The United States Department of Health and Human Services
Centers for Disease Control and Prevention

National Institute for Occupational Safety and Health (NIOSH)
Mine Safety and Health Research Advisory Committee (MSHRAC)
Fall Meeting

Virtual on Zoom, Open to the Public Wednesday, December 8, 2021
Thursday, December 9, 2021

Contents

Summary Proceedings

The fall 2021 meeting of the National Institute of Occupational Safety and Health (NIOSH) Mine Safety and Health Research Advisory Committee (MSHRAC) was convened on Wednesday, December 8, 2021, via Video Teleconference, at 10:30 a.m. EST, Kyle Zimmer, Chair, presiding. The meeting was then reconvened on Thursday, December 9, 2021, again via Video Teleconference, at 10:30 a.m. EST with Kyle Zimmer, Chair, presiding

Attendees

Members

Kyle Zimmer, Jr., International Union of Operating Engineers; Chair

Kristina Behringer, M.D.

Ronald Bowersox, United Mine Workers of America

Andrea Brickey, South Dakota School of Mines and Technology

Dale Drysdale, National Stone, Sand & Gravel Association

Tom Duffy, United Steelworkers of America

Thomas Harman, Portland Cement Association

Marifran Mattson, Purdue University

Steven Schafrik, University of Kentucky

Matt Stewart, R. T. Vanderbilt Holding Company, Inc.

Giovanna Biscontin, National Science Foundation, Ex Officio

Melanie Calhoun, Mine Safety and Health Administration, Ex Officio

Non-Members

George Luxbacher, Designated Federal Official, NIOSH Deputy Associate Director for Mining

John Howard, NIOSH Director

Amanda Azman, NIOSH Pittsburgh Mining Research Division

Pamela Drake, NIOSH Spokane Mining Research Division

Doug Johns, Director, NIOSH Spokane Mining Research Division Director

Jessica Kogel, NIOSH Associate Director for Mining

Steven Mischler, NIOSH Pittsburgh Mining Research Division

Gerald Poplin, NIOSH Spokane Mining Research Division

Bob Randolph, NIOSH Pittsburgh Mining Research Division

Steven Sawyer, NIOSH Pittsburgh Mining Research Division Director

Miguel Reyes, Pittsburgh Mining Research Division

Clara Seamen, NIOSH Pittsburgh Mining Research Division

Lisa Steiner, NIOSH OMSHR

Members Unable to Attend

Aubrey Miller, National Institutes of Health

Welcome and Meeting Logistics

Dr. Luxbacher, as the Designated Federal Official for the Committee, called to order the open session of the fall 2021 meeting of the NIOSH MSHRAC at 10:30 am Eastern Standard Time (EST) on Wednesday, December 8, 2021, via Zoom. A roll call of all MSHRAC members confirmed that a quorum was present. The roll was also called following each break and lunch to ensure that a quorum was maintained. A quorum was maintained throughout the day.

No conflicts of interest (COIs) were declared. Committee members were instructed that, if a conflict of interest comes up at any time during the meeting, they were to declare that conflict and recuse themselves from any discussion or voting on that matter.

Members of the public were notified that they would remain in listen-only mode until the Public Comment period, scheduled at the end of the presentations, although they could submit questions online via the Zoom chat feature to be addressed in the Public Comment period.

Announcements and Introductions

Dr. Luxbacher welcomed everyone and reviewed the two-day agenda for this meeting. He then reviewed the structure and history of MSHRAC, initially established in 1969, for the benefit of the new members. The two workgroups previously formed under MSHRAC were also described.

Agenda

Mr. Zimmer, MSHRAC Chair, welcomed the Committee members, noting the value he has personally received through participation on MSHRAC. He then acknowledged Mr. Drysdale's many contributions to the Committee since this would be his last meeting as a member. Mr. Zimmer then asked for an approval of the minutes from the prior meeting. Mr. Bowersox made the motion, seconded by Dr. Brickey. The floor was opened for discussion and the motion was then approved.

NIOSH Director's Opening Remarks

Dr. John Howard, MD

Director
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Howard thanked the members of the Committee for taking time to participate in the Advisory Committee for the mining program and expressed his appreciation.

