AN EFFECT OF UNBALANCED LOAD USAGE OF ELECTRICAL EQUIPMENT

Zuraidah Tharo[1], Amani Darma Tarigan[2], Rahmadsyah Pulungan,[3] Solly Aryza[4],

Andysah Putere Utama Siahaan[5]

Fakulty Science and Tekhnologi, Universitas Pembangunan Pancabudi, Medan, North Sumatera Indonesia

Abstract: *Usage Unbalanced expenses are considered normal for electricity consumers and often found in the field. There are a lot of Distribution Substation of 20 KV installed to serve electricity users, and the lack of management of the installation of kWh Meter based on the profile of each customer that is different from each other, as well as the varying use of electrical energy in each customer causing an unbalanced distribution of Distribution Transformers. A raises another problem, namely the loss of electrical power due to an imbalance in the Electric Load in each phase. Therefore, the authors analyze the effect of load imbalances on the age of electrical equipment. Then apply the right steps to balance the transformer load, so that consumers are expected to understand the consequences of Electric Load Imbalance better.*

Keywords: *Distribution Transformer, Load Imbalance, Electric Equipment Age.*

1. INTRODUCTION:

The process of distributing electrical energy starts from generation (PLTA, PLTM, PLTMG, PLTB, PLTS) then to Transmission (SUTET, SUTT) then to Distribution (TM) and ends at Consumer (TR) [1]. The process is a stage in the process of distributing electrical energy to get to consumers. Regarding the Medium Voltage Distribution (TM) so that it reaches consumers of Low Voltage (TR), it must go through a process of voltage reduction through a Transformer Distribution TM 20 kV. Distribution Transformer 20 kV serves to reduce voltage, from a voltage of 20 kV to a voltage of 400/231 volts, so that the consumption voltage in the community can utilize it [2].

The 20 kV transformer uses a 3 phase winding system (delta-wye), for Delta on the Middle-End, and wye on the Low Voltage side [3][4]. TR distribution to consumers consists of 3 phases, namely Phase R, Phase S, Phase T plus Neutral. Low Voltage PLN consumers divided into two more groups based on their usage, namely 3 phases and 1 phase customers. Then, divided again based on the different load contracts in each period, so that the energy usage in each consumer is increasingly varied. From this problem, another problem arises, namely the unbalance of the use of load which directly affects the current value in each phase of R, S, and T which is different [5].

Load imbalance will cause a loss effect not only for PLN companies but also consumers. The loss for PLN is the amount of energy that not channeled, the value of service voltage that not achieved, shortening the age of the electrical equipment and disruption of distribution often occurs. While the disadvantages for consumers are among those that are poorly received low voltage quality so that the electrical energy used is not by the needs of consumer household electrical equipment [6].

The imbalance will have a direct impact on the Distribution Transformer of 20 kV, starting from the current to the load whose values are different in each phase, so that on the Neutral side will have a present value. Under normal circumstances, if the phase R, S, and T are balanced, the current in Neutral is 0. Neutral which has a current value will undoubtedly cause equipment damage and loss. The damage that will arise from damage 20 kV Distribution Transformer, PHB-TR Equipment (Low-Voltage Contact Equipment), Low Voltage Cable Line (SKTR),

Channels Home (SR) and kWH [7]. While the loss that will arise is the loss of electrical energy from the neutral side and grounding and quality of service voltage is not achieved. Efforts that can be made to balance the load in each of the 3 phases are through the balancing process with methods that are by the conditions of distribution and consumer profiles. By applying the correct way, is expected that there would be a decrease in energy loss from the side of the load imbalance Distribution Transformer 20 kV [8]. This condition causes other problems, namely regarding the age of transformers decreasing and the damage of energy that should be utilized but the distribution loss at each Distribution Transformer is 20 kV [9]. Thus causing the unbalanced Transformer load to become out of control. The impact of more significant injuries. Followed by the 20 kV Distribution Station, there are a lot of Transformers whose balance is> 30% so that they become Targets

2. METHOD OF RESEARCH:

Research or problem analysis can be seen from the frequent damage to electrical equipment used, this causes curiosity as to the cause of damage to the computer, after having checked the electrical installation network there is no

problem, the research focused on Distribution Transformer 20 KV and its effect on equipment life due to load imbalance. The parameters observed in this study are:
1. Distribution Transformer 20 KV
2. 3 phase load on Distribution Transformer 20 KV
3. Electrical equipment that is damaged
Data were obtained from several electricity customers around the researchers.

Data analysis steps:
Determination of Balancing Targets
Based on Unbalanced Load that is not> 30% of transformer capacity, filtering can be carried out based on the results of quarterly data (October-December) measuring the load of substations - distribution stations 20 kV of the working area of PT. PLN (Persero) New Medan Rayon.

