On Secure Broadcast Assurance for Broadcast Control Centers (Postprint)

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Abstract

This article briefly introduces the establishment of a reliable safety assurance system for monitoring broadcast program signal transmission and emergency broadcasting in radio station broadcast control centers, and describes how to monitor and supervise pre-transmission and off-air signal status to ensure safe and high-quality broadcast program transmission.

Full Text

Introduction

The broadcast control center is a critical department responsible for radio program audio transmission, exchange, distribution, scheduling, monitoring, and emergency broadcasting. By integrating digital audio technology and communication network technology, the front-end equipment at the control center converts analog and digital audio signals into serial multi-channel digital audio streams for transmission over various distances via satellite, optical fiber, network cable, or copper wire. The control center unifies different frequency studios, production rooms, and transmitter rooms across the radio station, enabling centralized processing and distribution of all audio signals as well as centralized monitoring and management of equipment within the broadcast control network. This provides the radio station with a more flexible and powerful broadcast transmission system featuring robust and reliable safety backup, arbitrary program channel allocation, real-time status information acquisition, and diverse, flexible control and processing methods. The following sections describe our station's efforts to ensure safe broadcasting.

1. Signal Monitoring and Emergency Handling

Our station's safe broadcasting system primarily employs an FM broadcast color bar monitoring system to monitor and alarm both pre-transmission and off-air

signals, an FM transmitter intelligent monitoring system to track transmitter status information, and a slow recording system to monitor front-end studio signals while archiving broadcast audio for convenient retrieval and extraction. For emergency situations, we utilize an emergency music fill system to resolve broadcast safety issues.

1.1 Slow Recording System

The YAB3000 MULTIREC multi-channel slow recording system serves as a program broadcast monitoring system that enables real-time review of current programs, playback of previously aired content, and long-term archiving of premium programs. The system comprises two software platforms: the program recording platform (YAB3000 MULTIREC) and the program review platform (YAB3000 LP). The recording platform functions as the management tool for program recording, while the review platform serves as the management tool for program inspection. It maintains detailed daily broadcast records for each channel, allowing staff to review specific days' programming and providing clear visibility into the quality and content of all channel broadcasts.

For various program types including live broadcasts, speech, music, and advertisements, we establish the signal level center value at 0 dB, with a dynamic range of -30 dB to +15 dB. Signal interruption is determined when the level falls below the set threshold. We configure the normal dynamic range to display as color amplitude variations between 10% and 110% on the color bar display, with amplitudes below 10% indicating signal interruption. The system automatically monitors signal levels from audio collectors; when a monitored signal remains below -30 dB for 10 seconds, it automatically triggers an alarm, displaying a red bar for that frequency with audible and visual alerts while logging the fault duration. The alarm automatically clears when signal levels return to normal, or can be manually reset (e.g., during Tuesday system maintenance). The alarm display identifies whether the fault is in the pre-transmission signal or off-air signal, helping operators determine whether the issue lies with studio front-end signals or the FM transmitter, enabling appropriate emergency responses. The system supports expansion on a per-program basis and can be computer-controlled, with monitoring results and fault logs available for printing at any time.

1.2 FM Transmitter Intelligent Monitoring System

The transmitter intelligent monitoring system transmits real-time transmitter data to monitoring computers via remote monitoring adapters. Monitoring software displays real-time transmitter data and enables operation and fault analysis through the monitoring computer. The system features: real-time network monitoring of main transmitter operation; a B/S architecture for the monitoring software platform; remote transmitter power on/off control; power and frequency adjustment; real-time audio level bar display with gain adjustment; display of operating voltage, current, temperature, and output power for each power sup-

ply group; display of current, temperature, and power consumption for each final-stage power amplifier tube; display of overall efficiency, ambient temperature, and fan speed (controlled based on temperature); scheduled power on/off and power level changes; one-click switching for N+1 channel configurations; historical record queries for forward/reverse power and ambient temperature operation curves; fault information queries with automatic alarms for transmitter faults and audio loss; and support for data collection from newly added transmitters.

