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ANALYSIS OF LIGHTNING INTERFERENCE ON THE 500 KV DEPOK-TASIK TRANSMISSION TOWER

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ABSTRACT

Lightning is a natural phenomenon that can cause damage to transmission lines and cause disturbances in the distribution of electrical energy. Indonesia is a country with a high density of lightning strike in tropical areas such as in Java Island (Indonesia). The 500 kV Depok-Tasik transmission tower is part of the West Java interconnection. This transmission is 142 kms away and is supported by a tower of 340 units (tower 326-666), this transmission uses dual channels. This study aims to analyze and determine the method of lightning protection and to determine the magnitude of the voltage arising from a lightning strike in the 500kV transmission tower Depok-Tasik in order to be able to see the transmission parameters of the lightning density map, the trend of the time of the strike and the peak current frequency of the overvoltage caused by the lightning strike by analyzed using software falls. Software falls is a lightning analysis software used to study the relationship between lightning events and geographically referenced assets. Anomaly data on the 500kV Depok-Tasik conductor in 2021-2022 occurred 12 times, disturbances occurred 6 times in 2021 and 6 disturbances occurred in 2022, this can be a reference for asset inventory in the future.

Keyword: *Lightning, Transmission tower, 500 KV Depok- Tasik, Software Falls*

1. INTRODUCTION

Lightning is a serious problem for modern communities, direct lightning strokes can damage an object and hurt or even kill a living thing also Indirect lightning stroke can damage electronics and microcontroller stuff because it has very small or thin insulation [1]. Lightning is a natural phenomenon that can be analogous to a giant capacitor, where the first plate is the cloud (either the negative plate or the positive plate) and the second plate is the earth (considered neutral) [2].

Indonesia is an area with the highest thunder days per year in the world ranging from 180-260 thunder days per year with a density of lightning strikes to the ground (Ng) reaching 30 strikes per km² per year [3]. Transmission line fault case in PLN Trans-JBT from year 2015 till 2017 are dominated by tower accessories damage (42%) and then by lightning strike (27%) from total 557 case, this is due to high density of lightning strike in tropical area such as in Java Island (Indonesia) [4]. The height of the SUTT tower has a very high potential for lightning strikes. In maintaining the continuity of its distribution, routine maintenance and a good security system are needed to anticipate abnormal conditions [5]. The high voltage that exists between the conductor and the grounded tower or support pole causes ionization to occur which gives way for the electric charge induced by lightning to flow to the ground [6].

Lightning is a leading cause of outages on power utility transmission and distribution systems and the single largest cause of power outages in many lightning-prone regions in the world [7]. Generally, these power lines transverse high lightning corridors and are exposed to high lighting current magnitudes when the lightning strike occurs to or near the line [8]. Lightning strikes that hit the electric power

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system will cause overvoltage which is harmful to the equipment if allowed to flow through the system and be channeled to the load [9]. A direct lightning strike occurs when the strike hits the phase wires or ground wires in the transmission system, while an indirect lightning strike occurs when the strike hits the area around the transmission system [10].

Figure 1. Software Falls Front Page Logo

Common disturbances that cause severe damage to transmission and distribution systems are lightning and faults [11]. The 500kV Depok-Tasik transmission tower is part of the West Java interconnection. This transmission is 142 kms away and is supported by a tower of 340 units (tower 326-666), this transmission uses dual channels. This study aims to analyze and determine the method of lightning protection and to determine the magnitude of the voltage arising from a lightning strike in the 500kV transmission tower Depok-Tasik in order to be able to see the transmission parameters of the lightning density map, the trend of the time of the strike and the peak current frequency of the overvoltage caused by the lightning strike by analyzed using software falls. So that service providers can protect protection assets in the future for the Depok-Tasik 500kV transmission tower.

Software falls are lightning analysis software used to study the relationship between lightning events and geographically referenced assets [12]. In Figure 1, displays the logo on the main page of the Software Falls. Designing a simulation can be fuction to interpret initial data to help analyze and develop a technique or product in which it uses a combination of several approaches [13] [14].

2. METHOD

In Figure 2 shows about how the research process. The process begins with a literature study, the authors study the process of lightning occurrence, lightning protection on transmission lines, the introduction of software falls to study these software falls. Then model all parameters by entering the required parameter data. Then a simulation is carried out and the results are in the form of output data for analysis.

