Discussion on Maintenance Strategies for Ground Networks of Medium Wave Transmitter Antennas (Postprint)

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Abstract

The primary function of medium wave transmission stations is to transmit and share broadcast information. With the rapid development of the broadcast media industry, their role has become increasingly prominent, and higher requirements have been imposed on the efficiency and quality of information transmission. Based on this, this paper focuses on the study of antenna ground networks for medium wave transmission stations. To improve transmission efficiency and quality, maintenance techniques and relevant recommended measures for antenna ground networks are proposed for reference.

Full Text

Preamble

Title: A Discussion on Maintenance Strategies for Antenna Ground Networks at Medium Wave Transmitting Stations
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Abstract: Medium wave transmitting stations primarily serve the transmission and sharing of broadcast information. With the rapid development of the broadcast media industry, their role has become increasingly prominent, and higher demands have been placed on the efficiency and quality of information transmission. Based on this context, this paper focuses on the antenna ground network of medium wave transmitting stations. To better enhance the efficiency and quality of information transmission at medium wave transmitting stations, this study proposes maintenance techniques and relevant recommendations for antenna ground networks for reference.

Keywords: Medium wave transmitting station; Antenna ground network; Maintenance strategy; Information transmission; Broadcast media

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With the acceleration of urbanization, the site selection for medium wave transmitting stations has also changed. To better transmit broadcast information, stations have gradually shifted from remote urban areas to city centers. However, this transition presents certain limitations, as transmission signals can be obstructed by various high-rise buildings. If the antenna ground network experiences connection failures, information transmission effectiveness will be compromised. Therefore, it is necessary to seek scientific and effective maintenance methods for antenna ground networks, which is of great significance for ensuring the normal operation of medium wave transmitting stations and promoting the development of the broadcast media industry. Based on practical experience, this paper explores the maintenance techniques and management methods for antenna ground networks at medium wave transmitting stations.

1. Significance of Medium Wave Transmitting Stations and Antenna Ground Network Maintenance

Medium wave is a special type of radio wave that propagates information through the combined action of ground waves and sky waves, typically operating at frequencies between 300 kHz and 3 MHz [1]. Since ground waves have stronger field intensity than sky waves, and sky waves cannot be effectively absorbed and reflected by the ionosphere during daytime, medium wave transmitting stations are currently the primary medium for broadcast information transmission. At night, the combination of sky waves and ground waves enables efficient broadcast media information transmission. This demonstrates that medium wave broadcasting offers excellent technical advantages. Moreover, compared with conventional transmission methods, medium wave broadcasting demonstrates superiority in terms of transmission stability and security. Consequently, it is now widely applied in the broadcast information media field, with continuous efforts devoted to upgrading and transforming these transmission facilities to further promote the development of the broadcast media industry.

As established above, a medium wave transmitting station serves as a transmission medium that delivers broadcast information through the combined action of sky waves and ground waves. Consequently, it contains two critical supporting systems: the antenna and the ground network. The antenna con-

sists primarily of multiple monopole elements oriented vertically to the ground, utilizing radiation currents from the ground network to form the information transmission line structure. However, during actual information transmission, considerable current energy is lost, reducing broadcast information transmission efficiency. Additionally, the antenna ground network system is subject to numerous external conditions that degrade operational quality. For instance, accelerated urbanization has introduced many high-rise buildings that may cause antenna ground network malfunctions, affecting normal broadcast information transmission and even leading to various risk incidents such as startup failures and lightning strikes. Therefore, the current priority is to emphasize enhanced maintenance of antenna ground networks through scientific and effective measures to ensure normal operation of medium wave transmitting stations, enable proper broadcast information transmission, minimize transmission system failure frequency, and promote the development of broadcast media.

2.1 Multiple Influencing Factors

Currently, the operation of antenna ground networks at medium wave transmitting stations remains subject to numerous factors that degrade system performance [2], with natural and human factors being the primary influences on maintenance quality. Specifically, China' s rapid economic development has spurred continuous growth in the construction industry and extensive land resource development. During construction, contractors unaware of the ground network system structure may cause ground wire breakage. Alternatively, ground network systems exposed along roadsides are vulnerable to damage from external natural conditions, such as prolonged sun exposure and rainwater erosion, which eventually lead to line breakage. This not only affects normal antenna ground network operation but also introduces safety hazards. Furthermore, influences from buildings, water conservancy projects, and other facilities can cause line damage or exposure during ground network pre-installation. If garbage accumulates at fault locations, it will cause losses to radiated waves and damage equipment, potentially leading to short circuits.

2.2 Unsatisfactory Maintenance Effectiveness

The unsatisfactory maintenance of medium wave antenna ground networks primarily stems from problems in maintenance concepts and methods. Specifically, maintenance work still relies on manual detection methods, which are inefficient and fail to achieve ideal detection and maintenance results. Moreover, during actual detection, there are deviations in determining detection scope and cycles. For example, hidden safety hazards cannot be eliminated promptly, leaving numerous risks in medium wave transmitting stations that may cause functional failures during subsequent operation. Additionally, in terms of detection methods, some regions still employ large-scale excavation and replacement approaches, lacking targeted maintenance for antenna ground networks and clear maintenance direction. Such maintenance methods are time-consuming

and detrimental to improving maintenance efficiency, thereby reducing overall maintenance effectiveness.

