Research on High-Voltage Transmission System Operation on the Same Tower

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Abstract. The high-voltage DC adopts the simulation idea of a two-circuit system on the same convertor. The current DC system availability indicators were insufficient and proposed two reliability indicators, operating utilization and operating availability. At the same time, the active planned outage mode and the activities planned energy unavailability rate index was proposed, and the reliability evaluation program algorithm analysis based on programming developed to verify the feasibility of the power outage maintenance optimization mode, and at the same time provide certain guidance and reference significance for the subsequent design work of the same type of research. A calculation algorithm for evaluating the impact of the outage DC on the reliability of the system is proposed to calculate the value of the transmission system.

1. Introduction
The content of this research is mainly to propose new indicators to quantify the reliability and service levels of transmission companies. DC to DC can operate independently or jointly. Because of the existing problems of reliability indicators and the contradictions reflected in production and operation [1], the research has improved the existing indicators to form operation utilization rate and operation availability rate, which can better solve the problem in actual operation. Due to the important guiding role of the reliability assessment index system in the operation and management of electric power enterprises, to guide the operation and maintenance management of power transmission enterprises more scientifically and rationally, the reliability management index system must be continuously revised and improved to make it possible to view the overall situation [2].

2. Methods
The research methods focused more on the service life of the equipment itself, such as the theory of equipment condition based on life cycle cost, and the arrangement of equipment maintenance only considers the condition of the equipment itself. The literature proposes an overhaul plan based on the power grid risk theory, but there is no specific study on how to evaluate the impact of power transmission equipment overhaul on-grid risk [3]. Therefore, this research strictly follows the causality relationship and arranges the maintenance of the DC channel based on the influence value of the outage maintenance of the DC channel on the overall reliability of the power grid, which is significantly better than other research methods. The height of the demand is more reasonable to guide the operation and maintenance of the transmission system.
3. Double-Circuit Control System on The Same Tower

Because the control strategy and operation mode of the DC transmission system is quite different from that of the transmission system [4], the research did not consider the particularity of the DC system and the impact of the outage and repair of the DC channel on the overall reliability of the grid [5]. The structure of the converter station of the double-circuit DC transmission system on the same tower with a common station is shown in Figure 1.

![Structure diagram of a double-circuit DC transmission system with a common station on the same tower](image)

Figure 1. Structure diagram of a double-circuit DC transmission system with a common station on the same tower

According to the research content and objectives, the research finalized the implementation plan, and the implementation is divided into two main parts [6]. The first part is the improvement and application analysis of the DC reliability assessment index. The second part is the research on the application technology of power grid reliability assessment tools in the maintenance of DC equipment, including the construction of evaluation indicators and the application test of the optimal selection of DC outages [7]. Based on the analysis results, the active planned outage model is proposed to optimize the Equipment maintenance mechanism.

3.1. DC Station Control System

The construction and analysis of DC reliability evaluation indicators are divided into the investigation phase and the theoretical analysis phase. During the investigation stage, collect relevant information on the reliability of the DC system, and carry out the collection and sorting of relevant documents on reliability evaluation, and summarize the existing problems of reliability indicators and the contradictions reflected in production and operation [8]. In the theoretical analysis stage, new reliability index definitions and algorithms are conceived with the current situation as a breakthrough point to propose operation utilization and operation availability. Construct a calculation example based on the existing operating data, compare and analyze with traditional assessment indicators, verify the validity of the analysis reliability indicators [9].

3.2. DC Pole Control System

Aiming at the reliability impact assessment of the transmission system, the algorithm improvement, Pole Control System mainly focuses on the development of calculation software. The development of the simulation program is subdivided into two stages: interface development, reliability evaluation algorithm research. The purpose of the interface development is to convert and import the system power...
flow files in BA format into the simulation environment [10], to realize the prerequisites for the reading of power flow data and the development [11]. While the interface is being developed, the research has simultaneously carried out reliability evaluation algorithms, including the analysis of reliability algorithms, the construction of algorithm flow, and the research of algorithms [12].

4. Coordinated Control Function of Double-Circuit Dc System
The application research on the evaluation of the impact of DC outage on system reliability is divided into two stages: evaluation factor construction, reliability risk evaluation system construction. In the evaluation factor construction stage, proposed the evaluation factor unreliability contribution and analyzed the evaluation factor according to the simulation program developed in the second part, and improved the evaluation of the DC channel outage based on the summary of the application characteristics. Based on the results of the first stage, we proposed a reliability risk evaluation system, which can be divided into a DC outage risk evaluation system and a fuzzy risk evaluation system. Using various typical application tests were carried out to verify the operability of the quantitative assessment of the impact of DC outages in engineering applications, and to obtain the feasible basis for maintenance. Finally, a brief study discusses the influence of the light-load capacity of the transmission channel on the system reliability.

4.1. Double-Circuit Power Control Function
The research put forward concepts such as the active outage maintenance mode and the active energy unavailability indicators and verified the feasibility of the optimization of the power outage maintenance mode with a calculation example. Finally, based on the new indicators proposed in this research, combined with the development strategy and work focus of the system, the research proposed an optimized HV reliability system and explained the orientation and significance of the indicator system.

4.2. Coordination Principle of Double-Circuit Power Control
According to the simulation program developed in our research, the evaluation factor is calculated and analyzed, and the method of evaluating the impact of the DC outage is improved based on summarizing the application characteristics. Based on the results of the first stage, the research proposed a reliability risk evaluation system, which can be divided into a DC outage risk evaluation system and a fuzzy risk evaluation system. Using various typical operating modes, application tests were carried out to verify the operability of the quantitative assessment of the impact of DC outages in engineering applications, and to obtain the feasible basis for maintenance. The principle diagram of two-circuit DC power coordinated control is shown in Figure 2:

![Figure 2. Basic principle diagram of power coordinated control](image-url)
The index of operation utilization is proposed, which can measure the load intensity and utilization degree of the channel during operation, and better reflect the contribution of the energy availability rate of the transmission channel to the energy utilization rate. Combined with actual DC statistical data, the validity and rationality of the indicators are analyzed. The shortcomings of the availability index as an operation and maintenance assessment index, the operation index is proposed. This indicator replaces the capacity with the transmission power demand during the DC maintenance period for weighted conversion of the maintenance time so that the appropriate selection of the single-pole outage maintenance timing can be reasonably reflected in the index. Double-circuit DC system on the same tower regulator coordination control is shown in Figure 3:

![Figure 3. Double-circuit DC system on the same tower regulator coordination mode](image)

5. Results
The main research results are as follows:

1) The system analyzes the current shortcomings in the operation and maintenance of the DC system and its evaluation and assessment mechanism. It is pointed out that when the availability index is used to assess the operation and maintenance status, it is easy to guide the grassroots units to apply for less suspension and elimination to obtain high energy availability, and the hurry of shutdown and elimination will affect the quality of work, which increases the health level of equipment Potential risks of decline and forced outages.

2) Evaluated the reliability management index system and current status of the DC system adopted in my country. Based on the operational statistics of the circuit DCs, the statistical relationship between planned outages and forced outages is analyzed. Statistics show that there is a clear inverse relationship between the planned energy unavailability rate and the number of forced outages. It shows that if the right time is selected will help reduce DC outages and reduce the overall operational risk of the power grid.

6. Conclusion
The main feature of the research is the double DC system has a common starting point, a common drop point, a common line, and a common grounding pole. This special design makes the operation of the system more flexible, at the same time, the research has compiled simulation and proposed
concepts such as the index mode of active power and the active energy unavailability index, which provides strong operability for the practical engineering application of the theory.

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