

**STATUS UPDATE ON MSHRAC-APPROVED ACTION PLAN
FOR OMSHR TO ADDRESS THE NATIONAL ACADEMIES'
RECOMMENDATIONS**

March 24, 2014

Office of Mine Safety and Health Research



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Background

The National Institute for Occupational Safety and Health (NIOSH) contracted with the National Academies (NA) to conduct an evaluation of its research programs, including the Mining Program. Specifically, the Academy was tasked to evaluate the relevance and impact of the Program, and to assign a numerical score to represent its assessment. Additionally, the Academy was tasked to examine future issues and provide recommendations on areas for consideration of future research.

The Mining Program prepared an “evidence package” to document its activities and impact over the past ten years in both its Pittsburgh and Spokane Research Laboratories. The Academy completed its review of this package, and presented its findings to NIOSH in April 2007. The Mining Program then prepared a formal response to the Academy detailing its action plan. This action plan was subsequently reviewed and approved by the Mine Safety and Health Research Advisory Committee (MSHRAC) on January 23, 2008.

Purpose

The purpose of this second report to MSHRAC is to summarize the status of the Office of Mining Safety and Health Research’s (OMSHR) activities to implement the MSHRAC-approved plan to address the Academy’s recommendations.

OMSHR Strategy

After receiving MSHRAC approval for the December 2007 Implementation Plan, OMSHR leadership developed a strategy for executing the MSHRAC-approved actions for each NA recommendation. Key members of OMSHR leadership team were assigned responsibility for managing the implementation of each recommendation. These leaders worked with OMSHR scientists and engineers to develop and conduct specific activities associated with the approved actions. Finally, an OMSHR Senior Scientist was assigned the responsibility to monitor and track OMSHR’s detailed progress relative to all activities associated with each recommendation. The Associate Director for Mining continues to meet regularly with OMSHR leadership to discuss strategy and review the on-going progress to implement, and also to assess the impact of recommendations that have been implemented.

A total of eighteen recommendations were provided by NA ranging from organizational suggestions for improved operations to technical suggestions for addressing priority health and safety needs for the mining industry. The first round of performance scoring was conducted by MSHRAC in 2012, during which six of the recommendations were scored based on the categories of relevance, sustainability and impact. Those recommendations, and the scores assigned by MSHRAC, can be found in the score report in Appendix A. Six more recommendations will be scored in 2014, and the final six in 2016, using the same scoring rubric. While all of the recommendations are important, some are especially critical as OMSHR strives to excel in its mission. As such, they were given significant attention immediately after the NA published its recommendations, and then OMSHR’s implementation of those recommendations was brought to the Committee for evaluation in 2012.

The six recommendations selected for scoring in 2014 are:

Recommendation 2	<i>Increase Interactions with other NIOSH Programs</i>
Recommendation 3	<i>Enhance Interaction with MSHA</i>
Recommendation 5	<i>Ensure that most Guidelines and Processes are Relevant to the Entire Mining Community</i>
Recommendation 8	<i>Develop more Robust Methods of Monitoring In-Situ Safety Conditions</i>
Recommendation 11	<i>Include How Small Business Worker Populations will be Served</i>
Recommendation 15	<i>Evaluate Environmental and Occupational Hazards of Deeper Mines</i>

Detailed information and representative accomplishments for each of the above recommendations are included in the report.

Report Format

A table is presented for each recommendation, showing the NA recommendation and the associated MSHRAC-approved actions. A brief progress summary follows the table, and this summary is organized into the three categories that the Office of Management and Budget (OMB) is using to assess the responsiveness of the Mining Program to the Academy's recommendations. The categories are relevance, sustainability and impact for all recommendations. MSHRAC will be asked to assign a score to each category for each recommendation. The Program (OMSHR) staff performed a self-assessment, and this is available for review by the Committee.

Recommendation 1a: Fulfilled

Recommendation	MSHRAC-Approved Actions
More challenging, innovative goals and attendant objectives	Aggressive or challenging goals will be incorporated into OMSHR's Strategic Plan reflecting the impact of 2006 and 2007 mine disasters and the MINER Act and the need for improved leverage of resources and assets

Activities—

The strategic goals of the Mining Program continue to be quite aggressive and ambitious yet very challenging—e.g. eliminate black lung disease. The Strategic Plan contains goals and attendant objectives that reflect the impact of the 2006 and 2007 mine disasters, for example:

- **Intermediate Goal 5.4:** Prevent underground coal mine dust explosions by integrating OMSHR-developed technologies, rock dusting practices, and instrumentation into accepted industry practice.
- **Intermediate Goal 5.5:** Decrease the likelihood of explosions within sealed and unsealed abandoned areas of coal mines that can affect the active working areas.
- **Intermediate Goal 5.6:** Improve the potential for self-escape from mine fires and explosions through development of improved escape strategies, effective training materials and methods, and the development and implementation of new or existing technologies.
- **Intermediate Goal 5.7:** Improve the potential for safe and successful mine rescue operations through development of alternative approaches to mine emergency incident pre-event planning, incident management, and implementation of new or existing technologies to aid post-event exploration and mine rescue operations.
- **Intermediate Goal 5.8:** Improve the effectiveness of Critical Systems and the ability of these systems to survive and operate post disaster for use in emergency situations. Critical Systems currently include mine wide atmospheric monitoring and communication and tracking systems, but they may include other systems that are required to remain operational post disaster.

The Mining Research Program has aggressively focused on reducing the potential for coal mine explosions in a number of project areas including lab testing of newly developed rock dusting approaches, the measurement and reduction of float dust and a significant number of extramural research studies funded through the contract program. The contracts included technology developments on anti-caking rock dust, improved rock dust application systems, and enhanced monitoring technologies for bleeders and remote workings.

The Program's ability to leverage its resources has been improved through an expanded number of collaborations with other federal agencies and non-government organizations, including the following among others¹:

- Naval Research Lab
- Department of Defense (DOD) Joint Spectrum Center
- U.S. Army Corps of Engineers
- Sandia National Laboratory
- Los Alamos National Laboratory
- National Aeronautics and Space Administration (NASA)
- National Institutes of Standards and Technology (NIST)
- Safety in Mines Testing and Research Station (SIMTARS) (Australia)
- Central Mining Institute (Poland)

Sustainability—

¹ Please see Recommendation #4 for additional examples of extramural collaborations.

The Program has the resources and staff to continue pursuing challenging and innovative goals. There is a history of partnering and establishing research collaborations to leverage resources and accelerate the accomplishment of goals. The expanded level of leveraging implemented over the past five years forms a solid basis for continued leveraging at the same level.

Impact—

The enhancement of the Strategic Plan to include challenging goals that reflected the mine disasters of 2006 and 2007, as well as the involvement of new partners to increase the level of leveraging, has resulted in significant outputs and outcomes. Notable examples include:

- Partnered with experts in gas explosions from the Naval Research Laboratory (NRL) and experts in protective structure design from the U.S. Army Corps of Engineers to develop new seal design procedures and to verify those design procedures with testing.
- Developed improved methodologies for identifying and mitigating explosive accumulations of coal dust, thus providing the means to better control potential explosion hazards.
- Developed a suite of refuge chamber training packages to train miners concerning when to seek shelter, how to operate a refuge chamber, and what to expect physiologically and psychologically.

Recommendation 1b: Fulfilled

Recommendation	MSHRAC-Approved Actions
Take more proactive approach to identifying and controlling hazards	OMSHR will seek other sentinels and means for identifying unrecognized or emerging hazards in the mining workplace

Activities –

The analysis of surveillance data, discussions with stakeholders, and an extensive in-mine presence by OMSHR researchers have provided significant information on emerging or previously unidentified hazards or conditions that could possibly lead to hazards. In addition, OMSHR researchers coordinate with NIOSH's other surveillance activities, such as the Black Lung Surveillance Program in NIOSH's Division of Respirable Disease Studies (DRDS), and that information is considered as well. Mine Safety and Health Administration (MSHA) enforcement data and the experience of MSHA personnel provide yet another set of insights into problems and potential problems. All of these inputs are considered and are then used to identify appropriate research responses.

A common misperception is that the Mining Program operates reactively to regulatory drivers, and while it is true that new regulations often create a new and immediate demand for interventions, such

as training or control technologies, research projects are often initiated years in advance of a regulation. Once the regulation is passed, the research activities may increase significantly as a result of increased industry participation, congressional mandates, appropriation marks, and/or targeted funding. Notable examples of OMSHR's proactive approach are illustrated in all of the three major health rules of the past 15 years (noise, diesel, and dust):

- Initiation of research in 2008 to enable and facilitate a possible future reduction of the coal mine dust exposure limit (a proposed rule was published by MSHA in 2011, and is currently in process).
- Initiation of a major research program in 1999 to reduce exposure to harmful components of diesel exhaust (rule was published in January 2001)
- Initiation of a major research program to reduce hearing loss through engineering controls and other interventions was launched in 1998 (the final rule was published by MSHA in September 2001).

There are also examples in the safety area related to seal construction, rock dusting practices, and mine illumination, among others, where NIOSH's proactive identification of emerging or unrecognized hazards led to rulemaking and the timely introduction of interventions. Overall the approach for proactively identifying hazards has worked well and is on-going. Nonetheless, OMSHR is endeavoring to ensure that no emerging hazards or opportunities for eliminating hazards are missed, and towards that end and in response to the NA recommendation, OMSHR has investigated several different quantitative approaches that may prove useful in the earlier identification of emerging or unrecognized hazards.²

Sustainability—

The Program has the resources and staff to implement improvements. The ability to recognize emerging hazards and proactively act to develop interventions is a core competency of the Mining Program, and continuously improving it is important. In addition to evaluating and implementing the improvements identified to date, the Mining Program has resources to continue to seek new methods and approaches.

Impact—

- Identified several issues of concern in the assessment of explosibility hazards in underground coal mines that led to MSHA issuing an Emergency Temporary Standard (ETS) requiring 80% incombustible content in intake airways.
- Provided MSHA with noise exposure audits and resulting engineering control technologies leading to the implementation of noise reduction safety measures and accelerated acceptance by the industry.
- Combined a number of numerical methodologies into a single Methane Control and Prediction (MCP) software suite that correlates operational and geological parameters of U.S. longwall operations to methane emissions and the ability of mine ventilation and

² Please see the activities listed under recommendation #7, which relates to improving the use of surveillance information.

- degasification boreholes to remove gas from the mine (reducing the likelihood of a gas explosion).
- Developed a novel sampling methodology incorporating a portable instantaneous dust monitor, a video camera worn by the worker, and a software program to identify high dust exposure activities of mobile workers by meshing the dust data with the visual data.
 - Initiated research to develop a rapid end-of-shift or real-time silica monitor for use in mines using existing or emerging technologies.
 - Completed a pilot study of a “Severe Injury Surveillance System” which shows potential to better identify the risk factors for injuries, thereby facilitating a more proactive approach to developing control technologies or other interventions.
 - Completed a pilot study to develop a “targeting algorithm” that analyzes the MSHA enforcement database to target mines that are in need of specific existing interventions or problems in need of new interventions.

