INTERNATIONAL JOURNAL OF RESEARCH IN VOCATIONAL STUDIES (IJRVOCAS)
VOL. 1, NO. 4, JANUARY 2022, PP. 16~21
Print ISSN 2777-0168 | Online ISSN 2777-0141 | DOI prefix: 10.53893

Influence of Maneuvering Singa Feeder at Bukit Siguntang Substation on Power Shrinkage Using ETAP 19.0.1

Anton Firmansyah, Destra Andika Pratama, M. Raihan Ismail

Abstract— the need for electricity supply in the community and industry is increasing over time, it is necessary to provide energy and a safe and reliable electricity distribution system, which can minimize blackouts so as to maintain customer satisfaction. One way to increase reliability and minimize blackouts is through a network maneuvering process. This study calculates the magnitude of the power loss value on the power line in the feeder that maneuvers the Singa feeder with the aim of knowing the value of power loss that occurs during the maneuver so that network maneuvering activities on the Singa feeder become more optimal. The Singa feeder can be maneuvered by two feeders, namely the Kijang feeder and the Kancil feeder. Based on SPLN 72: 1987, the standard maximum value for medium-voltage

Keywords: Bukit Siguntang, Substation, Maneuver, Feeder, Losses, Power, Shrinkage, ETAP

1 Introduction

For an effort to maintain the availability of reliable and sustainable electricity supply, PT. PLN (Persero) performs network maneuvering activities on the distribution system. A distribution network maneuver is a series of activities that alter the normal operation of the network due to disruption or network work that requires a power outage, so that the power outage area is reduced and the distribution of electrical power remains in optimal condition [1].

Network maneuvering is an important step in the operation of an electric power distribution system. Because of the importance of this activity, the distribution operations controller (dispatcher) must be able to act quickly and precisely in maneuvering the network. The consideration of dispatcher when maneuvering the distribution network is to consider the maximum load capacity and protection equipment on the refiner and shrink that will arise as a result of the maneuvers carried out [2].

Bukit Siguntang Substation has 3 transformers with details, 1). 30 MVA transformers which supplies 4 feeders, 2). 30 MVA transformers which supplies 5 feeders and 3). 30 MVA transformers which supplies 5 feeders. The Singa feeder is supplied by transformer 3 30 MVA and can be maneuvered to 3 backup feeders in the event of a disturbance that causes transformer 3 to not be able to supply electricity, namely the kancil feeder, the kijang feeder and the dayung feeder. When maneuvering a network, dispatchers do not really consider how much power loss the line will be maneuvering.

2 Riseарch Methode

2.1 Research Data and Supporting Data

The research method is a method that has been systematically and scientifically determined to observe and analyze a problem which produces a conclusion that is useful for finding, developing and testing knowledge. The things discussed in the research method are as follows: This research was carried out in March 2021 - July 2021 completed at PT. PLN (Persero) UP3 Palembang and UIWS2JB. Research variables the research variable is the power flow contained in the electric power system at the Bukit Siguntang Substation calculation and using the ETAP Power Station 19.0.1 software. In this research process, the tools and materials used are: Laptop Hardware and ETAP 19.0.1 software, besides that, a feeder is also needed at the Bukit Siguntang Substation, namely: 1). Data on the capacity and load of the transformer at the Singa Feeder, Kijang and Kancil. 2). Conductor type data and conductor resistance value data. 3). Data Map source Feeder and 4). One Line Feeder Diagram.

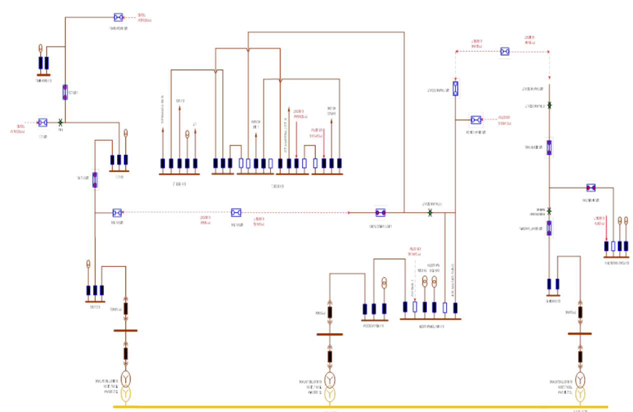


Figure 1. Singa, Kijang and Kancil Singel Line Diagram
Source : PT. PLN (Persero) UP3 Palembang, 2021

2.2 Lenght and Conductor Type Feeder on Bukit Siguntang Substation

In high-voltage overhead lines (SUTT), the distance between the tower/pole and others are located far apart so a conductor with better ability to transmit electrical energy.

