Analysis of Lightning Disruption Reduction in HVAD Tower 70 kV Parallel Inductance Grounding using NA2XSY Cable in West Java

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***Abstract*— The Sumadra - Pameungpeuk region has an uneven geographical location because it is traversed by mountains and beaches and has a high level of ISO Keraunic which causes many lightning strikes to occur in this region. The disturbance caused by lightning strikes is very worrying because it can disrupt the stability of electric power in West Java, Integrated Service Unit (ISU) Cirebon region in particular and can harm consumers as users of electricity. To minimize the disruption caused by lightning strikes in this study using the parallel mounting inductance method using NA2XSY cable. This study aims if there is a lightning strike on the GSW wire it can be immediately properly grounded. NA2XSY cable was chosen as direct grounding because the inductance value on the cable is smaller than the inductance value on the tower so that when NA2XSY cable is paralleled with the body tower it produces a low parallel inductance value so that it is expected to minimize the occurrence of back flashover due to the induction voltage resulting in the flash isolator. The results showed the lowest tower resistance value in the Sumadra-Pameungpeuk region of 0.21 ohms is located at tower number 77 and the highest resistance is 4.3 ohms at tower numbers 49 feet A and D, this meets PLN's standard of <5 ohms. Parallel inductance installation succeeded in reducing the disturbances caused by lightning, namely, in January-July 2018 the disruption occurred 4 times and in January - July 2019 became 2 times the disturbance.**

Keywords—***Lightning, Inductance, Back Flashover, HVAL, 70 kV.***

I. Introduction

In the electricity distribution system, the energy generated from the power plant is flowed through the transmission line and then into the distribution network to be distributed to customers [1, 2]. In general, the transmission line used is the High Voltage Air Line (HVAL) using bare wire by utilizing air as an insulating medium [3]. Wire conductor mounted on the tower construction tower that is strong and sturdy to withstand the load including the weight, tensile force and the force caused by wind exposure [4, 5].

HVAL is the most widely used in the (State Electricity Company) SEC network, because it is easy to assemble, especially for installation in mountainous areas and far from the highway, the price is relatively cheaper compared to the use of underground channels and easy maintenance. But sometimes the installed HVAL is in an area with a high potential for lightning strikes so that the transmission installation is prone to interference due to lightning strikes both direct and indirect strikes [6, 7].

To anticipate the disturbance caused by lightning strikes, efforts are needed to reduce the disturbance. Among these are the addition of insulators to increase (Basic Insulation Level) BIL, the addition of ground rods to reduce tower resistance values, and direct grounding using cables with low inductance values to reduce tower inductance values [8].

In general, if a disturbance due to lightning is corrected the first time is to reduce the value of security, not the value of inductance. For this reason, the writer is very interested in discussing the effectiveness of direct grounding using cables with low inductance values against lightning interference.

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II. Literature Review

Lightning, lightning, or lightning is a natural phenomenon that usually appears in the rainy season when the sky gives rise to a brief flash of dazzling light [9]. A few moments later followed by a thunderous sound called thunder. The difference in time of appearance is due to the difference between the speed of sound and the speed of light.

A. Factors Affecting Lightning Strikes

Factors that affect lightning strikes are the shape of objects on the surface of the earth, the effect of air resistivity, the effect of proximity to ground conductors, and the density of lightning strikes.

1. Shape of Objects on The Surface of The Earth

Lightning is more likely to grab high places on the surface of the earth. This is because the field strength around the edges or tops of the buildings is denser, and the nature of the load will tend to accumulate on the tops or ends of the pointed parts, as well as the sharp edges of the building.

2. Effect of Air Resistivity

Lightning currents will be released to earth through the most conductive or least resistive paths so that the lightning will look branched.

3. Proximity Effect of Ground Conductors

When a lightning rod conductor is passed by a lightning strike current, people or buildings around it will be able to be skipped by these flash currents, often called side-flashes or side-flashes. Electronic and microprocessor-based equipment can also be damaged by electromagnetic induction.