To find out the magnitude of lightning strikes and the number of lightning strikes per year and to find out locations with the highest lightning strikes, the Exposure type of analysis is used. to statistically assess design standards and general performance of assets. Procedure for use Exposure Analysis :

1. Specify the name of the analysis
2. Determine the data source
3. Determine the date and time of analysis
4. Determine the amplitude range
5. Determine the Expected Output.

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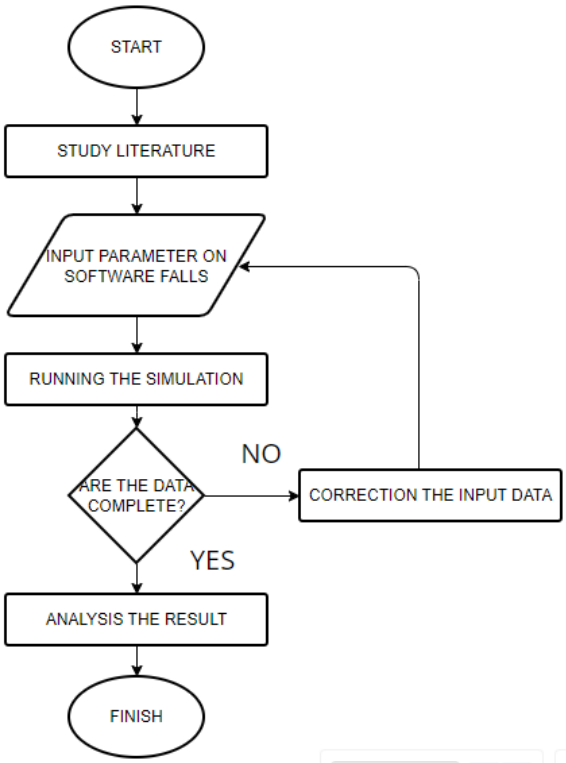

Figure 2. Research Flowchart

3. RESULT AND DISCUSSION

3.1. Lightning Strike Vulnerability Data on the 500 kV Depok-Tasik Conductor in 2021

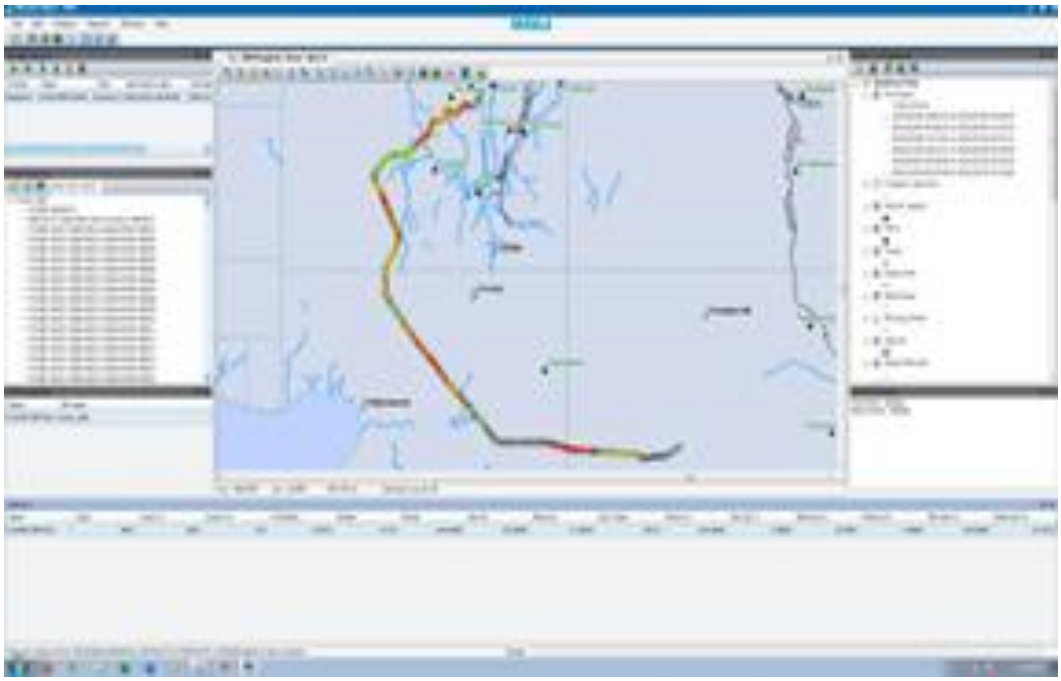

Figure 3. Lightning Density Map on the 500kV Depok-Tasik conductor in 2021

The results of the lightning strike hazard analysis using the falls software are shown in Figure 3, there are coordinates for towers with high lightning strike hazards indicated by red coordinates, which means the location of the tower is often hit by lightning.