DOI: HTTPS://DOI.ORG/10.53893/IJRVOCAS.V1I4.70

Wire type the conductor used in the transmission line is copper with conductivity 100% (Cu 100%), copper with a conductivity of 97.5% (Cu 97.5%), or aluminum with a conductivity of 61% (Al 61%). The following are the types of aluminum conductors:

Table 1. Lenght and diameter conduktor on Feeder

Conductor Type	Feeder's					
	Singa		Kijang		Kancil	
	Conductor Diamter (mm)	Lenght (km)	Conductor Diamter (mm)	Lenght (km)	Conductor Diamter (mm)	Lenght (km)
NA2XSEYFGbY (AL)	240	4.3	240	0.42	240	0,346
NA2XSEYFGbY (AL)	240	0.56	-	-	-	-
A3CS	150	2.8	150	3,2	150	3,7
A3C	150	0.45	150	2,6	150	2,06
NA2XSEYFGbY (AL)	240	4.3	-	-	-	-

Source : PT. PLN (Persero) UP3 Palembang, 2021

2.3 Feeder Load Type Feeder on Bukit Siguntang Substation

The load on the Bukit Siguntang substation feeder can be seen in the following table

Table 2. Feeder Load on Bukit Siguntang Substation

Feeder	Feeder Load	
	Current (Ampere)	Power (MW)
Kijang	**111,8**	**3,48**
Kancil	**97,7**	**3,04**
Singa	**56**	**1,74**

Source : PT. PLN (Persero) UP3 Palembang, 2021

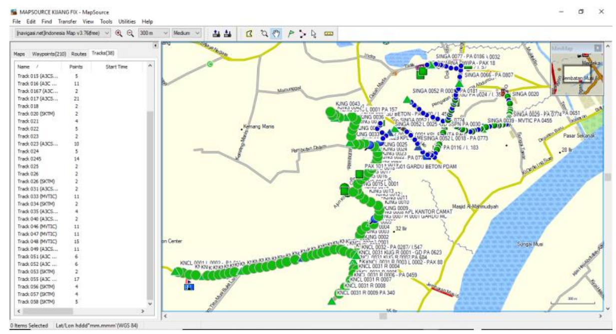
Table 3. Transformer Distribution Load on feeder Bukit Siguntang Substation

Kijang		Kancil		Singa	
Distribution Transformer (Code)	Load (kVA)	Distribution Transformer (Code)	Load (kVA)	Distribution Transformer (Code)	Load (kVA)
PAX101	150	PA0008	318	PA0006	128
PAX018	250	PA0011	59	PA0007	147
PAX088	75	PA0016	48	PA0188	224
PA0101	217	PA0017	160	PA0192	195
PA0115	171	PA0048	197	PA0295	107
PA0157	229	PA0124	151	PA0544	124
PA0180	89	PA0190	138	PA0557	226
PA0212	47	PA0329	31	PA0613	19
PA0229	250	PA0338	30	PA0717	44
PA0287	93	PA0422	0	PA0915	81
PA0340	135	PA0483	114	PA0916	29
PA0438	127	PA0508	107	PA0028	196
PA0445	102	PA0509	123	PA0464	16
PA0459	49	PA0563	111	PA0478	45
PA0501	88	PA0584	21	PA0641	65
PA0564	59	PA0619	131	PA0870	50
PA0623	7	PA0650	20	PAX122	315
PA0653	226	PA0732	78	PAX114	12
PA0684	58	PA0834	82	-	-
PA0725	75	PA0838	21	-	-
PA0772	63	PA0910	32	-	-
PA0024	137	PAX036	200	-	-
PA0030	98	PAX021	1000	-	-
PA0032	136	PAX029	100	-	-
PA0041	34	PAX020	150	-	-
PA0116	185	-	-	-	-
PA0117	175	-	-	-	-
PA0181	124	-	-	-	-
PA0186	17	-	-	-	-
PA0455	93	-	-	-	-
PA0481	51	-	-	-	-
PA0651	83	-	-	-	-
PA0724	33	-	-	-	-
PA0773	103	-	-	-	-
PA0774	34	-	-	-	-
PA0807	2	-	-	-	-