Load Balancing Simulation
Based on the measurement data of WBP and LWBP load, a load sharing simulation is performed in each phase, to determine how much the load is transferred in each phase. For the success of the work of balancing the load of the WBP and LWBP methods it is necessary to arrange the work order, so that the results can be maximized. Work order or Operating Standard from the balancing of the burden of the WBP and LWBP methods, is arranged as follows:
1. Determine the transformer that will be balanced.
2. Observe the JTR (Low Voltage Network) for all directions to the end of the network.
3. Record interesting things found such as:
a. There is one branch which only consists of 2 phases
b. A JTR connection
c. Anywhere there is an SR series
d. Where there are 3 phase customers
e. Where there are 1 phase large customers
f. Where there are non-household customers
g Is there a PJU load
h. Is there a load of tent stalls that only open at night.
4. Make a mark on the TR network that will be done.
5. Measure load (before balance) with tang ampere at night and during the day, which is right/good with the following criteria:
a. Normal weather / sunny (not cloudy/rainy)
b. The substation to be measured is not being hit by a blackout schedule
c. At the time of measurement it is during working days (not holidays). It's better between Monday and Thursday.
d. At substations that will be measured in normal conditions, there are no crowded events (open stage, world cup finals, etc.).
e. During the measurement process there is no single balancing activity in the field, such as identifying the phase or amperage of the customer.
6. Enter measurement data into the WBP and LWBP balancing simulations and try to simulate even though in this simulation we cannot simulate precisely because there is no exact data regarding:
a. How many customers in what phase
b. From "what phase to phase" the customer will be moved.
c. "About any customer" who will be moved.
d. "How much ampere" will be moved.
e. Print / print "Customer Transfer Recommendations"
f. Give the printed sheet "Recommendations for Transferring Customers" to officers to be executed in the field.
g Prepare all work equipment, K2K3 equipment, balance forms, and communication tools. Coordinate with relevant parties if blackouts are needed.
h. Perform load transfer work for load balancing work.
i. Perform repeated measurements, after the execution of the work of balancing the load on the same relative hour at the time of measurement, compare the differences before and after the execution of load balancing work.
j. Perform a load assessment, and provide an analysis of what steps will be taken by rearranging the load per phase per department. If it turns out that the results are insignificant, then balance the second stage within one week.
k. Enter measurement data on the work results in the field and match the previous balancing simulation data. Evalusai and analysis.
l. Print/print the "Evaluation" sheet. From this evaluation sheet can be seen how well the balancing results have been carried out.

Based on simple calculation results from the data that have done, it will be easier to determine the current value displacement that must be carried out, but it is not possible to move the current value based on the conditions in the field. Not only the factor of customer profile, but there are other technical factors into consideration, such as loading conditions in each department. The balancing process is carried out based on the results of the WBP measurement taking into account the results of the LWBP measurement during the balancing process in the field. The following are some of the balancing conditions that have been carried out by simulating and technical factors that occur during the balancing process. Measuring transformer neutral earthing resistance aims to find out how much the resistance value of the transformer neutral phase so that it could use as a calculation of the lost value due to the imbalance of the RS - T phase on a 20 kV distribution transformer. - each substation.

3. ANALYZE AND RESULTS.:

There are several different points between the balancing based on the simulation of the measurement of the results of the measurement with the adjustment of load balancing based on field conditions, including:

1. Balancing based on load measurement data with current value equalization method in each phase until reaching the average value is not an absolute benchmark to be used as an equilibrium provision in the field, but rather becomes a reference to how much the value of the load to be transferred or taken in each phase requiring. Because if it is absolutely based on the value of the load transfer based on the simulation, it will be very difficult to obtain this value because the value of the load usage in each customer is different up and down. Improving must be based on the susceptible habits of using the load in each phase in each of the majors.
2. There is also where the balancing conditions are only carried out through the transfer of a full load to an empty load in the direction of the substation because it is indeed more balance is needed to balance the transformer main phase load alone.

The simulation results of LWBP and WBP measurement data will be a good reference in balancing the load in the field because we can see how much load will be diverted during the day so that at night, the diverted load is also in accordance with the WBP balancing needs.

Based on measurement data that has been carried out after the balancing process, the difference in the reduction of neutral phase current values at night WBP and LWBP during the day can be obtained. So it can be interpreted that the balance process of the 20 kV distribution transformer load has improved even though the neutral phase current value is still close to zero. The following data corrects neutral phase current values before and after balancing is carried out.