4. Lightning Strike Density

In planning for protection against lightning strikes, the density number must be reviewed in advance to determine the quality of the protection system to be installed. This can be known by using a map of thunder days per year (ISO Keraunic level) then looking for the price of correlation with the density of lightning strikes to the ground.

B. Disturbances Due to Lightning Strikes on the Transmission Line

The main threats to interference due to lightning strikes on High-Voltage Air Ducts (HVAD) and Extra-high-voltage Air Ducts (EHVAD) transmissions are back Flash Over (BFO) and Shielding Failures (SF) on channel isolators [10].

1. Back Flash Over (BFO)

BFO occurs due to lightning striking the ground wire (GW) or Ground Steel Wire (GSW) in the middle or quarter of the goal or lightning striking directly on the tower. Both of them cause lightning current to flow into the tower in the form of waves traveling to the foot of the tower and into the earthing system, reflected back to the tower and occurs through a flashover on the insulator which can disrupt the distribution of electrical power due to the breakdown of the insulator in the tower. This event is called back Flash over BFO [11].

In the course of this lightning impulse current to the earthing system, this current will pass through a tower that has a tower inductance, which is L in μH / m. the presence of L in the tower will produce a high voltage due to every lightning strike always has the steepness of the lightning current wave, i.e. di/dt in kA/μs, so that the voltage in the tower arises U = L in/dt in kilo Volt.

Lightning current is channeled through the tower into the earthing system which has an impulse ground resistance equal to Rimp. I in kilos Volt. A strike on the ground wire will cause the lightning current to split into two, namely to the left and right of the ground wire. Current and voltage impulses will flow to each nearby tower. The lightning current is divided according to the number of ground and tower wire branches, while the lightning steepness will remain the same [12].

2. Shielding Failures (SF)

SF are direct lightning strikes of phase wire (generally small lightning from the side of the transmission). The lightning impulse current along with the lightning impulse voltage will flow both directions on the phase wire, the impulse voltage (U) arises due to surge impedance (Z) or the surge impedance at the line (U = Z. ½ i). The impulse current and voltage will move as a traveling wave and arrive at an insulator in the nearest tower. If this impulse wave is greater than the strength of the impulse penetrating from the insulator (BIL isolator), then it occurs through flashing or SF which can cause electrical power disruption. Both of these, namely BFO and SF occur because ground and phase wires and towers have a Surge impedance that depends on the system's working voltage.

Surge impedance is the reaction of an air channel, ground wire, structure or material struck by a lightning impulse current. Because of the current shape of the impulse, the voltage generated is also an impulse as

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shown in the picture that there are three voltages generated namely DC, AC and Impulse.

Earth resistance or earth resistance which is measured a lot today is DC resistance, measured by the earth tester Rdc, not Rimpuls. DC or AC resistors are generally used for the calculation of short circuit (short circuit) with low frequency, not to calculate the voltage or impulse current that has a high frequency, which is 10 kHz – 100 MHz.

The impulse R is very dependent on the steepness of the lightning current, so if it is measured with a DC or AC meter the value of R is small but if the lightning impulse current is steeped, the R will be very high. Statistically, Indonesia has lightning currents with steep faces. Because of this surge impedance the impulse voltage will be very high if the impulse current hits the tower, ground wire, or phase wire. The most important determining factor for BFO and SF in isolators is that the lightning impulse current has the steepness of the current wave, which is di/dt in units of kA/μs [13].

C. Protection of Transmission Lines Against Lightning Strikes

In general, the protection of air conductivity using ground wire. This method is a fairly effective protection against direct strikes to phase wire. In addition, other alternatives can also be used, namely air conductivity without ground wire but must be equipped with other supporting devices, namely protector tubes or protective tubes. This technology is only for air delivery <30 kV and is rarely used. - Protection with Ground Wire - Grounding Prisoners - Protection with Tools [7].

III. Research Methodology

A. Use of Grounding Isolation in the Air Duct Power System

In general, the air duct power system has used earth insulation. However, there are still some power system channels that do not use ground isolation because estimates of rare lightning strikes occur in the trajectory of the power system or the ground resistivity in the surrounding area is substandard that the use of ground insulation is considered to be uneconomic.