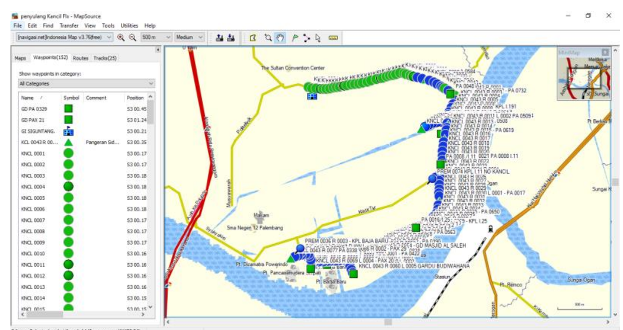
Source : PT. PLN (Persero) UP3 Palembang, 2021

2.4 Map Source Feeder on Bukit Siguntang Substation

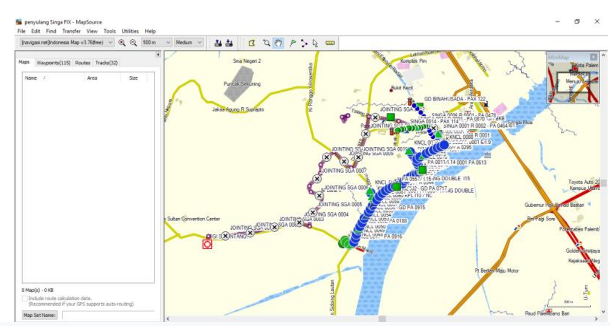
Data on the length and type of feeders and distribution substations of the Kijang, Kancil and Singa feeder can be measured through map source. Starting from the substation to the final load and voltage of the Kijang feeder can be measured accurately because it is based on GPS mapping.



a). Kijang Feeder



b). Kancil Feeder



c). Singa Feeder

Figure 2. Single Line Diagram Feeder on Bukit Siguntang
Source : PT. PLN (Persero) UP3 Palembang, 2021

DOI: HTTPS://DOI.ORG/10.53893/IJRVOCAS.V1I4.70

3 Result and Discussion

3.1 Line Resistance Calculation

The calculated resistance is at a temperature of 75^0, assuming the temperature at peak load, and at a temperature of 20^0 for low temperatures. Calculation using:

$$\frac{R2}{R1} = \frac{T + t_2}{T + t_1}$$

- NA2XSEYBY 240 mm
  $$\frac{R2}{0{,}125} = \frac{228 + 75°C}{228 + 20°C}$$
  $$248\ R_2 = 37{,}875$$
  $$R_2 = 0{,}152\ \Omega/km$$

- A3C-S 150 mm
  $$\frac{R2}{0{,}225} = \frac{228 + 75°C}{228 + 20°C}$$
  $$248\ R_2 = 68{,}175$$
  $$R_2 = 0{,}275\ \Omega/km$$

- A3C-S 150 mm
  $$\frac{R2}{0{,}225} = \frac{228 + 75°C}{228 + 20°C}$$
  $$248\ R_2 = 68{,}175$$
  $$R_2 = 0{,}275\ \Omega/km$$

3.2 Losses Power in Normal Condition

The calculation of the all feeder power loss value for the feeder that maneuvers uses $P_Z = 3.I^2.R.L$, the peak load is obtained from table 2. Length is obtained from table 1, and the resistance value is obtained calculation. Calculations can be done using the ETAP application to get the accuracy of the power loss values that occur in the field. In this report the author uses the ETAP 19.0.1 application.

