



U.S. Department of Energy
Energy Efficiency and Renewable Energy

industrial technologies program

U.S Department of Energy Mining Industry of the Future

Round I Projects



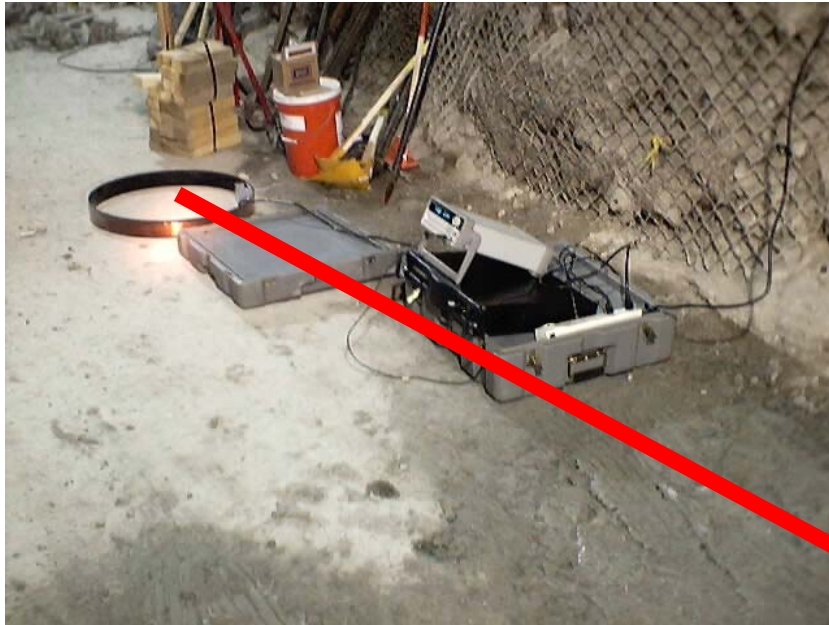
industrial technologies program

High-Temperature Superconductors in Underground Communications

- **Principal Investigator:** David Reagor- Los Alamos National Laboratory
- **NETL Project Manager:** Morgan Mosser
- **Partners:** RAG Coal, CONSOL, Inc., Hecla Mining, Asarco, Phelps-Dodge, Molycorp, Stolar Horizon, Harris Communications
- **Total Project Cost:** **\$2,142 K**
 - DOE Share: \$1,071 K
 - Participant Share: \$1,071 K
- **Project Period:** **48 months**
- **Project Start Date:** **Sept 1, 1999**
 - No cost time extension till June 30, 2003



High-Temperature Superconductors in Underground Communications





Project Objectives

- Develop and deploy a compact, sensitive wideband receiver for low-frequency underground communications signals, using high-temperature SQUID (superconducting quantum interference device) technology
- Increase the productivity of underground mining operations by about 5% resulting in a 5% energy savings per unit production
 - Receivers can be placed in small packages that can be easily carried by miners in an underground environment
 - Easier to install and maintain than hard-wired technology



Milestones and Status

Major Milestones Planned to Date/Status

<u>Planned Milestone</u>	<u>Scheduled</u>	<u>Completed</u>
– Field testing of background noise in mines	06/1999	06/1999
– Evaluation of industry communication needs	12/1999	12/1999
– Identify effect of MSHA requirements on system	12/1999	12/2001
– Demonstrate high-quality audio in lab	06/2000	05/2000
– Field demonstration of the digital audio	06/2000	08/2000
– Demonstrate long range audio to the consortium	06/2001	06/2001
– Design and build portable transmitters	06/2001	04/2001
– Transfer device fabrication to economical substrates	12/2001	12/2001
– Complete production prototype	06/2002	underway*
– Field demonstrate 2-way portable radio	12/2002	12/2002
– Transfer technology to communications partner	03/2003	underway**

- *see attached project note..



Key Accomplishments

- **Project Highlights**

- In response to interest from a number of companies the LANL licensing office is conducting a licensing competition with a deadline of April 23, 2004 to submit a licensing plan.
- We still have an active interest in the patent from Pyott-Boone. They are one of the companies participating in the licensing negotiations.



Project Note

- The production prototype milestone has been delayed pending interactions with potential vendors.
- We have developed a relationship with Pyott-Boone and they have started licensing negotiations with the LANL to commercialize the radio.



Good News!

- Our vendor for part of the underground radio system is willing to join a consortium to build a demonstration system in a mine. The concept is to take part of the underground radio system and use it to complete through-the-earth links in underground mines. The underground radio links would consist of repeaters that connect areas served by leaky feeder or line-of-sight systems. This will turn a vulnerable, singly connected system into a redundant multiply connected network, and also allow communications in areas that are currently difficult to serve. This is an immediate term application using items that have been demonstrated in the course of the project.



