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COMMUNICATION SYSTEMS FOR ISOLATED AREAS IN MINES - PHASE II

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ABSTRACT

A progress report is made on the CANMET communications systems project at Sherritt Gordon Mines, Ruttan Operations. The purpose of this project was to determine the current status of underground communications and to install and evaluate a state-of-the-art communications system.

A study by Falconbridge Limited concluded that medium frequency FM (frequency modulated) radios offered the best potential for underground communications and it was recommended a system built by Montan-Forschung in West Germany or its equivalent be used in field evaluation studies. The system was purchased and is being installed and evaluated at Ruttan Mine.

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INTRODUCTION

Improving underground communications is an important step to improving productivity and safety at Ruttan Mine. To provide improved and effective communications, a research contract was entered into with CANMET on the subject. The particular areas of interest covered by the contract include voice and data communication for mobile and stationary underground equipment, and voice communications for hoist operation.

The project consists of two phases. During the first phase a subcontractor was employed to gather technical information and publications on communication systems, visit a number of mines to evaluate their communication systems, and to recommend systems for field trials. The results of their research are available in previous CANMET publications (1,2). The second phase, which is currently in progress, is to purchase and install recommended systems at Ruttan and to evaluate their performance and effectiveness. This second phase consists of the installation and evaluation of four systems which are in various stages of installation and use at this time. The four systems are: a hoist radio system, a data system for mobile equipment and a rock mechanics monitoring unit.

Progress has been slower than anticipated, mainly due to limited manpower availability. As is the case with many companies over the last few years mining companies have reduced their staffs to the very minimum required to maintain production and profitability. As a result, longterm projects and projects which requiring considerable manpower have tend to be stretched out and done "in between" production related work. This paper is devoted to describing each of the systems, their applications and benefits.

HOIST RADIO SYSTEM

The hoist radio system is intended to provide voice communication and signalling between the hoist room and conveyances.

The system at Ruttan Mine is a Trolleyphone/Cagephone system manufactured by Femco in the U.S.A. and distributed by National Mine Service in Canada. The Trolleyphone unit is intended for permanent installation and is complete with a loudspeaker, a microphone, a push-to-talk footswitch and a push button for signalling. The Cagephone unit is a portable radio and has a built-in microphone and speaker, a push-to-talk button and a signalling button which transmits an audio tone to simulate the sound of a signal buzzer. The radios operate at 88kHz and are frequency modulated.

The system is installed with the fixed Trolleyphone in the hoistroom and its antenna is mounted beside the hoist rope just below the sheave wheel in the headframe. The portable Cagephone on the conveyance and its antenna are attached to the hoist rope at the conveyance. When one radio transmits, its antenna induces a radio signal into the hoist rope which in turn induces a signal into the receiving antenna at the other end of the rope.

The hoist radio can be used daily in the cage or during shaft inspections on any of the conveyances. For use on a daily basis in the cage, the Cagephone is mounted inside the cage with its antenna permanently attached to the cage hoist rope and the Trolleyphone is located near the cage hoist operator with its antenna mounted next to the cage hoist rope. For use during shaft inspection, the Trolleyphone is placed near the appropriate hoist operator and connected to the appropriate antenna in the headframe and the Cagephone is carried on the corresponding conveyance with its antenna temporarily attached to the hoist rope.

The components of the system at the Ruttan Mine consist of one Trolleyphone located in the production hoist room, one Cagephone and a total of six antennas. One antenna is located on each of the four hoist ropes (2 skips, cage and counter-weight) in the headframe. The fifth antenna is used on the appropriate conveyance during shaft inspection and moved from one conveyance to another as required. The sixth can be mounted permanently on the cage if it is desired to use the Cagephone in the cage on a daily basis.

The hoist radio system was installed and tested but it was found that the antennas in the headframe needed to be relocated closer to the hoist rope. New mounting brackets are presently being manufactured and are expected to be installed soon. Aside from this initial installation problem, the operation of the system is quite good. The Cagephone was probably intended to be mounted permanently in the cage. Since it has a combination speaker/microphone on the front of the radio it is necessary to have the unit at face level to speak into it. This is not a problem if the radio is permanently mounted at face level in the cage, but it is inconvenient if the radio is being used for shaft inspection since the user must raise the unit to face level to use it and unfortunately it is rather large and heavy. A handset has been added and it works very well. The Trolleyphone in the hoistroom was simple to install. The radio is mounted on or near the hoistman's console and the speaker, microphone and push-to-talk switch are simply plugged into prewired cables. While this results in a simple, foolproof installation it also results in many wires around the hoistman's console. One hoistman suggested using a handset as we did on the Cagephone.