- Power Losses at Kijang Feeder

  NA2XSEYBY 240 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 111.8^2\ x\ 0{,}152\ x\ 0{,}42$$
  $$P_z = 2393\ \text{W}$$

  AAAC 150 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 111.8^2\ x\ 0{,}275\ x\ 2{,}6$$
  $$P_z = 26810\ \text{W}$$

  AAACS 150 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 111.8^2\ x\ 0{,}275\ x\ 3{,}3$$
  $$P_z = 30029\ \text{W}$$

  Total Power Losses on Kijang Feeder
  $$P_{Total} = 2393 + 26810 + 30029$$
  $$P_{Total} = 59232\ \text{W}$$

  If the amount of power loss has been obtained, then the power received is $P_R = P - P_Z$, then the value of the percentage (%) of power loss is $\Delta P = \frac{P_{Loss}}{P} x\ 100\%$,
  $$\Delta P = \frac{59232}{3480000}\ x\ 100\ \% = 1.7\ \%\ \text{(in percent)}$$

From the data obtained through map source and the SLD of the Kijang, the load flow of the Kijang feeder can be simulated feeder Decrease the power of the Kijang feeder using the ETAP application as follows:

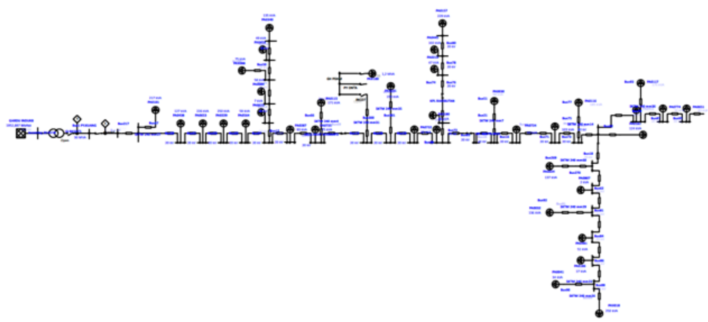


Figure 3. Single Line Diagram Kijang Feeder with ETAP

- Kancil Feeder Power Losses

  NA2XSEYBY 240 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 97{,}7^2\ x\ 0{,}152\ x\ 0{,}346$$
  $$P_z = 1506\ \text{W}$$

  AAAC 150 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 97{,}7^2\ x\ 0{,}275\ x\ 2{,}06$$
  $$P_z = 16222\ \text{W}$$

  AAACS 150 mm²
  $$P_z = 3.I^2.R.L$$
  $$P_z = 3\ x\ 97{,}7^2\ x\ 0{,}275\ x\ 3{,}7$$
  $$P_z = 29136\ \text{W}$$

  Total Power Losses on Kancil Feeder
  $$P_{Total} = 1506 + 16222 + 29136$$
  $$P_{Total} = 46864\ \text{W}$$

  If the amount of power loss has been obtained, then the power received is $P_R = P - P_Z$, then the value of the percentage (%) of power loss is $\Delta P = \frac{P_{Loss}}{P} x\ 100\%$,
  $$\Delta P = \frac{46864}{3040000}\ x\ 100\ \% = 1.5\ \%\ \text{(in percent)}$$

From the data obtained through map source and the SLD of the Kancil, the load flow of the Kancil feeder can be simulated feeder Decrease the power of the kancil feeder using the ETAP application as follows:

DOI: HTTPS://DOI.ORG/10.53893/IJRVOCAS.V1I4.70

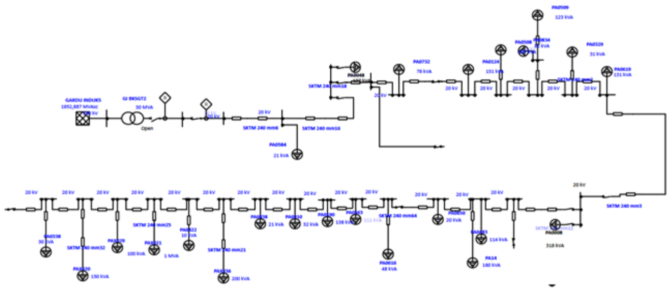


Figure 4. Single Line Diagram Kancil Feeder

- Singa Feeder Power Losses

  NA2XSEYBY 240 mm²

  $P_z = 3.I^2.R.L$

  $P_z = 3\ x\ 59{,}8^2\ x\ 0{,}152\ x\ 0{,}56$

  P_z = 913 W

  AAAC 150 mm²

  $P_z = 3.I^2.R.L$

  $P_z = 3\ x\ 59{,}8^2\ x\ 0{,}275\ x\ 0{,}45$

  P_z = 1327 W

  AAACS 150 mm²

  $P_z = 3.I^2.R.L$

  $P_z = 3\ x\ 59{,}8^2\ x\ 0{,}275\ x\ 2{,}8$

  P_z = 8260 W

  Total Power Losses on Kancil Feeder

  $P_{Total} = 913 + 1327 + 8260$

  P_{Total} = 10500 W

  If the amount of power loss has been obtained, then the power received is $P_R = P - P_Z$, then the value of the percentage (%) of power loss is $\Delta P = \frac{P_{Loss}}{P} x\ 100\%$,