Table. 1 Balancing Result Data

NO GARDU	BEBAN INDUK (SEBELUM)								BEBAN INDUK (SETELAH)							
	SIANG (LWBP)				MALAM (WBP)				SIANG (LWBP)				MALAM (WBP)			
	R	S	T	N	R	S	T	N	R	S	T	N	R	S	T	N
BS 070	63	45	76	30	95	52	123	64	59	60	59	15	102	89	92	35
BS 074	133	202	155	69	183	191	110	67	175	176	157	41	184	188	149	40
BS 115	56	39	44	20	114	29	41	53	47	62	64	15	47	62	64	15
BS 008	81	147	79	107	87	123	84	93	132	125	128	36	111	127	142	49
BS 006	69	110	121	50	58	100	147	57	105	85	79	23	122	111	88	35
BS 151	47	81	67	37	44	119	45	65	83	70	90	25	83	95	51	37
BS 150	32	6	22	22	44	8	22	32	16	22	22	10	28	15	22	16
BS 160	43	66	67	23	53	81	92	35	55	64	57	19	68	75	80	26
BS 073	75	104	60	43	97	110	58	45	77	90	80	22	95	79	88	23
BS 099	19	54	37	35	82	58	104	53	38	31	36	15	82	78	83	30
BS 111	80	61	103	52	112	82	134	70	79	71	94	21	105	125	128	52
BS 140	38	45	53	18	49	85	95	37	45	44	43	16	68	73	88	23
BS 174	27	12	14	13	43	26	32	19	19	18	14	11	33	36	32	13
BS 053	104	128	176	58	76	89	117	38	107	116	163	48	93	89	96	19
BS 110	23	26	41	17	48	41	74	21	22	23	33	12	54	52	60	18
BS 125	57	69	49	31	100	142	80	56	55	55	62	21	100	111	110	23
BS 142	64	64	42	32	97	82	64	46	62	67	54	22	83	82	75	25

Based on the measurement data after the balancing process is carried out, the author calculates to find the current value that flows in the neutral phase so that it can later be compared to the acquisition of saving kWh values between real in the field based on the calculation results. Here's the data:

Tables. 2 Neutral Phase Calculation Data

NO	NO GARDU	PENGUKURAN								PERHITUNGAN							
		SIANG				MALAM				SIANG				MALAM			
		R	S	T	N	R	S	T	N	R	S	T	N	R	S	T	N
1	BS 070	59	60	59	15	102	89	92	35	59	60	59	1	102	89	92	12
2	BS 074	175	176	157	41	184	188	149	40	175	176	157	18	184	188	149	37
3	BS 115	47	62	64	15	47	62	64	15	47	62	64	16	47	62	64	16
4	BS 008	132	125	128	36	111	127	142	49	132	125	128	6	111	127	142	27
5	BS 006	105	85	79	23	122	111	88	35	105	85	79	24	122	111	88	30
6	BS 151	83	70	90	25	83	95	51	37	83	70	90	18	83	95	51	39
7	BS 150	16	22	22	10	28	15	22	16	16	22	22	6	28	15	22	11
8	BS 160	55	64	57	19	68	75	80	26	55	64	57	8	68	75	80	10
9	BS 073	77	90	80	22	95	79	88	23	77	90	80	12	95	79	88	14
10	BS 099	38	31	36	15	82	78	83	30	38	31	36	6	82	78	83	5
11	BS 111	79	71	94	21	105	125	128	52	79	71	94	20	105	125	128	27
12	BS 140	45	44	43	16	68	73	88	23	45	44	43	2	68	73	88	18
13	BS 174	19	18	14	11	33	36	32	13	19	18	14	5	33	36	32	7
14	BS 053	107	116	163	48	93	89	96	19	107	116	163	52	93	89	96	6
15	BS 110	22	23	33	12	54	52	60	18	22	23	33	10	54	52	60	7
16	BS 125	55	55	62	21	100	111	110	23	55	55	62	5	100	111	110	10
17	BS 142	62	67	54	22	83	82	75	25	62	67	54	11	83	82	75	7

Based on the measurement data that has been carried out after the balancing process, it can get quite a good change from the aspect of Unbalanced Distribution Transformer of 20 kV, so that it can be said that the balancing target based on the target> 30% 20 kV Unbalanced Distribution Transformer has improved, although there are still some transformers that have not reached < 30%.

1. BS 070 substation no

Data from distribution transformers as follows:

a. Power: 100 kVA

b. Working Voltage: 21/20.5 / 20 / 19.5 / 19 kV // 400 V

c. Transformer: 1 x 3 phasa

Sehingga dari data di atas dapat dihitung:

S = 100 kVA

V = 0,4 kV phasa – phas

4. CONCLUSION:

1. Unbalanced loading on a 20 kV distribution transformer causes current to flow on neutral conductors. This current becomes a loss that must be borne by PT PLN because along the neutral conduct line there is resistance.
2. Load equalization is done by rewiring the customer's home connection from the dense phase to the lightweight aspect.
3. With a load equalization program on Distribution Transformers of 20 kV, the results of suppression losses in neutral conducts are 65.68 kW (LWBP conditions) and 72.72 kW (WBP conditions) based on measurement results.
4. Based on the measurement results, the results of suppression losses are 41.79 kW (LWBP conditions) and 44.82 kW (WBP conditions).
5. The differences that occur between the results of data based on measurements and calculations are due to several factors, including Transformer age, transformer oil content, transformer coil condition, lose contact conductor, neutral grounding resistance value, and precision measuring instrument.
6. Load balancing on transformers can extend the life of electrical equipment.

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