Research on Fault Classification of High-Voltage Line Based on Electronic Detection Technology

Chao Yang, Chang Su, Cong Tian

Heilongjiang University of Technology, Jixi, Heilongjiang, 158100, China

Keywords: Fault Classification, High Voltage Line, Electronic Detection

Abstract: The high-voltage transmission line is an important aspect of China's social development at this stage, and it is also an important part of the power system. In order to better protect the stability of high-voltage transmission lines, it is extremely necessary to take effective and timely diagnosis of high-voltage transmission line faults and actively take various preventive measures. This article analyzes and discusses fault diagnosis and preventive measures for high voltage transmission lines.

1. Introduction

High voltage transmission lines are an important aspect of maintaining the normal operation of the power system. For the use of such high-voltage transmission lines, the safe and effective operation must require the corresponding management personnel to carry out comprehensive and detailed investigation and analysis of the various faults and hidden dangers in the entire high-voltage transmission line, and on this basis can Better guarantee the reliability of its operation. In particular, for some failures that have already occurred, it is indispensable to strengthen the diagnosis and investigation, and it is also necessary to do a good job of corresponding preventive measures.

2. High Voltage Transmission Line Fault Diagnosis

One of the basic preconditions for the fault diagnosis of high-voltage transmission lines is to understand the various types of faults in the current high-voltage transmission lines in a comprehensive and detailed manner so that the direction can be specified for subsequent diagnostic work. In general, the current common high-voltage transmission line failures mainly fall into the following four categories [1]:

Lightning strike failure. For the normal operation of high-voltage transmission lines, lightning strike failure is the most common type of failure, and its impact on high-voltage transmission lines is also the worst. And because of the characteristics of the use of high voltage transmission lines, the frequency of such lightning strikes is still relatively high. Especially for some high-voltage transmission lines erected at high altitudes, they are more likely to experience lightning strikes. This kind of lightning strike phenomenon is most prominent in some poles and towers, and it must be highly valued.

Mainly refers to a kind of bad influence and damage to the high-voltage transmission line because of the local wind power is relatively large, this kind of influence is relatively common to the high voltage transmission line. Especially in some areas with more complex terrain, the performance of the problem is still extremely prominent, and it is very easy to cause the breakage of high-voltage transmission lines. Once the high-voltage transmission line breaks, it will inevitably cause its normal transportation to be interrupted, and the hazard is relatively large. It may even cause casualties to nearby residents.

Mainly refers to the high-voltage transmission lines in the process of operation, because of birds on the high-voltage transmission lines have adverse effects and interference, and will seriously lead to the entire power system interruption. In fact, it is mainly due to improper detention of birds or damage to high-voltage transmission lines. Such damage may also lead to the breakage of lines.

  DOI: 10.25236/scmc.2019.096

3. High Voltage Transmission Line Fault Diagnosis Measures

Clear fault area. For the fault diagnosis work of high-voltage transmission lines, the most important one of their main tasks is to identify the corresponding fault area. The main reason for this kind of fault area is to rely on the specific reaction of the relevant fault to judge. In general, once a certain area of the high-voltage transmission line fails, the relevant power system in the area will be interrupted or a variety of fault performance, and thus it can ensure that the corresponding power troubleshooting personnel find the fault more quickly and timely. Occurrence area.

Corresponding fault diagnosis is performed for specific currents, voltages, or resistances in the fault area. From this point of view, the main fault diagnosis method is to take corresponding detection means in the fault area to obtain the specific information that you want to know, such as the current status in the fault area, and thus to respond to this information accordingly. Judgment, preliminary understanding of the main reasons for its failure, for example, found that the current in the fault area shows a more obvious failure problem, it is inevitable that there may be a ground fault [3].

For the initial diagnosis of the cause of the failure to conduct on-site verification and inspection. For the judgment of the type of faults obtained from the preliminary analysis, it is necessary to further analyze the actual conditions on site so that we can better understand the accuracy of its corresponding fault diagnosis and re-examine the phenomenon of the fault diagnosis fault. Until the root of the problem is found.

