

Design of Mobile Live Broadcast Vehicle for Radio Stations (Postprint)

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Abstract

This paper presents a comprehensive summary and introduction of the mobile live streaming vehicle system, addressing design principles, vehicle layout, and main system equipment selection, based on the design overview of the newly constructed broadcast mobile live streaming vehicle for Xiangshui Radio and Television Station.

Full Text

Preamble

Design of Radio Broadcast Mobile Live Trucks

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Abstract: This paper provides a detailed summary and introduction to the mobile live truck system of Xiangshui Radio and Television Station's newly constructed broadcast mobile live truck, covering design principles, vehicle layout, and selection of main system equipment.

Keywords: broadcast mobile live truck; vehicle layout; mobile live broadcasting; fixed-site live broadcasting; UPS uninterruptible power supply; multiple operating modes

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1.1 System Design Philosophy

When utilizing broadcast mobile live trucks for field broadcasting, the system must meet requirements for safe, high-quality, and uninterrupted transmission

across all operational modes. For broadcast mobile live trucks, design must be grounded in overall system functional scalability, operational safety, and technological advancement.

Functional scalability requires that the overall layout design accommodate sufficient space for future system upgrades and functional expansion. The system functions should be easily extendable, with consideration given to development needs for the coming years. Operational safety is paramount, as live trucks primarily cover major events that are sudden and non-repeatable. Therefore, emergency backup systems must be adequately considered during the design process to enable rapid and reliable switching measures. Technological advancement demands that modern scientific and technological techniques be incorporated into equipment selection, not only to meet the future development needs of broadcast new media but also to drive the future development of broadcasting technology, characterized by flexible use, simple operation, and easy maintenance.

1.2 Basic Functions

The basic functions include: (1) effective coverage range of mobile FM broadcast signals within 2km; (2) sound reinforcement capabilities suitable for mobile broadcasting and field audio amplification; (3) ability to conduct fixed-site live broadcasting of on-site events while simultaneously capturing, editing, producing, and broadcasting field signals with synchronous recording capability.

Based on live broadcasting requirements, the vehicle interior is divided into four zones: driving area, broadcast area, equipment area, and roof platform. The broadcast area and equipment area constitute the main body of the vehicle system. Following the modification design of the broadcast mobile live truck, verification tests were conducted to ensure safety and compliance, with evaluation criteria including noise, vibration, and rain exposure.

The driving area accommodates two personnel, with a transparent soundproof partition between the driving and broadcast areas. A small square table installed in the space between the driver and passenger seats serves as the director's area, effectively transforming the driving area into a production control zone. The equipment area houses audio processing and power amplification equipment on racks that have undergone shock absorption treatment, providing safety assurance for broadcasting while the vehicle is in motion. The roof platform is equipped with roof railings, remote-controlled pan-tilt mounts, FM antennas, loudspeakers, 360° rotatable cameras, and antenna lowering mechanisms.

The broadcast workspace is where hosts conduct live programs, including primary and backup workstations and four height-adjustable chairs. The rear workspace houses electric cable reels and other auxiliary equipment. To achieve wear resistance, fireproofing, and immunity to thermal expansion and contraction, the broadcast and technical workspaces are designed with imported quartz wear-resistant plastic waterproof flooring, while the rear maintenance area uses

aluminum plate flooring, ensuring flat, aesthetic surfaces unaffected by interior temperature variations.

3. Signal System Design for Broadcast Mobile Live Trucks

Based on the characteristics of mobile broadcasting, broadcast mobile live trucks should be configured with highly reliable equipment. Additional functional requirements include: (4) the vehicle-mounted clock system can automatically, accurately, and rapidly obtain standard clock signals through GPS timing system configuration; (5) equipped with a wireless telephone hybrid enabling simultaneous multi-line telephone access, facilitating call connections and providing better hotline participation capabilities; (6) after real-time acquisition of on-site audio signals, transmission to the main studio and station master control room can be achieved via 3G and telephone line transmission functions; (7) four high-pitched speakers added to the roof enhance sound amplification effects, allowing hosts to interact with audiences using wireless microphones without remaining in the broadcast room, while the addition of rotatable and elevating cameras enhances broadcast visibility.

2.1.1 Vehicle Model Selection

The Xiangshui Radio and Television Station mobile live truck is modified from a Mercedes-Benz 524 van, with a total mass of 6.5 tons, total length of 6m, width of 2.1m, and height of 3.3m.

2.1.2 Cabin Layout

Main Control Mixing Console: The main mixing console is a STUDER SoundcraftFX16ii unit from Switzerland. In case of failure, primary and backup mixing console switching can be achieved through a patchbay on the main console, with simple and rapid operation. The mixing console supports multi-source switching, including 4 microphone channels and 16 stereo channels among other multi-channel input functions, achieving a streamlined system structure with simple and fast operation.