2.3 Relatively High Self-Loss

The antenna in a medium wave transmitting station' s antenna ground network is the above-ground component that connects vertically to the ground, forming a closed circuit. Based on the image principle, the earth functions as a conductor, causing antenna losses that the ground network is designed to reduce. However, in practical application, antenna ground networks exhibit relatively high self-loss, manifested in three ways: First, the presence of buildings and water conservancy projects near the ground network can easily cause damage and exposure that often goes unnoticed, increasing losses over time. Second, physical and chemical factors cause corrosion damage to the ground network, creating resistance short circuits that increase losses. Third, although medium wave transmitting antennas have wide signal transmission ranges, ordinary citizens lack professional knowledge and may accidentally damage cables during daily life and production activities, and some criminals may even steal cable lines [2].

3.1 Rational Ground Network Configuration

Ground losses in medium wave transmitting stations occur primarily at the antenna base. The most fundamental and effective method to improve antenna radiation efficiency is to install a ground network and configure it rationally. A medium wave antenna ground network uses the center of the tower base as its origin, typically employing copper wires or copper-clad steel with diameters of 2–3 mm, laid radially from the center outward. Based on engineering practice, the network consists of 60–120 wires, with lengths approximately 30%–50% of the tower height. Moreover, shallower burial depth yields better results, generally between 30–50 cm. The antenna tower at Hubei Radio and Television Station is a three-base structure with a height of 120 meters. At the center of the three towers, a copper plate disk with a diameter of 1 meter is buried, serving as the center point. Sixty copper wires, each 60 meters long, extend radially from the copper plate, with a burial depth of 40 cm. Additionally, three copper strips, each 30 cm wide, connect to the three tower bases. To further reduce ground network resistance, a 1-meter-deep ground well is excavated and connected to the ground network, completing the entire antenna ground network system. A single tower configuration is shown in Figure 1 [Figure 1: see original paper] [3].

3.2 Adoption of Advanced Detection Technology

The purpose of antenna ground network maintenance is to identify safety hazards promptly and prevent serious failures. The rational use of advanced detection technology enables non-destructive and proactive testing. Compared with traditional manual detection, this approach not only improves efficiency and

quality but also reduces personnel workload. Using the cable comprehensive detector as an example, this equipment tests for open circuits, short circuits, grounding, and low-resistance faults in power cables, while also detecting cable routes, burial depths, and cable identification to establish cable archives for daily maintenance management. The technical principle is shown in Figure 2 [Figure 2: see original paper]. The device consists of a transmitter, receiver, A-frame, and coupling unit, with characteristics including: (1) portability and lightweight design for convenient use; (2) digital design for stable and reliable performance; (3) large-screen LCD interface for easy learning and operation; (4) measurement results displayed through three methods: numerical values, grating lengths, and sound urgency; and (5) backlight functionality for nighttime operation. In practice, the QTQ-02C cable detector is commonly used, primarily for detecting buried cables, optical fibers, and metal pipelines, analyzing their burial depths, and identifying specific locations of cable core faults to provide a basis for subsequent fault handling. The cable detector can identify network breakage points in medium wave ground networks, effectively monitoring local pullouts, external exposures, and breakages.

3.3 Antenna Ground Network Maintenance and Inspection

Since antenna ground networks are not deeply buried, they are vulnerable to external damage. Without adequate protection, they are susceptible to various external conditions that accelerate corrosion and aging, increase maintenance costs, and affect the stability of broadcast information transmission at medium wave transmitting stations. Therefore, maintenance personnel must prioritize antenna ground network maintenance and intensify patrol and inspection efforts to extend service life and provide high-quality antenna networks for broadcast information transmission. To achieve this, station personnel must accomplish several tasks: First, equipment room personnel should conduct regular patrols and maintenance inspections of antenna ground networks to ensure normal function; otherwise, severe weather conditions such as lightning may cause rain and weathering damage that affects system operation and even impacts transmitter performance. Second, equipment room personnel should monitor construction activities around antenna ground networks to ensure full supervision throughout the construction period, particularly strengthening inspections of ground network copper wires to identify any excavation damage or exposed wires. Finally, enhanced maintenance requires understanding that ground network integrity impedance varies by region and climate—generally higher in arid regions and lower in rainy, humid areas. Comprehensive testing, including grounding resistance measurements, should be performed at least annually, with the standard being below 4 ohms. Measurements at Hubei Radio and Television Station' s transmitting station are consistently below 1 ohm, approximately 0.5 ohms. Any safety hazards in ground network resistance require immediate maintenance [4].

