Construction Scheme of Regional Power Grid Dispatching Intelligent Error Prevention System Based on D5000

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Abstract: A construction scheme of regional power grid dispatching intelligent error prevention system based on D5000 system is proposed. The system architecture, system requirements, technical requirements and acceptance criteria of the system are described in detail. It provides reference for the construction of intelligent error prevention in the process of integration of regulation and control and intelligent layout in other power industry.

1. Introduction
With the overall layout of power industry dispatch and control integration, and the upgrading and transformation of the entire network automation and intelligence, continuous improvement in efficiency has been brought to production, operation and maintenance. More and more manual on-site operations have been transformed into intelligent remote control operation. While the intelligent system faithfully executes the operator's instructions, the remote control personnel's negligence, paralysis, and habitual operation techniques lead to misoperation, some security risks outside of past experience are also quietly generated[1-2].

Therefore, how to eliminate man-made safety hazards as much as possible in the remote control process has become one of the new safety research topics in the process of power industry dispatch and control integration and intelligent layout[3-4].

In the construction of the D5000 intelligent dispatching control system, the construction of the dispatch and control intelligent error prevention system is essential. This article analyzes the construction requirements of the intelligent error prevention system based on the construction of the regional power grid D5000 system, and studies the technical requirements and solutions of the system Program.

2. System Requirements

2.1. Timely accurate remote control anti-error warning
For any operation that does not conform to the remote control anti-misoperation specification, an obvious prompt and warning will be given immediately. The current operation should be restricted, and a detailed explanation of the reason for the prohibition of the operation will be given.

2.2. Flexible advisory error prevention design
When the operator has questions about the operation sequence, the verification can be actively initiated to the system, and the system will automatically detect whether the operation complies with
the error prevention rules. If the operator does not need to check, he can operate directly through the SCADA system normally without going through the system check, thereby maximizing the operating efficiency.

2.3. Accurate active prevention and control of key equipment
The system calibrates some equipment as an operable range. When actual operations are carried out through the SCADA system, the active prevention and control of key equipment can be realized in remote control to prevent unplanned misoperation.

2.4. Preview of remote control operation results based on the whole network topology
When the operator performs important equipment operations, the system will prompt the actual impact on the existing network, and alert to check whether it meets the operation objectives, and clarify the scope of influence after the remote operation.

2.5. Adaptive generation and dynamic synchronization of SVG graphics
No matter of the commissioning of a new station or the renovation of an old station, system maintenance personnel do not need to reconstruct the power grid model and draw SVG graphics. Through the dynamic synchronization of the intelligent power grid, the daily maintenance "minimum investment" should be realized.

3. Technical requirement description and solution

3.1. Technical requirement description

3.1.1. Batch tasks
SCADA does not block for batch tasks. No need to send verification requests to the error prevention system. The anti-error system should support the passive anti-error mode. The SCADA sends a verification request for the opening and closing operations of the circuit breaker or isolating switch, and the anti-error system returns the verification result after judgment. SCADA judges whether the remote control operation function for the circuit breaker or isolating switch can be unlocked according to the verification result.

3.1.2. Daily operations
For daily operations, analog operations need to be performed on the error prevention system first. The error prevention system verify the analog operation equipment and the operation sequence, then send it to the SCADA system after the verification is correct. The SCADA system judges whether it is based on the verification result. The remote control operation function for the circuit breaker or isolating switch can be unlocked and executed in accordance with the operation sequence verified by the anti-error system. If the name or sequence of the equipment operated on the SCADA is inconsistent with the result of the anti-error verification, remote control is prohibited.

(1) SCADA adds the “Anti-error check” button on the remote control interface. Clicking this button will trigger SCADA to send an anti-error check request to the anti-error system.

(2) On the remote control operation interface of SCADA, the original “remote control” button should be “Disable” by default. Only when SCADA sends an anti-error check request to the anti-error system and obtains the “Operation Allowed” error prevention verification, the “Remote Control” button can be enabled.

(3) The SCADA system should provide the decomposition requirements for configuring the global enable or disable the use of the above two SCADA systems. When enabled, the above two requirements take effect; when disabled, the SCADA default operation logic is restored. In special circumstances, the communication between SCADA and the anti-error system is interrupted, and the remote operation must be urgently performed, the required function can be used for remote operation.
(4) The anti-error system can configure any anti-error verification request sent by the SCADA to the anti-error system by default. And the anti-error verification result returned by the anti-error system should be “Operation Prohibited”.

(5) The anti-error system can be simulated by the logged-in user of the dispatcher (user category) on the system client. The income statement day after the simulated operation can be recorded in the anti-error system. It can also be automatically cleared after the operation is completed according to the needs.

(6) For the error prevention verification request sent by SCADA to the error prevention system, only the operation object is the equipment that has been simulated and operated on the error prevention system, and is consistent with the operation sequence simulated on the error prevention system, then the anti-error verification result returned by the anti-error system will be “Operation Allowed”.

(7) The types of equipment allowed to operate in the anti-error system can be selected according to requirements.

3.1.3. Communication protocol
The anti-error system communicates with SCADA in real time to obtain real-time remote signaling data by default, and the anti-error system synchronizes in real time after the remote signal displacement occurs on the SCADA system. At the same time, it is necessary to provide a function to manually initiate a remote call request to SCADA. The SCADA system communicates real-time data remotely with the anti-error system through 104 protocol.