He then gave an update on the status of the NIOSH budget. That was followed by a review of NIOSH's COVID-19 response, a significant investment over the last two years of personnel and resources. The National Personal Protective Technology Laboratory (NPPTL) located in Pittsburgh along with the Pittsburgh Mining Research Division (PMRD) has been especially busy with PPE approvals and participation with ASTM on a new standard F3502-21 about standard specifications for barrier face coverings. Dr. Howard then reviewed the progress on the replacement for the Lake Land experimental mine with a new property in Mace, West Virginia.

Dr. Howard then concluded his remarks with a brief overview of the new variant of SARS-CoV-2 called Omicron. He then asked if there were any questions.

Matt Stewart, referencing a Wall Street Journal article on vaccine hesitancy among miners in the U.S., noted that there is a need to encourage miners to adopt the vaccines.

Report from the Associate Director for Mining

Dr. Jessica Kogel
Associate Director for Mining
Director, Office of Mine Safety and Health Research (OMSHR) National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

Dr. Kogel welcomed everyone to the meeting. She then began her presentation.

NIOSH is a federally funded research agency that focuses on the study of worker health and safety. NIOSH is part of the CDC which is one of 11 operating divisions within the U.S. Department of Health and Human Services. The institute is comprised of 13 divisions, offices, and labs (DLOs) in 8 locations across the US. Our research targets 10 industry sectors including mining and there are 2 divisions within NIOSH that are dedicated exclusively to mining research. Not only do we create new knowledge, but we transfer this new knowledge into practice. In addition to the DLOs NIOSH has 8 Centers each focused on different research areas and lead by NIOSH scientists and engineers. Many of these intersect with mining related research and provide an opportunity for mining researchers to collaborate and draw resources and expertise from across the institute. NIOSH also funds 36 multidisciplinary centers many of which are hosted by academic institutions, including the University of Kentucky and U of CO Boulder, both of which are engaged in mining related research. NIOSH interacts with other federal agencies including MSHA and OSHA which are regulatory agencies that work closely with NIOSH to ensure that regulations are supported by relevant science.

Federally funded miner occupational safety and health (OSH) research began under the United States Bureau of Mines (USBM). The USBM was established in 1910 to address the poor safety record of coal mining in the US which was marked by high fatality rates and adverse work conditions. The year 1907 was the deadliest year in US coal mines and became the tipping point that pushed the US Government to invest in improving miner health and safety. Joseph A. Holmes was appointed as the first director. He

was passionate about safety and believed that science was the only way to improve mine safety. When the USBM was closed in the mid-1990s, OSH research was transferred to NIOSH where we continue to carry out Dr. Holmes's research legacy. The NIOSH Mining Program's mission is to eliminate mining fatalities, injuries and illnesses through relevant research and impactful solutions.

Our research portfolio addresses 3 overarching strategic goals (SGs): 1) Reduce mine workers' risk of occupational illness and disease, 2) Reduce mine workers' risk of traumatic injuries and fatalities, and 3) Reduce the risk of mine disasters and improve survivability of mine workers in a mine disaster situation. Within these SGs our research portfolio spans a broad range of focus areas. Although these focus areas have served us well and have provided a robust framework for how we approach our research, we are in the process of developing a new organizational framework that is designed to promote systems thinking which recognizes the importance of collaborative and multidisciplinary research and is aligned with our strategic goals but is not constrained by them in a way that creates silos between research areas. We anticipate that our new matrix management organization will facilitate this new approach.

The new research framework is based on primary and secondary research domains. Secondary domains describe the intramural and extramural research activities within each primary domain that will occur over a 3-to-5-year timeframe while primary domains offer a longer-term view of our research portfolio. Domains are consistent with NIOSH strategic plans and Agendas including 1) the NIOSH Strategic Plan, 2019 – 2024, 2) the NIOSH Mining Program Strategic Plan, 2019 – 2023, 3) The National Occupational Research Agenda, and 4) The Miner Health Program, 2020-2030 Strategic Agenda.

