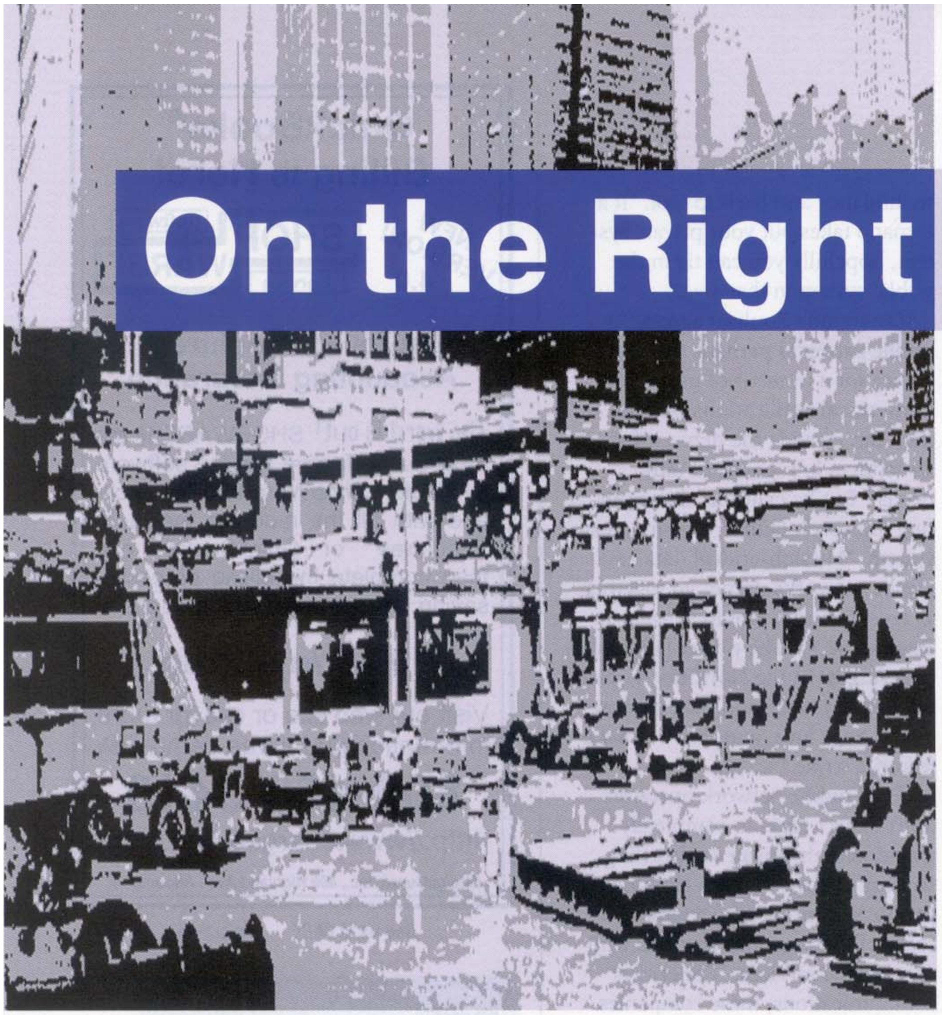
On the Right PATH



Radiating cable provides tunnel communications for the World Trade Center PATH rail system project.

By Tony Fedor

As debate continues regarding a final system design and proper memorial to the victims of the Sept. 11, 2001, terrorist attacks, the first phase in rebuilding lower Manhattan's commuter rail system has already been finished. Completed Nov. 23, 2003, the temporary PATH rail commuter station is the first step in the economic redevelopment of the World Trade Center site, providing transportation for the thousands of commuters between New Jersey and lower Manhattan.

A temporary transit station had to be constructed due to the extent of destruction in the area. Tunnels E and F and the rail system that serve the newly completed station also required excessive refurbishment. The project posed a challenge to the safety of the crew, however. Dangerous working conditions were magnified by a lack of effective two-way radio communications due to the inability of radio-frequency signals to operate satisfactorily within tunnels.

System Design

Newark, N.J.-based Daidone Electric was the contractor tasked with facilitating the electrical work at the new transit station and in the PATH rail tunnels. A wide range of electrical work was required, from traction and control to communications systems, as well as all electrical peripherals associated with the PATH restoration project.

Before any refurbishment work could commence inside the E and F tunnels, the company had to install a safe and reliable tunnel communications system. With the tough working conditions, it was imperative to provide a zero-failure, seamless communications system that would operate 24 hours a day, seven days a week. In most cases, this communications link was the only means of radio communication available between personnel in the event of an accident or emergency.

The complex propagation environment made the design and implementation of the tunnel radio system particularly challenging, as it had to propagate radio-frequency signals with enough strength to be received and transmitted throughout the tunnels. Daidone Electric's solution was to install a Nextel 900 MHz system for two-way radio communications. A Nextel donor site was located one block north of the corner of Church and Vesey streets, just northeast of where the north tower once stood. This donor site provided a sufficient downlink signal to the entrance of the E and F tunnels. An 11 dB directional yagi antenna was located at the tunnel entrance to provide the input radio signal to the tunnel portals.

Because the RF signals were not able to penetrate very far into the tunnels, and point source antennas were not a feasible solution, a leaky feeder backbone was installed to provide consistent radio-signal coverage throughout the 5,000-foot-long tunnels. The Yagi antenna was connected to a low-loss flexible LMR-600 coaxial cable, which then fed the input signal to the leaky feeder backbone.

Leaky Feeder Cable Design

As with all RF cables, the most important function of a radiating/leaky feeder cable is to transmit RF energy from one point to another, with a minimal amount of signal degradation or loss of power. In addition to maximizing downline signal strength, a leaky feeder cable must also allow a sufficient amount of RF energy to be released into the surrounding environment. This balance of downline signal attenuation and coupling loss to the environment is required to minimize the use of amplification systems such as bidirectional amplifiers (BDAs).

To achieve this balance, Daidone Electric used a T-Rad-600 flexible leaky feeder cable. The cable design utilized a high-velocity, closed cell structure, foamed polyethylene core, and semi-circular, bonded aluminum-Mylar laminated shield. The dielectric material offers a tough low-loss medium for the transfer of RF energy between the center conductor and outer shield. The semicircular shield allows a controlled amount of energy to be released and coupled into the surrounding environment.

Since the tunnels are nearly a mile long, the company had to install bidirectional amplifiers to amplify the radio network signals to operable levels within the tunnels. The amplified signals were then retransmitted down the backbone leaky feeder line to an 11 dB uplink

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yagi antenna located at the other end of the tunnel. The combination of leaky feeder cable and BDAs provided acceptable receive and transmit quality throughout every section of the tunnel and minimized any dead-spot areas, which are common with a discrete antenna system.

With the completion of the temporary PATH rail commuter station, the WTC site is now one step closer to reconstruction. An effective in-tunnel radio communications system was critical to the rail project, although implementing it was hardly a simple task.

Providing seamless uniform tunnel radio coverage will continue to challenge engineers across the world. With the proper system design, careful selection of feeder and radiating cables, and efficient bidirectional amplifiers, acceptable radio coverage can be provided to address critical communications. ■

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