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Review on Risk Assessment of Power System

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Abstract

With electric power system becoming more and more complex and intelligent these days, its uncertainty also increases. This paper classifies the references of the risk assessment on power system from the aspects of evaluation hierarchy, evaluation category, evaluation model, power system status, time and simulation algorithm. The purpose of this paper is to reveal the research status and compared the advantages and disadvantages of the methods used. And the future development of risk assessment on power system is also prospected.

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Keywords: power system; risk assessment; review

1. Introduction

With electric power system becoming more and more complex and intelligent these days, its uncertainty also increases. This brings new challenges to risk assessment and management of the power system. The risk assessment of power system has been developed for nearly half a century, from deterministic methods to probabilistic methods, from local to wide area, from simple to complex research methods. However, the risk assessment of power system has its specific typical and relative independence. Therefore, the classification of risk assessment of power system brings a lot of confusions to researchers and engineers.

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This paper classifies the risk assessment of power system from the aspects of evaluation hierarchy, evaluation category, evaluation model, power system status, time and simulation algorithm, from which the research status and future development direction can be seen. At the same time, some new research methods are introduced, and their characteristics are summarized for reference. Finally, the future development of risk assessment on power system is prospected.

2. Classification of risk assessment on power system

2.1. Classification by evaluation hierarchy

At present, there are a lot of classification methods on risk assessment of power system, which can be divided into component level and system level according to the classification of evaluation hierarchy. Some analyzed from component level[1-2]. A risk assessment method of power system based on risk theory was presented by Zhang Yiming[1]. By means of five kinds of risk indicators, the risk level and importance of each component in the system are determined. However, the impact of the number of risk indicators on the evaluation results should be further studied. D. E. Newman analyzed the influence of the network upgrade on the long-term dynamics and large-scale cascading failure probability in the power transmission system through the global dynamic model[2]. The author concluded that redundancy should be added to reduce the risk of large scale blackout.

Most other papers of risk assessment on power system generally evaluated from the system level[3-4]. Hou Hui summarized the modeling methods of safety risk assessment for power system under snow and ice disaster[3]. The author pointed out that there was still a lack of research on the risk assessment of power system under ice and snow disaster. A model was established to simulate typhoon and assessed loss separately from the resulting power outages[4]. In the future, historical data could be corrected to improve the precision of the model by studying the impact of global climate change on hurricane behavior.

2.2. Classification by evaluation category

The researches of risk assessment on power system can be classified according to power generation, transmission, and distribution system according to evaluation category. Li Wenyuan pointed out that assessing the risk on power system from three functions simultaneously was not realistic[5].

Reliability evaluations on power generation system were introduced in some researches[6-7]. Wang Jing evaluated the reliability of power generation system by combining the total probability formula and Monte Carlo method[6]. On the basis of ensuring the reliability index close to the target value, the calculation was greatly simplified. In the future, the author would continue to discuss how to select the generator parameters to minimize the computational cost. Luo Yi established an evaluation model on reliability of microgrid generation system by using Nataf exchange principle and multiple Gauss numerical integral method of probability and considering the correlation of output of Distributed Generator (DG)[7]. The disadvantage was that the constraints of the components were not considered.

Some researchers evaluated the reliability of power generation and transmission systems[8-9]. Yu Xiang pointed out that the model of reliability evaluation on power generation and transmission systems should include two modules: the mathematical model for the components of power generation and transmission systems and system voltage correction[8]. However, the author did not enumerate examples. Based on the analytical method and the simulation method, a hybrid algorithm was proposed to evaluate the cascading failures of power generation and transmission systems[9]. The method had certain advantages both in accuracy and efficiency.

Others evaluated the reliability of power distribution system[10-11]. Wang Chengshan divided the complex distribution network, and put forward the regional benchmark simulation and simplified regional simulation[10]. The author used the forward reasoning to calculate the reliability index. The advantage of this method was that the simulation speed was improved. The disadvantage was that the defect of non-sequential Monte Carlo method could not be avoided. Xie Kaigui spread the consequence of the faulty of switch over the two sides of the switch, so as to avoid analyzing the switch[11]. The calculation efficiency was improved. However, when the grid was very complex, the traversing algorithm would reduce the computational efficiency.