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RIM System for Imaging Ahead of Mining

- **Principal Investigator:** Marianne Walck - Sandia National Laboratories
- **NETL Project Manager:** Morgan Mosser
- **Partners:** Stolar Horizon, Inc; CONSOL, Inc.; Kennecott
- **Total Project Cost:** \$1544K
 - DOE Share: \$212K
 - Participant Share: \$1332K
- **Project Period:** 48 months
- **Project Start Date:** October 1999
 - No cost time extension to September 30, 2003



Project Objectives

- Validate, with in-mine testing, an advanced Radio Imaging Method (RIM) system that will provide accurate information on the location of the anomalous geologic conditions within an ore body prior to mining
- Employ RIM system to improve the quality of mined ore, reduce wear on mining machinery, facilitate mine operations, and reduce costs



Milestones and Status

Major Milestones Planned to Date/Status

<u><i>Planned Milestone</i></u>	<u><i>Scheduled</i></u>	<u><i>Completed</i></u>
- In-Mine RIM-IV System Complete	Sept 02	100%
- RIM data collected at Mine 1	Oct 02	100%
- RIM data collected at Mine 2	Nov 02	100%
- Down-Hole RIM-IV system complete	Feb 03	100%
- Mines #1 & #2 deliver ground truth data	March 03	100%
- SH completes FWIC inversion	May 03	100%
- Acquire MSHA approvals for RIM	May 03	100%
- Convert to DSP electronics	March 04	100%
- Mobilize Fiber Optic Hoists	March 04	100%
- Employ Multi-Display Function	March 04	100%
- SNL delivers final report to DOE	April 04	90%



Key Accomplishments

- **Recent Project Highlights**

- The electronics for the receiver (RX) and transmitter (TX) have been converted from analog to digital (using DSP platforms). This greatly improves system performance.
- One key improvement, a 170-dB total dynamic receiver range, translates into a 25% increase in the operating range of the system (distance between TX and RX).
- The packaging of both the In-Mine and Down-Hole systems has been improved with the new electronics. Both systems are now comprised of three modules (not 4) and power consumption has been reduced.
- MSHA Approval was recently granted for the Intrinsically safe Battery Pack. Antenna modules are still pending.



Key Accomplishments

- **Project Highlights**

- Latest field tests show RIM-IV system capable of 2000 feet range with phase stability greater than 3 degrees.
- There are now twelve imaging frequencies available: 20, 21.25, 40, 52.5, 70, 80, 81.25, 90, 190, 200, 290, and 300 kHz.
- The In-Mine system can be mechanically reconfigured for Down-Hole use with only an antenna and fiber-optic change.
- RIM In-Mine and Down-Hole versions of RIM-IV are being produced in small quantity at Stolar.
- RIM is primarily a field service business with select RIM equipment being offered for lease.



Key Accomplishments

- **RIM-IV Surveys completed include in last quarter 2003:**
 1. Down-Hole Tomography of Metalliferous Ore Bodies in Canadian Shield
 2. Down-Hole Tomography of Abandoned Mine Workings in Indiana Coal Seam
 3. Down-Hole to In-Mine Tomography of Abandoned Mine Workings in West Virginia Coal Seam
 4. In-Mine Tomography of Fault Features in Utah Coal Seam

Two RIM-IV In-Mine Reconnaissance Surveys were performed in February 2004. Primary focus has been on DSP upgrades.



Commercial Surveys 2002

- Oxbow Mining Co., Oxbow Mine – Colorado, USA (January 2002)
- Consol Energy, Mine 84 – Pennsylvania, USA (April 2002)
- Genwal Mining Co., Genwal Mine – Utah, USA (June 2002)
- Blue Mountain Energy, Deserado Mine – Colorado, USA (July 2002)
- UK Coal, Daw Mill Colliery – Warwickshire, UK (July 2002)
- Genwal Mining Co., Genwal Mine – Utah, USA (August 2002)
- UK Coal, Daw Mill Colliery – Warwickshire, UK (September 2002)
- Genwal Mining Co., Genwal Mine – Utah, USA (October 2002)
- Consol Energy, Mine 84 – Pennsylvania, USA (November 2002)



Commercial Surveys 2003

- UK Coal, Daw Mill Colliery – Warwickshire, UK (January 2003)
- UK Coal, Daw Mill Colliery – Warwickshire, UK (February 2003)
- RAG, North Goonyella – Queensland, Australia (March 2003)
- BHP, Crinum – Queensland, Australia (March 2003)
- Peabody, Big Run Mine – Kentucky, USA (September 2003)
- INCO Limited – Ontario, Canada (October 2003)
- Black Beauty Coal Company, Francisco Mine – Indiana, USA (November 2003)
- Andalex Minerals, West Ridge Mine – Price, Utah (December 2003)



Commercialization

Benefits

Productivity and Profitability

- RIM imaging ahead of mining will reduce the risk of interrupting production because of adverse geologic conditions. When RIM is integrated into underground mine planning, forecasting of production can improve 10 percent, which in turn enables financial performance to achieve profit objectives.

Energy Savings

- RIM imaging directed more effective drilling programs. Drilling only in desired areas and extracting cleaner coal is expected to reduce energy use 2.7 trillion Btu/yr by 2020.



Commercialization

- The Stolar Global Center for Geologic Interpretation has continued to perform geologic imaging and geotechnical consulting on a “Field Service” level.
- Lease options are being structured that would allow a customer to maintain possession of the system and perform survey when needed under the supervision of SGCGI’s geophysicist and geologists.
- Sales efforts currently include marketing of In-Mine RIM-IV, Down-Hole RIM-IV, and RIM-based risk reductions to the coal mining industry.



Project Recognition

- “*Crosswell Systems for Imaging Ahead of Mining*”, T. W. H. Caffey, National Mining Association Convention, 10-13 October 1999, St. Louis, MO
- “The Smart World of Mining”, World Coal Magazine, May 2001, p 51-54
- “Breakthrough Technology”, World Coal Magazine, May 2002, p 23-26
- “A Clearer Image”, World Coal Magazine, Vol. 11 No. 12, December 2002
- “Sensing the future”, World Coal Magazine, May 2002
- “Better Intelligence”, World Coal Magazine, Vol. 12 No. 12, December 2003