One consideration when planning such a installation is how to provide communication to several hoists at various times. Do you want a radio in the cage at all times and a second radio for shaft inspections on a production hoist or are you only going to use radios for shaft inspections and only have one radio? Another possibility is to have one radio semi-permanent in the cage and take it out for shaft inspections on other hoists. Some type of switching arrangement for multiple antennas might be required if only one radio is used. As well, when only one radio is used, it may be necessary to move the Trolleyphone from one hoistroom to another or install duplicate speaker and microphone facilities in each hoistroom.

The initial application of the hoist radio was for shaft inspections on the production hoist. The next step will be to use it for shaft inspections on the cage hoist and possibly to have the radio full time in the cage except when it is needed for shaft inspections. At about this point it will be necessary to decide on whether to obtain a second radio which which would be kept permanently in the cage or to continue switching between the cage and shaft inspections.

VOICE RADIO SYSTEM

The underground radio system is intended to provide voice communication for operators of mobile equipment and for personnel in remote areas where telephones are not installed.

The system under evaluation at Ruttan Mine is manufactured by Montan-Forschung in West Germany and distributed by IMS Electronics in Canada. The system consists of a central base station, mobile and portable radios, and an antenna system. The radios are frequency modulated and operate in the medium frequency band at 430kHz and 290kHz.

The base station is supplied with a loudspeaker, a handset and two waveguide ohmmeters which are used to monitor the antenna impedance. The antenna consists of a #12 gauge single conductor insulated wire which is suspended along the back of the drift. The antenna can be wired as a closed loop or as two legs which are terminated through resistors to ground. The handheld portable radios are euqipped with a shoulder strap, two controls, an on-off switch and a push-to-talk button.

The mobile radios consist of two units: an antenna unit mounted in a location where it is exposed to the antenna wire, and an audio unit mounted in a location where it is acccessible to the operator. The audio unit has an on-off switch, a power on light and a volume control. A loudspeaker and a microphone with a push-to-talk button and a keypad is also provided for selective calling. The selective call feature allows the person who is initiating a call to signal the particular radio which he wishes to contact.

The system in use at Ruttan Mine consists of one base station, seventeen mobile radios and six portable radios. The base station is installed in the electrical substation on 730 m Level (730mL) in the lower part of the mine. The antenna is installed on two levels in the form of a closed loop from the base station on 730mL (down the ramp to 800mL, across 800mL to the shaft station, up the shaft to 730mL and back to the base station). On each level there are shorter branches which extend into the main haulage routes. The antenna is presently being extended up the ramp to 660m and 620m Levels.

The underground voice system, as it was initially installed, has had only limited success. The system is quite capable of providing good communications but the initial installation did not include enough radio equipped vehicles or cover a large enough area to be effective. Work is underway to increase the number of radio equipped vehicles and to expand the antenna to include the full lower beat of the mine. The antenna is a critical component of the system and, if it is damaged, communication can be lost or very limited. Any damage must be repaired immediately or the system will not be accepted by mine staff on the basis of unreliability. Similarly, radios which malfunction must be repaired or replaced to ensure constant availability of communications. Personnel must be trained to make repairs to the system and the radio system must be a high priority item of the person's job. Ambient noise is another major problem. Unlike most vehicles used above ground, which have enclosed cabs, underground vehicles generally have open cabs. The operator is subject to very high noise levels which may prevent the operator from being able to hear incoming calls. The use of a selective calling feature, which gives a visual indication of incoming calls for a particular radio, is a practical solution. Increasing the number of radio equipped vehicles, increasing the area of radio coverage and the addition of selective calling should provide faster acceptance and a better evaluation of the system. If and when the system is fully accepted and operates satisfactorily it may be extended to cover additional beats or may be patched into a telephone or pager phone system.

MOBILE EQUIPMENT DATA SYSTEM

The data system is intended to provide data communications for mobile equipment to a central monitoring location.

The data system is built by Montan-Forschung and is distributed by IMS Electronics. The system uses the same radio base station and antenna as the voice system but operates at 190kHz and 593.5kHz. Data equipment on the vehicles consists of a keyboard and a data radio. Data is sent via the radio system from the vehicle to the base station. From the base station, the data is sent over a hardwired circuit to an interface computer, which is connected to an IBM Personal Computer.