  $\Delta P = \frac{10500}{1860000}\ x\ 100\ \% = 0.56\ \%$ (in percent)

From the data obtained through map source and the SLD of the Kancil, the load flow of the Kancil feeder can be simulated feeder Decrease the power of the kancil feeder using the ETAP application as follows:

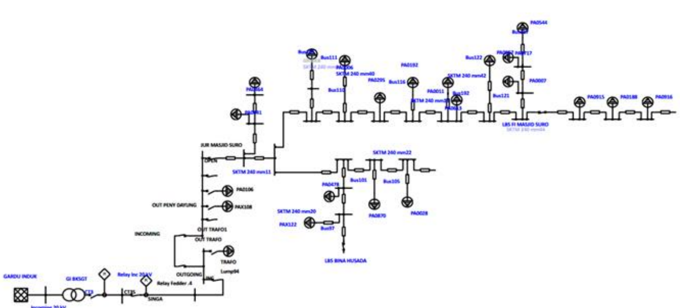


Figure 5. Single Line Diagram Singa Feeder

3.3 Losses Power on Maneuvering Conditions

Singa feeder load can be fully maneuvered to 2 feeders, simulation in this report maneuver the Singa feeder load in zone 2 after the output of Mayor subtation circuit, and simulated with the ETAP. Calculation of the power loss of the Singa feeder after being maneuvered can be done by adding up the power loss of the singa feeder and the feeder to be maneuvered, namely the kijang feeder and the kancil feeder.

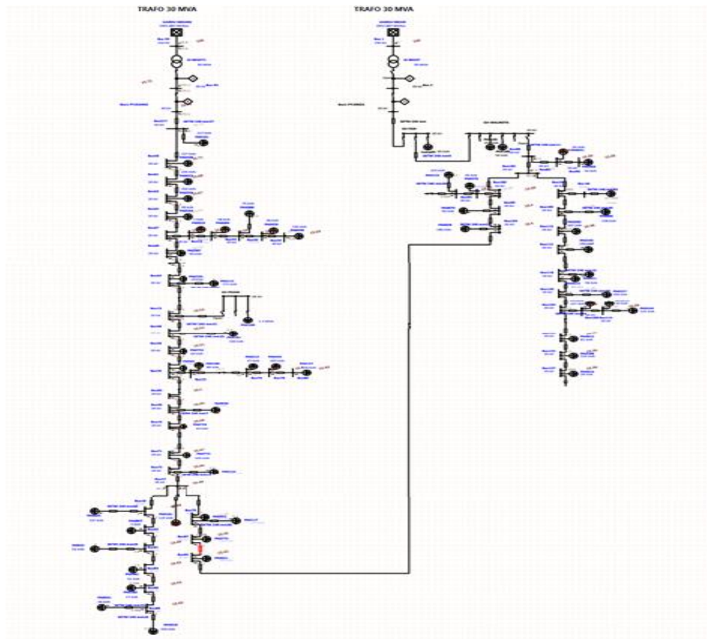


Figure 6. ETAP Simulation Maneuvering Single Line Diagram

3.3.1 Losses Power on Singa Feeder Maneuvered to Kijang Feeder

Singa Feeder loses power after being maneuvered into the Kijang feeder through the Talang Semut LBS.

✓ Power Losses on Kijang Feeder Maneuver in Singa Feeder

Power Losess = ΔW Kijang + ΔW Singa
= 59232 + 10500
= 69732 W

$\Delta P = \frac{69732}{5340000} x\ 100\% = 1{,}3\%$

3.3.2 Losses Power on Singa Feeder Maneuvered to Kancil Feeder

Singa Feeder loses power after being maneuvered into the Kancil feeder through the Musi 6 LBS.