To conduct this research NIOSH maintains one-of-a-kind, state of the art research facilities that include unique laboratory facilities such as the Virtual Immersion and Simulation Laboratory, Longwall Instrumented Aerodynamic Model, Automated Breathing and Metabolic Simulator Laboratory, Mine Roof Simulator, High-Energy High Displacement Test Frame, Full-scale Continuous and Longwall Mining Galleries, Diesel Research Laboratory, and the Marple Aerosol Test Chamber. Additionally, for screening the respiratory health status of coal miners, NIOSH maintains several fully equipped mobile vans under the Coal Workers Health Surveillance Program. For more than 100 years NIOSH has conducted large scale underground methane and coal dust explosion research. This research has always been an essential part of our portfolio and is used to validate lab and pilot scale results in a facility designed to replicate a working coal mine. MSHA relies on this research when writing new regulations.

Although there have been a few breaks in full scale underground research due to lack of access to facilities, NIOSH has had a consistent presence in this research area. Initially this research was done at our Pittsburgh (Bruceton) campus, but it had to be shut down due to the growth of neighborhoods in the immediate vicinity. At that point the research was moved to a more remote location at the Lake Lynn Experimental Mine (LLEM). It closed in 2012 due to lease expiration which followed a roof fall in 2008 that lead to the curtailment of much of the research for safety reasons. Starting in 2017 we began conducting underground research through the Barbara mine in Poland with which NIOSH has had a long relationship. Soon after Lake Lynn closed CDC along with GSA began the search for a replacement facility.

The search process began in 2013 with an engineering study completed by an outside firm. The next step was to procure funding and once that was done a Request for Expression of Interest went out in 2016. The initial REOI limited the search area to within a 200-mile radius of Bruceton and resulted in one response that did not meet the established technical criteria. A second REOI was published in 2016, expanding the search to 48 states; there were 3 responses, and one met the technical criteria. This then led to a series of steps including completing an Environmental Impact Study (EIS), holding a series of public meetings to gather feedback from the local community, addressing their concerns (water, dust, noise, trucks) and the signing of a Record of Decision (ROD) for the Mace property located in West Virginia. The Mace property will replicate the LLEM as much as possible and will consist of both surface and underground research facilities and will target several different research areas. The bulk of the development will be underground with only 11.7 acres of surface development on a 461-acre site.

We consider diverse inputs when developing our research program. Research priorities are guided by stakeholder input such as the NORA Mining Sector Council and their National Occupational Research Agenda, Mine Safety and Health Research Advisory Committee (MSHRAC), External Program Reviews (2007, 2019), National Academy of Sciences Consensus Studies, and other reports. Additionally, we consider input from our multi-stakeholder partnerships. Mining research is most effective when it has been done in cooperation with the ultimate users of the research. Successful transfer of technologies requires close cooperation with operating mines for field testing of new technologies and for help with development of new technologies. Mine workers are also key partners. Significant improvements in health and safety have resulted from laws or regulations that forced the adoption of new technologies but there has been voluntary adoption as well. This is because miners and mine management expect continuous improvement in H&S however this must be balanced against production and costs. There must also be close cooperation and collaboration between research and the rule making process so that regulations are based on science as much as possible. Manufacturers are vitally important to the process. They take research concepts and prototypes to production and market. Manufacturers also are critical to successful design. Priorities are also guided by policy and the regulatory agenda.

One of the moist important formal mechanisms for input is through MSHRAC which was established to advise NIOSH on mining OSH research. Under the auspices of MSHRAC we have also established 2 subcommittees to advise NIOSH on two new research areas: Miner Health and Automation and Emerging technologies. Both subcommittees convened multiday stakeholder workshops that focused on specific questions aimed at helping NIOSH better define its research portfolio and priorities in each of these two areas.

NIOSH also receives input from external reviews that are held approximately every 10 years. In 2005, NIOSH commissioned the National Academies of Science (NAS) to conduct the reviews of eight research programs selected primarily because they represented the majority of NIOSH's budget. The reviews were guided by a framework created by a NAS Framework Committee and a logic model developed with assistance from the RAND Corporation. Evaluators chose to employ the contribution analysis (CA) framework to guide the next series of program reviews. Through the application of this framework, a program assembles evidence to demonstrate a plausible association between its activities and the observed impacts. In other words, it seeks to show contribution to an outcome rather than causal attribution. During 2017-2019, NIOSH conducted five external program reviews (Healthcare and Social

Assistance, Exposure Assessment, Construction, Emergency Preparedness and Response, and Mining) using CA.

