Analysis of Common Technical Faults in Radio and Television Transmitting Antennas and Their Countermeasures: Postprint

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Abstract

In the diversified development of modern information dissemination, broadcast television occupies an important position. Within broadcast television systems, the transmission antenna represents one of the critical applied technologies, whose rational deployment can significantly enhance both signal transmission speed and quality. Nevertheless, in practical applications, broadcast television transmission antenna technology frequently encounters certain technical obstacles that substantially affect broadcast television information delivery, thereby preventing normal system operation. Consequently, it is essential to comprehensively understand these common technical faults to implement effective remedial measures and ensure normal broadcast television operation. This paper investigates broadcast television transmission antenna technology, analyzes common technical faults, and proposes targeted solutions.

Full Text

Analysis of Common Technical Faults and Countermeasures of Broadcast Television Transmission Antennas

Abstract: In the development of diversified modern information dissemination, broadcast television occupies an important position. In broadcast television, the transmission antenna is one of the key applied technologies, and its rational application can significantly improve signal transmission speed and quality. However, in practical applications, broadcast television transmission antenna technology often encounters certain technical obstacles that substantially impact broadcast television information, causing the system to operate abnormally. Therefore, it is necessary to understand these common technical faults in detail to implement effective solutions and ensure normal broadcast television operation. This paper examines broadcast television transmission

antenna technology, analyzes common technical faults, and proposes targeted countermeasures.

Keywords: broadcast television; transmission antenna; technical fault; television signal; transmission technology

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Currently, continuous scientific and technological development has prompted rapid advancement across various industries, with the broadcast television industry developing particularly quickly and gradually entering a new era of networking and digitization. In broadcast television, the transmission antenna represents one of the primary information transmission technologies, significantly affecting signal transmission quality during equipment operation. If transmission antenna technology malfunctions, it directly impacts normal broadcast television operation and causes substantial damage to the broadcast television industry. Therefore, it is essential to understand common technical faults of broadcast television transmission antennas to implement targeted solutions and ensure normal operation.

1. Overview of Broadcast Television Transmission Antenna Technology

People' s daily lives are inseparable from media such as broadcast television, which has widespread practical applications. To achieve high-quality program effects, broadcast television must continuously innovate and improve transmission antenna technology to fully realize its potential and promote sustainable development in the broadcast television industry. During broadcast television signal transmission, antenna technology primarily works by emitting signals through a transmitter, converting broadcast television signal data into high-frequency carriers, processing them, and transmitting them to the antenna for radiation into relevant areas, thereby achieving signal transmission. This process requires equipment such as antennas, transmitters, feedlines, and communication towers. During signal emission, the transmission device can effectively convert and process signals, also serving as a signal conversion unit. Both image and audio information can be appropriately converted and transmitted [1], and these two types of information can be transmitted simultaneously after conversion [2]. During signal transmission, various signal types can be received, including shortwave signals, which can be converted into electromagnetic wave signals for reception and transmission. Relevant equipment can then convert these signals into audio or images. When improving broadcast television transmission technology, transmission centers configure multiple antennas and generators for unified allocation and signal processing. Currently, broadcast television information is

developing rapidly with broad application prospects, driving China' s broadcast television industry toward networkization, digitization, and interactivity [3,4].

2. Common Technical Faults of Broadcast Television Transmission Antennas

When addressing broadcast television transmission antenna faults, it is important to recognize that this equipment is outdoor-based and primarily metallic, requiring full consideration of adverse weather effects. Prolonged exposure to harsh weather conditions such as rain, snow, and high temperatures can easily cause equipment corrosion, significantly impacting normal operation. If the insulating components on the antenna surface are damaged, signal transmission efficiency and quality are substantially affected. Therefore, it is necessary to understand these common technical faults [5].

2.1 Return Loss Technical Fault

Among broadcast television-related faults, the most common is return loss technical fault. During signal transmission using antennas, when the transmission port impedance of the cable link antenna fails to meet standard requirements, reflection loss occurs, which is termed return loss [6,7]. During normal antenna operation, radio wave signals are transmitted toward the input port, and return loss is inversely proportional to this transmission. Greater loss increases the negative impact of reflection on light sources and system components. Therefore, it is necessary to maintain reflected power within a small range to enable high-power signal transmission. This fault seriously affects antenna signal transmission and coverage area, requiring fiber end faces to be spherical to effectively reduce loss [8].

