# Research on Intelligent Electrical Energy Saving and Real-time Scheduling Control

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**Abstract:** With the construction of UHV power grid and the rapid development of new energy, the operation characteristics of the power grid have undergone major changes. The alarm processing function of the existing dispatching automation system can no longer meet the development requirements of the integrated operation of the extra-large power grid, and it is necessary to monitor the various services in the real-time monitoring. The alarm information is comprehensively processed to improve the overall sensing ability of the dispatching to the operating state of the power grid, and to respond to the emergency handling capability of the power grid fault. Combining the development and application of the integrated intelligent alarm function of the smart grid dispatching control system, this paper introduces its overall architecture and key technologies, and forms a comprehensive alarm for the dispatching operation mode, online rapid diagnosis of equipment faults and real-time fault information between multi-level dispatching sharing, and gives the demonstration application effect and future research prospects.

## 1. Introduction

With the rapid development of China's new energy and the construction of large-scale power grids with UHV grids as the backbone grids, the grid's operational characteristics have undergone major changes. Objectively, it is required to change the existing dispatching operation mode and improve the dispatching business innovation capability, especially the need to strengthen dispatching the intelligent level of accident handling and improving the efficiency of dispatching accidents to ensure the safe and sTable operation of large power grids. In recent years, scholars and experts at home and abroad have carried out in-depth research and preliminary practice around intelligent alarm technology, and achieved remarkable results. From the existing research results, it mainly focuses on two aspects: First, the use of expert systems, genetic algorithms and fuzzy sets and other artificial intelligence analysis algorithms to analyze and process the alarm information of the dispatcher to realize online diagnosis of equipment faults; On the other hand, combined with the characteristics of monitoring services, research on hierarchical classification, reasoning analysis and comprehensive display of alarm information.

## 2. Intelligent status of alarm information processing in dispatching automation system

With the advancement of the construction of UHV AC-DC interconnected power grids, the operational characteristics of regional power grids have changed significantly, and the risk of power outages of large-area equipment has been increasing due to the failure of single equipment. The results of the recent US and Canada power outages and the European blackouts show that the lack of information sharing between dispatching agencies at all levels is an important factor leading to the expansion of accidents. Therefore, it is necessary to study the wide-area distributed intelligent alarm technology, realize a little alarm and multi-point response of grid disturbance, and improve the coordinated processing capability of all levels of dispatching to cope with grid faults.

The practical level of online fault diagnosis of power grid needs to be improved. At present, online fault diagnosis algorithms are mostly based on a single data source, which is susceptible to the impact of basic data quality, and the accuracy of fault analysis is not high. Therefore, it is necessary to study online comprehensive fault diagnosis based on multi-source information fusion

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to improve the accuracy and practicality of online fault diagnosis. Level.

Independent production of various production systems within the former dispatch center, including energy management system (EMS), wide area measurement system (WAMS), online safety and stability warning, relay protection and fault information management system (referred to as Baoxin system) and lightning online monitoring After dozens of systems, the alarm information is distributed in each independent system, lacking effective integration and classification. In the dispatching operation monitoring, it is necessary to monitor the alarm information of multiple systems at the same time, which increases the pressure of alarm handling and is difficult to adapt to the integration of large power grids. Business requirements for the operation. Therefore, from the perspective of scheduling daily monitoring services, the unified alarm service interface is used to integrate, analyze, and display the alarm information of each application function, and improve the alarm handling efficiency of the operating personnel and the overall sensing ability of the grid operating state.

For this reason, the National Electric Power Dispatching Control Center (referred to as the National Tuning Center) has carried out in-depth research on the intelligentization of alarm information at the beginning of the design of the smart grid dispatching control system. This paper combines the development and application of the integrated intelligent alarm function of the smart grid dispatching control system. It is discussed from four aspects: its overall structure, key technologies, demonstration applications and subsequent prospects.

## 3. The Key technologies

The data source of the intelligent alarm is the original alarm information on the substation side. The previous intelligent alarms mostly use the centralized analysis architecture. The main station needs to collect a large number of original alarm information of the substation, which increases the data communication pressure between the main substation and the main station. The operation and maintenance workload of the terminal, therefore, it is necessary to study the distributed intelligent alarm architecture of the substation-regulation center, to realize the local identification and alarm direct transmission of the substation side of the equipment failure, optimize the alarm transmission content between the main substation, and reduce the main substation. A large amount of transmission of raw alarm information. In addition, with the enhancement of the integrated operation characteristics of the extra-large power grid, the risk of a single equipment failure affecting the entire network is increasing. Therefore, it is necessary to study the real-time sharing technology of the equipment failure alarm information to realize a little alarm and multi-point response of the grid disturbance. Supports the rapid coordination of faults between multi-level scheduling.

Firstly, according to the switch displacement and protection action signals, a heuristic search method is adopted to match the suspected fault component set that satisfies the alarm rule through the network topology analysis and the expert alarm rule base; on the basis of obtaining the suspect fault component set, further Determine whether the faulty device is powered before the fault. If the faulty device is not powered before the fault, the above alarm information caused by the two conditions of the equipment debugging alarm signal and the trial transmission failure is used to analyze the electrical quantity information of the PMU data or the fault recording data. Verification, if the current suddenly changes before and after the fault, it is a faulty device, otherwise it is debugging alarm information. In addition, for complex faults, a fault analysis method similar to the protection device (ie, soft protection fault analysis) is further adopted, and the faulty device is located based on the original waveform data of the fault recording. Based on the faulty equipment positioning, the fault details are analyzed by using the fault recording data or the fault briefing of the protection substation system, and the fault phase, fault ranging and short circuit current are obtained.