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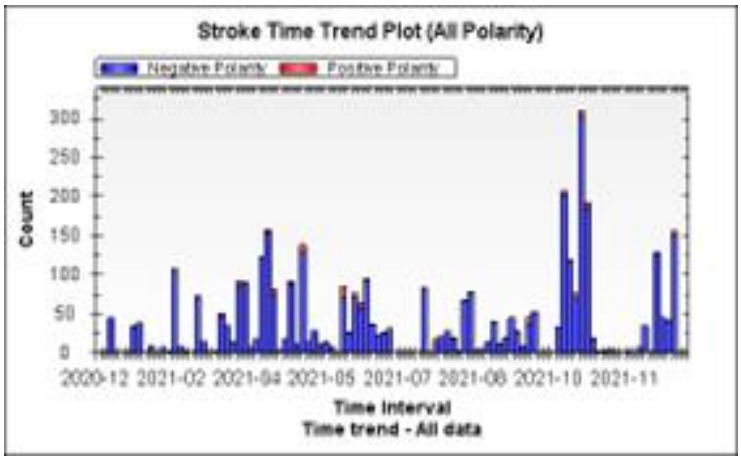

Figure 4. Time trend graph for the 500 kV Depok-Tasik conductor in 2021

From Figure 4, it is obtained that the lightning strike hazard data on the 500kV Depok-Tasik conductor surged in October. This is because in October until the end of the year it has entered the rainy season. Lightning occurs more frequently during the rainy season because in these circumstances the air contains a higher moisture content which causes the insulation power to decrease and currents to flow easily, so that the tower is easily struck.

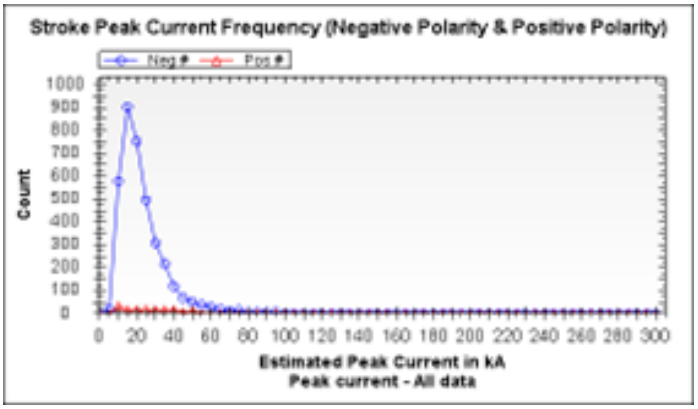

Figure 5. Graph of peak current frequency on the 500 kV Depok-Tasik conductor in 2021

The following is the data obtained from the analysis of the peak current frequency:
1. Peak current frequency 15kA = 600 times Lightning strike (negative)
2. Peak current frequency 20kA = 900 times lightning strikes (negative)
3. Peak current frequency 25kA = 800 times lightning strikes (negative)
4. Peak current frequency 27kA = 500 times lightning strikes (negative)
5. Peak current frequency 30kA = 300 times lightning strikes (negative)
6. Peak current frequency 35kA = 200 times lightning strikes (negative)
7. Peak current frequency 40kA = 100 times lightning strike (negative)

From Figure 5 it can be seen that the highest peak current frequency on the 500kV Depok-Tasik conductor is 40kA and the lowest peak current frequency is 15kA. The highest total lightning strikes occurred at a peak current of 20kA, which occurred 900 times, and the lowest total strike occurred at a peak current of 40kA, which occurred 100 times.