✓ Power Losses on Kijang Feeder Maneuver in Kancil Feeder

Power Losess = ΔW Kancil + ΔW Singa
= 46864 + 10500
= 57364 W

3. 4 Main Priority Analysis

Based on the results of calculations and simulations using ETAP obtained the following data :

DOI: HTTPS://DOI.ORG/10.53893/IJRVOCAS.V1I4.70

Table 4. Power Losses Normal Conditions

Feeder	Power Losses		Power Losses (%)	
	Calculate (W)	ETAP Simulation (W)	Calculate (W)	ETAP Simulation (W)
Kijang	59232	14500	1.7%	0.416%
Kancil	46864	23600	1.5%	0.776%
Singa	10500	1600	0.56%	0.086%

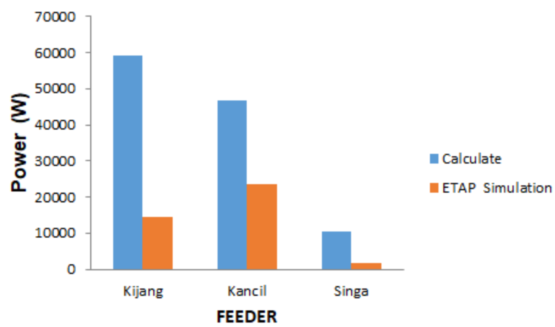


Figure 8. Calculate Power Losses at Maeuver Condition

Table 5. Power Losses Maneuver Conditions

Feeder	Power Losses		Power Losses (%)	
	Calculate (W)	ETAP Simulation (W)	Calculate (W)	ETAP Simulation (W)
Singa - Kijang	69732	49500	1.3%	0.923%
Singa - Kancil	57364	50400	1.17%	1%

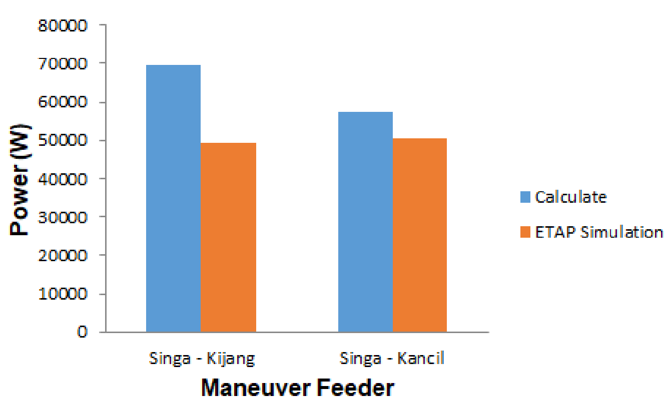


Figure 9. ETAP Simulation Power Losses at Maeuver Condition

From the table and graph above, it is known that the Kijang feeder is the most optimal feeder based on the shrinkage value after being maneuvered using the ETAP simulation. However, there are differences from manual calculations and using ETAP simulations where the manual calculation priority scale shows that the Kancil feeder is more optimal in the shrinkage value. This is because in manual calculations the load is considered to be at the end of the channel so that the value of the current flowing at the base of the channel to the end of the channel remains the same. Meanwhile, using ETAP simulation, the load can be accurately simulated the position of the load with respect to the conductor, which causes the current flowing at the base of the channel to the end of the channel to be different so that the calculations carried out can be more accurate as in real conditions.

This difference is seen more clearly in the shrinkage value of the Kancil feeder which is larger than the Kijang feeder. Where, in the ETAP simulation the Kancil feeder has a conductor length of 1.37 km which is located at the base of the network which has no load while the Kijang feeder only has the longest conductor of 400 m at the base of the network where the current flowing at the base of the network is greater than in the middle. and the end of the network

The difference is also seen in the value of shrinkage during maneuvering. The position of the maneuvering point on the Talang Semut LBS, located at the end of the Kijang feeder resulted in an increase in the current value in almost the entire Kijang feeder channel and then it was divided into the Singa feeder channel. When compared to the Kancil feeder, whose maneuvering point is at the base of the feeder, the increase in current value only occurs at the base of the Kancil feeder channel, then it is divided into the Singa feeder channel where only the base of the Kancil feeder experiences an increase in current value.