Recommendation 2: Fulfilled

Recommendation	MSHRAC-Approved Actions
Increase interaction with other NIOSH programs	OMSHR will seek the assistance of other NIOSH divisions especially in medical, industrial hygiene, and surveillance areas
	Challenge MSHRAC with more substantial assignments

OMSHR has significantly increased interactions with other NIOSH divisions and MSHRAC at both the strategic and project-specific levels to address a number of high priority research areas with the Mining Program and within the other industry sectors served by NIOSH. Some notable activities and accomplishments include:

Activities—

- Collaborating with the Division of Respirable Disease Studies (DRDS) and the Division of Applied Research and Technology (DART) to more comprehensively address the issue of dust-related lung disease in mining and other industry sectors
 - *Strategic:* OMSHR and DRDS jointly reviewed the findings of the DRDS black lung surveillance program and identified and developed a suite of collaborative exposure assessment and engineering control projects to address these findings.
 - *Strategic:* A health surveillance program for western metal/non-metal miners is being developed, and this is being incorporated into a broader “Total Worker Health” approach. DRDS Staff will lead this OMSHR-funded effort, along with the NIOSH Office of Total Worker Health, marking a significant expansion of the existing mineworker respiratory-disease surveillance effort within NIOSH. To date, the effort has included the recruitment of a Medical Officer to lead the surveillance program, designing and procuring a mobile van for monitoring purposes, and hiring of several support staff. This major initiative is being staffed out of NIOSH’s Spokane Facility.
 - *Strategic:* Requested review and comment from DRDS on the National Occupational Research Agenda (NORA) Mining Sector Council Research Agenda being developed in 2011 and formally added a DRDS representative to the Council.
 - *Project-Specific:* OMSHR and DRDS collaborated to develop and disseminate a user-friendly, best practices guide to controlling respirable dust in coal mining, the “Best Practices for Dust Control in Coal Mining” Information Circular.
 - *Project-Specific:* OMSHR provided silica exposure assessment and engineering control support to an Institute-wide team evaluating health and safety issues associated with hydraulic fracking technology.
 - *Project-Specific:* OMSHR, DART, and the National Asphalt Pavement Association (NAPA) worked collaboratively to transfer control practices and technologies developed by the Mining Program for use on road milling machines during the extraction of asphalt pavement to limit silica dust exposure.
- Collaborating with the Health Effects Laboratory Division (HELD) to more comprehensively address the issue of particle-related lung disease in mining

- *Project-Specific:* OMSHR and HELD collaborated to evaluate the toxicological properties of diesel particulate matter and began correlating toxicological results with specific diesel particulate matter characteristics.
- *Project-Specific:* OMSHR and HELD are collaboratively conducting research on the health effects of nanoparticles that are created by the diesel particulate matter control technologies currently in use in the mining industry.
- Collaborating with the National Personal Protective Technology Laboratory (NPPTL) to more comprehensively address the issues associated with breathing air supplies in mining
 - *Strategic:* OMSHR and NPPTL collaboratively reviewed existing NPPTL self-contained self-rescue (SCSR) certifications to identify regulatory clauses that would preclude some emerging technologies from being used in next generations SCSRs—a plan was jointly developed for how these technologies could be included in the future.
 - *Project-Specific:* OMSHR included several experts from NPPTL to serve on a subject matter expert panel related to the design and implementation of self-contained breathing apparatuses (SCBAs) and SCBA refill stations in US mines.
 - *Project-Specific:* OMSHR, NPPTL, and MSHA worked collaboratively to resolve safety issues with the CSE SR 100 Starter Oxygen Assembly.
- Collaborating with the Division of Applied Research and Technology (DART) to more comprehensively address the issue noise induced hearing loss in the construction sector
 - *Project-Specific:* In support of a DART-developed noise mitigation plan for the General Contractors Association of New York City and the New York City Department of Environmental Protection, OMSHR provided design ideas for pile driver noise controls, a common piece of equipment used in the construction industry.
 - *Project-Specific:* OMSHR and DART worked collaboratively to identify noise sources and develop noise controls for jackhammers typically used on construction sites.
- Collaborating with the Division of Safety Research (DSR) to improve the design and evaluation of equipment and technologies used in numerous industry sectors
 - *Strategic:* OMSHR and DSR are collaboratively collecting data and writing a report on anthropometric demographics for the U.S. mining population—this has significant implications for numerous future projects related to mining equipment design.
 - *Project-Specific:* OMSHR collaborated with DSR to conduct AutoROPS testing with a commercially available zero turn lawnmower that was converted to remote control for full-scale testing with an instrumented mannequin.
 - *Project-Specific:* OMSHR collaborated with DSR to test a commercial aerial scissor lift for stability during curb impact and simulated pothole drop.
 - *Project-Specific:* OMSHR collaborated with DSR on developing blind area diagrams for equipment used in highway work zones and surface mining.
 - *Project-Specific:* OMSHR collaborated with DSR to adapt proximity detection technology to dump trucks.
- Challenged MSHRAC with substantial assignments to enhance the Mining Program’s impact

- *Strategic:* Revised Executive Secretary’s presentation to more clearly communicate the questions and expectations of MSHRAC at the beginning of each meeting, and revised the minutes to capture those “assignments” to the Committee.
- *Strategic:* Solicit feedback from MSHRAC on major strategic issues, for example the alignment of OMSHR’s intramural research expenditures with fatality and non-fatal days lost injuries for coal, metal/non-metal, and stone, sand, and gravel sectors. A detailed figure is provided illustrating these expenditures and surveillance data for each year over a 5-year period.
- *Strategic:* Revised Executive Secretary presentation to solicit feedback from MSHRAC on the selection of research imperatives—imperatives are those research efforts deemed highest priority whereby human capital and fiscal resources would be reallocated as necessary to ensure successful and timely completion at the expense of lower priority efforts.
- *Project-Specific:* Revised MSHRAC meeting format to include a review of OMSHR’s research approach, findings, and recommendations for important research areas. While by no means an exhaustive list of research areas reviewed by MSHRAC to date, some representative examples include oxygen supply, explosion prevention through effective rock dusting and gob gas monitoring, report to Congress on deep-cover retreat mining (Crandall Canyon), safety culture—presentations are provided to throughout the research process allowing MSHRAC to provide feedback on progress, impact, and future direction.

Sustainability—

Project-specific collaborations between OMSHR researchers and other researchers within the Institute are encouraged and are now occurring routinely. To ensure sustainability, OMSHR identifies three priority goals each year for research considerations by all other divisions within NIOSH—current goals address the areas including reduced exposures to respirable coal dust, reduced hazards from coal mine explosions and reduced hazards from catastrophic ground collapses in underground mines. Strategic engagement is also ongoing and sustainable as represented by OMSHR’s commitment to fund the silica surveillance program in the Spokane Facility and the permanent edition of DRDS Staff on the NORA Sector Council.

MSHRAC will continue to be tasked project-specific and strategic assignments as defined by the new meeting format and style of the Executive Secretary presentation. Project-specific reviews for the current MSHRAC meeting will include research on self-escape, controlling float dust, and health and safety management systems.

Impact –

The activities described above have had significant impact on health and safety in the mining industry as well as in other industry sectors. Rather than presenting an exhaustive list of impacts for all of the activities described above, a reduced, representative description of impact is provided below:

- The “Best Practices for Dust Control in Coal Mining” Information Circular is a significant output that has been met with tremendous industry support through the adoption of the recommended practices and control technologies. In a one year time period, the page hosting this document was viewed nearly 1,000 times with the document being downloaded over 400 times.

Colinet JF, Rider JP, Listak JM, Organiscak JA, Wolfe AL [2010]. Best practices for dust control in coal mining. Pittsburgh, PA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2010-IC 9517.

- Through collaborations with DRDS, the Mining Program has significantly enhanced its ability to serve the industry through the development of a new surveillance program for silicosis in western metal/non-metal mines. This surveillance program enables the Mining Program to develop control technologies and workplace practices to minimize exposure to silica and significantly improve the quality of life for metal/non-metal miners just as has been done in the coal sector.
- Through collaboration with NPPTL, existing standards will no longer preclude a variety of technologies from being incorporated into the next generation SCSRs to improve efficiency and usability—including these other technologies are paramount to successfully designing the next generation SCSRs to ensure the tragedy of Sago is never experienced again.
- Through collaboration with DSR, anthropometric demographics for the US mining population will be obtained. Existing data is approximately 30 years old and no longer represents the aging mining population. These data are an essential component to OMSHR’s human-centered design research effort and will allow equipment, devices, and the worker’s environment to be designed for the size and capabilities of the existing workforce.
- Through collaboration with numerous NIOSH divisions, the Mining Program has successfully transferred its exposure assessment and control technology development and evaluation practices to numerous other industry sectors such as the Oil and Gas, and Construction Sectors. The impact of this work is well-documented in the following publications:
 - NAPA operating guidelines for milling machines were revised to include general dust control operating practices based on OMSHR’s evaluation of water spray and evacuation dust control systems for milling machines.
 - Zechmann E, Hemmelgarn A, Hayden C. [2011] Noise Source Identification and Assessment of two Noise Controls for Jack Hammers, Proceedings of Noise-Con 2011, Portland, OR, May 25-27, 2011, Institute of Noise Control Engineering, 13 pages.
 - ASABE (American Society of Agricultural and Biological Engineers) best paper 2012 award for “Evaluating the Protective Capacity of Two-Post ROPS for a Seat-Belted Occupant during a Farm Tractor Overturn”. (OMSHR-Lutz; DSR-Guan, Hsiao, et al).
 - Robson L, Stephenson C, Schulte P, Amick B, Chan S, Bielecky A, Wang A, Heidotting T, Irvin E, Eggerth D, Peters R, Clarke J, Cullen K, Boldt L, Rotunda C, Grubb P [2010]. A systematic review of the effectiveness of training & education

for the protection of workers. Toronto: Institute for Work & Health; Cincinnati, OH: National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication No. 2010-127, 140

- Robson LS, Stephenson CM, Schulte PA, Amick BC III, Irvin EL, Eggerth DE, Chan S, Bielecky AR, Wang AM, Heidotting TL, Peters RH, Clarke JA, Cullen K, Rotunda CJ, Grubb PL, A systematic review of the effectiveness of occupational health and safety training, *Scandinavian Journal Work Environ Health* 2012;38(3):193-208
- MSHRAC, after review of the alignment of OMSHR's expenditures with fatality and non-fatal days lost injuries, suggested that a re-examination of the needs in the stone, sand, and gravel sector would be appropriate. Subsequently, the Associate Director for Mining re-engaged with the National Stone, Sand, and Gravel Association, and other stakeholders to request additional input into needs and research gaps. An intramural team of researchers from across the organization was constituted to review additional surveillance data for the stone, sand, and gravel sector—this review, in conjunction with input has resulted in a new research imperative for OMSHR, researching decision-making strategies and influencers to determine how to best empower workers with the knowledge, skills, and abilities to recognize and mitigate hazards.

Recommendation 3: Fulfilled

Recommendation	MSHRAC-Approved Actions
Enhance interaction with MSHA where research needs are closely aligned with MSHA's legislative and shorter-term requirements.	OMSHR will establish an MOU with MSHA to clarify the working relationship between the two agencies
	OMSHR will encourage MSHA to share a longer-term view of its priorities for future regulations allowing adequate time for completion of research to better inform their regulatory decisions
	OMSHR will strengthen its collaborations with other federal agencies

OMSHR has worked closely with MSHA over the last several years to address the priority needs of the organization while also expanding research efforts in health and safety areas of high-priority. These include initiatives in lowering the respirable coal dust standard to 1 mg, studying the safety issues associated with rock dust characteristics, refuge alternatives issues, proximity detection studies, field research to determine the impact of scrubbers on dust and ventilation systems during deep cut mining and ventilation problems associated with underground longwall coal mining.

Activities—

- Signed a new memorandum of understanding (MOU) with MSHA in January of 2009 that strengthened coordination and consultation regarding health and safety needs and issues for the mining community, processes for commenting on research and dates for public dissemination, and on research, training, and technical assistance. While an MOU is helpful, the needs of mine workers are well served if the leadership in NIOSH and MSHA understand the differing mission of each, and within that context, work to support each other's mission. Toward that end, the coordination and support between has ranged between good and excellent depending on the personal engagement of executives in both Agencies and the degree of alignment on politically sensitive issues. This is attributed to the following activities, among others:
 - The NIOSH Associate Director for Mining and the MSHA Deputy Assistant Secretary for Policy meet (by phone or in person) every few weeks, and other executive level meetings, sometimes involving the Assistant Secretary, are held on major issues.
 - OMSHR continues to add research tasks or projects to address MSHA informational needs, even when this means suspending other research tasks to adequately staff the MSHA-priority requests.
 - OMSHR provides briefings to the Assistant Secretary and other MSHA executives on contemporary issues.
- The strong collaboration and coordination between OMSHR and MSHA, as a result of the frequent meeting and discussions, were successful in expanding cooperation through all levels of both organizations. Communication routinely occurs at the technical levels resulting in collaborative efforts in all program areas. Examples include respirable dust, rock dust, refuge alternatives, cross-training between agencies, data gathering and analytical assistance on specific program needs, and sharing of programmatic priorities. The close

collaboration is beneficial to both organizations and several research studies conducted by NIOSH have included MSHA personnel on the planning, implementation and publication of results.

- Responded to an MSHA request to participate in a ground control stability problem at an underground coal mine in Kentucky. Completed an observational and numerical analysis of the mine conditions and developed a mining plan to overcome the high-stress conditions of the property.
- Conducted training, at the request of MSHA, at the Beckley Academy for mine inspectors and roof control specialists. This training is generally conducted annually and covers a number of different topics including ground control, dust control, hearing loss prevention, ergonomics and explosion prevention.
- Strengthened collaborations with NASA and the Departments of Defense, Energy, and Homeland Security, and the Naval Research Lab through an Interagency Working Group (IWG) established by mandate of the MINER Act of 2006. Subsequently the relationships established through the IWG have been used to initiate new research collaborations. The collaborative projects include drilling studies, development of robotic systems for mine rescue, mine explosion prevention, enhanced oxygen supply for miner escape and a variety of studies associated with the use of communication and tracking systems for underground coal mines. A number of extramural research contracts and grants have been awarded in areas of high-priority to MSHA. These include trapped miner research technology development, development of robotic research systems for mine rescue (scout robot and snake robot), development of a mine rescue drilling system, through-the-earth communications systems and the development of a mine escape vehicle.

