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Medium Frequency Mine Emergency Communications—An Emerging Technology

Objective

To evaluate and develop medium frequency communications technology for emergency underground mine communications. Medium frequency communications systems do not require a powered underground infrastructure to be installed for operation, and may therefore provide a higher degree of survivability after a mine disaster than other types of systems.

Background

In June 2006, Congress passed the Mine Improvement and New Emergency Response Act (MINER Act), mandating that underground coal mines provide emergency response plans that include two-way wireless communications and electronic tracking systems within three years. To satisfy that legislation a wide variety of communications systems have been developed to meet the guidance set forth in the Mine Safety and Health Administration (MSHA) program policy letters that followed. In the years following the MINER Act of 2006, the National Institute for Occupational Safety and Health (NIOSH) supported the development of different types of communications and tracking technologies.

Most underground mine communications systems use hand-held, high frequency radios similar to systems used on the surface. These high frequency systems require the installation of underground powered infrastructure that is susceptible to damage from events such as roof falls and explosions. In contrast, medium frequency (MF) systems use existing mine conductors for communications, such as underground transport rails and mine power cables, which have a better chance of remaining intact after a mine disaster.

In December 2006, NIOSH entered into an interagency agreement with the US Army to evaluate communications technology originally developed by Kutta Technologies for the military, with the goal of adapting that technology for mine emergency communications.

Figure 1. Medium frequency (MF) communications on existing conductors (highlighted green) in a mine.

Medium Frequency Operation

MF systems operate between 300 and 3,000 kilohertz (kHz). Underground, MF signals have a unique effect that makes them parasitically couple to nearby metal conductors. Unlike most traditional high frequency systems, MF signals can travel long distances underground without aid from powered infrastructure. MF signals can propagate onto many different kinds of common conductors found in a mine ranging from page phone lines to metal pipes or track (see Figure 1).

Once a medium frequency signal couples to a good conductor, it can travel several miles. Because MF signals can travel over multiple conductors at the same time, they may provide more diverse paths for emergency communications to propagate out of the mine. This could

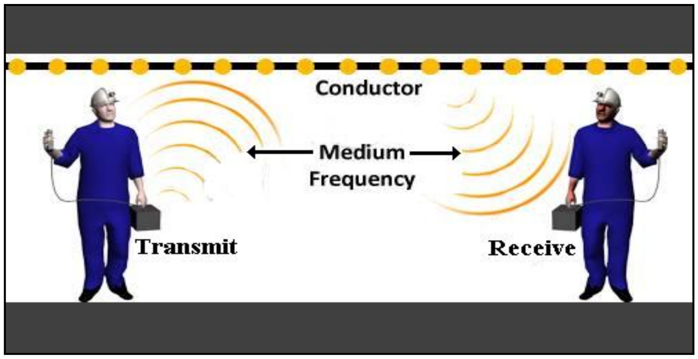

Figure 2. A simple example of MF communications.

increase the chances of successful communications in a situation where the mine's power and its infrastructure become disabled.

An underground MF communications system consists of as little as three parts: an MF transmitter, a conducting medium, and an MF receiver (see Figure 2). An MF transceiver can function as the transmitter and receiver, allowing miners to transmit and receive with the same device. In order to communicate, miners should be in the same entry as the conductor on which they intend to transmit and receive MF communications. The closer the MF radio is to the conductor, the further the signal will travel down that conductor. This holds true for both sending and receiving MF signals.

Test Results and Status of MF Technology

The first MF radio prototypes were delivered to NIOSH in 2009 by Kutta Technologies, Inc. The purpose of the prototypes was to determine if the technology could be packaged with an omnidirectional antenna, using a small battery operating at intrinsically safe levels, and still achieve satisfactory performance. The prototypes were tested in several underground coal mines. In one coal mine, it was observed that the MF signal traveled for over two miles (the maximum extent of the mine available during the testing period). Observations in some coal mines have shown that MF signals can travel as far as five miles without any amplification from powered infrastructure. It should be noted that each test was dependent on the specific mine environment, and that configuration of the metal conductors can affect the overall performance.

These tests also demonstrated that MF could be interfaced with other existing primary communications systems such as ultrahigh frequency (UHF) leaky feeder. Kutta Technologies developed an MF-to-UHF bridge that allows miners to use the same hand-held radio they use with a leaky feeder system (see Figure 3). The MF-to-UHF bridges are installed in fixed locations near the leaky feeder cable.

By mid-2010, portable MF radios and fixed-location MF-to-UHF bridges were approved by MSHA for permissibility (see Figure 4). The size of a portable MF radio is 12 x 12 x 6 in, which is sufficiently compact for

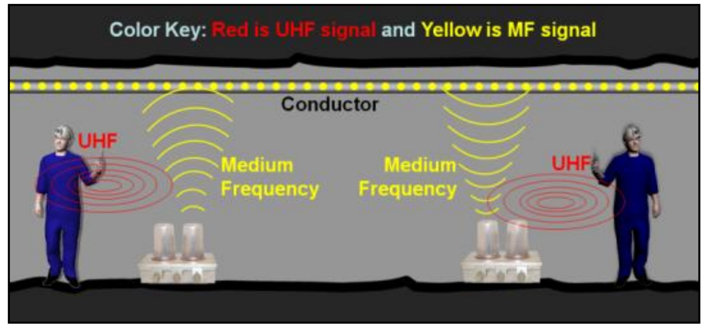

Figure 3. A simple example of an MF-to-UHF bridge.

Figure 4. Permissible medium frequency radios.

the radio to be carried to the face area, but not small enough to be worn on the miner. One potential way to ensure availability would be to store the MF radios at strategic areas and carry them for use during escape along a nearby conductor. Several operators have already installed MF radios and bridges in their underground coal mines for use during a mine emergency.

The technology described in this article is available from Kutta Technologies (http://kuttatech.com/).

For More Information

For more information on this technology and its use, contact Nick Damiano (ndamiano@cdc.gov) or the Health Communications Coordinator (OMSHR@cdc.gov), NIOSH Office of Mine Safety and Health Research, P.O. Box 18070, Pittsburgh, PA 15236-0070.

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