Substation intelligent alarm is the most reasonable technical solution to solve a large number of original alarm information transmission between the main substation. However, the substation intelligent alarm is still in the preliminary research stage, and the stability, reliability and alarm correctness of the software function need to be improved. The substation has been piloted and has not been extensively promoted. Therefore, at this stage, the main sub-station still transmits a large amount of original alarm information. However, with the development of the control integration service, the centralized monitoring of the substation needs to collect a large number of device status alarm information (the alarm signal of a single 500kV station). In the hundreds of thousands or so, or even more), the current data transmission between the main sub-station adopts the IEC60870-5-101/IEC60870-5-104 protocol, and the master station side must model the alarm information and configure the point number. Significantly increased the data communication pressure and operation and maintenance workload between the main substation, has been unable to adapt to the requirements of the development of the grid operation. In order to solve the above problems, the National Center has established Q/GDW11021-2013 “Substation Regulation Data Interaction Specification“, whose important content is to realize the direct transmission of substation alarms. The so-called substation alarm direct transmission is based on the existing substation monitoring system, adding a graphics gateway machine, converting the original alarm information of the substation into a standardized alarm clause, through DL/T476-2012 "Power System Real-Time Data Communication Application Layer Protocol" Directly transmitted to the dispatching master station, after receiving the substation alarm direct transmission information, the dispatching master station parses and processes the standardized alarm clauses, and obtains information such as alarm level, time, equipment and reason, and comprehensive intelligence at the main station side. The alarm function is classified and displayed. The definition of the alarm is directly described in the syslog mode. The alarms are described in the five-segment standard of “Level, Time, Device, Event, and Cause“. The segments are separated by spaces. The format is “<Alarm Level> <Space>. Alarm time <space> Device name <space> Alarm content <space> Alarm reason". For each specific definition, refer to the "Substation Control Data Interaction Specification", which will not be detailed in this paper.

In order to solve the problem of real-time sensing of fault information between multi-level scheduling, the integrated intelligent alarm function firstly proposes and realizes the real-time sharing of fault information between multi-level scheduling. The overall architecture is shown in Figure 3. Taking the control sub-center as an example, when a device failure occurs, the integrated intelligent alarm function on the control center side pushes the fault briefing (including the fault time, faulty equipment, fault phase, and coincidence situation) to the national adjustment center through the service bus of the basic platform. And fault ranging, etc.), after receiving the fault briefing push information, the national adjustment center sends the fault briefing confirmation information to realize the reliable transmission of the fault briefing, and the comprehensive intelligent alarm function of the national adjustment center analyzes and processes the alarm information. Figure alarm. In addition, the control sub-center similarly pushes the device fault briefing to the corresponding provincial adjustment center according to the monitoring right of the device.

The alarm information of grid equipment failure is divided into three categories: steady state data (including switch displacement, total accident signal, protection action signal, etc.), dynamic data (synchronized phasor data collected by PMU device in real time), and transient data (Fault recording), different types of data have different characteristics for the real-time and analysis results of fault analysis. The steady-state data has strong real-time performance and complete layout, but the analysis results can only cover the fault time, faulty equipment and coincidence; the PMU data has strong real-time performance and incomplete layout, and the analysis results can further obtain faults on the basis of steady-state data; The transient data has poor real-time performance and stability needs to be improved. At this stage, the conditions for full access are not available. However, the analysis results can further obtain fault location, short-circuit current and other information based on the PMU data. Therefore, it is necessary to comprehensively utilize various types of alarm information. On the one hand, the results of fault diagnosis are improved through different data characteristics, the real-time of fault diagnosis and the comprehensiveness of analysis results are improved, and on the other hand, redundancy between multi-source information is

Effectively solve the problem of false alarms caused by single error alarm information.

In the past, the online fault diagnosis algorithm was not enough to estimate the basic data quality problem at the beginning of the design, and there was no effective verification method for the error alarm information. After the actual operation, the overall false alarm rate was high, which affected its practical level. Therefore, the study of practical alarm information verification technology is the key to the design of grid online fault diagnosis algorithm, and it is also an important means to improve its practical level. Based on the basic data quality problem, the integrated intelligent alarm function focuses on the original alarm information and the alarm information of each application analysis result, and identifies the correctness of the alarm information to reduce the false alarm rate.

## 4. Conclusion

At present, the integrated intelligent alarm function mainly focuses on equipment fault location, and has weak support for fault handling after power grid operation state adjustment and power restoration. Scheduling and running experience is often the key factor to determine the efficiency of fault handling. The unstructured information such as scheduling fault handling experience, offline accident plan and equipment operation risk points are collected, integrated and object modeled to form a knowledge base of dispatch fault handling experts. Through the online matching with the expert knowledge base in the actual failure situation, the auxiliary suggestions for dispatching accidents are given, which can effectively improve the fault handling efficiency.

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