

DESCRIPTION OF MSHA-APPROVED TECHNOLOGIES

Handheld two-way radios

General Information:

Handheld, portable radios (walkie-talkies) are two-way radio transceivers widely used by consumers and can also be engineered for use in industry and more rugged working environments, including underground mines.

Pros:

- Page phones are currently available and are MSHA approved.
- Handheld walkie-talkies have the capability of providing two-way voice communication.
- Flexibility can be provided for use (frequency range and number of channels).

Cons:

- These frequencies cannot penetrate rock due to the high level of attenuation that they suffer. Communication is problematic if the devices aren't within "line of sight" of each other.
- Limited range; typically about 500ft.

Leaky Feeder Communication Systems

General Information:

"Leaky Feeder" systems are two-way radio systems that feature a base station on the surface that communicates with individual underground radio units, such as walkie-talkie radios. To allow radio frequencies to function underground, it is necessary to replace a standard surface antenna system with a cable network. The cable networks should be installed to effectively radiate the signal throughout the mine. The cable is designed to "leak" signal, which allows radio transmissions to both leak from the cable and also enter the cable. The systems are generally used for both data and voice communications.

Pros:

- These systems are currently available and are MSHA approved.

- Leaky feeder systems have the capability of providing two-way voice communication.

Cons:

- The main limitation is based on the frequency band for two-way voice, data and video is VHF. These frequencies cannot penetrate rock due to the high level of attenuation that they suffer. Communication is problematic if the devices aren't within "line of sight" of each other. An example of this problem is the inability of a commercial radio signal to broadcast through tunnels. Therefore, the walkie-talkie user must be fairly near the underground leaky feeder cable network to adequately communicate with the system.
- The cables are subject to damage, which can disable the system.

Mine Page Phones.

General Information:

Paging telephones are self-contained battery-powered communication units that provide loudspeaker paging and handset party line conversation over a two-conductor telephone line. In general, they operate from 12 volt DC lantern batteries. When paging, the user's voice can be heard via loudspeaker at all telephones connected to the system.

There is no practical limit to the number of units which can be connected to a paging telephone system. The units can be placed miles apart or as close together as a few feet. The system arrangement need not be on a loop basis, but can include branch circuits as required for convenience.

Pros:

- These systems are currently available and are MSHA approved.
- Paging telephones have the capability of providing two-way voice communication wherever telephone lines are installed.
- Mature technology with simple and familiar operation.
- The units are relatively immune to interference from other electrical systems.
- Small portable units are available, which connect to the telephone lines with alligator clips.

Cons:

- The cables are subject to damage, which can disable portions of the system.
- The lantern batteries can be subject to frequent replacement.
- Most units are not carried by the user, but mounted at permanent or temporary fixed sites, requiring the user to be at the device to communicate.
- To use the small portable units, one must find and connect to the telephone line, which may be difficult in an emergency.

Radio Frequency Identification (RFID) Tracking Systems**General Information**

RFID tracking systems enable the identification of a miner's location in an underground mine. The miner wears a transmitter, which sends out a unique pulsed signal that is received by a receiver "reader". This is a mature technology that is just recently being introduced into underground United States mines.

- Requires hard wire data and power connections.
- The readers are not MSHA approved (therefore, not intrinsically safe) but could be placed in explosion proof boxes.

Pro:

- If the system is disrupted, it still could provide the last recorded location of all personnel and equipment underground.

Cons:

- System is subject to damage from fire and explosion which could compromise the ability to track personnel or vehicles.
- The tracking accuracy is limited by the number of installed readers. The range of the readers is typically limited to approximately 200 feet. Therefore, if the readers are spaced (as commonly done) at 3000' intervals, a signal is received when the transmitter passes within 200' of reader A, but then not again until it passes within 200' of reader B. If the system is disrupted in an emergency and personnel need to be located, this limitation would create a potential search window of approximately ½ mile.

PED System - Mine Site Technologies

General information:

The PED system is a one-way "Personal Emergency Device", a communication system featuring a belt-wearable receiving unit for individual miners. Mine Site Technologies was issued MSHA Approval for the Model PED1 Paging Receiver/Cap Lamp, meaning that this system may be marketed for use and used in underground gassy atmospheres. The system generally consists of a transmitter capable of sending communications that can be received as a text message by miners through their PED. The PED system is currently used at about a dozen U.S. underground mines and has also been deployed at mines in other countries, particularly Australia.