Sustainability—

These practices were put into place, and have been on-going for the past six years. The resources and staff are in-place to continue these practices. Importantly there is a substantial amount of institutional momentum to continue these successful inter-agency collaborations. Notwithstanding, it will require constant attention, as staff look upwards and downwards in the organizations for indications of the value of interagency collaboration.

Impact—

Examples of these practices and their impacts are:

- Responded to a number of official requests from MSHA. The nature of these requests has fallen into four major categories: Assistance with research or testing (20%), information concerning past or on-going OMSHR research (60%), review of proposed and final rules (15%), and briefings (5%).
- Developed (and involved MSHA in the initial planning of) a number of research collaborations and partnerships with industry, labor, and government organizations,

- including MSHA, in four significant areas: the Mine Emergency Communications Partnership (MECP); the Composition and Fire Retardant Properties of Belt Materials in Underground Coal Mining; Design Criteria for Seals in Coal Mines; Rock Dust, and the Oxygen Supply Partnership.
- Collaborated with MSHA to conduct workshops and disseminate information on “best practice” control technologies to reduce respirable dust exposure in coal and metal/nonmetal mining.
 - Collaborated with MSHA to reduce Coal Workers Pneumoconiosis (CWP) by summarizing and distributing best practices for controlling respirable dust levels in a NIOSH publication and cosponsoring a series of regional workshops with MSHA.
 - Based on recommendations from a NIOSH report released in May 2010 containing new scientific evidence on inerting explosible coal dust, MSHA issued an emergency temporary standard (ETS) for increasing rock dust content in underground coal mines
 - OMSHR worked with MSHA to evaluate the Coal Dust Explosibility Meter (CDEM) in coal mines throughout the U.S.
 - MSHA collected rock dust samples throughout the U.S. to support OMSHR’s research into explosion prevention.
 - OMSHR collaborated with MSHA to evaluate and make recommendations for retreat mining practices and pillar design under deep cover. As a result, MSHA issued a Program Information Bulletin (PIB) in December, 2010, to notify the mining community of the availability of new versions of OMSHR’s Analysis of Retreat Mining Pillar Stability (ARMPS) and Analysis of Multiple Seam Stability (AMSS) computer programs that incorporated a number of new features to improve performance, particularly in deep mines.
 - Collaborated with MSHA and cosponsored a workshop to discuss proximity warning and detection systems for mining equipment.
 - A NIOSH/MSHA task force validated that the NIOSH Report of Investigations (RI) 9380 “Fire Detection for Conveyor Belt Entries” is still valid for determining the placement of carbon monoxide (CO) monitors on the conveyor belt line at higher ventilation rates, and when using the wider conveyor belts currently installed in many underground coal mines.
 - Demonstrated the performance of the snake robot for assisting in mine rescue operations to MSHA personnel at the Safety Research Coal Mine.
 - Conducted research on refuge chambers to address the concerns of MSHA related to temperature rise in refuge alternatives located in hot mines.
 - MSHA personnel routinely provide technical and policy-level reviews of nearly all OMSHR reports prior to publication of the research results.
 - The geotechnical analysis and redesign of the underground coal mine in Kentucky resulted in a dramatic improvement in the ground control conditions at the mine. The new design was implemented by management, approved by MSHA and has overcome the potential instability issues experienced at the property. The approach developed by OMSHR is being used for current and future mine planning.

Recommendation 4: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Fully utilize outside technical expertise through a vibrant extramural and contract research program	OMSHR will continue its expanded investment in extramural research for improved communications and tracking systems for mine emergencies, refuge chambers, and for improved SCSRs
	OMSHR will establish a safety technology contracts and grants program as mandated by the MINER Act

OMSHR has continued the aggressive implementation of the extramural research program for both contracts and grants for improving mine health and safety and has also expanded the contract program to implement a capacity building program for the mining engineering universities in both ground control and mine ventilation. A total of 15 contracts were awarded within these two areas of importance.

Activities—

Through the year 2006, the NIOSH Mining Program was predominantly an intramural research program. Subsequently, the intramural research branches were encouraged to utilize contract and grant activities to complement and leverage the intramural program. At the same time, the MINER Act of 2006 authorized OMSHR to establish a contracts and grants program to identify, develop, commercialize, and diffuse technologies that would improve mine safety and health.

- The Division of Mining Science and Technology was established within OMSHR with a primary responsibility to implement the contracts and grants mandate of the MINER Act.
- OMSHR invested approximately \$50 million in extramural contract efforts through the awarding of more than 100 contracts since the inception of the MINER Act, primarily in the areas of: communications and tracking, escape, rescue, sensory systems, and intervention research.
- OMSHR invested approximately \$10 million in contracts to complement and leverage the intramural research program and nearly \$10 million in interagency agreements with other government entities including the national labs and various agencies within the Department of Defense.
- OMSHR is continuing to invest more than \$10 million annually for the development of new health and safety technology and for ensuring the future of the mining universities in the two critical areas of ground control and mine ventilation.
- OMSHR is continuing to fund a contract, with two western universities, to ensure the development and implementation of training research to address the health and safety needs of miners located in the western regions. The contract has been very successful and accomplishments are readily available for review at the website of the University of Arizona and the Colorado School of Mines.
- For the current year, OMSHR has received more than 50 white paper proposals for the development of new technology for improving miner health and safety. This demonstrates

the success of the extramural program in accomplishing the goal of an expended research program using external partners.

- OMSHR awarded over \$6 million in 2012 for extramural contracts and grants for improving miner health and safety.

Sustainability –

The ability to fund extramural contracts and grants from the Mining Program is dependent upon continued funding at the same level, with modest increases to keep pace with inflation. The process to conduct a robust extramural program is in place and has been on-going for the past seven years, and given continued funding, the staff and processes are in place to continue it.

Impact –

- Developed a specialized mine escape vehicle under contract that will incorporate enhanced breathing capacity, communications, and guidance into a conventional mine transport vehicle.
- Developed and tested a prototype of a dockable, self-contained self-rescuer under contract with Technical Products Inc. Developed and commercialized several leaky feeder and node-based primary communications systems under an intensive, targeted extramural contract program.
- Tested a through-the-earth communications system under contract with Lockheed Martin that does not require any infrastructure within the mine to function.
- Contracted with universities and government agencies for their expertise to improve the utility of refuge technologies and strategies following mining disasters.
- Contracted a study to investigate mine escape requirements, competencies, and training which was contracted to the National Academy of Sciences in 2011.
- Developed a prototype scout robot, which provides a forward-looking capacity to assess conditions as rescue teams cautiously work their way into a mine to rescue trapped miners, under contract with Sandia National Labs in 2010.
- Developed a device called the “snake robot” to be deployed down small-diameter boreholes that are drilled into a mine under contract with Raytheon Sarcos, LLC in 2011.
- Through an interagency agreement with the U.S. Army Corps of Engineers and the U.S. Naval Research Laboratory, analyzed the problem of mine explosions using sophisticated modeling techniques.
- Provided educational information to the mining industry regarding the behavior, limitations, and safety requirements for radio systems in underground coal mines, promoting the safe and effective deployment of systems in all U.S. coal mines within the MINER Act time frame.
- Awarded competitive contracts for the development of miner tracking and primary communications systems that led to several commercial products being available within the MINER Act time frame, including the L3 Communications wireless mesh C&T system and the Becker MSHA permissible leaky feeder system.
- OMSHR awarded over \$60 million to external partners since the start of the newly initiated contracts and grants program for improving miner health and safety including 14 interagency agreements with different government agencies.

Recommendation 5: Fulfilled

Recommendation	MSHRAC-Approved Actions
Partner more broadly so that most guidelines and processes are relevant to the entire mining community	OMSHR will establish a process and review the in-mine tasks of current projects to assess their relevance to the mining community, taking actions as appropriate
	OMSHR will continue to emphasize this issue in training of project managers and principal investigators
	OMSHR will continue to rely heavily on traditional labor and industry partners to help ensure its work will serve the industry-at-large

Activities—

The NA Committee provided this general recommendation without noting any specific instances of guidelines or processes being unnecessarily restricted in their applicability. Subsequent feedback from labor, industry, government, and academic stakeholders indicated that the Mining Program’s products are widely applied and useful, and there are surrogates to show the widespread adoption of Program outputs. Therefore, OMSHR took a “big picture” approach to addressing this recommendation by engaging in activities that would:

- Reflect new approaches for assessing OMSHR’s portfolio of projects and dissemination plans relative to broad applicability and generalizability
- Directly engage researchers in developing training guidelines to ensure project managers and principle investigators are sensitive to the issue of broad applicability
- Demonstrate OMSHR’s continued commitment to and expansion of its already-existing industry partnering activities

Specifically, OMSHR engaged in the following activities:

New Approach for Portfolio Assessment

- Numerous OMSHR Executives reviewed all funded projects, intermediate outcomes targeted by the organization, and the strategic plan. These Executives documented the mining sector(s) being served by each project, overall impact of the project outputs on mining practices within these sectors, alignment of these projects with the strategic plan, and identified potential program gaps for each sector.
- A new approach to developing dissemination plans is currently under development. All projects will be linked to targeted intermediate outcomes developed by OMSHR leadership with numerous projects supporting a single intermediate outcome. All project staff supporting a given intermediate outcome will meet annually to develop/revise a Dissemination Plan whereby the target audience for all outputs and the intended action are

clearly defined. Executive review of these Dissemination Plans will also occur annually to ensure dissemination reaches all effected members of the mining community.

Researcher Engagement

- Through collaboration between OMSHR Executives and Researchers, several research design and evaluation guidelines documents were revised or developed:
 - Peer-review guidelines for technical, stakeholder, and policy reviewers were revised to more clearly articulate the need for stakeholder and policy reviewers to comment on issues related to applicability of the proposed recommendations.
 - Research proposal guidelines were revised to highlight the need for researchers to clearly communicate the current state of practice and knowledge as it relates to the problem area as well as define any existing technologies and technology gaps, clearly articulate how achieving the stated objectives of the research project would specifically benefit the miners, mining companies, MSHA, and broad society based on potential changes/advancements in product design, legislation, training, work methods, etc.—proposals are sent to peer-review for feedback and comment from industry partners.
 - Literature review guidelines were developed to ensure researchers fully and adequately document and define existing state of practice and available technologies across the industry (these guidelines further facilitate the development of a comprehensive research proposal).
 - Protocol design guidelines that highlight statistical sampling versus convenience sampling issues and considerations to ensure representative samples are used for studies enabling generalizability of recommendations—all research proposals are now reviewed by an OMSHR Statistician to comment on research design and sampling strategy.

Partnering

- Continued with the long-standing practice of establishing new partnerships to develop solutions to challenging problems. Notable examples of the past few years are the development of improved oxygen supply and rock dust.
- Instituted the NIOSH Mine Safety and Health Technology Innovations Award to recognize mines and companies that have made an extraordinary effort to apply technology in innovative ways, above and beyond mandatory requirements, to improve mine worker safety and health—partnered with Associations in the coal, metal/non-metal, and stone, sand, and gravel sectors to promote and reward participation from their membership.
- Revised MSHRAC Executive Secretary presentation to solicit feedback from MSHRAC regarding the alignment of OMSHR’s intramural research expenditures with fatality and non-fatal days lost injuries for coal, metal/non-metal, and stone, sand, and gravel sectors. A detailed figure is provided, illustrating these expenditures and surveillance data for each year over a 5-year period.
- Revised MSHRAC meeting format to include a review of OMSHR’s research approach, findings, and recommendations for important research areas. Presentations are provided to

members throughout the research process allowing MSHRAC to provide feedback on research design and applicability of findings.

Sustainability –

These processes are in-place and require no new investment of personnel or funds, and as such, they will continue.