NIOSH research is also driven by the National Occupational Research Agenda (NORA). Priorities for this research agenda are influenced by burden, need and impact which may be framed in terms of the number of workers at risk for a particular injury or illness, the seriousness of a hazard or problem, and the chance that new data or approaches can make a difference.

Ron Bowersox then asked about what would be involved in the title search for the Mace property. Dr. Kogel and Dr. Luxbacher explained that the government is required to do a detailed title search confirming that there are no property issues before moving forward on an acquisition.

Kyle Zimmer thanked Dr. Kogel for her overview, noting that this was very beneficial for the new members and that the research underway by the Mining Program also transcends into other areas such as construction. Dr. Kogel then noted that NIOSH has an internal steering committee that meets quarterly to discuss mining, oil and gas, and construction.

Budget and Resources

Dr. Jessica Kogel
Associate Director for Mining
Director, Office of Mine Safety and Health Research (OMSHR) National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

Dr. Kogel then reported on Budget and Resources.

Since 2005 Mining Program funding has been more or less flat. Throughout this time period there have been earmarks that have bumped up funding for specific projects. Some of these are one-time bumps, others have continued. In 2010 funds went to Virginia Tech and in 2016 $1.8 million was appropriated for the NAS Respirable Dust review. In other cases, the Mining Program took on unfunded obligations. For example, RHD required funding for FY17 increased by $1.8 million ($0.7 for Miner's Choice to $2.5 million for CWHSP) in response to 2014 MSHA Rulemaking (2016 NIOSH rule); the NIOSH Mining Program contributed $1.479 million of that. This was an unfunded mandate from MSHA.

During this same timeframe costs have increased, and these cost increases fall into one of 4 categories: 1) PS&B increases driven by a range of factors including step and grade increases, annual cost of living increases, locality pay increases, 2) increases in the cost of materials and supplies (primarily driven by inflation), 3) working capital increases and 4) costs associated with maintaining and upgrading aging facilities. In addition to this we have also added new programs that have costs associated with them including improving IT infrastructure and compliance, adopting and standing up the laboratory quality management system, and both capital and operational costs associated with building. Universities also depend heavily on NIOSH for research funding. This is because traditional mining engineering research is often not competitive for NSF or other government funded research programs.

Because of our flat funding and increasing costs the program has had to make difficult choices to maintain good organizational health. For example, although the NIOSH Mining Program is authorized to hire 264 FTEs, the program has limited hiring to a maximum of 206 FTEs with 145 FTEs for PMRD, 55 FTEs for SMRD and 6 FTEs for OMSHR. For both divisions, the largest cohort is professional staff who, on average, have a higher pay rate than other categories. The bulk of annual funding supports salaries and benefits (PS&B). Despite these funding challenges the program still meets and even exceeds its mission "to eliminate mining fatalities, injuries and illnesses through relevant research and impactful solutions." This reflects strong leadership at both divisions and the flexibility, ingenuity, and resilience of all Mining Program employees.

There were no questions.

PMRD Program Overview

Dr. Steven Sawyer
Director for Pittsburgh Mining Research Division National Institute for Occupational Safety and Health Centers for Disease Control and Prevention
Dr. Sawyer gave an overview of the Pittsburgh Mining Research Division (PMRD).

The organization structure of PMRD sits under the umbrella of the OMSHR mining program. The location of PMRD is 12 miles south of downtown Pittsburgh in Bruceton, PA and is referred to as the Bruceton Research Center. The campus is comprised of 238 acres of federal land that of which NIOSH occupies 175 acres. PMRD shares the campus with NIOSH's National Personal Protective Technology Laboratory (NPPTL), MSHA Technical Support's Pittsburgh Safety & Health Technology Center (PSHTC), and DOE's National Energy Technology Laboratory (NETL).