- It utilizes either a surface or underground antenna loop which radiates a radio frequency signal enabling one way communication to the underground workings.
- System dims and flashes lamp for about 10 seconds then sends a text message to the wearer. Individual, group or broadcast messages can be sent.
- There is only one US mine currently using the surface antenna.
- The problem of using a surface antenna is a logistical one mainly with the terrain.
- The maximum amount of cover for a surface antenna to be effective is about 2500' - 3000'.
- There have been a couple of success stories with respect to use in US mines, Willow Creek being the primary one.
- The system is MSHA approved for use on Koehler, MSA and Northern Lights [Canadian Manufacturer] cap lamps.
- Battery life - normally 8-12 hours but if lamp is turned off this time could be extended to days.

Pros:

- System enables communication of text messages from a central control center on the surface to miners underground. It uses a through the earth transmission system. The transmitting antenna can be installed either underground or on the surface. If installed on the surface, the system does not depend on any underground wiring.
- The system is relatively easy to use. It can convey a text message of up to 32 characters.

- The PED receiver is attached to the miner's cap lamp battery. This ensures the receiver is always with the miner.
- System has the potential of providing messages to miners during the early stages of a mine fire including evaluation instructions.
- Can be retrofitted with existing cap lamp manufacturers lamps, Koehler, NLT and MSA.
- System can be deployed in an emergency by stringing antenna cable on the surface thus enabling one way communication from the surface in some cases. This deployment may take time, however.

Cons:

- Installations incorporating underground antenna loops may be compromised in the event of a fire or explosion preventing communications.
- Systems employing underground antenna loops are not intrinsically safe and power must be removed in the event of a fan outage or other incidents such as mine fires and explosions, thus disrupting communication capability.
- The PED System only provides one-way communication from a person sending a message to a person receiving a message. The person sending the message receives no confirmation that the message was received.

MSHA PED Evaluation Results:

The operation of the PED system at several U. S. underground coal mines was investigated by MSHA Technical Support engineers, with the participation and full cooperation of both the mine operators and miners using the system. The investigation included an evaluation of the PED in the only U.S. mine that deploys a surface mounted antenna, and in several mines in Australia. In a cooperative effort with Mine Site Technologies, MSHA and a state of West Virginia Board of Coal Mine Health and Safety representative visited four mines in Australia, including the only underground coal mine with a Tracker IV installation. The issues reported below regarding signal loss or "shadow" zones were investigated to accurately determine the nature of these anomalies.

- Antennas are installed to provide coverage in pre-determined areas. In one U.S. mine surveyed, the antennas provide coverage to virtually the complete mine. In three other mines, the coverage was limited to the active working area of the mine.
- All four mines visited reported experiencing "shadow zones" in the areas where the system is intended to provide coverage. "Shadow zones" are areas, within the antenna radius coverage, where a message sent may not

- be received by a miner wearing the PED receiver. MSHA engineers verified this in one particular mine.
- The PED system was installed at the four mines surveyed in February 2006 to enable the mine to contact key personnel in the mine. Although mines did consider the system to be useful in the event of an emergency at the mine, the primary reason they reported that the system was installed was to contact personnel so that they could assist with a malfunction in the mine affecting production.
 - The PED receiver is attached to the miner's cap lamp battery. This ensures the receiver is always with the miner. It increases the size and weight of the cap lamp battery. The increased size simply requires a larger cap lamp pouch and miners seem to get used to the increased weight (one pound).
 - The PED System only provides one-way communication from a person sending a message at the PEDCall computer to a person receiving a message via a BeltPED. The person sending the message receives no confirmation that the message was received. If the receiving BeltPED does not receive the message at the time it is sent, the message is lost. For this reason, a typical message is for the person receiving a message to call the person sending the message. This is to ensure that the receiver received the message.
 - All four mines visited used an underground antenna. This approach was taken because mine owners did not have the right of way on the surface and because they felt the antenna in the mine would be easier to maintain.
 - The PED System was reported by mine personnel to interfere with other mine communication systems such as pager phones, trolley phones and mine phones. Each mine has developed methods to reduce this interference to a tolerable level.

The transmission of the message is not instantaneous and is dependent on the length of the message. The longer the message the longer it will take to transmit. A 32 character message may take almost 3 minutes for the receiver to receive the message.