Impact –

New Approach for Portfolio Assessment

- The new approach to portfolio assessment has been used to identify the need for revisions to existing intermediate outcomes and the OMSHR strategic plan.
- The software tool for developing and managing the Dissemination Plans has been completed—intermediate outcomes are currently being revised by OMSHR leadership. However, the planned outputs for all projects have been reviewed to ensure that they will apply broadly to the target audience, with the understanding that projects often target only a part of the entire mining industry, e.g. underground stone or surface coal mines, mines under deep cover, or small mines.
- There has been a notable improvement in the strategic alignment between planned outputs and accomplishment of programmatic intermediate outcomes and intermediate goals.

Researcher Engagement

- To date, nearly 70 OMSHR employees have directly participated in the development of guidelines documents relating to scientific excellence. OMSHR's Associate Director for Science has conducted workshops and provided detailed explanations to management and staff; and the Associate Director for Mining has conducted a few workshops and discussed these matters in detail at all-employee meetings.
- For the fourth consecutive year, OMSHR has used the revised research proposal and peer-review guidelines—a marked improvement in the quality of engagement with reviewers has been noted.
- For the second consecutive year, OMSHR Statisticians have reviewed all project proposals to ensure adequate consideration of the overall research design, especially the planned sampling strategies. On occasion, OMSHR Statisticians were able to identify limitations in the robustness of the planned design as it relates to generalizability, allowing these shortcomings to be addressed in an appropriate timeframe.

Partnering

- MSHRAC review of OMSHR's expenditures with injury and fatality data across coal, metal/non-metal, and stone, sand, and gravel sectors identified a gap related to the stone, sand, and gravel industry. As a result, OMSHR has reached out to the National Stone, Sand, and Gravel Association to discuss potential research needs. OMSHR has redirected several existing projects and started several new projects to address the identified gap area.
- Many projects involve partners to ensure broad applicability, and some examples are:

- Partnered with the Safety in Mines Testing and Research Station (SIMTARS) of the Queensland government in Australia to bring tube-bundle technology for monitoring gas concentrations to the U.S. coal mining industry.
- Launched an initiative in the metal/nonmetal mining-hearing-loss-prevention research program to include the Nevada Mining Association, Kennametal, Corry Rubber, Joy, and Vulcan Materials Company, with the goal of presenting a series of workshops on interventions throughout the U.S.
- Partnered with the Industrial Minerals Association – North America (IMA-NA) and many of its members to develop a handbook that provides information on proven and effective engineering control technologies to lower workers' respirable dust exposures at industrial minerals operations.
- Partnered with Vale, the second largest mining company in the world, to evaluate the in-use effectiveness of diesel emissions controls.
- Partnered with IMA-NA and National Stone, Sand, and Gravel Association (NSSGA), United Mine Workers of America (UMWA), Vulcan Materials, Martin Marietta, Bridger, Whitney Limestone, and Florida Phosphate to develop and implement ergonomic and risk factor awareness training for miners.
- Partnering with Bituminous Coal Operators Association (BCOA), National Mining Association (NMA), United Mine Workers of America (UMWA), the Mine Safety and Health Administration (MSHA), the U.S. Navy, and the National Aeronautics and Space Administration (NASA) to develop improved oxygen supply technologies for mine workers and mine rescue teams.
- Partnering with the Industrial Minerals Association-North America; the National Stone, Sand, and Gravel Association, the Carmeuse Group, Allegheny Minerals Corp., and Imerys to identify chemical additives and to refine process technologies that will prevent caking in rock dust used in underground coal mines.
- Over the last year OMSHR researchers collaborated with more than 100 organizations within the mining community, including all sectors of the mining industry and a large number of mining equipment manufacturers. The collaborations included surface and underground mining operations and, as an example of the breadth of the research program, more than 50 underground coal mines were involved in the studies.

Recommendation 6: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Place greater emphasis on outputs preferred by mining operators, miners, and other nontechnical users	OMSHR will use its request for proposals for independent studies to “Develop Effective Technology Transfer Communications Strategies of Research Results to Occupational Health and Safety Communities of Mining and Non-Mining Communities to be used in the Workplace” and other appropriate means to increase communication in clear language to all parts of the mining community

Activities—

Historically, the Mining Program has emphasized the use of practical guidebooks, videos, and other easy-to-apply communication mechanisms, and the Program has received positive feedback on the use of these practical outputs. However, the Mining Program has not conducted surveys and research to determine quantitatively the preferred communication products. The Program does use peer-reviewed journals to report the scientific basis for its more practical products, and the Program continues to distribute a mix of products to reach differing segments of a target population (for example, training products offered both as table-top booklet exercises and web-based modules).

The following specific activities have been undertaken to further improve the communication products produced by the Mining Program.

- Contracted an independent study to “Develop Effective Technology Transfer and Communications Strategies of Research Results to Occupational Health and Safety Communities of Mining and Non-Mining Communities to be used in the Workplace.”
- Created a Health Communications Team, within OMSHR, to assist researchers in communicating health and safety research findings to customers and stakeholders, including mine operators, labor unions, enforcement agencies, industry associations, rank-and-file miners, and the general public.
- Conducted a Survey of Coal Mine Safety Interventions to gather data from working coal mines on the adoption and implementation of OMSHR-developed practices to mitigate safety and occupational hazards. A principal purpose of this survey was to evaluate whether coal mine operators/safety personnel are familiar with OMSHR research, whether they recognize it as useful, whether they have adopted such measures in their mines, as well as the barriers to adoption.
- Funded a contract to improve the NIOSH Mining website (<http://www.cdc.gov/niosh/mining/>) and to develop the necessary back-end tools to update the appearance, improve the arrangement of content, and to provide an easy-to-use interface for users to access research findings and practical guidance. The website redesign

has been completed and positive feedback has been received from many stakeholders on the improved version.

- Conducted an online survey of users of the existing website with the goal of determining how current users were finding information, what they were looking for, and from what industry those users originated.
- Continued to exhibit the results of our research and highlight new products and high-profile research in every major mining conference in the country on a regular basis.
- Utilized the results of the mining demographics survey to guide the development of communication products to identify needs for bilingual products, for example.
- Funded a study (currently underway) entitled “Evaluating Information Dissemination through a Systems Approach.”

Sustainability –

The intent of this recommendation has been accomplished and will be sustainable primarily through the on-going work of the Health Communications, Surveillance and Research Support Branch. The Health Communications Team has been staffed with two health communications specialists, one technical writer, one technical editor, a videographer, an exhibit specialist, a visual information specialist, a technical information specialist, and a marketing specialist. The Computational Research Team has been staffed with four programmers and one IT specialist.

Impact –

- The results of these efforts are being used to increase our understanding of how to develop clear and concise outputs for all parts of the mining community. For example:
 - The frequency of use of “Technology News,” which is one dissemination product format, is being increased based on the finding that it is a very effective mechanism for reaching a large number of stakeholders and transferring research or technology findings. Moreover, their quality is being improved—they focus on innovation attributes and are easy to read and understand. OMSHR has published 22 Technology News that reflect these improvements.
- OMSHR’s Health Communications Team has completed a “branding” effort that has included the development of a specific color scheme and logo. These colors and the logo are now applied to health communications products designed to deliver important health and safety information to industry members (e.g., website, exhibit booth, stickers, and brochures). The goal of this branding is to begin to build a basic knowledge base within OMSHR stakeholders about the organization’s role and function as it relates to mine safety and health. Moreover, by developing a consistent “brand,” OMSHR has differentiated itself from MSHA and other occupational safety and health organizations, improving knowledge of OMSHR’s role in the mining industry.

- The new website is written in plain language, allows users to easily find information from a variety of mechanisms that are new to the site, allows users to subscribe to pages based on their self-identified role in the industry (e.g., mine operator, trainer, etc.), and improves outside search tools' ability to find NIOSH information on the website through improved use of key words attached to web pages, OMSHR products, and improved organization of material. This new website was made available to the public in September 2012.

Recommendation 7: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Make better use of MSHA and other existing surveillance data and work to make these surveillance programs more robust	OMSHR will fund one or more studies on approaches that would make the surveillance program more robust
	OMSHR will consider the need to update demographics data on a more regular basis than was done in the past, although an annual update is probably not feasible

Activities –

- Developed, through contract research, a Severe Injury Surveillance System using the MSHA data and the Abbreviated Injury Scale (AIS) to evaluate feasibility and usefulness of focusing surveillance efforts on management of severe injuries as a proxy for fatal events.
- Funded a contract to investigate the relationships between mine size, employment levels, and fatality and injury rates.
- Funded a contract to determine the number and types of mining machinery (continuous miners, roof bolter, shuttle cars, scoops, etc.) that are currently being used within one state. The information will be used to further estimate, by extrapolation, the total number and types of mining machinery being used by the domestic underground coal mining industry. This information will be used to help target interventions.
- Funded a contract to develop a process and protocol utilizing MSHA enforcement data, combined with other data sets, to develop an algorithm to better target research and intervention activities for the mines with the greatest need.
- Funded the first comprehensive survey of the U.S. mining population in more than 20 years. The National Survey of the Mining Population captured the current profile of the U.S. mining workforce.
- Developed and published a methodology for evaluating the injury and fatality rates for contractors within the mining industry.
- Developed a plan for updating the Demographics Survey more frequently.

Sustainability –

Extramural contracts are an effective mechanism to access and take advantage of surveillance expertise, and they are being used to complement and augment the intramural surveillance program. These collaborations are now firmly established and interactions will continue into the future as the staff and processes are in place. The funds required for updating the Demographics Survey are substantial, but this need has been incorporated into the budget.

Impact –

- A pilot study using the Severe Injury Surveillance System suggests that severe injuries could be a proxy for future fatalities, and the potential application of this sentinel is planned. Already, the OMSHR Surveillance Team has received training in the AIS coding scheme, is currently coding injury records in the MSHA Accident/Injury database from 2000-2011, and is developing statistical models to determine which mines are at high risk for fatal injuries.
- The study into potential relationships between mine size, employment levels, fatality and injury rates, and mine characteristics revealed the impact of intermittent employment on fatality rates, and this finding is currently under study.
- The project to develop an algorithm to target mines for specific interventions has been completed and is currently being evaluated. If it is worthwhile and valuable OMSHR will utilize it and also make it available to MSHA.
- The recently completed National Survey of the Mining Population has provided much-needed surveillance data, and undoubtedly it will help guide research planning, project implementation, and intervention effectiveness work, among others. The survey's employee-level data will be used to determine the accident rates for various demographic and occupational groups as well as provide information that will be used to improve the safety and health of miners.
- The National Survey needs to be conducted more frequently. However, assessing all mining sectors simultaneously requires large resources. With the knowledge gained from the first survey it conducted, OMSHR intends to focus this surveillance effort on one major mining sector each year—coal, metal, nonmetal, stone, sand and gravel mines—with each being surveyed once every 5-6 years. A standard set of demographic and occupational questions will be included with each focus area for issues of importance in the specific mining sector.

Recommendation 8: Fulfilled

Recommendation	MSHRAC-Approved Actions
Develop more robust and better methods of monitoring in-situ safety conditions in mines	OMSHR will continue research on monitoring of in-situ safety conditions for surface and underground mines
	OMSHR is likely to expand work in this area under the mandate of the MINER Act to increase efforts in the area of safety technologies

Activities—

OMSHR has both intramural and extramural activities to support this recommendation with the development of real-time instruments to detect hazardous substances or conditions and measure exposure levels where appropriate. Extramurally, OMSHR employs a diverse set of contracting mechanisms to meet the MINER Act technology mandate and this recommendation. One such mechanism is its annual Broad Agency Announcement for Development and Demonstration of Mine Safety and Health Technology. With input from mining stakeholders, OMSHR identifies health and safety gaps and allows private sector bidders to propose potential technology solutions. Health and safety gap areas detailed in the FY13 and 14 Announcements and related to the recommendation include:

- Technology for detection of hazardous conditions assessment of remote areas of the mine and the development of fast acting atmospheric (methane) detectors for inclusion on mobile equipment
- Technology to de-energize batteries to prevent them from serving as a potential ignition source when mine conditions are compromised
- Technology to monitor the state of the battery during recharge cycles to prevent overcharging conditions
- Technology to monitor and control heat build-up in small format batteries to eliminate thermal runaway before it happens
- Technology to determine dispersion of float coal dust and adequacies of rock dust over large areas are also being sought to automate rock dusting application equipment
- Technology to monitor nitrogen dioxide and carbon monoxide exposure in underground mines that is person wearable and real-time

Specific technologies developed through OMSHR's intramural and extramural efforts are highlighted in the "Impact" section below.

Sustainability –

Development of these technologies is an integral part of the Mining Program's activities, and given continued funding this work will remain an important part of the portfolio. Additionally, this effort is directly aligned with the MINER Act mandate whereby OMSHR has developed an ongoing, robust contracting effort to ensure these technologies continue to be developed and commercialized.