Within PMRD there are three Branches, the Health Hazards Prevention Branch (HHPB), the Mining Systems Safety Branch (MSSB), and the Human Systems Integration Branch (HSIB). HHPB contains three Teams, the Mineral Assessment and Monitoring Team, the Respirable Hazards Team, and the Workplace Health Team. MSSB contains five Teams, the Fire Prevention Team, the Ventilation and Explosion Prevention Team, the Ground Control Stone Team, the Ground Control Coal Team, and the Mining Technologies Team. HSIB contain four Teams, the Human Integration Team, the Escape, Rescue, and Training Team, the Health Communications Team, and the Surveillance and Statistics Team. The team names reflect the expertise within each.

PMRD currently has 148 employees which are broken down into 128 Title 5 Permanent Employees, 19 Title 42 Fellowships, and 1 Commission Corps. The positional composition is as follows: 67 Engineers, 26 Technicians, 17 Administration, 13 Scientists, 4 Geologists, 3 Industrial Hygienists, 3 Health Communications, 3 Statisticians, 2 Statistical Assistants, 2 IT Specialists, 2 Miners, 2 Visual Information Specialists, 1 Chemist, 1 Sociologist, 1 Epidemiologist, and 1 Technical Writer/Editor.

The keystone features of the campus are the underground mine and research mine. The original portion of the underground mine, now referred to as the Experimental Mine, was established in 1910 as part of the US Bureau of Mines. This mine was established to replicate a true mining environment for research purposes. The Safety Research Mine was developed in the Mid-50's to help research some of the new mining practices at the time, such as mechanized mining, mine fire control, ventilation, instrument testing, post-disaster survival and rescue training.

Other notable PMRD sites are the Mine Roof Simulator (MRS). The MRS is a large-scale material and structural testing press capable of applying loads up to 3 million pounds vertically and 1.6 million pounds horizontally. The platens are 20 ft x 20 ft and test articles could by 16 ft tall. Originally used for evaluating the performance of longwall shields, the MRS tests primary and secondary support systems for the underground mining industry including novel crib designs, wood and concrete post designs, wire and plastic mesh and screening, and concrete block structures. The results from a variety of research studies conducted in the MRS have been compiled and prepared into a software package entitled Support Technology Optimization Program (STOP) that is readily available from the NIOSH Mining website.

The NIOSH Hemi-Anechoic Chamber is used primarily for noise source identification (NSID) to help target noise control efforts. The chamber has Eckel Supersoft Panels on the walls and ceiling to yield a virtual free field over a reflecting plane (the hard floor). The interior dimensions of the room are approximately 55 ft. long by 33 ft. wide by 23 ft. high yielding a volume of approximately 41,745 cubic ft.

The NIOSH Acoustic Test Chamber is a very large acoustic reverberation chamber. It is mainly used to assess experimental noise controls on machines by measuring total sound power before and after the controls are installed. Determining sound power level in a reverberant field is one of several methods available to calculate the noise emission of equipment. The NIOSH Hemi-Anechoic Chamber is used primarily for noise source identification (NSID) to help target noise control efforts. Research findings using this chamber have resulted in significant accomplishments for reducing excessive noise exposures on assorted drills and armored chain conveyors used in the mining industry, and the improved approaches have been adopted. Of note are the development of the bit isolator for drilling applications and the advancements for reducing noise levels on continuous mining machines.

The Virtual Immersion and Simulation Laboratory (VISLab) contains a 360° cylindrical projection system that uses stereoscopic 3D technology to simulate virtual environments for training mineworkers. There is a transition to Head Mounted Displays (HMD) for this training work, which helps foster mobility. The lab is currently focused on advancing mine rescue and escape training issues—two of the most difficult areas for ensuring mine worker safety and topics that can't be easily or routinely studied under actual field conditions.

The Diesel/Aerosol Laboratory is designed to study particulate emissions found in an operating underground mine including diesel particulate matter (DPM) and other dusts. Instrumentation enclosed within the isolated Marple chamber includes a tapered element oscillating microbalance (TEOM) for determining dust mass, and other instruments capture particle size distribution and concentrations. Many of the findings from the research have been extensively adopted by the mining industry, and the

results are covered in detail in Report of Investigations 9687 entitled Diesel Aerosols and Gases in Underground Mines: Guide to Exposure Assessment and Control.

The Human Performance Lab allows researchers to simulate a mine setting and mining tasks with actual full-scale mining equipment. It is 80 feet long by 24 feet wide with a height-adjustable roof. This lab allows for examining the effects of physical demands and movement patterns of workers and the evaluation of possible interventions.