Many distribution channels do not use earth insulation because they already use a neutral cable in the conductor phase. But truly neutral cables cannot protect the conductor phase from direct lightning strikes. The response of the air duct to the lightning strike directly depends on the design of the duct itself, this response also depends on the location of the strike, namely in the conductor phase, support poles or in areas near the power system. Each has a different response.

First the ground wire was installed to reduce the induced voltage in the conductor phase due to lightning strikes to the ground near the power system, but later research stated that voltage induction due to indirect strokes is not harmful to high voltage power systems, so the function of the grounding cable changes. The ground wire before it functions to protect the voltage induction from indirect lightning strikes has turned into a protective (shield) conductor phase from the threat of lightning strikes directly into the conductor phase.

The conductor phase is electrically isolated from the pole, meaning the bound insulator has a steady state limitation of the transient voltage frequency generated by switching or lightning. Shielding wire goes directly to the ground and sometimes shielding wire is also assisted by other equipment. It is important that the shield cable is directly connected to the ground on each pole because the shielding wire works effectively when the ground impedance can be connected directly to the ground.

In principle the function of the shield cable is to protect the conductor phase from lightning strikes directly to the conductor phase and to make this shield cable work properly is the shield cable must be installed in the right position so that all lightning strikes from the backflow current exceeding the critical limit can grab the shield cable without disturbing the conductor phase. Failure occurs when lightning strikes the conductor phase without hitting the shield cable. But if the backflow current exceeds the critical limit while the shield cable is not placed in the right place, then the strike can directly hit the conductor phase so that it can disrupt the power system channel.

B. Selection of Cables for Parallel Inductance Installation

The choice of cable specifications for parallel inductance installation is an important aspect to consider. In terms of function can be used optimally and in terms of more economical prices. The following is Table 1 specifications of several types of cables.

Table 1. Cable Characteristics

Characteristics	**Bare Copper**	**Copper Tape**	**NA2XSY**
Impedance (Ω)		230	
Inductance (H/m)	1 μ	963 n (0,93 μ)	0,556 μ
Capacitance (F/m)			
Cross sectional area of conductor (mm^2)	50	25 x 3 (75)	50
Resistance (m Ω/m)	0,3785		0,407
Price per m (IDR)	50.000	250.000	78.540

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In Table 1 there are four types of cables, the first is that bare copper has an inductance of 1 µH/m this is the same as the value of the tower inductance so that when paralleled it does not reduce the tower inductance. For copper tape cable has an inductance value close to 1 µH/m so that when paralleled with the tower body there is no significant decrease in the value of the inductance especially the price of this cable is very expensive and prone to theft because installation is done in an open HVAD tower and anyone can take it.

Considering that the inductance value is quite low at 0.556 µH/m, and the price is more economical, it was decided to use a 50 mm^2 NA2XSY cable in Parallel Inductance installation in the 70 kV Sumadra-Pameungpeuk HVAD Tower.

C. Parallel Inductance Installation Process

Planning for Parallel Inductance installation at the Sumadra-Pameungpeuk conveyor was carried out in April 2018 and was completed on 19 August 2018. For Parallel inductance installation the following materials are needed:

Table 2. Parallel Installation Materials Inductance

No	Material	Needs	
1	NA2XSY 50 mm^2 Single Core	30	meters
2	T plate Clamp GSW 55/GSW 55	1	Unit
3	Parallel Grooved Clamp GSW 55	4	Unit
4	GSW 55	8	meters
5	Aluminum cable shoes 50 mm^2 (2 bolt holes)	1	Unit
6	Aluminum cable shoes 50 mm^2 (hole 1 bolt)	2	Unit
7	Heat shrink outdoor termination Kit 50 mm^2	0,67	set
8	Stainless clamps	13	Unit
9	Cable ties stainless	26	Unit
10	Galvanized nut and bolt M 10 x 30	2	Unit
11	M 12 x 30 galvanized nuts and bolts	2	Unit

Parallel inductance installation process:

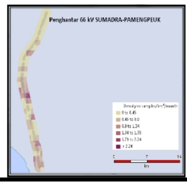
1. Preparation and transportation of materials and equipment to the work location.
2. Measuring ground foot resistance.
3. Parallel the GSW of the right and left sides of the tower using a parallel groove clamp.
4. Install 2 bolt hole cable shoes on the upper side of the NA2XSY cable and 1 hole cable shoe on the underside of the cable.
5. Install heat shrink on both sides of the NA2XSY cable end.
6. Raise the NA2XSY cable to the top of the tower by using a rope.
7. Install inductance cables in GSW parallel using T plate clamp.
8. Tie the NA2XSY cable to one side of the tower using a clamp.
9. Connecting NA2XSY cable with existing grounding feet.
10. Measuring ground resistors after parallel inductance mounting.

IV. Results and Discussion

D. Lightning Lightning Density

In 2017 the distribution of lightning in the Sumadra-Pameungpeuk region occurred from tower 1 to tower 80. The number of positive lightning was 39 times with an average positive current of 27,256 kA and negative lightning as much as 371 times with an average negative current of 28,744 kA.

Table 3. Sumadra-pameungpeuk Regional Lightning Density Density in 2017 and 2018

Description	Year 2017	Year 2018
Number of positive lightning	39 times	45 times
Number of negative lightning	371 times	574 times
Average positive current	27,256 kA	27,15556 kA
Average negative current	-28,744 kA	-24,409409 kA
Lightning Density Map		

In 2018 the distribution of lightning occurred around tower 44 to tower 79 with more lightning than in 2017, namely positive lightning 45 times, and negative lightning 574 times. The average lightning current in 2018 is lower than in 2017, namely a positive current of 27.155556 kA and a negative current of -24.409409 kA.

B. Grounding Tower Conditions

Grounding tower functions to attract lightning or receive lightning strikes to be channeled towards the ground. The smaller the ground foot prisoners the faster the lightning strike channeled to the ground. To reduce the earth value can be done by adding rods at the foot of the tower, this can be calculated using a parallel formula. The more rods installed the smaller the parallel value is

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important. According to the PLN standard the high voltage tower grounding values based on the voltage can be seen in the following table:

Table 4. Standard Grounding Tower Legs Based on the Voltage Value

No	Voltage	Grounding Standard
1	70 kV	< 5 ohm
2	150 kV	< 10 ohm
3	500 kV	< 10 ohm

To reduce the value of grounding the tower foot on the conductor of Sumadra-Pameungpeuk 3 x 4 grounding system is used in each tower foot there are 3 rods planted as deep as 3 meters. The following are ground foot tower data in the Sumadra Pameungpeuk area which has prisoners above 2 ohms.

Table 5. Grounding of the Sumadra-Pameungpeuk Tower

Tower	Parallel Ground				Highest Resistance Rating (Ohms)
	A	B	C	D	
44	3.10	3.10	3.00	3.10	3.10
45	2.6	2.7	2.6	2.6	2.70
46	2.7	2.7	2.7	2.7	2.70
47	3.60	3.50	3.50	3.50	3.60
48	2.3	2.3	2.3	2.3	2.30
49	4.3	4.2	4.2	4.3	4.30
50	3.4	3.4	3.4	3.4	3.40
51	2.6	2.5	2.6	2.5	2.60
52	2.5	2.5	2.5	2.5	2.50
53	1.90	1.90	1.90	2.00	2.00
55	2.5	2.5	2.5	2.5	2.50
56	2.5	2.5	2.5	2.5	2.50
58	2.5	2.5	2.5	2.5	2.50
61	2.3	2.3	2.3	2.3	2.30
64	2.03	2.03	2.03	2.03	2.03
71	2.2	2.2	2.2	2.2	2.20
72	2.8	2.8	2.8	2.8	2.80
77	0.21	0.21	0.21	0.21	0.21
Highest ground value					**4.3 Ohm**
Lowest ground value					**0.21 Ohm**

From Table 5 data it is known that the highest tower foot grounding value in the Sumadra-Pameungpeuk Conductor is 4.30 Ω, so that the grounding tower leg on this section meets the standard (ie <5 Ω).

