Industry Best Practices for Radiating Cable Installation in Tunnels

In order to identify optimum locations for radiating cables, one must have an understanding of specific requirements for the network and how the radiating cable location impacts signal coverage. Tunnels vary in length, gradient, width and height, and so the design of an in-tunnel wireless system that ensures full coverage is non-trivial. The primary goal is to identify a methodology to marry up a conceptual design with the realities of what is practical inside the tunnel. There are standard items to look for in any site walk.

Route of radiating cable

The physical placing and mounting of the radiating cable is critical to ensuring the signal levels are of sufficient strength for the data transfer to occur effectively. Typically, two cables are used; one for send and one for receive. Since the mobile device is on board a train, the most desired radio wave penetration into the carriage is through the train windows.

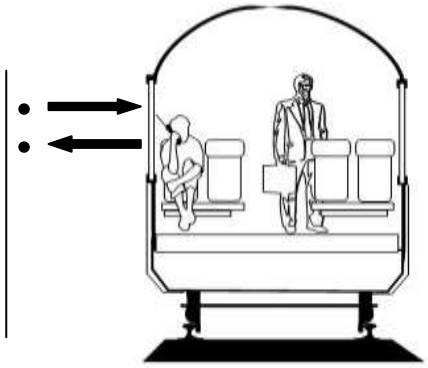

Figure 1

Therefore, a couple of critical measurements must be known prior to performing the tunnel site walk. First, the radiating cables should be spaced a minimum of 12 inches apart. Second, they should be located at a height that ideally keeps them centered on the trains windows as shown in the figure 1 above, (window height varies depending on track bed and train type).

Interference in the route

Keeping the previous in mind, special attention must be paid to the tunnel walls and objects that prevent installation of the radiating cable at the optimum location. All objects or obstructions need to be identified to allow for the planning of splices or alternate radiating cable routing. AirCell® radiating cable works best when it is not located in direct contact with steel or metallic objects. Minimum separation from metallic objects by at least 4" (approximately 100 mm) and separation from a concrete wall by at least 2" (approximately 50mm) is recommended. High voltage lines may induce low frequency noise on the cable. If arcing occurs in the system, the broadband noise that is generated could degrade communications. To ensure the best performance, install the radiating cable as far as possible from high voltage lines.

Tunnel wall materials

Attention to where the cable mounts will be attached to the tunnel wall is an important consideration when performing the site walk and should be scrutinized closely. What do the tunnel walls look like? Are they steel, reinforced concrete, or some other material? These notes are of importance since the amount of labor to mount cable hangers to the different material types will vary as will the time/cost.

Installation of cable hangers

Trilogy offers custom hanger solutions for high-speed train applications as well as hangers for fire prevention and messenger wire attachment. Contact Trilogy's Product Engineering support at (601) 932.4461 for assistance selecting the best solution for your application. The most common hanger installation is on the concrete walls inside the tunnel. Trilogy has standard hangers for this application which allow for ease of installation. For concrete tunnels, spacing the hangers at 2 meters (6.56 ft) intervals for 7/8" and larger diameter cables will ensure excellent support with minimum sag. The standard installation method requires drilling and installing a drop-in anchor into the concrete wall of the tunnel as shown in figure 2 below.

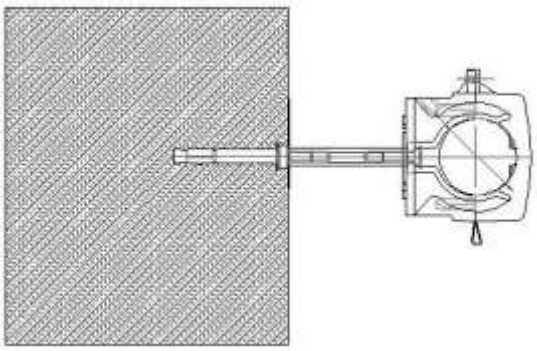

Figure 2

AirCell® radiating cables used in long subway runs are subjected to outside forces that include temperature changes and external forces due to trains moving along the cable. Because of these forces, the cable and its hanger assembly must be dynamic in their ability to withstand these forces and to insure the cable's physical and electrical performance remains within specification.

Correct placement of cable clamps need to take into consideration movement of the AirCell® radiating cable due to these forces. Hence, the cable must be able to move laterally to compensate for changes in length due to temperature and possible movement due to other external forces. The way this is accomplished is to form an expansion loop between cable segments.