The Longwall Instrumentation Aerodynamic Model (LIAM) is a 1:30 scale physical model of a portion of a longwall operation designed to simulate the airflow characteristics along the face and along or through the gob. It was created to conduct detailed studies of longwall ventilation in a controlled environment. The LIAM also serves as a dynamic tool for in-person demonstrations of mine ventilation. The LIAM research has contributed greatly to the understanding of the mine ventilation in longwall mines such as airflow pathways behind the shield line and in the gob.

The Longwall/Continuous Miner Lab is 125 feet in length and represents a segment of a longwall mining face. Full-scale models of a shearer, 25 shields, and a panline are used to simulate an active longwall face. It is used to conduct tests of engineering control technologies in a controlled environment where the complexity or period of the testing would prohibit evaluation in an operating mine. The directional water spray systems and the shearer clearer dust control systems were developed and proven using this facility. These two technologies have been adopted by all longwall systems used in the United States and by most longwall mines throughout the world. The acceptance of these two systems and the diffusion of the technology are near 100% for the underground coal mining industry.

PMRD also has additional labs and areas such as the following:

- Dust Explosibility Lab
- X-Ray Diffractometer (XRD)
- Radio Frequency Lab
- Dust Filter Weighing Lab
- Cryogenic Air Supply Evaluations (CASE)
- Fourier Transform Infrared Spectroscopy (FTIR)

Even with all the capabilities on-site at PMRD, field visits are also critical to our research projects and operations.

Since last MSHRAC Meeting held on November 9, 2020, PMRD produced 144 outputs of which 41% of those were translational and 59% were science outputs. The translational outputs have been very successful in reaching significant impact to the industry. They were developed to translate research to stakeholders who can implement changes. Therefore, the mining industry is using our solutions to improve mineworker health and safety.

The output sector breakdown is 51% of coal; 22% stone, sand & gravel; 10%; industrial minerals; 10% metal and 7% oil & gas.

PMRD values the partnership approach and has hundreds of connections through various associations and stakeholder groups. As good partners, we need to bring something to the table. What we bring is the same today as it was in Dr. Holmes' time -- a scientific approach to finding solutions that work.

Dr. Sawyer then concluded his presentation and asked if there were any questions.

Mr. Stewart noted that over 50% of PMRD outputs are coal-related and, given the shift in resource production in the U.S., the trend is away from this. He also noted that the U.S. is moving toward policy to encourage rare earth research and production and that might be translated to NIOSH getting funding for extramural work in academia.

Dr. Sawyer responded that we constantly revisit our strategic plan and adjust our work accordingly. Dr. Luxbacher also noted that our work is in mining occupational health and safety, not minerals processing like the former U.S. Bureau of Mines, which limits our involvement in rare earth recovery. The Mining Program outputs are mining centric, and largely translatable to all segments of the industry. For example, the program doesn't focus specifically on critical minerals, but because critical minerals involve mining for extraction, NIOSH research is directly applicable. Dr. Kogel added that there a lot of legacy issues around safety health related to coal mining that will continue to create a need for further health and safety research.

SMRD Program Overview

Dr. Douglas Johns
Director for Spokane Mining Research Division National Institute for Occupational Safety and Health Centers for Disease Control and Prevention
Dr. Johns gave an overview of the Spokane Mining Research Division (SMRD).

Dr. Johns introduced himself as the Director of the Spokane Mining Research Division and noted he did graduate work at the University of Washington, earning an M.S. and Ph. D. in Environmental and Occupational Hygiene. He provided an overview of his career with the EPA and CDC as a Senior Health Scientist, Branch Chief, Deputy Division Director and now Division Director, and expressed gratitude for the work of Federal Advisory Committees, including MSHRAC. Dr. Johns then thanked and recognized Pam Drake for contributions to the Division as a scientist and leader in anticipation of her retirement and welcomed Cara Halldin as the new SMRD Deputy Director. Dr. Johns presented an overview of the structure of the Division before and after their reorganization, which he noted was approved in May 2020. He noted the plan of NIOSH and the NIOSH Mining Program to grow SMRD and establish two Branches, a Miner Safety Branch and a Miner Health Branch. Implementation of the reorganization began in October 2020. Dr. Johns listed the expertise within SMRD and noted the Division has been extremely successful in recruiting new talent over the past two years, while acknowledging that they are not yet fully staffed to support their two new Branches. In particular, he noted a lack of expertise in exposure science and industrial hygiene, as well as a need for an industrial engineer. He also expressed concern that the Division's budget had remained relatively flat, but that NIOSH and Mining Program leadership was working to increase the Division's funding as planned and