4. Implementation of Fault Classification of Transmission Lines

In accordance with the requirements of actual transmission line design and installation in China, a 500 kV double-ended power transmission line model with a length of 200 km was built in PSCAD/EMTDC.

The line model uses a frequency-dependent model to make the simulation model closer to the real-world physical system. In the case of power frequency, the positive sequence parameters are: $r1=0.01\Omega/km$, $x1=0.266\Omega/km$, $b1=0.4355\times10\text{-}5$ S/km; zero sequence parameter is $r0=0.278$ Ω/km, $x0=0.969$ Ω /km, $b0=0.271\times10\text{-}5$S/km. In this simulation model, there are 1087 groups of A, B and C three-phase current data of 10 types of faults with different fault positions, different transient resistances and different fault conditions. A total of 1087 groups are used as samples for fault classification, among which Ag fault 125 groups and Bg faults There were 125 groups, 94 Cg failures, 91 ABg failures, 108 BCg failures, 112 CAg failures, 119 AB failures, 109 BC failures, 121 CA failures, and 83 ABC failures [4].

To verify the adaptability of rough neural network-based fault classification methods to noise interference, Gaussian noise with a signal-to-noise ratio of 30 dB was injected into the fault current obtained from the simulation model. Take the threshold $\varepsilon0 = \varepsilon6 = 0.8$, $\varepsilon1 = \varepsilon5 = 0.3$, $\varepsilon2 = 0.008$, $\varepsilon3 = 0.08$, $\varepsilon4 = \varepsilon7 = 0.1$, and according to Section 3.1, extract the 13 groups of characteristics of each group of simulation data to form the transmission line fault classification The eigenvector Ti = [Ti1,Ti2,...,Ti13]T, i=1, 2,· · · , 1 087.

Fault analysis using single-ended data includes impedance, voltage, and solution equations. Impedance method is to use the voltage and current measured at one end of the line during a fault to calculate the impedance of the fault circuit, which is proportional to the distance from the point of measurement to the point of failure, so as to determine the fault distance. According to the voltage method [5], when the fault occurs on the transmission line, the voltage at the fault point has a minimum value. By calculating the distribution along each fault phase voltage, the lowest point of the fault phase voltage is found to achieve fault location. According to this, it also proposes to calculate the voltage along the fault line distribution of the positive sequence fault component, negative sequence and zero sequence component, and find the highest point of the voltage to achieve fault location. Comparing the two methods is more simple. The solution equation method is based on transmission line parameters and system models, and uses the voltage and current of the distance measurement point to find the distance of the fault point directly by solving the equations.

The solution equation method includes the solution of a complex equation and a solution of a differential equation, the former being solved in the frequency domain and the latter being solved in the time domain.

1) Measurement of line parameters. In the fault analysis method, the transmission line parameter calculation method is performed under a variety of assumptions, and it is difficult to ensure that the transmission line parameters are consistent with the actual situation on the site. The parameters of the high-voltage transmission line are also affected by factors such as geology, climate, and uneven distribution of earth resistivity along the line, and even the length of the line varies with the season, which is an important cause of ranging error. 2) The issue of collection of power frequency electrical quantity. Because the current and voltage in the algorithm adopt the power frequency electric quantity, in the transient process of the fault, the current and voltage include the non-periodic component, the power frequency component and each harmonic component. Therefore, the collected data must be digital before fault location. Filtering. 3) Synchronization of sampled data. The two-end synchronization method at both ends uses a simple and accurate synchronization algorithm. First, it is necessary to solve the problem of simultaneous sampling at both ends of the line. The traditional clock synchronization method is difficult to meet requirements. The precise time signal transmitted by GPS has laid a solid foundation for achieving high-precision fault location with double-end accuracy. However, there is a need to increase hardware devices such as GPS receivers and the cost is high. At the same time, actual distance measurement depends on the reliable operation of GPS. In addition, the hardware in the site still has a certain time delay for the collected information. Therefore, it is difficult for both ends to achieve true data synchronization. Therefore, there are certain limitations in application.

5. Failure Prevention Measures for High Voltage Transmission Lines

For the common fault types of high-voltage transmission lines, the corresponding preventive measures should also be multi-faceted, and only the protection of its various aspects of the influencing factors and root causes of the failure can be better controlled, in order to ultimately enhance its corresponding Fault prevention effect.