2.2 Transmission Antenna Technical Maintenance Fault

Additionally, during normal broadcast television operation, antenna technical maintenance faults are prone to occur, affecting normal signal transmission. Daily maintenance requires adequate attention to this issue. If transmission antenna faults occur suddenly without timely effective emergency intervention, serious transmission failures will result, affecting the normal operation of broadcast television equipment [9]. During routine maintenance, attention must be paid not only to broadcast television antenna maintenance but also to equipment related to transmission stations. With rapid scientific and technological development, antenna technology requires continuous improvement and refinement, demanding that maintenance personnel continuously enhance their professional skills and comprehensive qualities to better accomplish their tasks, closely observe potential new problems in daily maintenance, and resolve them promptly [10,11].

2.3 Standing Wave Ratio Fluctuation Fault

Standing wave ratio (SWR) faults primarily involve problems with the SWR. When radio frequency changes during transmission, the SWR changes accordingly, and impedance specifications must ensure a reasonable range. During actual operation, high matching degree is required to maintain transmission antenna stability. Under such operational demands, antenna transmission signals are prone to problems, and the SWR tends to become unstable [12]. The ratio between feedline characteristics and antenna impedance must match the SWR, or water ingress into the antenna and feedline can cause SWR fluctuations. Feedline damage and antenna bending can cause SWR deviations, while feedline connector and lightning protection equipment faults can also create standing wave conditions, affecting SWR stability. During signal transmission, if the SWR rises significantly, matching difficulty increases, causing large reflection fluctuations at the transmission antenna port and potentially leading to overvoltage phenomena that can damage broadcast television transmission stations. These faults are common SWR fluctuation faults [13].

3. Issues in Technical Maintenance Management

3.1 Imperfect Maintenance Work Mechanism

During broadcast television transmission technology operation, failure to comprehensively consider various influencing factors and understand optimized maintenance work mechanisms results in a lack of scientific emergency plans for responding to unexpected incidents and natural disasters. Even when emergency plans are formulated, they often become mere formalities without practical implementation. During routine maintenance of broadcast television transmission technology, technicians tend to overemphasize transmission equipment while neglecting maintenance of auxiliary system equipment and various process links, leading to significantly increased fault rates and substantial impacts on normal information data transmission. Therefore, it is necessary to continuously improve the technical maintenance work mechanism to fully realize its function and effectively standardize maintenance work responsibilities [14,15].

3.2 Incomplete Technical Maintenance Management

Currently, while the maintenance and management levels of broadcast television antenna technology are continuously improving, the absence of a comprehensive maintenance management system significantly impacts the smooth implementation of related work. During routine maintenance of broadcast television transmission technology, technicians exhibit varying levels of comprehensive quality, lack necessary professional ethics, and possess insufficient practical experience, thereby affecting normal broadcast television operation. To address this phenomenon, it is necessary to comprehensively analyze various influencing factors, strengthen technical maintenance management levels, establish scientific and

comprehensive maintenance management systems, and conduct regular training for technicians to promote professional skill enhancement and improve professional ethics, enabling them to better accomplish technical maintenance tasks and elevate technical maintenance management standards [16].

3.3 Issues with Technical Maintenance Resources

As broadcast television transmission technology continues to develop, it is necessary to optimize the integration and sharing of various information resources to continuously improve resource utilization efficiency, strengthen cooperation, and enhance operational effectiveness. However, in actual operation, broadcast television transmission stations possess their own jurisdictional systems with poor sharing and complementarity, and different stations maintain different technical levels. Therefore, it is essential to optimize and integrate technical maintenance resources to ensure complementary sharing of information resources among various transmission stations, thereby significantly improving overall performance levels [17].

4. Countermeasures for Common Technical Faults

To ensure normal operation of broadcast television transmission antennas, it is necessary to understand common technical faults to implement targeted solutions. Common fault locations in broadcast television transmission antennas include three main components: the transmission antenna, communication tower, and feedline. During fault troubleshooting, strict adherence to relevant procedures is required to improve troubleshooting efficiency, perform timely maintenance on various faults, and ensure normal operation while reducing fault occurrence.