Signal Source Section: The mobile live truck broadcast workspace is equipped with a DELL OptiPlex 790MT computer, allowing hosts to copy pre-prepared audio materials and background music from USB drives into the workstation for playback using audio players during live broadcasting. SHUER wireless microphones, wireless headset microphones, and Beyernamic wired headsets are configured to meet mobile live broadcasting requirements. High-quality passive microphone splitters distribute output signals to primary and backup mixing consoles, enabling mutual backup functionality. High-quality vehicle-mounted cassette decks and CD players are configured to provide mobile live broadcast signal sources while ensuring shockproof effects. A telephone hybrid (Italian AEV TELEREPOR) supports two-line telephone field connections.

Signal Processing Section: Mixing console output signals pass through a broadcast delay unit, are processed by a DSP digital audio processor, and then distributed to transmitters and power amplifiers after signal splitting.

Signal Transmission Section: The main transmitter is an Italian AEV Sislco EXC 120GT, with the main transmission system connecting the primary transmitter to the roof-mounted collapsible circularly polarized FM transmitting antenna. The backup transmitter is an AEV Sislco EXC 30GT, with the backup transmission system connecting the backup transmitter to the roof-mounted ceiling whip FM transmitting antenna. Mixing console output signals are directly distributed to both transmitters through an audio splitter. If the main transmitter fails during mobile live broadcasting, it can be directly shut down and the backup transmitter activated to ensure continued mobile broadcasting.

Field Sound Reinforcement: Four high-pitched speakers are mounted on the roof, with two 300-watt high-frequency loudspeaker amplifiers configured inside the vehicle.

Power Supply System: Two sets of batteries separately power two UPS units, with each set providing 4 hours of continuous live broadcasting when fully charged, and both sets providing 8 hours of continuous operation. Both UPS units are connected to an automatic switcher that supplies power simultaneously during broadcasting. If the main UPS fails, immediate seamless switching to the backup UPS occurs to ensure normal equipment operation.

Air Conditioning Configuration: Air conditioning system noise in the broadcast workspace should not exceed 40dB. While the vehicle is in motion, the heating and cooling systems for the driving area, equipment area, and broadcast workspace are provided by the vehicle's built-in air conditioning system. The cooling capacity for the equipment area and broadcast workspace should not be lower than 3500 kcal/h.

4. Operating Modes and Workflow

Mobile FM Broadcasting: During mobile FM broadcasting, hosts and guests wear headsets for real-time commentary. Headset signals are transmitted to primary and backup mixing consoles through passive microphone splitters. Signal sources primarily consist of vehicle-mounted CD players and audio workstations, with signals distributed to primary and backup mixing consoles through audio splitters or patchbays for playback of opening/closing themes, background music, and songs. If the main mixing console fails, one-key switching via an audio switcher enables continued broadcasting through the backup console. Audio switcher signals are input to the delay unit and then distributed to primary and backup transmitters for FM transmission, with primary and backup transmitter signal emission switched via a coaxial transfer switch. Directors, hosts, technicians, and guests can monitor signals in real-time through headphones and headset distribution amplifiers.

Fixed-Site Live Broadcasting: The live truck serves as a broadcast room at event sites, accommodating one host and 1-2 guests who conduct programs inside the vehicle using wearable headsets. Primary and backup mixing consoles utilize audio workstations and vehicle-mounted CD signals for background music and song playback. Hotline participation calls during broadcasting can be answered through wired or wireless telephone hybrids on the truck, with the director using the director system in the driver's cab to connect and disconnect hotline calls. Signals are transmitted back to master control via digital audio encoding transmission for live broadcasting. If the main mixing console fails, staff can quickly switch to the backup mixing console using the audio switcher. The audio switcher inputs signals to the delay unit, which are then distributed to the audio workstation for synchronous recording. Technicians, hosts, guests, and directors can monitor signals at any time through headphones and other equipment during broadcasting.

Field Sound Reinforcement: On-site signals are input to the main mixing console, then distributed through the audio switcher and delay unit. After optimization at the audio processing center, signals are transmitted to external power amplifier speaker equipment for field sound amplification. If the main mixing console fails during this process, the backup mixing console can be quickly switched to continue broadcasting.

Mobile Broadcast with Sound Reinforcement: One host and 1-2 guests conduct broadcasting inside the moving live truck using headsets. Vehicle-mounted CD signals and audio workstations are distributed to the mixing console through audio splitters for background music and song playback. The audio switcher enables one-key switching between primary and backup mixing console playback. Audio switcher output signals are sent to the delay unit, then distributed to constant-voltage power amplifiers, and finally transmitted to roof-mounted speakers to achieve mobile broadcast sound reinforcement.

5. System Equipment Installation and Commissioning

Live System Signal Diagram:

Practice has proven that this system design is safe, reliable, technologically advanced, and highly practical and rational. For Xiangshui Radio and Television Station, this system fully satisfies their requirements for broadcast mobile live broadcasting, with broadcast program formats and quality receiving positive recognition, playing an important role in the development of Xiangshui's broadcasting 事业.

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

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