Impact –

- Intramural
 - Developed an in-situ monitoring tool for measuring and displaying, in near real time, the miner's cumulative dust exposure (personal dust monitor).
 - Installed a panel-scale seismic monitoring system for deep cover longwall mining (the system is now being used to study and refine the algorithms). Completed laboratory and field studies of air velocity sensors that would be suitable for long-term applications in underground mines.
 - Initiated a project to develop a real-time respirable quartz dust monitor for use in underground mines using infrared and laser-induced breakdown spectroscopy technologies.
 - An example of the success of the research program for advancing monitoring technology for the underground mining industry is the design and development of a miniature data acquisition system (MIDAS). There were no commercial systems available for data collection purposes that were designed specifically for the underground mining industry primarily because of the size of the market. MIDAS, developed at the Spokane Facility, has been successfully transferred to the private sector, can also be used in underground coal mines, and has been employed by a number of organizations for continuous monitoring of underground conditions.
 - Completed the design and testing of a system for measuring the performance of shotcrete applications for roof support in underground metal mines. The system was successfully implemented at a number of underground metal mines and allows for detailed analysis of shotcrete performance under near real-time conditions.
 - Completed the development and testing of a technology for real-time measurements of the explosibility of coal dust-rock dust mixtures for in underground coal mines. The technology, known as the Coal Dust Explosibility Meter (CDEM) has been successfully transferred to the mining community and is routinely used by the underground coal mining industry.
 - Conceived, designed and constructed a portable seismic calibration source for use in any location in an underground coal mine since the technology requires no power source. The technology allows for the determination of the velocity profiles within the surrounding rocks and represents a significant accomplishment for the field of seismic monitoring in underground mines. Research studies are being completed at two western U.S. underground coal mines with the potential for significant seismic events to occur during mining.
- Extramural/Broad Agency Announcement
 - OMSHR receives more than 50 white papers per year with the impact of awarded contracts being fully detailed in OMSHR's annual report to Congress. Select examples are detailed in the following bullets.
 - Technology enabling mine workers to remotely characterize methane clouds does not currently exist. As part of an ongoing contract, OMSHR has funded the development of a technology to address this gap representing a significant

advancement on the current “point reading” technologies that require a worker to be in close proximity to the measurement location.

- Technology to remotely monitor conditions in bleeders or enable communications between a miner inspecting the area and others did not previously exist. As part of a completed contract, OMSHR funded the development of a technology to address this gap allowing more timely knowledge of, and response to, unusual and potentially dangerous conditions.
- OMSHR recognized the need to improve the accuracy, quantity, and timeliness of methane and temperature measurements taken throughout the mine, the man-hours devoted to sensor calibration and system maintenance, and the utility of these systems to be used in the most active areas of a mine, remote workings, and bleeder entries. As part of an ongoing contract, this gap area is being directly addressed.
- Technology to monitor multiple gases with one unit while tracking the miner performing inspections in remote areas did not exist. As part of a completed contract, OMSHR funded the development of a technology to address this gap. The contractor is pursuing MSHA approval.
- Technology does not exist to measure the amount of liberated float coal dust and determine the necessary quantity of rock dust to be dispersed for proper inertion. As part of an ongoing contract, OMSHR has funded the development of a technology to address this gap.

Recommendation 9: Fulfilled

Recommendation	MSHRAC-Approved Actions
Develop a more proactive, aggressive, and strategic dissemination agenda that is informed by research about the diffusion of new technologies, processes, and practices. Determine the likely end users of its products	OMSHR will increase its efforts to be informed on the latest research findings for improving the translation of research projects into practice, and it will apply this knowledge to its r2p activities
	OMSHR will fund a study to assess the diffusion of its interventions into the mining practices of the nation’s coal mines
	OMSHR will conduct a project entitled “Developing an Information Dissemination Model for Pittsburgh Research Laboratory [OMSHR] Research Translation Efforts”
	OMSHSR will fund a study to enhance its technology transfer program
	OMSHR will evaluate the effectiveness of select training products

Activities—

- Conducted a Survey of Coal Mine Safety Interventions to gather data from working underground coal mines regarding OMSHR’s ability to mitigate safety and occupational hazards through the dissemination of research results, recommendations, techniques, and products. There were 37 longwall and 382 non-longwall mines that made up the survey population.
- Collected information about the number and characteristics of coal mines that have adopted the NIOSH-recommended practices in the areas of dust control, explosions, and falls of ground, as well as mine emergency preparedness and training. Funded a contract to conduct a survey of coal mine safety interventions.
- Funded a contract to evaluate the effectiveness of the Technology News—a continuation of a publication series started by the former U.S. Bureau of Mines and widely distributed throughout the U.S. mining community.
- Funded a contract entitled “Design and Assist in Developing the Most Effective Technology Transfer and Communications Strategies of Research Results to Diverse Segments of the Occupational Safety and Health Communities of Both Mining and Non-Mining Communities to be Used Effectively in the Workplace” to improve product dissemination.
- Initiated a project entitled, “Developing an Information Dissemination Model for Pittsburgh Research Laboratory (PRL) Research Translation Efforts” to improve translational efforts through the development of an information dissemination model and develop audience-specific training and dissemination targets.

Sustainability –

As a result of implementing the MSHRAC-approved actions, new processes were identified, developed, and adopted by OMSHR. The actions include a focus within each research project on intervention effectiveness, on transfer of research findings, and on diffusion of technology. The processes have become routine within the OMSHR program.

- Developed a structured research model to show direct linkage to the reduction in the incidence rate of noise-induced hearing loss at all stages of research activities. In use by the Hearing Loss Prevention Research Program, this model aligns all phases of research, development, and assessment of control technologies. Each stage of the model has corresponding metrics (built from noise control engineering, industrial hygiene, and social science disciplines), which creates a more transparent and consistent process to evaluate control technologies.
- The project “Developing an Information Dissemination Model for PRL Research Translation Efforts” applied the ecological approach to behavior change from public health practices to build a model specific to OMSHR’s research agenda as well as industry audience segmentation and dissemination preferences.
- Through a contract funded to evaluate technology transfer efforts, OMSHR’s research dissemination activities and products were analyzed according to the ecological model. This evaluation examined the effectiveness of OMSHR’s diffusion of innovations across research imperatives within all strategic goals and is used to guide information dissemination practices for key research imperatives.

Impact –

- The results of the Survey of Coal Mine Safety Interventions indicated that a significant number of “mine safety contacts” were unaware of OMSHR interventions, and further that some safety contacts did not differentiate between NIOSH and MSHA. Three specific actions were initiated as a result of this survey: 1) engage in branding and more direct outreach to mines; 2) work with MSHA to target information and interventions to mines with specific needs; and 3) improve the usability of the NIOSH Mining Website.
- Based on knowledge gained from “Developing an Information Dissemination Model for PRL Research Translation Efforts,” hearing loss prevention researchers captured industry-level perspectives related to dissemination preferences and barriers to adoption. These findings were used to build a technology transfer strategy for project research evaluating the effectiveness of noise control technologies.
- OMSHR’s redevelopment of the NIOSH Mining Internet integrates findings on industry audience segmentation and dissemination preferences based on the project “Developing an Information Dissemination Model for PRL Research Translation Efforts.”

Recommendation 10: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Develop demonstration projects that show the feasibility and effectiveness of interventions	Demonstrations of the effectiveness of new technologies in operating mines will continue to be a significant activity within OMSHR

Activities-

The mining community has known the value of demonstration projects for many decades. Some of the Bureau of Mines' most impactful technologies, e.g. rock dusting and roof bolting, followed their in-mine demonstration projects. This approach has continued to the present. Over the past decade, the very successful "Diesel" and "Noise" Partnerships (NIOSH-led) among industry, labor, and government had, as a major goal, the in-mine demonstration of the effectiveness of various technologies. Over the past five years, project plans have been examined specifically to ensure that demonstration projects were being used whenever appropriate, and none were found to be deficient in this regard. Currently, approximately 65% of the projects incorporate a demonstration component. Examples of the demonstrations that occur as a result of this on-going emphasis are listed under the "Impact" section.

Sustainability –

The incorporation of demonstration projects into the research portfolio is a long-standing practice that is critical to the achievement of Program goals. This will continue, and will not require additional resources.

Impact—

- Funded an In-Mine Inert Gas Generator Demonstration to demonstrate a safe method to render and maintain sealed, abandoned mine areas inert.
- Demonstrated the efficacy of tube-bundle monitoring technology to remotely monitor gas concentrations in an underground coal mine.
- Demonstrated a real-time, personal dust monitor (PDM) that allows mine workers to monitor their dust exposures during their working shift and take corrective action when the device indicates a potential overexposure to respirable coal mine dust. Extensive laboratory testing was followed by demonstrations at over 100 mines located throughout 10 MSHA enforcement districts.
- Demonstrated the NIOSH-developed Elemental Carbon (EC) Monitor in 11 mines across the United States, Canada, and Australia to show that it can provide a real-time surrogate measurement for diesel particulate matter.
- Conducted in-production and isolated zone testing of diesel emissions control systems in four mines in the United States and Canada.

- Demonstrated the NIOSH-developed clothes cleaning booth system, which is designed to minimize the respirable dust exposure to workers from contaminated work clothing at silica sand processing plants.
- Completed a nine month, in-mine demonstration project of the dual-sprocket coated chain that was designed to reduce noise on a continuous mining machine, to show that the life of a “quiet” chain was similar to the life of the traditional chain.
- Demonstrated the drill bit isolator at five underground coal mines to show it provided 3–5 dB(A) of noise reduction while reaching a durability goal of drilling up to 2,500 ft.
- Demonstrated emergency response training procedures at mine rescue contests and mine sites (for example, 20 Mile Mine).

Recommendation 11: Fulfilled

Recommendation	MSHRAC-Approved Actions
Include how small business worker populations will be served	OMSHR will revisit its Strategic Plan and this area has been identified as one of the challenges to be addressed
	OMSHR will develop an action plan for this area separately and will include discussions with MSHA's Technical Assistance Program to identify small mines that have special safety and health problems and needs

Activities –

OMSHR revised its strategic plan to clearly emphasize the need to develop health and safety solutions and conducted a series of activities to identify the overarching barriers that small mines face relative to implementing health and safety interventions:

- Conducted a study to characterize the demographics of small mines with input from MSHA's Small Mine Office.
- Conducted a small mine workshop in Logan, West Virginia, in September 2008 where 90 participants provided insight.
- Conducted numerous in-person meetings with health and safety leadership in Colombia, a country with an extensive small mines cohort in underground coal.
- Conducted in-person and phone meetings with representatives from the workers' compensation industry.

Major areas of concern were:

- Inability of small mines to easily and inexpensively access and obtain information about health and safety practices.
- Limited availability of low-cost technology solutions and/or solutions requiring minimal technical training.
- Existing health and safety management systems and research are directed towards larger mines with greater resources and staffing capabilities.

OMSHR developed a comprehensive strategic approach to address these areas of concern through the following activities:

- Access to Information—reducing the need to travel and increasing awareness
 - Workshops formerly held at only one location were videotaped and posted on the OMSHR website to enable small mining operations to review the content at their convenience and without the need for travel. Thirteen workshops are currently available and cover topics such as reducing miners' exposure to DPM and gases, risk-based analysis for ground control, and controlling respirable dust in coal mines: <http://www.cdc.gov/niosh/mining/workshops/index.html>.