needed to support the new organization. He noted that even at their peak, SMRD would be the smallest Division in NIOSH that includes official subunits or Branch. The functional statements of SMRD and SMRD's two Branches were published in the Federal Register in May 2020.

Briefly introducing SMRD's Miner Safety and Miner Health Branches, Dr. Johns highlighted some of the unique research facilities and research program areas within SMRD, including the High Energy High Displacement (HEHD) machine used to test the strength of mesh and shotcrete panels, as well as their environmental chamber, currently being used to conduct research on heat stress. He noted that the Division works in close partnership with many mines and is always looking to strengthen, expand, and formalize these partnerships. In addition to continuing Division research efforts over the past 18 months, Dr. Johns noted that many staff from both Branches of SMRD provided direct and indirect support to the COVID-19 response.

Dr. Johns then reviewed the demographics of SMRD's employees and noted while 15% of employees were eligible for retirement now, the Division also has many employees new to the Federal government who have been getting up to speed quickly working closely with those in the Division with more experience and institutional knowledge. He then introduced the Federal Employee Viewpoint Survey (EVS) and noted he uses the feedback from the EVS to monitor the status and morale of the Division and inform where adjustments might need to be made. Presenting some results from the most recent SMRD EVS results, he noted that the Division is trending in a very positive direction and that over the past couple of years SMRD has been among the top two or three NIOSH Divisions in terms of overall positive responses in the EVS.

Dr. Johns then described several efforts the Division undertook to keep all employees engaged and feeling connected during the pandemic when it has not been possible to meet in person. Early in the pandemic, he started a weekly All-Hands Zoom meeting called the "SMRD Sticking Together" to provide updates and announcements from leadership including information on resuming research and plans for staff to return to the lab. He also mentioned two new annual meeting the Division has established: 1) a "State of SMRD" meeting in the winter to provide updates on our hiring and succession plan, recent accomplishments, and areas of focus for the next year, and 2) and an SMRD Retreat in the summer to get input on strategic planning from both research and administrative perspectives, highlight recent accomplishments, as well hold didactic sessions on topics of interest to Division employees. Dr. Johns congratulated the Division for their efforts during the pandemic, noting that even with the constraints of limited lab access and ability to conduct fieldwork, the Division has been able to publish articles and finalize and disseminate other outputs at a similar rate to previous years.

During their retreat held on September 7 and 8, 2021, SMRD tested out a hybrid model with 8 employees participating physically distanced and masked in a conference room, with the rest of the Division participating remotely from their own laptops. Their experience was shared with NIOSH leadership in preparing for a phased return to the workplace. Dr. Johns described the process the Division used for the strategic planning exercise leading up to the retreat, with a focus on prioritizing research program areas and developing plans to facilitate collaboration. Senior Division leadership worked with individual teams to get input from everyone, and Branch Chiefs and Team Leaders reported out during the retreat on these discussions. Dr. Johns described the matrix that was developed for this planning, which was organized around the mining program's primary and secondary functional domains. The matrix included options to further divide program areas into mining sectors, conduct strategic forecasting on areas with continuing needs, emerging areas, and programs that may need to be phased out. The matrix also included fields to document the nature, extent, and mechanisms of collaboration

from other parts of NIOSH and CDC. Dr. Johns noted that he was impressed with what the teams came up with and shared during the retreat and expressed optimism that this type of effort will be of great value in maximizing impact and efficiency.

