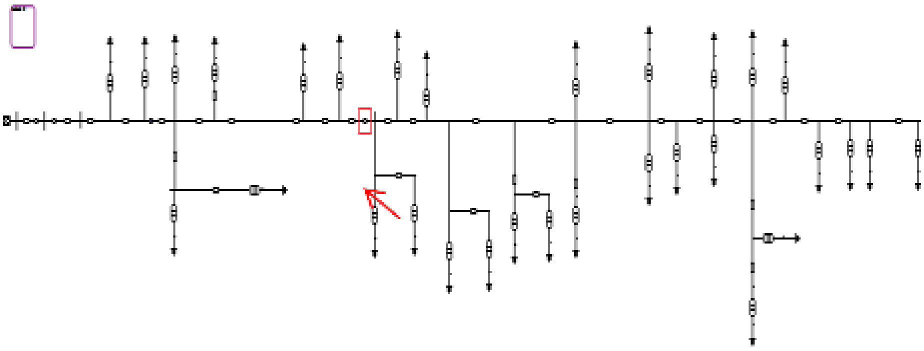

Figure 6. Section 2 Placement of Sectionalizer

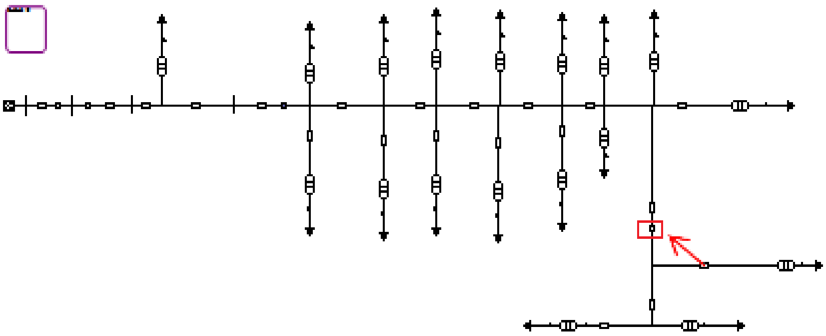

Figure 7. Section 3 Placement of Sectionalizer

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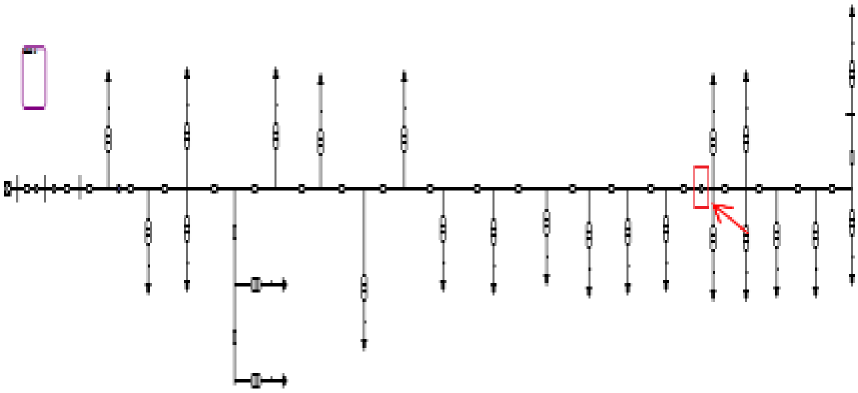

Figure 8. Placement of Sectionalizer Section 4

Table 5. Simulation Results of Reliability Index with Sectionalizer

Rusa Feeder	SAIFI	SAIDI	CAIDI
SECTION 1	2,1482	6,4834	3,018
SECTION 2	4,1022	11,9459	2,912
SECTION 3	1,2448	3,6905	2,965
SECTION 4	2,3233	5,4094	2,328
TOTAL	9,8185	27,5292	11,223

Table 5 shows that from the experimental results after the addition of protective equipment, namely sectionilizer to minimize disturbances that occur. The results of the reliability index in the form of SAIFI, SAIDI and CAIDI are 9.8185 (f/customer.yr), 27.5292 (hr/customer.yr) and 11.223 (hr/customer interruption).