The keyboard on a vehicle has twelve keys which corresponds to various operating modes of the vehicle, such as hauling ore, hauling waste, shutdown for servicing, etc. The vehicle operator pushes the button which corresponds to his vehicle's status and this data is transmitted via the radio system to the base station. The data is sent from the base station to the interface computer, which controls the collection of data from all the equipment on the system and which also displays the status of the equipment it is monitoring. The interface computer also sends data to an IBM Personal Computer which is used to store data, produce reports and provide graphic displays.

Another feature of the system is the capability to monitor the location of equipment. This is accomplished by having the vehicle "check in" when it reaches selected locations. At each selected location an infra-red transmitter is mounted in the drift. Each infra-red transmitter transmits a coded signal, which is received by an infra-red receiver on the vehicle as it passes the transmitter. The code is sent to the interface computer and then to the IBM PC which is programmed with the location of each infra-red transmitter and its code. When the computer receives a position code from a particular vehicle, it can then relate the position of that vehicle to the location of the infra-red transmitter and display the vehicle's location on a graphic display of the mine. By keeping track of the sequence of location reports which a vehicle sends back, the computer can also determine in which direction the vehicle is travelling.

It is planned to most keyboards, radios and infra-red receivers on scooptrams and infra-red transmitters at appropriate locations between drawpoints and the orepass on the 730mL and the 800mL. The system will be used to monitor the production and movement of scooptrams working on the two levels.

The data system is initially being implemented on only a few scooptrams which will be assigned to operators who are most likely to accept the system. We have a few scooptram operators with mining engineering backgrounds who would probably be more receptive to new ideas such as this.

Installation of the data system is still in the preliminary stage and only the most preliminary evaluation is currently possible. Operator acceptance may be a significant problem since the system is essentially monitoring their work and activity. Operator co-operation and training will be a significant factor in the full implementation of this project. As with the voice system, repairs and maintenance to the system must be a high priority if acceptance is to be achieved and maintained.

ROCK MECHANICS MONITORING UNIT

The rock mechanics monitor unit is intended for use by our Geology Department to provide remote monitoring of extensometers.

The monitoring unit is designed and built by IMS Electronics and operates in conjunction with the Montan-Forschung radio system. The unit takes up to 16 analog input signals in the range of 0-10 V.d.c., converts them to digital values and transmits them over the radio system to the base station. From the base station, the signals are sent over a hardwired circuit to a computer which recovers the original input signals. The signals can then be processed, displayed, or stored as required.

The unit is intended to be used in remote locations serviced by the radio system, but which may not have electric power available. It is battery operated and has a timer which turns the unit on about every 5 minutes in order to scan all the inputs and transmit resulting data to the computer.

The original and primary application of the unit is to monitor analog extensometers as part of a rock mechanics project in progress at Ruttan Mine. However, through the use of appropriate transducers and sensors, which convert physical conditions such as temperature or pressure to analog signals in the range of 0-10 V.d.c., a variety of conditions can be monitored using the same unit. The unit should be very useful for on-line monitoring of conditions which might ordinarily be checked only 2 or 3 times a week. Acceptance should not be a problem since it will relieve personnel of a time consuming task and will provide data on a much more frequent basis. A reliable radio system is required if it is to replace manual reading of rock mechanics instrumentation.

EXPECTED BENEFITS

The benefits from use of a hoist radio stem from the availability of a second form of communication system in the shaft in addition to signals. Voice communication gives additional security by being able to talk to someone in case of problems or emergencies. Signal systems occasionally malfunction and the radio can provide an alternative signal system to replace the regular system while it is being repaired.

Utilisation of a mine wide radio system can potentially productivity and safety. Faster communication with maintenance personnel reduces downtime, increases equipment availablity and improves productivity. Personnel working alone or in isolated areas have immediate communication in the event of emergencies.

The data system provides reports which contain the same information as operators shift reports and will therefore eliminate this task. More detailed monitoring of vehicle usage, such as operating, idle or shutdown hours, will be automatically provided. Instantaneous monitoring of production is another benefit. In addition, the system can be adapted to monitor such functions as engine temperature or oil pressure which could provide useful information for a preventative maintenance program. As experience with the system is gained other benefits will likely be realized.

The rock mechanics monitor unit will be used to monitor extensometers and probably environmental conditions in the mine. Its major benefits will be an increase in monitoring frequency and the relief of personnel from a time consuming task. Its general applicability will make it useful for any number of applications where monitoring of trends over a long period of time is desired.

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