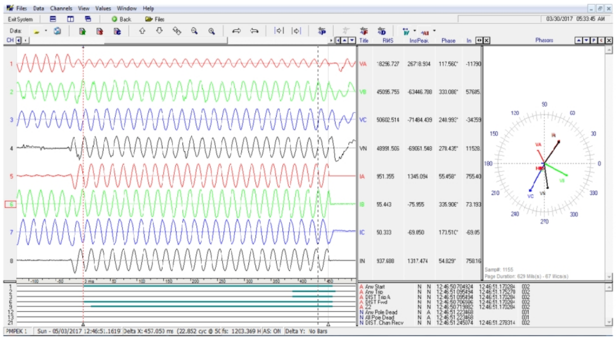

Figure 1. Recording of Distance Sumadra GI Relay 05 March 2017

C. Relays that Work When Interference Occurs

When there is a lightning disturbance in the Sumadra-Pameungpeuk region there are 2 relays that work distance relay and reclose.

1. Distance Relay

Distance relay is used as the main security in a transmission system. This relay works by measuring the amount of impedance and is divided into several security coverage areas, namely zone-1, zone-2, and zone-3, and is equipped with teleprotection in an effort to protect the work always fast and selectively in the security area.

Figure 1 is the result of distortion reading by distance relay on March 5, 2017 at GI Sumadra, which leads to Pameungpeuk 1. At 12:46:51, an interruption occurs in the RN phase in Zone-2 which is known from the high current and low voltage values when compared with phase S or T that is 951,355 A and voltage is 18,296,727 V.

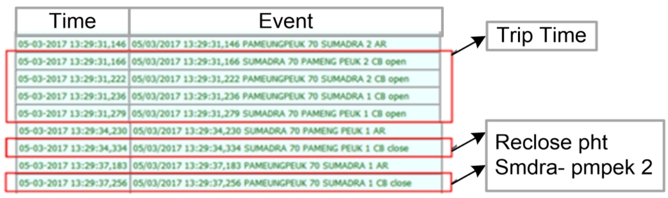

Figure 2. Display of PMT Work When Reclose on March 5, 2017

2. Reclose

Reclose works automatically to secure the system from over current due to short circuit. How to work is to close back and open automatically can be set an interval, if a temporary disturbance occurs, the reclose opens and closes again after the interruption disappears, if the interruption is permanent the reclose will open fixed (lock out).

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Figure 2 is one of the results of the reading of the event on March 05, 2017 the introduction of Sumadra-Pameungpeuk 1-2, the introduction of Sumadra-Pameungpeuk 2 trip at 13:29:31, and the introduction of Sumadra-Pameungpeuk 1 auto reclose at GI Sumadra is read at at 13:29:34, and at GI Pameungpeuk it reads at 13:29:37.

3. Grounding System Calculations

To calculate the lightning impulse voltage, one must learn how this lightning impulse current reaches the earthling system. An impulse current strikes across an inductance tower, which is L in µH/m. The existence of L in the tower produces high voltage due to each lightning strike always has the steepness of the lightning current wave, ie, di/dt in kA/µs, so that the tower voltage of V lightning impulse = L di/dt in kilo Volt. The lightning current channeled through the tower enters the earthing system has an impulse grounding resistance of R. thereby generating a voltage of V impulse = R x I in kilo Volts.

4. Calculation of The Existing Grounding System

The lightning impulse voltage at Sumadra-Pameungpeuk tower is as follows:

Lightning current = 31.7143 kA
Tower foot resistance = 4.30 Ω
H / mµTower inductance = 1
Distance of the top Cross Arm to the ground = 30 meters
in / sec = 30 kA / µs
The number of keeping isolators = 6, BIL = 610 kV
Then the voltage generated is:
U = (4.30 x 31.7143) + (1 x 30 x 30)
U = 136,37149 + 900 = 1036,37149 kV
(exceeds BIL Isolators)

It is known that the impulse resistance of insulators is 610 kV for 6 discs, then 1036,37149 kV> 610 kV. If the lightning surge voltage exceeds the breakdown voltage of the insulator, a back flash over (BFO) occurs.