- GIS technology and statistical and mapping techniques were combined to develop a Small Mine Seminar Location Analysis Tool to identify training sites that would be centrally located for miners who work in a region with numerous small mining operations.
- Web-based training classes have been developed for commodities where the targeted small mines are not located in reasonable proximity to one another (e.g., S-Pillar training).
- Continued to organize and implement the Annual Underground Stone Safety Seminar to reach out to a mining sector that has a large percentage of operations that are identified as small business populations. For the seminar held in December 2013, almost 200 miners representing about 20 small mine operations attended.
- OMSHR's newly designed website which was released in September 2012—includes a link on its homepage to a page specifically designed for small mine operators, linking them directly to relevant content such as workshops. Operators may also subscribe to the page, thus being notified automatically when new content is added. The small mines page includes links and additional information on relevant publications, workshops, videos and training materials.
- A variety of social media platforms are being used for communicating to mining stakeholders and the approach includes a dissemination plan complete with metrics to determine the effectiveness of reaching workers at small mining operations. Based on data received at this point, the NIOSH homepage has been the most effective at reaching the desired stakeholders.
- Cost of Solutions and Training Necessary for Use
 - Developing an ergonomics audit tool for bagging operators, haul truck operators, and maintenance and repair workers. This tool is being designed such that it can be used on any web-based device (e.g., tablet, smart phone). Additionally, to reduce the training necessary, this tool will allow the user to answer a series of simple questions about the tasks performed by these workers and will then direct them interventions and other workplace solutions available on the OMSHR website or from other entities.
 - Conducting a study on fatigue management for haul truck operators with a specific focus on identifying low-cost, low-tech solutions for small mines.
 - Developing a suite of economic tools that have direct application to small mining operations to help identify the costs and impacts of injuries within their operations. These tools include *Safety Pays for Mining* (an approach successfully used by OSHA for other occupational sectors) and an employer costs tool complete with an embedded accident cost simulator focused on providing an accurate business cost model for mines.
 - Using readily available technologies in the virtual reality field, OMSHR researchers recently devised and evaluated a low-cost way for health and safety training to bring virtual reality-based training activities to remote locations, thereby enabling

- small mines to obtain access to the same types of training activities larger mines use.
- Evaluated the use of the workers' compensation system as an economic tool to reduce the financial burden that small mines experience when implementing health and safety solutions. Studies were conducted relative to the use of roof screen to reduce traumatic injuries and the use of personal protective technology and training materials to reduce cumulative knee injuries.
 - Health and Safety Management Systems for Small Mines
 - Collected input from domestic and international parties to inform the development of a Request for Proposals (RFP) related to establishing health and safety management systems specifically to meet the needs of small mines.
 - The statement of work developed for the RFP was highly comprehensive and included the following tasks:
 - Develop a rationale and criteria to define two cohorts of small mining operations, metal/nonmetal and stone, sand and gravel—note: small mines that are owned and operated by large mining companies were not the target for this effort requiring the need for a clear cohort definition.
 - Characterize safety and health challenges/barriers facing the two cohorts
 - Catalog unique workplace practices and interventions small mines should consider given the existing challenges/barriers.
 - Formulate a strategy to implement and assess an effective safety management program for the two cohorts.
 - Pilot test the proposed safety system program at a representative mine.
 - Develop an evaluation protocol for the safety system.
 - Implement and evaluate safety system program at two to four metal/non-metal mines and at least one sand or gravel mine.
 - Compile a final report with recommendations and guidance for the small mines community.
 - A contract was awarded to the University of Utah in FY13—the PI is also leading NMA's CORE Safety effort.

Sustainability –

OMSHR has the personnel and technical resources in place to continue providing information to small mines that reduces or eliminates the need to travel and provides access to information without the need for the operator to spend countless hours searching for solutions, e.g., subscribing to the small mines page or the OMSHR social media outlets. OMSHR has numerous research tasks developing low-cost/low-tech solutions for small mines and will continue to do so with the inclusion of the small mines emphasis in its strategic plan. The health and safety management systems for small mines work is highly sustainable given the contract has been awarded and includes numerous time points where NIOSH researchers are provided an opportunity to comment on the direction of the research.

Impact –

- A feasibility study was completed using the Small Mine Seminar Location Analysis Tool by applying the technique to small underground coal mines (<50 employees) in the eastern U.S. in the region covering West Virginia, Kentucky, Virginia, and Tennessee. The Analysis Tool demonstrated that workshops held in South Charleston, Pikeville, and Middlesborough would ensure that 48% of small coal mine operations in this region and 58% of employees working in these mines would be within a 50-mile radius of the training locations.
- The Underground Stone Safety Seminar has reached more than 3,000 stone miners representing more than 75 organizations. The topics presented at the seminar series have addressed virtually all topics of health and safety that are relevant and of interest to the stone mining sector. These range from dust and diesel exhaust control, to ventilation and ground control technologies to musculoskeletal disorder prevention to noise control, equipment safety and blasting safety. This seminar series has an exceptionally high percentage of attendees that are actual mine workers (more than 50%).
- An OMSHR funded contract was completed using a GIS platform to identify the geographic locations of small mine operations in the U.S. to be used for planning workshops and health and safety seminars. The information is now being used by the research branches for planning technology transfer events.
- After developing its S-Pillar software to assist in pillar design at room and pillar stone mines, OMSHR held a one-hour, web-based training session on the use of the software in June 2011. The session was an interactive, hands-on training session with opportunities for questions and discussions. More than 20 people attended, 15 being stone operators and 5 were consultants and MSHA specialists.
- OMSHR currently has three recent workshops it previously conducted posted on its website in video form for review by members of the industry who were unable to attend the original workshop. The topics include: explosibility issues in coal mines and the use of the CDEM, state-of-the-art proximity detection systems, and current practices with communications and tracking systems.
- Three peer-reviewed journal articles have been published related to how savings through the workers' compensation system could offset the costs of implementing health and safety solutions.

Recommendation 12: Fulfilled

Recommendation	MSHRAC-Approved Actions
Incorporate training into the strategic goals of all research areas	OMSHR will ensure the revised Strategic Plan clearly presents its current practice of using training as a tool under each strategic goal
	Using training as a tool under each strategic goal will be fully integrated at the Spokane Research Laboratory by the end of FY08 ³

Activities—

- Updated the OMSHR Strategic Plan to integrate training under each primary strategic goal.
- Transferred training experts into each of the strategic goal programs and integrated training objectives into the many projects within that strategic area.
- Constituted a small group of researchers to investigate training effectiveness in a mining context.
- Constructed a new Mine Rescue and Escape Training (MRET) Laboratory in 2011 to conduct research on the use of immersive virtual environments to improve mine safety and health training across several strategic goals.
- Developed a 5-year vision for what training should become, in partnership with representatives from industry (coal, metal/nonmetal/and stone/sand/gravel), labor, and MSHA. This 5-year vision is being used to inform the NIOSH research planning process.

Sustainability –

The training goals for each program area and each project within the mining research portfolio have been implemented and are on-going. Existing staff and resources are in place to continue and the leadership team and principal investigators are supportive of the importance of training goals.

Impact –

- Developed training interventions within the individual strategic goal areas, for example:
 - SG2 - Randolph-RF, Reinke-DC, Unger-RL [2008]. NIOSH Hearing Loss Simulator Instruction and Training Guide. DHHS (NIOSH) Publication No. 2008-119, 9 pp.
 - SG3 - Moore SM, Steiner LJ, Nelson ME, Mayton AG, Kelley Fitzgerald G, Hubert JP [2008]. Keeping Knees Healthy in Restricted Work Spaces: Applications in Low-Seam Mining. Information Circular 9504, DHHS (NIOSH) Publication No. 2008-130.

³ The mining research portfolios in Pittsburgh and Spokane were integrated into one mining portfolio during the reorganization of OMSHR in 2010.

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- SG4 - Kowalski-Trakofler KM, Barrett EA, Urban CW, Homce GT, [2007]. Arc Flash Awareness: Information and Discussion Topics for Electrical Workers. DHHS (NIOSH) Publication No. 2007–116D.
 - SG5 - Margolis, Kowalski-Trakofler, Kingsley Westerman [2009]. Refuge Chamber Expectations Training. Information Circular Report 9516, DHHS (NIOSH) Publication Number 2009-169.

 - OMSHR developed workshops across the program to diffuse research findings, and this was in part due to the better integration of training and health communications experts throughout the Program. Examples include the following topics, among many others:
 - Preventing Coal Dust Explosions
 - Communications and Tracking
 - Practical Strategies to Reduce Diesel Emissions
 - Best Practices in Metal/Nonmetal Dust Control
 - Reducing Workplace Accidents Through Risk Assessment
 - Ergonomic Principles
 - Emergency Response
 - Proximity Warning

Recommendation 13: Fulfilled

Recommendation	MSHRAC-Approved Actions
Stay aware of pertinent current and emerging research, including international research, and be prepared to act on potential health and safety issues	OMSHR will seek external input (international) to determine future research areas, continue to monitor international progress in mining safety and health problems, and take steps to improve its international awareness and activities
	OMSHR will seek the advice of MSHRAC on emerging safety and health issues and the need for new research areas

Activities—

- Initiated technology transfer by hosting an international workshop on gob monitoring and seal practices in Australia.
- Participated in the Global Mining Research Alliance (2000 - 2006) with other research organizations in Australia, Canada, and South Africa, the Asia-Pacific Partnership on Coal, among others, to ensure that OMSHR scientists are aware of the latest research conducted in other countries that have advanced mining industries.
- Sponsored experts from organizations in other countries to come to OMSHR for sabbaticals, lecture series, and workshops, for example:
 - Commonwealth Scientific and Industrial Research Organization
 - Safety in Mines Testing and Research Station (SIMTARS, Australia)
 - Glowny Instytut Gornictwa (Central Mining Institute, Poland)
 - Minerals Industry Safety and Health Centre
 - Construction Forestry Mining Energy Union
 - KOMAG Institute of Mining technology (Poland)
- Communicate and cooperate with Australian Coal Association Research Program and Australian Mineral Industry Research Association.
- Communicate with mining safety and health research agencies in other mining countries, e.g. Australia, Poland, and South Africa, to discuss methods, technologies, and gap areas.
- Participate in NIOSH's global health program.

Sustainability –

The activities identified here can be conducted using the resources available, and will continue. Until 2010, OMSHR funded international travel for project-related research for approximately 3-4% of the professional staff each year. Not only did this serve the immediate needs of a particular project, but it exposed the researchers to mining and mining research approaches in different parts of the world. This was viewed as a critical professional development and succession plan activity, in addition to its value to a project. The travel ceilings and international travel restrictions adopted by the Department to limit travel by government employees has effectively eliminated international travel for anything but immediate and high-priority needs. If those policies should change in the future, then this could again

become an important mechanism to help ensure that U.S. mining safety and health researchers are well versed in the practices found in other countries.

Impact –

Staff are aware of international mining practices, the use of technologies, and the safety and health challenges that are surfacing in other countries, through their on-going participation in professional societies, maintaining a familiarity with the published literature, and engaging in the previously listed activities. The close collaborations with foreign agencies that have been established, and are working well, are serving not only to apprise researchers of practices and problems, but facilitate collaborative problem solving and the sharing of solutions.

Recommendation 14: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Be prepared to deal with issues associated with increased remote control and automated equipment and systems	OMSHR will maintain awareness of trends toward the use of remote control and automation in mining and focus on the impacts of technology on miner safety and health
	OMSHR will work on any interventions that may be needed to control new hazards that may be introduced, but it does not plan to develop any new automation or remote control technology

Activities—

- Continually monitoring trends in the use of remote control and automation in mining both domestically and internationally.
- Proactively considering the types of hazards that could possibly be introduced, as well as the potential improvements in safety or health, resulting from automated or remote control systems.
- Proactively considering the aforementioned trends and developments in the research planning cycle.

Sustainability –

Responding to these emerging issues is a core part of the OMSHR research program, and as such, the staffing and funds are available to address problems of this nature.

Impact –

- Focused on the hazard of a worker moving into the operational space of automated or remote controlled equipment, and considered means of protecting the miner. An Intelligent Proximity Warning System (iPWS) is under development that would be significantly more protective in a range of possible scenarios than conventional proximity warning systems.
- Developed a Visual Warning System (VWS) for remote control continuous mining machines capable of providing four different modes of warning. The VWS uses LED and fiber optic strings mounted on the exterior of the machine that are activated to provide visual warnings for other miners working near hazardous machine motion. Other work is underway to combine the VWS with the iPWS.