Trilogy recommends placement of these expansion loops between every 500 to 1,200 feet of cable installed. Each end of the cable segment is terminated by an AirCell® connector. Between these segments, a flexible AirCell® jumper cable is inserted as a loop to absorb any displacement in cable structure. The attenuation loss due to the connectors and loop is less than 1 dB of insertion loss.

All major tunnel systems use this approach to insure that the radiating cable and its connecting components do not fail due to normal movement of the cable system resulting from a change in temperature or other outside forces. Examples of major tunnel systems where this type of construction has been incorporated include the Washington DC Metro, London/Heathrow Metro, the Hong Kong Metro, the Singapore Metro, the New York City Metro, and many others.

Installing the anchors and radiating cable can be accomplished using masonry drilling equipment following normal safe practices. Figure 3 demonstrates how a four-man team can install the hangers and radiating cable in a rail tunnel. Maintaining contact by simplex radio ("walkie-talkie") with the vehicle driver will allow the installers to direct the start and stop of the vehicle. The hanger installer should spread the opening of the self-locking hanger as wide as possible to ensure that the AirCell® radiating cable can be inserted easily.

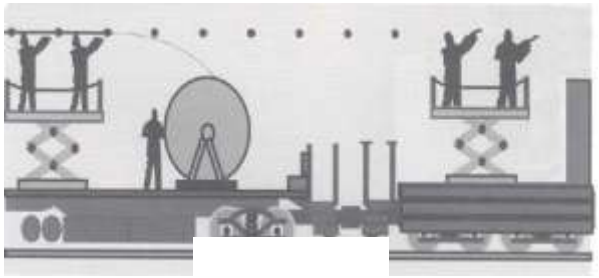

Figure 3

System grounding

The recommended location of grounding kits is 6 inches behind a connector. It is important to keep the grounding wire routed as straight down as possible toward the earth in order to provide the least path of resistance to ground for lightning transients. It should be noted that installation of the grounding straps on radiating cables will result in a slight increase in attenuation, which will affect expected system performance.

Cable movement

Reels of cable must not be dropped from any height, particularly from trucks or other transporting equipment. Lifting reels of cable may be done by one of the following methods. Using a steel shaft or pipe inserted through the reel hubs and lifted with appropriate slings, using a spreader above the reel to avoid pressure against the reel flange. Alternately fork trucks may be used to lift cable reels, but care to ensure that the fork tines slide under both reel flanges must be used in order to support the reel weight. When required, reels may be rolled, but the surface area must be clean of any objects that the reel could roll over and cause damage to the cable externally, such as rocks and lose hardware.

Storage

Proper storage of cable reels depends on available space and facilities. The location should minimize the chances of damage during cable storage. Each reel of cable has protective lagging which should not be removed until the cable is to be installed. The reel lagging not only protects the cable during shipment, it also aids in protection during storage where reel flanges can be rolled into other reels causing exterior damage to the cable. Cable stored in outside areas should be covered to protect the cable from the elements.

Handling

Large coaxial cables once spooled onto a reel take on a memory of the reel's drum diameter. To minimize the effect of the cables memory during an installation the cable should be installed into the hanger supports as the cable is un-spooled over the top of a reel. Any remaining cable memory may be changed by manually forming the cable along its length. Cable handling/pulling in cold weather conditions can be more difficult depending on the cables construction. All coaxial cables have some form of polymer content, whether in the cables dielectric or jacket material. While these materials are rated for extreme temperatures before they become fragile, they do become more difficult to handle as they are exposed to cooler temperatures. As a rule, no coaxial cable should be installed and handled when the cable temperature is 0°C or below mainly for safety reasons. Trilogy's AirCell cables are comprised of high quality materials that can withstand installation temperatures as extreme as -24°C. However, cold weather induced cable stiffness must be considered along with radius and number of bends in the proposed installation. When possible the cable reels should be moved from the storage area to an area to warm prior to installation.

Maintenance

The frequency of cleaning the outer-jacket for radiating cables within a tunnel varies for each tunnel and depends on environmental conditions. One condition used to determine the frequency of cleaning is the average daily traffic that uses the tunnel. Since most of the contaminates that collect on the radiating cables are from the train exhaust, steel wheel particles, brake shoe dust, and carbon brush dust from electrics, tunnels with lower traffic will have less contaminate accumulation on the cables and can be cleaned less frequently. As a rule of thumb, cable cleaning should be performed every six months.