5. Grounding system calculations after inductance parallel mounted

When using a 20 kV NA2XSY cable with a size of 50 mm2 which has an inductance value of 0.407 mH / km and is paralleled with a tower having an inductance value of 1 H / m, the total inductance value is lower than the value of the pure tower inductance.

Lightning current = 31.7143 kA
Tower foot resistance = 4.30 Ω
H / mµH / m, cable inductance =0.407 µ
Tower inductance = 1
Total Inductance $= \frac{1 \times 0,4}{1 + 0,4} = \frac{0,4}{1,4}$ =0,289 µH/m
Distance of the top phase Cross Arm to the ground = 30 meters
in / sec = 30 kA / µs
Number of keeping isolators = 6, BIL = 610 kV (attachment to FOV table)
Then the voltage generated is:
U = (4.30 x 31.7143) + (0.289 x 30 x 30)
U = 136.37149 + 260.1 = 396.47149 kV
(under the isolator BIL)

From the calculation results above the use of parallel inductance can be applied to reduce the level of interference caused by lightning, because it reduces the potential for a back flash over when a lightning strike occurs

E. Data Interference

To improve the protection system of an equipment needed disturbance data to find out how much the effect of interference caused by lightning on the transmission line. Following are the data of disruption that occurred in the delivery of Sumadra-Pameungpeuk during the period 2015 - July 2018.

Table 6. Sumadra-Pameungpeuk Disruption Data for 2015-July 2018

No	Conductor	Voltage	Total Tower	Operation Age	Lightning Interference			
					2015	2016	2017	Jan to July 2018
1	SMDRA-PMPEK	70 kV	81	22	6	9	6	4

From Table 6. it is known that the conductor of Sumadra-Pameungpeuk has 81 tower assets with an operating age of 2018 is 22 years. In 2015 the number of disturbances was the same as in 2017 which was 6 times, and in 2016 it was the year with the most number of disturbances which was 9 times, while in the January-July period 2018 the number of disruptions decreased by 4 times.

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Table 7. Data for Sumadra-Pameungpeuk Disruption August 2018-July 2019

No	Conductor	Voltage	Total Tower	Operation Age	Lightning Interference	
					2018 (Aug-Dec)	2019 (Jan -Jul)
1	SMDRA-PMPEK	70 kV	81	22	0	2

Table 7 noted that there were no disruptions during the August-December 2018 period and from January to July 2019 there were 2 disruptions. The breakdown and date of occurrence are explained in the following table.

Table 8 List of Sumadra-Pameungpeuk Disorders in 2019

No	PHT	Tower	Date	As a result of Disorders
1	SMDRA-PMPEK 1	D.50	30 Jan 2019	Gross isolator T.46-52; A.52 rusty conductor jumper terminals D.54 suspension nut missing, damper loose
2	SMDRA-PMPEK 1&2	D.48, D.55-56	01 Mar 2019	T.A46, and D.49 populated insulator

In 2018, the disturbance occurred in January to April 2018 while the Parallel Inductance was completed in August 2018, this means that during the period 2018 to 2019 after the parallel inductance installation, there were 2 times interference which resulted in reclose. From table-8 it can be seen that one of the causes of reclose due to lightning strikes is dirty insulators and corrosion on SUTT equipment apart from the quality of the grounding system itself.

F. Analysis and Discussion

Disturbances caused by lightning strikes on the tower are explained by several factors, namely isocruentic level, tower resistance, lightning current, and tower inductance. To minimize disturbances, not only decreases the tower resistance side, if the tower resistance is below the standard, but the inductance is high enough this will potentially lead to a back flashover because the voltage generated by lightning strikes is greater than the level of insulation ability at the isolator. Impact of flash to breakdown on the arching horn or the isolator.

From the results of disruption data occurred during the 2015-2019 period there was a significant decrease in disruption. It was proven that after the parallel inductance installation there was a decrease in the number of disturbances from what was originally in 2017 by 6 times, in 2018 before the parallel inductance was installed 4 times after the installation in August 2018 until July 2019 there were 2 times interference.

