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MSHA/OSRV

Mine Safety and Health Administration
Request for Information

Overview: Extreme Endeavors has been developing equipment for the purpose of analyzing and testing in underground facilities for over two years. We have been working to classify the underground environment for the protection of endangered species of bats and for military operations. To date there has been very little invested in the classification of the environment underground. Through our research we have been able to learn of how the outside pressure interacts with the air pressure inside of an underground facility, and how varying pressure outside can create temperature differentials (some of which may be anti correlated with the surface temperature).

We currently have several proposals under review by the federal government that is directed toward military operations to classify and detect caves and underground facilities. Working with NASA Langley, we are broadening the sensitivity and details of our measurement process. One comment heard by a local mining company, "the months of September and October are when most of the problems happen in our Limestone Mine, we just blame it on the time of year". Extreme Endeavors sees the value of this comment in that there has to be a scientific reason for this. It has been shown that collapses occur during times of high barometric pressure; does the cooling of the earth play a roll in this for September and October? This is just one of the questions our environmental sensors are trying to establish.

The Owner and President of Extreme Endeavors, Mike Masterman lives within five miles from the Sago Mine, making him personally involved in the technology ventures for underground operations. Even though Extreme Endeavors is relatively small, its technological ability, partnerships and personal interests in this field make them an ideal candidate for research and development to aid miners and mine rescue operations.

A. Rapid Deploy Systems

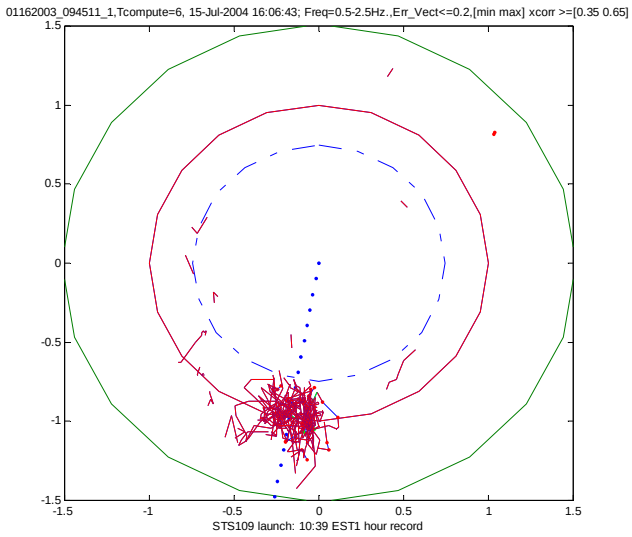
Rapid Deploy Systems are systems which are easily transportable for use in mine emergencies and which can be quickly set up to provide emergency service. An example would be a seismic sensing system for detecting movement underground, or an electromagnetic sensing system to detect signals transmitted by trapped miners. These systems may employ advanced technology and may be under development.

- 1. What kinds of rapidly deployable systems could be used to locate miners who are trapped by a mine emergency?

Extreme Endeavors is currently working in partnership with NASA Langley in the development of a system to measure and classify the underground environment. By electronically "listening" to low frequency noise (.1 to 10 hertz), we can not only detect environmental parameters, but also detect sounds from humans and from shifts in the earth or rubble.

2. How would such a system work?

Low frequency MEMS transceivers that detect frequencies below what the human ear can hear can be structured in a specific orientation and through use of advanced digital signal processing techniques we can determine the direction of where the sounds are coming from. Since the system utilizes extremely low frequency, the propagation through rock and out of a mine shaft will be better than any instrumentation ever seen. The recent advancement in sensor sensitivity and MEMS developments make this technology feasible for the mining environment.



Low Frequency Acoustical Detection of A shuttle launch from over 1000 miles away

Discussions for this system began initially to detect people in caves for military applications. For the mining industry, small low frequency transmitters may be placed on the miners so that when an accident occurs, location is detectable even behind a wall of rubble. The transmission of the low frequency acoustics can be shown to be extremely robust as shown in the figure, when NASA Langley in Virginia was able to detect the sounds of the space shuttle lifting off in Florida.

This same system could be utilized as not only a location beacon, but as a communications system and environmental monitoring system (see section E). As this technology advances, three or four different transceivers could feasibly be placed on the surface and the transmission of the .1 Hz sound wave could be initiated by all units, and received by the miner underground. The time as to which the miner receives the signal could then be used to calculate the distance from the transmission- then through triangulation, the location of the miner can be found. This is similar to an approach utilized by GPS technology, where the location process would take on the order of a minute instead of the order of seconds as seen by satellite navigation.

- 3. Is the system currently available? If not, what obstacles are there to the development and implementation of this type of system? How long would it take to develop the system?

This system is currently under development by Extreme Endeavors, working in conjunction with NASA Langley, the Robert C. Byrd Institute for Advanced Flexible Manufacturing and the Technology Commercialization Center for NASA Technologies. NASA Langley provides some of the world's top scientific staff and Extreme Endeavors provides engineers with real world experience that specializes in designing equipment for harsh environments, taking state of the art technology from the R and D shelves and putting it into the correct environment. The chief Scientist from NASA Langley recently submitted an Innovative Partnerships Program proposal to pursue utilization of low frequency sound signature use in remote detection of anomalies in underground environments.

Working in conjunction with NASA Langley, Extreme Endeavors could perform testing and analysis to determine and illustrate that the concept is feasible within 4 to 5 months. Extreme Endeavors could utilize developments made under a contract with the National Personal Protective Technology Laboratory to include the advanced digital signal processing and have a system ready for mining operations within 1 year after the proof of concept. Extreme Endeavors is currently entering discussions of a partnership with Texas Instruments and this could potentially be used to take the product to market more rapidly.

E. Communications

- 1. What types of communication systems can be utilized in an emergency to enhance mine rescue?

There is a direct trade off between bandwidth, frequency, and penetration through land. For example the higher the frequency, the more the bandwidth of data (voice and other) can be transmitted, yet penetration through rock degrades. When transmitting at a lower frequency, you have less the bandwidth but better the penetration through earth. Extreme Endeavors is proposing a software defined radio system that automatically detects its environment and reacts accordingly.

For example, normal underground communication could be effective at 80KHz. If a collapse were to occur, this frequency may not be able to propagate out. The Software Defined Radio technology being developed by Extreme Endeavors could easily switch to a lower frequency (say 300 Hz) and retry transmission of a text message. In the event this fails, the same Software Defined Radio could switch to a low frequency acoustical system.

This software defined radio circuitry currently measures 5 inches by 2.5 inches and is in the process of being reduced down to the size of a credit card. This technology utilizes the latest in Texas Instruments Digital Signal Processing and was presented as one of the most innovative technologies at the User's Conference in 2006.

An additional capability currently under analysis for military underground operations is using low frequency radio transmission with a specialized buried antenna, eliminating one reflection before penetrating the earth.