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Postprint of Intelligent Renovation of Power Distribution Safety in Broadcasting Stations

Authors: Qin Yican

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Abstract

Broadcast stations utilize dedicated mains power supply, are equipped with large-capacity UPS systems and emergency generators, and have conducted comprehensive drills for various emergency contingency plans. However, safety broadcast accidents caused by power distribution system issues account for 10% annually. Therefore, consideration should be given to introducing a dynamic monitoring system for electrical safety to implement intelligent transformation of power distribution safety.

Full Text

Intelligent Transformation of Power Distribution Safety in Radio and Television Stations

Abstract: Radio and television stations in China utilize dedicated municipal power supply lines, maintain large-capacity uninterruptible power supplies (UPS), and operate emergency generators, with comprehensive emergency response protocols and regular drills. Nevertheless, broadcast safety incidents attributable to power distribution system failures account for approximately 10% of annual occurrences. This paper argues for the implementation of dynamic electrical safety monitoring systems to enable intelligent transformation of power distribution safety management.

Keywords: Radio and television station power distribution systems; safe broadcasting; dynamic monitoring systems; intelligent transformation
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According to data from the China Fire Services Bureau' s *China Fire Statistics Yearbook*, electrical fires account for 30% of total annual fire incidents and

80% of major and catastrophic fires, making them the primary fire safety hazard. In 2017, over 10% of broadcast safety incidents in Guangxi' s radio and television system were caused by power supply failures. In one serious case at a municipal station, both municipal power lines tripped without the duty personnel' s knowledge, resulting in UPS power depletion and a major responsible accident involving multi-channel broadcast suspension for several hours. Given that electrical fires produce severe social impacts, radio and television station power distribution systems should implement dynamic electrical safety monitoring systems to establish early warning mechanisms. Such systems enable 24-hour continuous monitoring of electrical anomalies, allowing for prediction, forecasting, and prevention of electrical fires. Network technology can fill gaps in traditional fire safety monitoring, ensuring immediate detection of municipal power disconnections and eliminating hazards before incidents occur, thereby truly achieving stable prevention and effective control of safety accidents caused by distribution system failures.

1. Analysis of Hidden Danger Causes

Radio and television stations represent first-tier power supply guarantee units in China, utilizing independent dual-source municipal power dedicated lines, large-capacity UPS systems for all broadcasting equipment, and emergency generators with comprehensive emergency protocols and regular drills. Under normal circumstances, power distribution systems rarely experience problems. Hidden dangers primarily arise from two scenarios: first, electrical fires that destroy circuits; and second, power outages that go undetected. Despite the installation of traditional leakage switches and circuit breakers, electrical safety dynamic monitoring systems remain necessary for four key reasons.

First, current leakage switches and circuit breakers on the market are not required by international or domestic standards to have fire prevention functions. These devices require 1-2 hours to respond to line overload conditions (non-short-circuit scenarios). Second, these switches employ mechanical contact separation, generating electric arcs during disconnection that blacken the contacts. Combined with temperature fluctuations and oxidation from long-term use, parameter drift can cause switch failure, creating significant risks. Third, although monthly button testing is mandated for leakage and air switches, this requirement is virtually never met in practice, meaning protection functionality cannot be guaranteed over time. Fourth, when short-circuit faults trip circuit breakers and broadcasting systems automatically switch to UPS power, duty personnel may remain unaware, preventing timely notification of maintenance staff to restore municipal power supply.

Electrical fires generally refer to fires caused by fault-related energy release—such as high temperatures, electric arcs, electrical sparks, and non-fault energy release—from electrical circuits, equipment, and distribution devices under combustion conditions. These fires are typically categorized as leakage fires, short-circuit fires, and overload fires. Early warning signs include: (1) leakage

current in circuits; (2) excessive circuit current; and (3) abnormal temperature increases in lines.

Primary factors causing cable fires include: (1) some cables operating at full or frequent overload capacity, resulting in excessive temperature rise and rapid insulation aging, leading to short-circuit ignition when exposed to moisture or overheating; (2) during cable installation, space constraints sometimes force excessive cable concentration and stacking, causing outer sheath damage from scraping, collision, compression, and twisting, which facilitates water ingress and moisture absorption, potentially causing insulation breakdown and arc ignition during operation; (3) rodent damage causing cable faults and fire spread; and (4) aging wires and circuits that are difficult to detect, which can cause fires when equipment operates under overload conditions. In summary, the primary cause is line aging, which is inherently difficult to identify and confirm.