1.3 FM Broadcast Color Bar Monitoring System

The FM broadcast color bar monitoring system consists of the YAB3000 color bar monitoring system (software plus audio signal acquisition cards) and MD730+ multi-channel broadcast demodulators (receiving off-air signals). Audio signal acquisition cards collect signals from both the audio distributor's studio outputs and the off-air signals received by MD730+ demodulators for each frequency. The color bar monitoring software displays these as colored bars, with different colors indicating different statuses: green bars for normal audio, red bars for no-audio alarms, and pink bars for poor-quality broadcast alarms, accompanied by audible and visual alerts.

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The color bar monitoring system reduces workload in the master control room, improves monitoring accuracy, enables operators to identify problems immediately, and helps preliminary fault localization. This provides operators with actionable procedures, significantly reduces fault processing time, ensures safe broadcasting, and provides scientific basis for maintenance and identification of regular fault patterns through its reporting functions.

1.4 Emergency Music Fill System

The emergency music fill system operates on the principle of ensuring broadcast continuity first, then addressing problems. The system comprises three parts: First, an audio switcher (four inputs, one output, four-to-one selector) connected to a fill workstation. The switcher's four inputs receive analog signals from the studio, digital-to-analog converted studio signals, backup workstation signals, and fill workstation signals. When studio signals fail, the system switches to the backup workstation; if the backup also fails, it switches to the fill workstation. Since our FM transmitter room is on the same floor as the control center, we have emergency direct audio cables that can connect studio signals directly to the transmitter's analog input, bypassing faulty equipment. Second, the transmitter room is equipped with a machine room fill system consisting of a fill workstation and audio distributor, ensuring the FM transmitter always has an audio source. Third, an emergency studio on the same floor as the control center serves as a backup when the main studio is unusable, with identical equipment configuration including hotline facilities.

1.5 Live Room and FM Machine Room Environmental Monitoring System

This system comprises a hard disk recorder, high-definition cameras, thermometers, and hygrometers. It provides video monitoring of studios and FM machine rooms to prevent unauthorized access, while monitoring ambient temperature, humidity, fire, and theft conditions.

1.6 UPS Uninterruptible Power Supply System

Studios and the control center use UPS uninterruptible power supplies to prevent equipment damage from voltage fluctuations or power outages. All equipment can be supported for over three hours of continuous operation.

2. Safety Broadcast Assurance

The principle of safety broadcast assurance is to ensure broadcast continuity first, then address problems.

2.1 Emergency Handling of Critical Situations

We monitor FM signal transmission in real-time through the FM signal monitoring and alarm system. During broadcast interruptions or poor-quality transmission, we implement emergency handling through the emergency music fill system, first switching to the backup workstation via the audio switcher to ensure normal program broadcasting. If the backup workstation cannot meet broadcast requirements due to program or server issues, we switch promptly to the continuously operating fill workstation. In case of critical equipment failure in the control center, such as audio processors, we immediately activate the

uninterrupted fill system in the FM transmitter room to ensure continuous audio source. All equipment audio lines have direct bypass jumpers, allowing any faulty equipment to be bypassed immediately. Backup equipment is available for critical devices like broadcast workstations and audio processors. An emergency backup studio is equipped to ensure normal broadcasting when studio equipment fails (e.g., mixing console failure).

2.2 Routine Maintenance

Safety broadcast assurance emphasizes routine maintenance—preventing problems is better than handling them after they occur. We strengthen weekly Tuesday equipment maintenance including dust removal, equipment restarts, and status indicator testing; inspect equipment grounding, check audio cable connectors, identify overheating equipment, and monitor abnormal alarm displays.

2.3 Strengthening System Construction, Personnel Training, and Emergency Drills

We establish various management systems and workflows, conduct regular operator training to ensure standardized responses to problems, and carry out emergency drills for various potential situations with detailed records. This hands-on practice ensures operators remain calm during actual emergencies and can truly implement the principle of ensuring broadcast first, then handling problems.

The broadcast control center is the core of radio broadcasting, and its safe operation is particularly important. Safe broadcasting involves not only equipment operation but also human factors. Reasonable emergency drill arrangements and timely identification of safety hazards during specific operations are significant for safe broadcasting. The important principle of safe broadcasting is to ensure broadcast continuity first, then address problems.

[Figure 1: see original paper] Broadcast Control Center Equipment Connection Diagram

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Note: Figure translations are in progress. See original paper for figures.