3.1.4. Function priority
On the anti-error system, the login user of automation (user category) can set whether a factory station is controllable based on the factory station. If it is not set, the default is uncontrollable. The priority of this function is higher than 3.1.2. If it is not set to allow remote control of “Plant A”, even if the simulation operation of “Plant A” is performed on the anti-error system client and entered, SCADA is also not allowed to control the remote-control equipment of “Plant A” is operated.

3.1.5. Point table
The point table (correspondence between equipment point number and equipment ID) required for remote signaling of real-time data between the anti-error system and SCADA is automatically interacted by the anti-error system and SCADA through programs.

The SCADA system generates a file separately from the corresponding information of the remote communication device point number and the device ID, and sends it to the error prevention system regularly along with the CIM model file and the SVG graphic file. The file name of the point number relationship information of the remote signaling equipment sent to the anti-error system is “dianbiao.csv”, and the content is as follows:

1234, 220002306, chn01
1250, 220002309, chn01
1251, 220002501, chn02
……

The anti-error system can directly read the remote signal point number data from the dianbiao.csv file.

3.1.6. Programmatically import
The anti-error system should support the function of programmatically importing CIM model libraries and SVG graphic files.

(1) The SCADA system can regularly export CIM model library files, SVG graphic files, and remote communication equipment point number correspondence information (3.1.5). The file name should be the same each time for the error prevention system to determine the specified file.
(2) The SCADA system provides scripts or functions that can manually transmit the above-mentioned files to the error prevention system under special circumstances.

(3) The anti-error system can periodically check the CIM model library files sent by SCADA to the anti-error system. If there is a change in the model library file, it should be prompted that the CIM model of the logged-in user of the automation (user category) has changed.

(4) The error prevention system provides functions to reload the CIM model library, SVG graphic files, and the correspondence information of the point number of the remote communication equipment within five minutes, and the loading does not affect the normal operation of the anti-error system.

3.1.7. Logical judgment
The anti-error system supports the logical judgment of “hanging the power card”. The SCADA system can send the equipment maintenance card attribute maintenance card to the error prevention system through the real-time data channel with the error prevention system. If there is no notice, it is considered that the insurance card is not attached. The anti-error system can realize the operation prompt of “Equipment with the security card, operation is prohibited” when the user uses the simulated operation of the “3.1.2” function according to the data of the security card.

3.1.8. Other requirements
Other requirements of the anti-error system should be concise and clear, with simple and user-friendly functions such as zooming in and out. The blocking logic is provided as a tool for checking before the dispatcher orders and training and learning for newcomers. The system runs on the “Meditation Rock” operating system. The anti-error server should provide dual-system hot backup mode deployment.

3.2. Solution network diagram

4. Acceptance Criteria

4.1. Basic operating functions
Plant site management, user management, zoom in and zoom out of the main wiring diagram of the plant site, ground query, tag query, real-time data status query, anti-error calibration record query and other functions.

4.2. Reloading functions.
After the power grid model changes, SCADA re-exports the latest power grid model data to the error prevention system, which includes the CIM model, SVG graphics, and remote signaling point table, which are placed in the error prevention system. After the system has pre-determined the location, the latest power grid model data is reconverted and loaded into the error prevention system through the
4.3. Real-time data synchronization
The anti-error system and the SCADA system establish a real-time data exchange channel, and obtain real-time data of the entire network's remote signaling status based on the 104 protocol. On the SCADA system, after the remote signal is shifted, the error prevention system is synchronized in real time.

4.4. Configuration Adding
When the power grid model changes, the error prevention system retrieves the new plant by reloading the grid model data, and combines with other classification dimensions to classify the new plant and station. At the same time, it will automatically be displayed on the main interface of the error prevention system. Generate the button for the plant station.

4.5. Factory lockout function
After setting the lockout, for all the remote control verification requests sent by SCADA to the anti-error system for the factory station equipment, the anti-error system returns “Prohibited Operation”. After the setting is unlocked, the remote control verification request sent by SCADA is verified according to the whitelist.

4.6. Whitelist function
When the whitelist is activated, SCADA sends the devices recorded in the whitelist, the error prevention system returns “Verification Passed”, and sends the verification request of the devices not recorded in the whitelist, and the error prevention system returns “Prohibited Operation”.

The whitelist requires the display of the operation sequence, and the operation sequence has been checked by logic to prevent errors. The operation sequence of the remote control switch on SCADA is the same as the simulated remote control switch sequence on the error prevention. If the operation sequence is inconsistent, remote control is prohibited. This function is enabled by default, when the whitelist is empty, all remote control verification requests sent by SCADA, the anti-error system will return "Prohibited Operation".

4.7. Anti-error rule triggering
When the whitelist function is not activated, SCADA sends a verification request, and the anti-error system will judge according to the system's anti-error rule, and reply the verification result according to the actual existing network conditions.

4.8. Calibration interface
SCADA establishes a calibration channel to the anti-error system, sends an “error-proof verification request” to the anti-error system before remote operation, and responds according to the “error-proof verification result” message in the anti-error system. The content determines whether the SCADA remote control operation can be further executed, is prohibited or requires the remote control operator to determine whether it needs to continue.

5. Conclusion
This article combines the construction of the D5000 intelligent dispatching control system, summarizes the system requirements and technical description of the intelligent control and anti-error system construction program, and provides some references for the intelligent anti-error construction program in the construction process of other power industry control systems.

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