4.1 Communication Tower Maintenance

Communication towers constitute critical equipment comprising antennas, communication devices, systems, and tower structures. Tower materials utilize hot-dip galvanized anti-corrosion metal materials capable of withstanding harsh weather conditions. Communication towers primarily receive and transmit signals to increase signal strength for better transmission and reception. During installation, towers are typically erected at high elevations in relatively open areas to effectively expand radiation coverage. Towers may be affected by severe weather, making them susceptible to deformation and corrosion that can cause various faults. Therefore, it is necessary to strengthen maintenance and management, regularly inspect tower foundations, and promptly understand tower structure and soil conditions to ensure stability. Tower design employs four-legged self-supporting structures with steel construction to significantly improve anti-loss capability. Reinforced stability construction ensures towers can resist magnitude 8 earthquakes and category 12 hurricanes, while anti-corrosion materials prevent tower deterioration and effectively extend service life [18].

4.2 Daily Maintenance of Transmission Antennas

During normal operation, broadcast television transmission antennas exhibit characteristics of high frequency and continuous operation, involve numerous devices, and are affected by harsh environmental factors. Professional personnel must be assigned for management and maintenance, and a comprehensive maintenance management system should be established to specify maintenance content and schedules. Regular maintenance and inspection of transmission antennas should be conducted, supplemented by irregular patrols to reduce fault occurrence and ensure normal operation. After severe weather, transmission antennas and related equipment must be inspected, with particular attention to line connectors, antenna fasteners, and masts. Any loosening, aging, or radiation issues should be promptly maintained or replaced [19]. Simultaneously, antenna accuracy must be tested. During antenna operation, base station detection equipment should be selected for comprehensive testing, ensuring the antenna remains stable during testing while conducting detailed inspections of related components. Antenna adjustment plates affecting transmission performance should be examined to ensure normal operation. Masts and other devices must be monitored to ensure proper functioning. If problems are detected during inspection, timely repair or replacement should be performed to ensure component integrity, with continuous monitoring of various related devices to ensure stable operation. Generally, antennas come in various types, including parabolic antennas and Yagi antennas. During antenna maintenance, it is essential to promptly identify loose component contacts, understand component properties and characteristics, and perform tightening procedures based on their features. Equipment that is unusable or fails to meet quality standards should be replaced promptly. Effective maintenance of transmitters should be performed using antenna transmission equipment for monitoring to closely supervise the operation of related devices and instruments, regularly check common antenna parameters, comprehensively assess daily antenna working conditions, and implement reasonable protective measures to identify and address safety hazards promptly.

4.3 Feedline Maintenance

When signals are transmitted through broadcast television transmission stations, the primary transmission medium is the feedline, which primarily uses copper wire. Particularly during high-frequency signal transmission, this material helps avoid external interference and effectively reduces equipment loss. When feedlines and feed pipes are used simultaneously for high-frequency signal transmission, electromagnetic waves reflect back and forth between the core wire and feedline while continuously moving forward, protecting the shielding layer and avoiding external signals, thereby significantly reducing transmission loss. During routine equipment inspection, careful observation is required to check whether feedlines are damaged or loose. Once these phenomena appear, timely handling is necessary to ensure normal broadcast television transmission

antenna signal transmission. As science and technology continue advancing, antenna technology requires not only high-power operation but also ensured quality levels and reduced loss. During maintenance, intelligent technology should be promptly adopted to effectively liberate labor force and significantly improve maintenance efficiency [20]. Additionally, detailed inspection of connection parts between transmission stations and feed pipes is required to promptly detect abnormalities, closely observe whether performance remains stable, and handle anomalies in a timely manner to effectively avoid arcing phenomena. Impedance transformers and feed pipe interfaces should be comprehensively inspected, with prompt securing if loosening occurs to prevent water leakage. Regular inspection of cable contact performance is also necessary to ensure safe and reliable feedline system operation.

Conclusion

Broadcast television is closely related to people' s daily lives. The continuous development of broadcast television transmission antenna technology has brought considerable convenience to people' s lives while increasingly demanding signal transmission stability. It is essential to understand common technical faults of broadcast television transmission antennas in detail to implement timely targeted solutions, ensure normal operation of broadcast television transmission antennas, and reduce fault occurrence.

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