From the disturbance data in table-8 the disturbance is not only caused by insufficient lightning protection, but there are other factors that must be considered, namely the cleanliness of the insulator, because in 2019 the disturbance due to lightning strikes is caused by dirty insulators, dirty insulators can be conductive in humid, dew, and rainy weather conditions so that a leakage current will flow from the phase wire to the ground or vice versa through a conductive layer attached to the surface of the insulator.

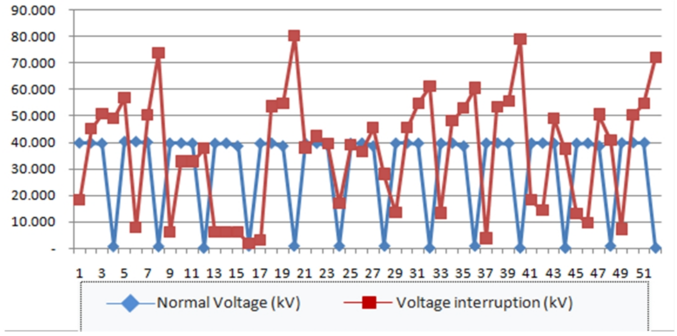

Figure 3. Comparison of Normal Voltage and Voltage When Interference Occurs

Graph display voltage and current under normal conditions and fault conditions during the period 2017-July 2019. This is intended to determine the comparison of voltage or current conditions under normal conditions with conditions when lightning disturbances occur.

From Figure 3 it is known that the comparison of two conditions, for blue, is the normal condition of each successive phase, namely R, S, T and N. Under normal conditions the voltage in the R, S, T phases can be said to be balanced ± 40 Volts with a voltage at Neutral approaching zero.

In the fault condition, illustrated in orange, the voltage in each phase is unstable, there is a decrease far below the normal stress condition and there are some that have increased. For interrupted phases due to lightning strikes the voltage decreases while other phases affected by the disturbance will experience a slight increase in voltage. For phase-neutral, if it is affected by phase-ground disturbance, the voltage at neutral which was originally close to zero will be very high at 80.159 kV.

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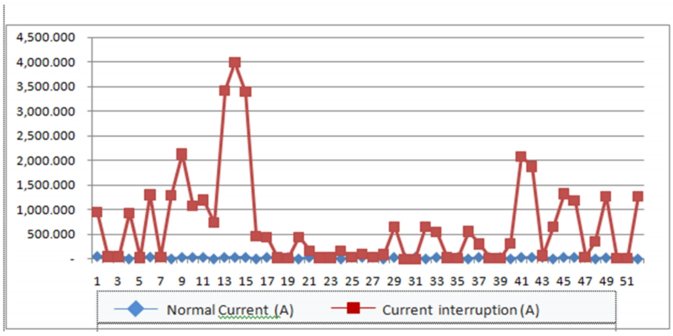

Figure 4. Comparison of Normal Current and Current When Interference Occurs

Figure 4 is a comparison of normal current conditions with lightning disturbance current conditions. Normal currents are depicted in blue and interference currents are represented in orange. Under normal conditions, the currents in the R, S, T phases tend to be stable depending on the load being channeled, which ranges from 24-50 Amperes. When there is a disturbance due to lightning strikes, the phase is interrupted with a very large current increase, with the highest current value of 3,996,197 amperes, which is when there is a 3 phase disturbance to the ground that occurred on December 8, 2017 which resulted in Sumadra-Pameungpeuk 1-2 trip.

V. Conclusion

From the discussion on the parallel inductance at the Sumadra-Pameungpeuk 70 kV tower, the following conclusions are obtained:

1. The lowest tower resistance value in the Sumadra-Pameungpeuk region of 0.21 ohms is located at tower number 77 and the highest resistance is 4.3 ohms at tower numbers 49 feet A and D, it meets PLN standards of <5 ohms.
2. Parallel inductance installation succeeded in reducing the disturbances caused by lightning, namely in January 2018 the disruption occurred 4 times and in January-July 2019 it became 2 times the interference.

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