Table 6. Percent Improvement of Reliability Index Before and After Placement of Sectionalizer

% SAIFI	%SAIDI	%CAIDI
10,4	8,8	0,37

Table 6 shows a comparison of the reliability index on the Deer feeder before and after the placement of the Sectionalizer. Based on their placement in each section, it resulted in an increase in the reliability index of SAIFI, SAIDI, and CAIDI by 10.4%, 8.8%, and 0.37%. This shows that the sectionalizer is able to work to reduce the disturbance that occurs for each section so as to increase reliability in the Deer feeder with a SAIFI value of 9.8185 (f/customer.yr), SAIDI 27.5292 (hr/customer.yr) and CAIDI 11.223 (hr/ customer interruption) with a percentage increase of 10.4% SAIFI, 8.8% SAIDI and 0.37% CAIDI. However, the increase in reliability in this feeder still does not meet the standardization.

4. Conclusion

Unreliability still occurs in the Rusa feeder, based on the simulation results of the reliability index using the Section Technique method, it is known that SAIFI 11.231 (f/customer.yr), SAIDI 30.55 (hr/customer.yr), and CAIDI 11.015 (hr/customer interruption). After adding a sectionalizer for each section in the Deer feeder, it resulted in an increase in SAIFI of 10.4%, SAIDI of 8.8% and CAIDI of 0.37%. The results of this index calculation do not meet the standards of SPLN 68-2 1986 SAIFI 3.2 (f/customer.yr) and SAIDI 21.9 (hr/customer.yr)

References

[1] C. A. Craig, “Electricity Generation, Electricity Consumption, and Energy Efficiency in the United States: A Dual Climatic-Behavioral Approach,” p. 164.
[2] “Rahman et al. - 2017 - Energy Consumption Analysis Based on Energy Effici.pdf.”

ISSN (Printed) : 2579-7271
ISSN (Online) : 2579-5406

[3] M. F. Adiguna, “Pada Penyulang Kayutangi Menggunakan Metode Reliability Network Equivalent Approach (RNEA),” pp. 1–9, 2019.
[4] A. T. Maliky, “Analisis Keandalan Sistem Distribusi 20 kV Pada Penyulang Pejangkungan Di PT PLN Pasuruan Menggunakan Metode RIA (Reliability Index Assesment),” pp. 835–843, 2015.
[5] J. E. Wicaksono, “Penyulang Lowokwaru Menggunakan Metode RIA (Reliability Index Assessment) Dan Software Etap (Electrical Transient Analisys Program),” Universitas Muhammadiyah Malang, 2019.
[6] M. Imron, “Inilah Daftar Kabupaten dan Kota Terbesar di Provinsi Riau Indonesia,” 2018. https://www.kuwaluhan.com/2018/08/inilah-daftar- kabupaten-dan-kota_27.html (accessed Sep. 24, 2020).
[7] PT. PLN (Persero) ULP Rumbai, *Rekap Bulanan Gangguan Feeder 2019*. Pekanbaru, 2019.
[8] (BPS) Badan Pusat Statistik, “Badan Pusat Statistik Kependudukan Wilayah Rumbai,” Rumbai, 2019.
[9] A. Triyollinna, R. Thayib, and A. Hamdadi, “Studi Penempatan Sectionalizer Pada Jaringan Distribusi 20 kV Di Penyulang Kelingi Untuk Meningkatkan Keandalan,” *Mikrotiga*, vol. 2, no. 1, pp. 5–10, 2015.
[10] M. Fauzi, Irfan, “Analisis Koordinasi Recloser Dan Sectionalizer Pada Jaringan Distribusi 20 kV Di Gardu Induk Wonogiri,” 2019.
[11] M. Sanaky, Rizal, “Peningkatan Indeks Keandalan Dengan Penambahan Recloser Pada Sistem Distribusi di PLTD Subaim Menggunakan Metode Section Technique,” Fakultas Teknologi Industri Institut Teknologi Nasional Malang, 2017.