The 500kV Depok-Tasik conductor is supported by 340 towers starting from tower numbers 326-666. In this study, to determine lightning strike hazard data at tower locations, the authors grouped tower data according to tower locations sequentially. Towers totaling 340 towers are then grouped into 7 segments. One segment consists of 50 transmission towers, with details as follows:

Segment 1 = Towers 326-376

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Segment 2 = Towe rs 377-427
Segment 3 = Towers 428-478
Segment 4 = Towers 479-529
Segment 5 = Towers 530-580
Segment 6 = Towers 581-631
Segment 7 = Towers 631-666

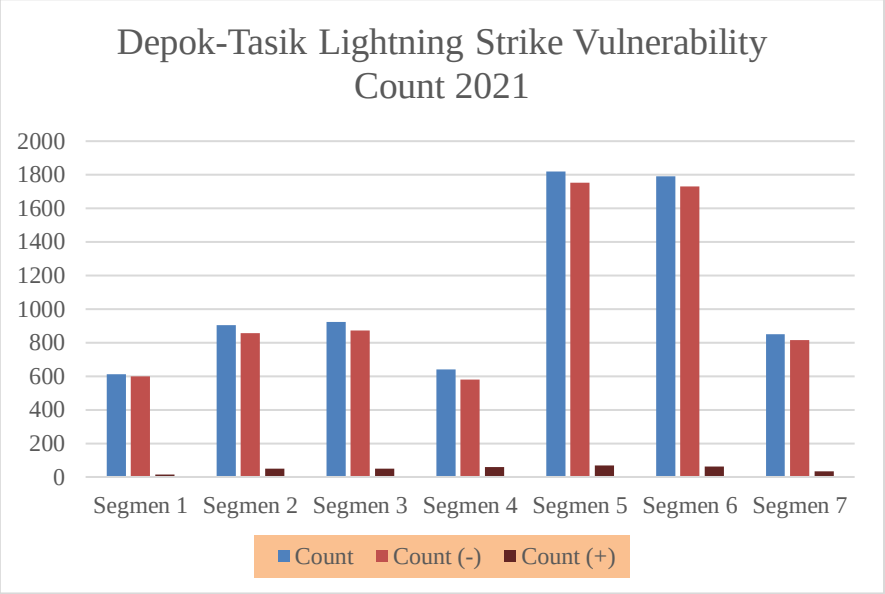

Figure 6. Graph of lightning strike hazard data on the 500kV Depok-Tasik conductor in 2021

In Figure 6, the data shows that the highest lightning strike hazard occurs in segment 5 (Tower 530-580), namely 1819 strikes and segment 6, namely 1791 strikes. Meanwhile, the lowest lightning strike hazard occurs in segment 1 (Tower 326-276), which is around 612 strikes.

3.2. Lightning Protection Methods to be Used in the 500 kV Depok-Tasik Conductor in 2021

The transmission line on the 500kV Depok-Tasik conductor is 142kms away and is supported by as many as 340 transmission towers. On each transmission tower, starting from tower 0326 – tower 666, 2 GSW (Guy Steel Wire) exiating has been installed as the lightning protection standard used. However, there are several towers with a high vulnerability to lightning strikes, so these towers use other methods to strengthen lightning protection. Among them, there are some that use the method of adding grounding, the i-GSW method and the insulated GSW. The selection of additional lightning reinforcement methods was carried out with several trials so as to get a method that matches the lightning strike vulnerability found in the tower.

4. CONCLUSION

Based on the results of studies that have been carried out, data processing using Falls software by entering various parameters, it is concluded that the highest total lightning strikes occur at a peak current frequency of 20 kA with the number of strikes hitting the tower 900 times; Lightning strikes relatively occur every month, with the highest number of lightning strikes occurring in October with 300 strikes; Lightning vulnerability data based on tower number shows that the tower located in segment 5 (Tower 530-580) has the highest lightning strike vulnerability, in that segment lightning strikes occurred around 1819 times in 2021; The lightning protection method used on the 500 kV Depok-Tasik conductor is installed by exiating 2 GSW (Guy Steel Wire) as the lightning protection standard used; Anomaly data on the 500kV Depok- Tasik conductor in 2021-2022 occurred 12 times, disturbances occurred 6 times in 2021 and 6 disturbances occurred in 2022. This can be a reference for asset inventory in the future.

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