Recommendation 15: Fulfilled

Recommendation	MSHRAC-Approved Actions
The mining programs should be prepared to provide recommendations to safeguard health and safety as best strategies for mining deep resources are developed. Environmental and occupational hazards of deeper mines should be evaluated	OMSHR will conduct a project to examine research issues associated with mining at greater depths
	OMSHR will consider other related needs in its strategic planning process

Activities—

- OMSHR leadership examined the trend towards mining at greater depths, to identify knowledge or practice gaps that could be addressed through research, and the results of which would form the basis for recommendations on strategies. The major gap area identified was in the ground control area, and more so for coal rather than metal/nonmetal mining. Another identified concern is ventilating deep mines in hot ambient conditions. The general need has been considered in the strategic planning process, and specific research opportunities are considered in the annual project planning cycle.
- Projects were developed to conduct research into the gap areas associated with mining at greater depths.
- MSHRAC was asked to review OMSHR's deep cover retreat mining research for coal mines.
- A research project was conducted to evaluate coal pillar performance as it relates to current mining conditions. The updated information is being added to the ground control tool bar program, Analysis of Longwall Pillar Stability (ALPS) and ARMPS, to reflect the change in underground mine conditions. The results of the study was published and presented at two venues and the research was awarded "the Best in Ground Control" at the 32nd International Conference on Ground Control in Mining.
- Initiated a new project, Development of Guidelines for the Design of Support Systems to Manage Coal Mine Rib Hazards, to address the concerns associated with high-stress and deep coal mining operations on rib instability. The research is being conducted by underground experiments and numerical simulations and is focused on the development of an engineering design methodology for rib support. The approach considers natural conditions at the mine site such as depth, seam height, cleat spacing and roughness with consideration for intrinsic and secondary supports. More than 20 case studies have been included in the project.
- A new research project was conceived and initiated for a deep silver mine to evaluate the ground control performance for high-stress mining conditions. The project takes a systems approach to developing design and operational procedures that maximize protection from

- dynamic instability and, at the same time, minimize support installation risks to set a higher overall safety standard for deep vein mines. The new project includes lab testing, field measurements and numerical modeling. The results of the project will have application to virtually all deep underground mines and will provide insight, understanding and ultimately an engineering approach for preventing ground failures. The research approach and methodology were reviewed and approved by MSHRAC at the previous meeting.
- Completed two extramural research projects related to high-stress and deeper mining conditions. Both focused on dynamic failures in underground coal mines, often referred to bumps or bursts, and both completed an extensive and innovative approach using laboratory experiments. The information from the lab studies, using actual coal specimens from different mines, provides insight for understanding the mechanisms associated with these types of failures. The details on the studies are available at the OMSHR website.
 - Initiated an internal study to examine risk and risk mitigation associated with “loss of cooling” in deep hot metal mines.

Sustainability –

The intent of this recommendation was to ensure that a proper research foundation would be in-place to support the development of recommendations to safely mine at greater depths. The appropriate changes have been made to the Strategic Plan and the project planning cycle to ensure that this occurs. Progress will continue toward the goal as long as current staffing and funding levels are maintained.

Impact –

- An intermediate goal was added to the Strategic Plan (IG 6.1) to develop design strategies to prevent catastrophic roof and pillar collapses and other excessive stress-related damage resulting from dynamic failures in both coal and metal/non-metal mines.
- An intermediate goal was added to the Strategic Plan to “Develop mine and pillar design strategies to prevent catastrophic roof collapses and pillar failures and excessive stress-related damage that degrades global stability. The solution to dynamic failure of the mine structure both at the local and regional scale will be resolved through a more fundamental understanding of the trigger mechanism and development of mine design control interventions. Overcoming this barrier will require advancements in seismic analysis, numerical modeling, and effective risk management.”
- MSHRAC reviewed OMSHR’s deep cover retreat mining research at the June 3-4, 2009, meeting. The Committee suggested that coal research should be leveraged to include similar rock mechanic behaviors in metal and nonmetal mines and expressed the need for a best practices guide on how to safely conduct retreat mining, with an emphasis on training. The ground control research program was expanded following the recommendation from MSHRAC to expand the research efforts in metal and nonmetal mines.
- Completed a major intramural project, “Dynamic Failure Prevention in Deep Coal Mines” (2008-2010) that developed computational tools for modeling caving mechanisms in deep

- mining by installing a suite of rock mechanics instruments to monitor loading conditions at a deep longwall mining operation where pillar design was modified due to increasing depth of cover.
- Revised the ARMPS program to better reflect the influence of barriers and load transfers in deep mining conditions by allowing formation of an arch over the panel area to reduce tributary area loading when the panel width is narrow in a project entitled "ARMPS Update" (2008-2010).
 - Initiated a study entitled "Calibration and Verification of Longwall Stress Models" where advanced modeling tools are being utilized to evaluate design methodologies and perform sensitivity analysis of input parameters to develop guidance in numerical mine design methods.
 - Conceived, designed and constructed a portable seismic calibration source for use in any location in an underground coal mine since the technology requires no power source. The technology allows for the determination of the velocity profiles within the surrounding rocks and represents a significant accomplishment for the field of seismic monitoring in underground mines. Trials are being completed at two western U.S. underground coal mines having the potential for significant seismic events to occur during mining.
 - Initiated a project entitled "Coal Mine Safety Applications of Seismic Monitoring" that is building on the recommendations of the University of Utah expert panel to incorporate seismic monitoring into mine design and hazard management practices. A panel-scale seismic monitoring system was installed at a deep longwall mine and studies of seismic response of the strata to mining were conducted to assess design performance.
 - Updated the ALPS data set to reflect the last 10 years of mining, including a significant number of panels deeper than 600 m in the "Empirical Guidelines for Longwall Ground Control Design – The Analysis of Longwall Pillar Stability (ALPS) Update" project.
 - Conducting a study called "Identification of Areas at Risk for Coal Bursts in Deep Cover Room and Pillar Mines" to update a database of coal bump incidents during retreat mining by identify influencing factors, such as geologic structures and near-seam geology, that act as precursors to bump-prone conditions. A risk assessment methodology is being developed that will allow mine operators to characterize mining areas at a high risk of bumping.
 - Contracted with the University of Utah to develop improved processing techniques for locating mine seismic energy sources and expand the regional seismic monitoring coverage of deep coal mining areas in Utah.
 - Contracted with West Virginia University to update LaModel software to improve performance in deep cover applications.
 - Contracted the Colorado School of Mines to utilize finite difference software to analyze coal pillar failure modes.
 - Contracted with the University of Nevada, Reno, to pursue the development and application of software to model heat transmission and management in deep metal mines.

Recommendation 16: Fulfilled

Recommendation	MSHRAC-Approved Actions
Address the health effects of mixed exposures, such as diesel exhaust, hydrocarbons, and noise, as well as the combined effects of mixed noise (continuous and impulse-impact) environments	OMSHR will alert other NIOSH divisions to the concern for mixed exposures in mining

Activities—

OMSHR does not conduct health effects research, but the other NIOSH divisions were alerted to this concern at the NIOSH Quarterly Management Meeting on January 8, 2008.

Sustainability –

The action for this recommendation has been completed.

Impact –

- A report by the NORA Mixed Exposures Team states that: “The problem of understanding the true health effects of real-world mixed exposures is mind-boggling unless systems are in place for clarifying research priorities within major occupational groups.” The report goes on to say that “Mixed exposures are too complex and variable to prescribe any single approach as most appropriate for understanding related health effects. Research in this area must offer a way to focus on key health issues considering an overwhelming number of permutations of types and sequences of exposure to multiple stressors in the workplace, as well as interactions among workplace and non-workplace exposures.”
- NIOSH researchers in the hearing loss program published 40 manuscripts on chemical-noise interactions between 1989 and 2005 and continue to make presentations at national and international scientific conferences on the subject.
- More recent NIOSH work dealing with mixed exposures evaluated an audiological assessment protocol that tests a worker’s hearing ability and that is sensitive enough to distinguish the effects of noise from the effects of chemicals. This was achieved in collaboration with Yale University and the results were published in 2009 in a report entitled “Peripheral and Central Auditory Dysfunction Induced by Occupational Exposure to Organic Solvents.”
- In 2010, NIOSH collaborated with the Nordic Expert Group in publishing a document providing guidance for addressing the hearing loss prevention needs of the chemical-exposed worker.

Recommendation 17: Fulfilled

Recommendation	MSHRAC-Approved Actions
Consider the extent and effects of radon and radiation exposure in the presence of other potential chemical agents as the United States increases its reliance on nuclear energy	OMSHR will be alert for plans made by industry to renew uranium mining in the U.S. and will evaluate the risks to mine workers
	OMSHR will offer workshops or employ other health communications strategies to inform this re-emerging industry of the radiation health hazards and the technology needed to control the hazards
	OMSHR will consider the longer-term need for research in this area in its revision to the Strategic Plan

Activities—

- Initiated an internal study in 2007 to determine the nature and extent of research gaps to protecting miners from exposure to radon and its progeny in the event that uranium mines begin to open in the U.S.
- Created a Uranium Worker Protection Work Group (UWPWG) in 2010 to investigate the state of safety and health for uranium workers, including miners, in the U.S. and throughout the world. This group, which was formed by the NIOSH Director, has a mission to “determine emerging processes and industry growth projections, identify gaps in worker protection throughout the uranium processing cycle, make recommendations for worker safety and health improvements globally, develop a research agenda to address identified gaps and emerging issues, and develop/disseminate publication products.” OMSHR has two representatives on the UWPWG.
- Continue to track developments in the U.S. uranium mining industry and the associated safety and health of mine workers.

Sustainability—

The mechanism for achieving the intent of this recommendation is in place and the resources to sustain this effort, i.e. to monitor for resurgence in domestic uranium mining, are available.

Impact—

- The final report of the 2007 study to determine research gaps to protecting miners from exposure to radon and its progeny summarized industry trends and explored key health and safety issues. It concluded that there were no known research gaps, and that the anticipated surge in U.S. uranium mining had not yet begun.
- The UWPWG continues to develop information for a report that will characterize the scope of the current industry and forecast projected growth. The report will also describe the uranium fuel cycle and processes and examine U. S. and international regulations. Radiation

monitoring, exposure assessment, and current control practices will be summarized and existing systems for data retention and worker exposure tracking identified. Finally, the report will submit a list of knowledge gaps and research needs and make recommendations to the NIOSH Director for future activities in this area. At this time, the UWPWG has not identified any unmet needs for protecting uranium miners.

Recommendation 18: Fulfilled

Scored in 2012

Recommendation	MSHRAC-Approved Actions
Attend to workforce replacement issues expected within NIOSH to ensure a supply of capable researchers as its older researchers retire	OMSHR will continue to recruit aggressively
	OMSHR will continue to urge the leadership of the Department of Health and Human Services and the Centers for Disease Control and Prevention to remove their restrictions on the use of the recruiting tool existing under law allowing for the significant increase in pay for highly accomplished engineers and scientists with highly sought skills and allowing for the ability to hire in a matter of days, not months

Activities—

OMSHR has been well aware of the looming crisis in recruiting expertise to maintain the current core competencies of the Mining Program, and OMSHR has been quite vocal, to MSHRAC and to the Agency, about the barriers to recruitment. Barriers are both internal, and often self-imposed, and external. For example, it typically takes 6 – 12 months to fill one position, and the time between the identification of a candidate and the job offer is generally 3 or more months. Good candidates are often lost during this time period. The global demand for mining professionals combined with the Federal Government's inability to offer competitive salaries and benefits continues to severely restrict the recruitment of good candidates. An engineer with average to above-average grades and experience can expect to receive a starting offer of nearly twice the amount that can legally be offered by NIOSH. Despite these barriers, OMSHR continues to pursue a range of activities to recruit talent and to develop talent internally, as follows:

- OMSHR Leadership formulated two teams, a hiring, recruitment and retention team, and a succession management team to address workforce attrition issues. Action plans for both teams are developed and implementation of those plans is occurring.
 - Expanding the pool of available talent through the OMSHR capacity-building programs in ventilation and ground control, that are being implemented at many of the mining engineering programs at U.S. Universities.
 - Hiring engineers and scientists who lack mining backgrounds, and then developing that expertise through in-house educational programs, support to take university courses, and support to obtain graduate degrees in disciplines of critical need.
 - Continuing to aggressively recruit for scientist and engineer positions by: advertising regularly in leading mining and other professional journals, actively recruiting at mining conferences, increasing the direct contacts with university faculty, increasing the number of on-campus visits by senior technical staff to increase awareness of the opportunities available at NIOSH, posting announcements on various websites, and by including an employment notice on the OMSHR website.

- Using special federal hiring programs to the fullest extent, including the Fellowship program that allows non-U.S. citizens to be hired, the Student Career Experience Program (SCEP) that allows promising students to be noncompetitively converted to term, career, or career-conditional appointments following completion of their academic and work experience requirements and the Student Temporary Employment Program (STEP) which allows the hiring of college students to work part-time through the school year and throughout the summer. Additionally, a new program, the Pathways Program, which includes the Internship Program and the Recent Graduates Program will provide streamlined developmental platforms tailored to promote employment opportunities for students and recent graduates.
- Developed and implemented global (common needs across entire program) and local (branch and division level) succession plans for sustainability of the program. The plans were developed to ensure employees have the necessary skill set, tools and resources to: 1) perform in their current job function (e.g. senior researcher in a specific program area, front-line supervisor, senior technician in a specific program area and project leader) and to 2) prepare for advancement to a more senior job function within the program in the next 3 to 5 years.
- Urging the leadership of the Department of Health and Human Services (DHHS) and the Centers for Disease Control and Prevention (CDC) to remove their self-imposed restrictions on the use of Title 42 tools to recruit and retain mission-critical staff.
- Engaging the part-time services of recently retired employees to mentor newly hired staff, as well as to fill a gap in expertise on critical issues.