Additionally, the verticality of the antenna tower connected to the ground network must be monitored, as none of the tower base components or connections

can be neglected. Only when these components function properly can ground network safety and usability be ensured, and potential safety hazards in medium wave transmitting stations be completely eliminated.

4.1 Transforming Maintenance Concepts to Improve Scientific Maintenance

During medium wave transmitting station operation, the antenna ground network system plays a crucial role as the key to medium wave information transmission, directly affecting broadcast quality. Without scientific and efficient maintenance, broadcast information transmission will be severely constrained, introducing numerous risks. Therefore, maintenance departments must first prioritize antenna ground network maintenance and develop high-standard maintenance implementation plans in strict accordance with relevant national standards to effectively guide maintenance operations. Simultaneously, when developing maintenance plans, maintenance personnel should conduct comprehensive site environment surveys and analyses in advance to ensure plan 科学性. Additionally, thorough understanding of damage conditions in medium wave transmitting station antenna ground networks requires intensified detection efforts, employing different detection methods based on specific fault conditions, such as electrical characteristic detection and power measurement instrument detection [5]. Through rational detection methods, fault properties can be identified promptly, enabling targeted repairs based on fault problems and causes to ensure maintenance effectiveness and guarantee normal antenna ground network operation.

4.2 Strengthening Patrol Inspections to Eliminate Safety Hazards

In addition to transforming outdated maintenance concepts and systems, medium wave transmitting station antenna ground network maintenance requires flexibility—adjusting maintenance plans according to actual conditions, particularly extending maintenance cycles appropriately to enhance patrol inspection intensity. This includes inspecting the internal environment and site of medium wave transmitting stations to avoid safety hazards caused by oversight or careless inspection. Since its relocation and construction in 2006, Hubei Radio and Television Station has experienced several factors affecting antenna ground networks: (1) damage from excavators during sewer network renovation; (2) damage from excavators during rainwater drainage system construction; (3) exposed copper wires due to road surface damage; and (4) ground wire breakage at road edges caused by settlement issues. Therefore, emphasizing the impact of construction-related damage and addressing antenna ground network hazards promptly ensures effective power transmission and improves broadcast quality. Typically, if only one or two ground network copper wires are broken, the damaged sections are reconnected with new copper wire welding during the Tuesday maintenance shutdown period. If extensive

damage occurs during construction, welding repairs are performed promptly under reduced power conditions. When addressing ground wire breakage, natural factor impacts must also be considered. For example, seasonal changes affect antenna ground networks differently—preventing line faults caused by external temperature variations or damage from long-term exposure to rain. Alternatively, applying grease lubrication and anti-rust paint to tower base connections provides effective rust protection. These measures reduce overall antenna corrosion and aging while extending service life.

Additionally, professional maintenance personnel should conduct regular tower inspections, including checking tower body fastening screws, replacing corroded screws promptly, and applying grease lubrication and anti-rust paint for corrosion protection. This ensures normal antenna operation, prevents ground network heating, and guarantees transmission efficiency and effectiveness. Insulation effectiveness should be enhanced through rust prevention treatment on screw caps and critical components to avoid external environmental interference. Enhanced maintenance also requires understanding that major overhaul cycles vary by region and climate—generally 5–8 years in arid regions and 3 years in rainy, humid regions. Hubei Radio and Television Station employs professional antenna tower maintenance organizations every three years for a one-month major overhaul. During overhaul, maintenance personnel inspect from the antenna top downward, applying rust prevention treatment, confirming fastener security, removing rust and repainting corroded components, and replacing severely corroded parts. In short, comprehensive inspection and maintenance of the antenna network during overhauls requires checking every screw to eliminate hazards and ensure broadcast efficiency and quality [6-7].

4.3 Forming Inter-departmental Synergy to Enhance Monitoring

Considering the complexity of medium wave antenna ground network maintenance, multiple departments must form synergies to enhance monitoring efforts. First, relevant personnel must improve their awareness of power grid protection and conduct timely maintenance on damaged networks. Simultaneously, construction departments must strictly follow regulations when constructing antenna ground networks and must not perform excavation or construction work near them. Second, local government agencies should coordinate effectively to facilitate joint protection of medium wave transmitting stations by multiple departments, preventing various factors from affecting antenna ground networks. Third, maintenance cycles can be divided into weekly, monthly, and annual inspections. Inspections involve comprehensive and detailed examination of key components and sites to prevent equipment failure accidents. Maintenance involves repairing and servicing all components, focusing on anti-corrosion, reinforcement, and component replacement to extend service life [8-9].

Conclusion

In summary, maintenance of medium wave transmitting station antenna ground networks is particularly important and necessary. To ensure overall station stability and effective signal transmission, maintenance personnel must conduct in-depth research on existing problems and employ effective maintenance methods. This paper elaborates on antenna ground network maintenance techniques from three aspects: rational ground network configuration, adoption of advanced detection technology, and antenna and electrical maintenance. Only by transforming maintenance concepts, strengthening patrol inspections, and forming inter-departmental synergies can maintenance quality be improved to ensure normal operation of medium wave transmitting stations.

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