One of the most effective measures for the most common lightning strikes in the operation of high-voltage transmission lines is to install lightning protection facilities in corresponding locations. This can achieve a better lightning protection effect, especially for lightning arresters on various towers. For the installation, its active prevention and prevention value is still relatively high. In addition, in order to reduce the possibility of lightning strikes on high-voltage transmission lines as much as possible, strict control should also be taken for the selection of their corresponding lines, ensuring that their line selection is in some moderate areas, and high-voltage transmission such as poles and towers should be avoided as much as possible. Equipment, which is also a key point to reduce the possibility of lightning strikes.

For the impact of the wind power on the operation of the high voltage transmission line, the most important preventive measure is to reinforce the high voltage transmission line. This kind of reinforcement operation is significant for the stability of the high voltage transmission line. Specifically, the reinforcement operation of such a high-voltage transmission line mainly involves the following two aspects: On the one hand, the corresponding tower structure should be reinforced to ensure that the tower has a strong reliability and stability, avoiding the tower in the wind There are problems such as collapse under the effect; on the other hand, strict control and monitoring of high-voltage transmission lines should be carried out, especially for some high-voltage transmission lines with relatively large distances, and the use of joint transmission lines can be used. Fix each other and enhance their resistance to wind.

For high-voltage transmission line breakage faults caused by various natural or external factors in the operation of high-voltage transmission lines, control and checks must be carried out from the roots. This kind of root control is mainly directed at high-voltage transmission lines. The choices are controlled, in particular, a strict review of the material of the high voltage transmission lines. The material of this kind of high-voltage transmission line has attracted people's attention during the entire design process of the high-voltage transmission line, but often the designer will always tend to consider the energy consumption problem of this transmission line selection, and its stability. However, it is rarely involved, which means that the corresponding high-voltage transmission line designers should ensure as much as possible that they have strong strength and tensile strength. In addition, effective design should be made for the cross-sectional area of these high-voltage transmission lines. The increase in the cross-sectional area also helps to increase its corresponding strength, but its cross-sectional area does not increase indefinitely. It also needs to take into account the weight of the transmission line itself so that it can guarantee its corresponding use effect.

6. Conclusion

During the operation of high-voltage transmission lines, the occurrence of faults is relatively common, and the types of these faults are also varied. For example, lightning strike failures, wind failures, bird damage failures, and natural disaster failures are relatively common. Based on this, it is extremely necessary to strengthen fault diagnosis. Through a comprehensive and effective diagnosis to understand the type and location of the corresponding fault, and take corresponding measures to prevent it according to the fault, it can be seen that the corresponding prevention is extremely effective. The necessary and most critical point. Of course, this kind of prevention must take the diagnosis as the basic premise and reference. For these failures, besides giving high attention to the construction of high-voltage transmission lines and improving the quality of their construction, they should also focus on strengthening some lightning strikes. The concern of the problem is to use the most reasonable grounding or lightning protection measures to strengthen the protection of high-voltage transmission lines and avoid the occurrence of various failure problems as much as possible.

References

[1] Bo Z Q, Aggarwal R K, Johns A T, et al. A new approach to phase selection using fault generated high frequency noise and neural networks [J]. IEEE Transactions on Power Delivery, 1997, 12(1): 106 -115.

[2] Mahanty R N, Dutta G P B. Application of RBF neural network to fault classification and location in transmission lines [J]. IEE Proceedings: Generation, Transmission and Distribution, 2004, 151(2): 201-212.

[3] Silva K M, Souza B A, Brito N S D. Fault detection and classification in transmission lines based on wavelet transform and ANN[J]. IEEE Transactions on Power Delivery, 2006, 21(4): 2058-2063.

[4] Youssef O A S. New algorithm to phase selection based on wavelet transforms [J]. IEEE Transactions on Power Delivery, 2002, 17(4): 908-914.

[5] Pradhan A K, Routray A, Pati S, et al. Wavelet fuzzy combined approach for fault classification of a series-compensated transmission line[J]. IEEE Transactions on Power Delivery, 2004, 19(4): 1612-1618.