2. Solution Approach

The occurrence of safety production or broadcast accidents at radio and television stations produces severe consequences. Therefore, installing electrical safety dynamic monitoring systems provides an additional robust "firewall" for power distribution safety, preventing any electrical circuit faults from escalating into electrical fires due to untimely resolution, while also avoiding undetected power outages.

4. Construction of Dynamic Monitoring System at Hechi Radio and Television Station

Prior to the 19th National Congress of the Communist Party of China, Hechi Radio and Television Station identified power distribution system hazards during safety inspections. To ensure safe broadcasting during this critical period, the station raised funds to construct a new power distribution room and implemented an electrical safety dynamic monitoring system for intelligent transformation of the entire station' s power system. The system comprises three components: front-end devices, system platform, and client interface, providing 24-hour continuous monitoring of power system operation across all office floors.

4.1 Front-End Devices

Front-end devices consist of electrical safety monitoring modules installed in power distribution cabinets and boxes. The core components include detectors and communication modules. Three detector types are employed: leakage transformers, current transformers, and temperature sensors. Hechi Radio and Television Station selected open-type transformers for their advantages of convenient installation, easy removal, no requirement for line modification, and no need for power shutdown during installation.

Current transformers detect AC voltage signals, which are amplified through

operational amplifier circuits and then converted via A/D conversion, transforming the analog AC voltage signal into leakage current values displayed on LCD screens in Chinese. Temperature sensors detect line temperature variations, with converted values displayed in real-time Chinese characters on LCD screens. Communication modules collect detector data every 30 seconds and transmit it to the system platform database server via GSM/CDMA wireless communication.

4.2 System Platform

The system platform is installed at the equipment provider' s facility, comprising a database server and monitoring backend. The database server analyzes and organizes sampling data in real-time, comparing it with historical data to generate audible and visual alarms for anomalies, which are then communicated to relevant station management personnel through the client interface.

The monitoring backend provides both control and query functions: (1) ultra-large capacity for storing massive monitoring information; (2) recording of monitoring information including unit profiles, GPS positioning, responsible personnel names and phone numbers (three groups: primary, secondary, and leadership), alarm SMS notification numbers (five numbers), each monitoring module' s address code, mobile number, installation location description, and alarm status; (3) map-based visualization when monitoring modules trigger alarms; (4) active querying of each front-end detection device every 30 seconds to ensure no alarm information is missed; (5) access to historical alarm records for each monitoring module; and (6) recording of client login information.

4.3 Client Interface

The client interface is designed in two versions: PC and mobile. Users can access the electrical safety monitoring system IoT platform from any Internet-connected computer or mobile device by entering their user ID and password.

Following completion of the power distribution system transformation, the dynamic monitoring system has operated normally. Hechi Radio and Television Station experienced no incidents during the 19th National Congress period, successfully completing its safe broadcasting mission. Over the subsequent year, only one alarm occurred: in September 2018, the second-floor office line temperature reached 74°C. Upon inspection, maintenance personnel discovered a loose screw at the circuit breaker outlet causing poor contact. After tightening, temperature returned to the normal value of 27°C and the alarm was cleared. This hazard elimination demonstrated the system' s effectiveness.

4.3.1 Client Functions The client interface provides the following functions:

1. Intuitive display of information for all installed electrical safety monitoring modules, including address codes, mobile numbers, and installation locations (organized by region, building, and floor).

2. Management personnel can edit and modify the above information.
3. Real-time display of current monitoring and alarm status for each module.
4. Active querying of real-time sampling data from any individual monitoring module.
5. Access to historical alarm records for each monitoring module.
6. When a monitoring module triggers an alarm, a pop-up window immediately appears on the PC client displaying alarm location and type; simultaneously, the mobile client sends instant SMS notifications to designated phone numbers, prompting management personnel to access the mobile client for details.
7. Remote "reset" control capability for front-end monitoring modules from the client interface.

At Hechi Radio and Television Station, a computer in the broadcasting department runs the PC client for duty personnel monitoring, with immediate emergency protocol activation upon anomaly detection. Additionally, heads of the technical department and office, along with maintenance responsible persons, have downloaded the mobile client to their personal phones for rapid real-time data review and timely work arrangement when receiving alarm notifications.

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(Author Affiliation: Hechi Radio and Television Station)

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