The value of shrinkage on the Kijang and Kancil feeders in normal conditions and in a state of maneuver does not exceed the standard set by SPLN 72: 1987 which is below 2% so that the order of priority patterns for maneuvering the Singa feeder is as follows: 1). Kijang Feeder, 2). Kancil Feeder

4 Conclusion

The two feeders who maneuver the singa feeder, namely the kijang feeder and the kancil feeder, have a power loss value that is still within normal limits and in accordance with the standards set by SPLN 72: 1987, which is below 2%, so it is no longer necessary to improve the power loss value of the feeder.

The priority scale for maneuvering the Singa feeder based on the power loss value is the Kijang feeder because the Kijang feeder power loss value is better than the mouse Kijang feeder. From the results of manual calculations and ETAP simulations, the final results in looking for power losses are differences in results and the differences are quite visible. Finding the value of power loss using ETAP simulation, the

DOI: HTTPS://DOI.ORG/10.53893/IJRVOCAS.V1I4.70

load can be accurately simulated the position of the load against the conductor so that the calculations carried out can be more accurate like real conditions. While the manual calculation of the load is considered to be at the end of the channel. This means that manual calculations can be used to find power losses, only the results obtained are less efficient and less accurate in accordance with the reality that occurs in the field.

ACKNOWLEDGMENT

The author would like to thank the Manager, Supervisor, and all employees of PT PLN (Persero) UP3 Palembang who have helped in this research.

REFERENCES

[1] Alif Karnandi Ode, Moethia Faridha "*Pengaruh Manuver Jaringan Distribusi 20 Kv Terhadap Indeks Keandalan Penyulang BT07 Batulicin"* ode | EEICT (Electric, Electronic, Instrumentation, Control, Telecommunication) (uniska-bjm.ac.id), 2020

[2] Aj Firdaus, *"Analisa Beban Section Untuk Menentukan Alternatif Manuver Jaringan Distribusi 20 Kv Penyulang Brg-3 PT. PLN (Persero) Unit Layanan Salatia"*, - Jtet (Jurnal Teknik Elektro Terapan), Jurnal.Polines.Ac.Id 2013

[3] Arismunandar, Artono. 2004. Teknik Tenaga Listrik Jilid II. Jakarta : PT. Pradnya Paramita

[4] Cekdin, Cekmas. 2013. Transmisi Daya Listrik. Yogyakarta : Andi

[5] Kadir, Abdul (2000). Distribusi Dan Utilisasi Tenaga Listrik. Jakarta: UI – Press.

[6] L. Multa and R. P. Aridani, "Modul Pelatihan ETAP," Modul Pelatih. ETAP, 2013.

[7] Ratno Wibowo, Winayu, dkk. 2010. Buku I Kriteria Disain Enjinering Konstruksi Jaringan Distribusi Tenaga Listrik. Jakarta Selatan: PT.PLN (Persero)

[8] Sarimun, Wahyudi. 2016. Proteksi Sistem Distribusi Tenaga Listrik Edisi Kedua. Depok : Garamond.

[9] Suswanto, Daman. 2009. "Sistem Distribusi Tenaga Listrik".Padang : Erlangga

[10] Standar Perusahaan Listrik Negara (SPLN) 41-8. 1981. Hantaran Aluminium Campuran. Jakarta : Departemen Pertambangan dan Energi.

[11] Standar Perusahaan Listrik Negara (SPLN) 41-10. 1991. Syarat Penghantar. Jakarta Selatan : Departemen Pertambangan dan Energi

[12] Standar Perusahaan Listrik Negara (SPLN) 52-3. 1983. Pola Pengaman Sistem. Jakarta Selatan : Departemen Pertambangan dan Energi.

[13] Standar Perusahaan Listrik Negara (SPLN) 72. 1991. Spesifikasi desain urntuk Jaringan Tegangan Menengah (JTM) dan Jaringan Tegangan Rendah (JTR) Jakarta Selatan : Departemen Pertambangan dan Energi

[14] Stevenson, William D. 2000. Analisa Sistem Tenaga Listrik. Jakarta : Erlangga

[15] Zuhal, (1995). Dasar Teknik Tenaga Listrik dan Elektronika Daya. Jakarta : PT Gramedia Pustaka Utama.