Sustainability—

Recruiting and succession efforts continue to address this critical issue. In addition, OMSHR will continue to invest funds to attract high-quality students into specific disciplines of mining where expertise is lacking.

Impact –

- Sponsored training courses in the elements of coal mining, metal/nonmetal mining, and ventilation engineering for new non-mining recruits (to date nearly 30 people have been trained on and at these on-site courses).
- Assisting approximately 27 staff to obtain advanced degrees in core areas of the mining program.
- OMSHR has expanded its efforts in using the Pathways Program for attracting and recruiting recent graduates in science and engineering fields that match the high-priority needs of the research program. This program, in conjunction with the fifteen capacity-building contracts with mining engineering universities will allow for a more effective and efficient hiring process.
- Currently employ 10 SCEP/STEP students with the potential for additional appointments thru the Pathways Program.

- On average, employ 20 STEP students during the year.
- Since 2008, recruited and hired a total of 104 personnel including engineers, scientists, technician and support staff for the program.
- Fifteen capacity-building contracts have been awarded to universities with accredited mining engineering departments, and approximately 52 graduate students are currently being supported by the ventilation and ground control capacity-building contracts. In addition, there have been two PhD and ten Master of Science students graduated from the OMSHR capacity-building programs.
- Additional capacity building contracts using the Broad Agency Announcement approach are being prepared and are planned for release during 2014.

Appendix A - 2012 Mining Program Score Sheet

Directions: For each recommendation listed below, please circle a score for each scoring element and provide a brief justification for the assignment of that score. The work group may provide scores in .5 increments where they deem appropriate. If the group chooses to do that, please put a .5 next to the corresponding number and circle that number.

Recommendations Completed:

Recommendation	MSHRAC-Approved Actions
The Mining Program should fully utilize outside technical expertise through a vibrant extramural and contract research program.	OMSHR will continue its expanded investment in extramural research for improved communications and tracking systems for mine emergencies, refuge chambers, and for improved SCSRs
	OMSHR will establish a safety technology contracts and grants program as mandated by the MINER Act

Achievement: 1 2 3 4 5

Brief Justification: The committee felt strongly that extramural funding must continue to receive the support and focus it has gotten from NIOSH so that the best ideas and the technologies are provided to assure miners' health and safety. The MINER Act has established processes for involving extramural researchers, authorizing OMSHR to establish a contract and grants program to identify, develop, commercialize and diffuse relevant technologies, particularly in the areas of communications and tracking, escape, rescue, sensory systems and intervention research. The committee noted the increased extramural funding since 2006, and feels that there has been substantial achievement in the MSHRAC-approved action items above.

Sustainability: 1 2 3 4 5

Brief Justification: The Committee felt that there were adequate processes in place to assure continued budgetary support for extramural funding, assuming that there is continued Mining Program funding with no substantial cuts.

Impact: 1 2 3 4 5

Brief Justification: There was extensive discussion of the importance and impact of a vibrant extramural and contract research program, particularly to assure that state-of-the-art technology is adopted and used. The committee members agreed that the Mining Program is quick to respond to short term applied research needs, and feels that extramural partnerships are functioning well. Examples of the impact of this recommendation include the specialized mine escape vehicle under contract; the development and testing of a prototype dockable SCSR; the

development and commercialization of several leaky feeder and node-based primary communications systems through a targeted extramural contract program; and the testing of a through-the-earth communications system with Lockheed Martin.

Recommendation	MSHRAC-Approved Actions
The Mining Program should place greater emphasis on outputs preferred by mining operators, miners, and other nontechnical users.	OMSHR will use its request for proposals for independent studies to “Develop Effective Technology Transfer Communications Strategies of Research Results to Occupational Health and Safety Communities of Mining and Non-Mining Communities to be used in the Workplace” and other appropriate means to increase communication in clear language to all parts of the mining community

Achievement: 1 2 3 4.5 5

Brief Justification: The committee had an in-depth discussion of this important recommendation, and suggested several approaches for “how to get the information into the hands of the miners.” There was discussion of whether information generated from the mining program may sometimes be too technical, and several ideas (ie, examining the approach used by the Chemical Safety Board, contributing more articles to trade association magazines, increasing the number of Technology News summaries) were suggested and/or endorsed by committee members. The committee reflected that non-union miners are a particularly difficult audience to reach to communicate health and safety information. There was consensus that NIOSH is very responsive to addressing industry’s needs and that the Mining Program has been creative in expanding its approach to using surveys and research to develop communication products. A number of activities that have been undertaken to further improve the communication products developed by the Mining Program include: an independent study to “Develop Effective Technology Transfer and Communications Strategies (as outlined above); the creation of a Health Communications Team within OMSHR; a survey of Coal Mine Safety Interventions; funding of a contract to improve the NIOSH Mining website; an online survey of users of the existing website to determine their information needs and approaches; participation in regional and national mining conferences; using survey findings to identify needs for bilingual and other targeted products; and funding a study to evaluate information dissemination through a systems approach.

Sustainability: 1 2 3 4 5

Brief Justification: The committee acknowledged the clear commitment from NIOSH regarding the importance of sustaining this emphasis on outputs and knowledge transfer. The creation of the new organizational unit, the increased staffing of the Health Communications and

Computational Research Teams, and the expansion of research efforts reflect growth and creativity in assuring sustainability.

Impact: 1 2 3 4 5

Brief Justification: Results are being used by the Mining Program to increase understanding of how to develop clear and concise outputs for all sectors of the mining community. For example, the Health Communications Team logo and branding efforts are being applied to communications to build knowledge and clarify OMSHR's role in mining industry safety and health. The new website is more clear, more user friendly and more comprehensive in enhancing users' ability to find relevant information.

Recommendation	MSHRAC-Approved Actions
The Mining Program should make better use of MSHA and other existing surveillance data and work to make these surveillance programs more robust.	OMSHR will fund one or more studies on approaches that would make the surveillance program more robust

Achievement: 1 2 3 4 5

Brief Justification: The committee felt that the surveillance program has become more robust and that NIOSH "did what they committed to do" in terms of better using MSHA and other existing surveillance data. Specifically, funded and/or completed activities included the following: development of a Severe Injury Surveillance system using MSHA data and the Abbreviated Injury Scale to assess feasibility and utility of surveillance of severe injuries as a proxy for fatal events; contract to investigate relationships between mine size, employment rates and fatality/injury rates; contract to assess mining machinery and related interventions; contract to use MSHA enforcement data to target research and intervention in mines with greatest need; comprehensive and updated survey of US mining population; published a methodology for evaluating injury/fatality rates for mining contractors; and developed a plan for more frequent updating of demographic survey data.

Sustainability: 1 2 3 4 5

Brief Justification: If adequate budgetary support for this recommendation continues, the mechanisms are in place to assure that the surveillance programs remain robust and that extramural contracts will remain effective methods for assuring surveillance expertise. Collaborations are firmly established, and budgets have been adjusted to assure that, for example, the Demographic Survey plans are maintained and updated.

Impact: 1 2 3 4 5

Brief Justification: The committee expressed some concern regarding the remoteness (2008) of the existing data and the importance of reflecting changes following implementation of the MINER Act. However, strategic planning is on-going to create more frequent tracking and trend data analysis, with a yearly focus on one major mining sector for surveillance. Additionally, there are results pending from the recently completed National Survey of the Mining Population that will help guide research as well as progress in developing an algorithm for targeting mines for specific intervention. The OMSHR Surveillance Team has received training in the AIS coding scheme and is developing statistical models for predicting which mines are at high risk for fatal injuries.

Recommendation	MSHRAC-Approved Actions
The Mining Program should develop demonstration projects that show the feasibility and effectiveness of interventions.	Demonstrations of the effectiveness of new technologies in operating mines will continue to be a significant activity within OMSHR

Achievement: 1 2 3 4 5

Brief Justification: The committee expressed frustration and regret about the loss of the Lake Lynn facility, limiting research demonstration projects in mine explosion prevention. Despite this loss, the committee is pleased with Mining Program's overall efforts focused on demonstrations of new technologies in operating mines (for example, rock dusting and roof bolting, mine rescue, ventilation in stone mining, and diesel research). Over the past decade, the

NIOSH-led diesel and noise partnerships have been successful models of in-mine demonstration of technology efficacy.

Sustainability: 1 2 3 4 5

Brief Justification: The incorporation of demonstration projects into research efforts is key to NIOSH efforts and should continue as a sustainable activity for the foreseeable future. Notably, 65% of projects include a demonstration component.

Impact: 1 2 3 4 5

Brief Justification: The impact of demonstration projects showing feasibility and effectiveness of prevention interventions is central to work of the Mining Program and will remain a significant activity. Specifically, project impacts have included the following: funding for an in-mine inert gas generator demonstration to create and maintain sealed, abandoned mines; demonstration of efficacy of tube-bundle monitoring technology to remotely monitor gas concentrations in underground coal mines; demonstration of real-time PDM use in over 100 mines; demonstration of the elemental carbon (EC) monitor in 11 mines to verify its use as real-time surrogate for measuring diesel particulate matter; zone testing of diesel emissions control system in 4 North American mines; demonstration of a NIOSH-developed clothes cleaning booth system to minimize respirable silica exposure; completion of a 9-month demonstration project of the dual-sprocket coated chain to reduce noise from continuous mining machines; demonstration of the drill bit isolator at 5 underground coal mines to verify noise reduction while achieving a durability goal of drilling up to 2500 feet; and demonstrating emergency response training procedures at several mine rescue contests.

Recommendation	MSHRAC-Approved Actions
The Mining Program should be prepared to deal with issues associated with increased remote control and automated equipment and systems.	OMSHR will maintain awareness of trends toward the use of remote control and automation in mining and focus on the impacts of technology on miner safety and health
	OMSHR will work on any interventions that may be needed to control new hazards that may be introduced, but it does not plan to develop any new automation or remote control technology.

Achievement: 1 2 3 4 5

Brief Justification: This is an important area for which NIOSH is continually monitoring national and international trends in the use of remote control and automation in mining, considering hazards as well as improvements from automated or remote control systems, and using this information in their research planning cycle.

Sustainability: 1 2 3 4 5

Brief Justification: This is a core area of the OMSHR research program for which staffing and funds are available and will be mobilized.

Impact: 1 2 3 4 5

Brief Justification: Efforts are focused on assessing and controlling the hazards of a worker moving into the operational space of automated or remote controlled equipment. Both the Visual Warning System for remote control of continuous mining machines as well as the Intelligent Proximity Warning System under development are promising areas of further research.

Recommendation	MSHRAC-Approved Actions
The Mining Program should seriously attend to workforce replacement issues expected within NIOSH to ensure a supply of capable researchers as its older researchers retire.	<p>OMSHR will continue to recruit aggressively</p> <p>OMSHR will continue to urge the leadership of the Department of Health and Human Services and the Centers for Disease Control and Prevention to remove their restrictions on the use of the recruiting tool existing under law allowing for the significant increase in pay for highly accomplished engineers and scientists with highly sought skills and allowing for the ability to hire in a matter of days, not months</p>

Achievement: 1 2 3 4 5

Brief Justification: The committee spent some time discussing the looming crisis in recruiting researchers with expertise to maintain current core competencies of the Mining Program, along

with the barriers to recruitment (including the increased global demand for mining professionals, the Federal Government's inability to offer competitive salaries and benefits, and the time delays in filling positions). NIOSH reported having hired 70-80 people in the Mining Program over the past several years, and leadership is clearly committed to aggressive recruitment and communication with DHHS and CDC to facilitate efficient and effective recruitment to the program.

Sustainability: 1 2 3 4 5

Brief Justification: Because of the crisis in this area, the committee considered not scoring this category. There was strong consensus that, unless processes are standardized and improved, sustainability will become an even more substantial issue in the future. However, Mining Program leadership articulated committed and thoughtful approaches to workforce replacement issues, and will clearly do everything in their power to assure that the problem is addressed and funds are invested to attract high-quality students into specific mining disciplines.

Impact: 1 2 3 4 5

Brief Justification: The Mining Program has sponsored training courses for new recruits; assisted staff in obtaining advanced degrees in core mining areas; employed STEP/SCEP students for the program; and awarded 15 capacity building contracts to accredited mining engineering departments.