Dr. Johns described processes NIOSH had put into place early in the pandemic to allow some limited lab work and field work where controls could be put in place and noted that the mining program had played a significant role in developing these processes. He gave an example of an SMRD request to do some testing of synthetic mesh in the lab in October 2020 that was approved by NIOSH. He further noted that a limited number of SMRD researchers and technicians have been allowed to come into the lab on a regular schedule starting in the summer of 2020. Dr. Johns then provided an overview of recent renovations and upgrades to the Industrial Hygiene laboratory at the Spokane Research Laboratory that were funded by the CDC through an approved Program Repair and Improvement Request. Another request was approved to renovate a lab space to accommodate 3D printers used by both SMRD and the NIOSH Western States Division.

Dr. Johns discussed the NIOSH travel risk frameworks that facilitated limited travel, the first developed in July 2020, and the updated version finalized in May 2021 to incorporate considerations of vaccination status. Dr. Johns noted that the development of these frameworks was led by SMRD researchers and leadership. These frameworks and travel guidelines have allowed some limited field work to continue during the pandemic.

Dr. Johns provided an overview of SMRD's Diversity, Equity and Inclusion (DEI) efforts. He gave the definition of diversity and inclusion as presented in each NIOSH Division's Blueprint in Action and displayed the Division's DEI goals. Finally, he noted that seven of eleven of SMRD's most recent hires were from one or more of the Division's underrepresented groups.

Dr. Johns then thanked the committee and welcomed questions.

Kyle Zimmer commended him for his adjustments to the mode of operations for getting things done during the restrictions related to the pandemic.

MINER Act Extramural Research Program Overview

Dr. George Luxbacher
Deputy Associate Director for Mining
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Luxbacher gave an update related to the MINER Act extramural research.

The extramural research program in its current form began in 2007/8 when the NIOSH Mining Program received supplemental funding for extramural research related to the MINER Act; that funding has been maintained and remains dedicated to that purpose. He noted, using the Continuous Personal Dust Monitor (CPDM) as an example, that it takes a significant time for research to develop into a

commercial product, although there are others impacts, such as significant publications, during that period.

The grants program is coordinated through the NIOSH Office of Extramural Programs (OEP), the contracts program primarily utilizes annual broad agency announcements (BAAs), and interagency agreements are utilized for specific topic areas to take advantage of other government agency expertise.

The primary grants are U60 collaborative grants directed toward western states' mine workers training that have been in place since about 2000. There are currently two universities, the University of Arizona and Colorado School of Mines, participating. Additional U-60 grants directed towards underground mine evacuation, technologies, and human factors research and limited to universities with graduate programs in both mining engineering and explosives engineering were given in FY21. Two collaborative grants have been given under this program, to New Mexico Tech and Missouri University of Science and Technology; a kickoff for those two programs is scheduled for January 11th, 2022.

In terms of contracts, there are currently 34 technology and seven capacity build contracts. This is a larger number than typical but is related to no cost extensions given on many contracts related to COVID delays. Twelve contracts were issued under the 2021 fiscal year broad agency announcement, with a value of $4.1 million, and an additional $0.5 million in optional phases for three of the contracts. These twelve contracts are grouped into four areas: five are related to respirable dust, three to automation, three big data, and one continues efforts in battery safety.

The FY 2022 BAA solicitation came out just before the MSJRAC meeting and proposals are due January 15th related to three focus area: coal dust silica, a regulatory review for automation, and simulation of modeling for automation systems, as well as proposals outside of our focus areas.

The seven ongoing capacity build contracts are related to mine design and began in 2019 for a five-year cycle. Capacity build contracts were initiated for mine ventilation in 2009 and then in ground control in 2011 following several events that demonstrated a need for qualified mine professionals in these areas. These contracts are done in accordance with provisions in the Occupational Safety and Health Act of 1970. Plans for another round of capacity-build contracts under ground control or a similar topic are on hold until such time as the COVID issues are negligible at the university level, since these five-year contracts are not eligible for a no cost extension.

As to impact, the 34 contracts have funded over 71 faculty members, 113 masters-level students and 91 Ph.D. students. The current 2019 mine design contracts are estimated to add 20 masters and 15 doctoral students to this total.

Dr. Luxbacher then reviewed the results of a contract with Rand Corporation entitled Assessing the Market for Electronic Technology for Underground Coal Mines Safety and Health Applications. The Miner Act mandated that the NIOSH Mining Program investigate commercialization of technologies, resulting in over 133 contracts to date. While there was a lot of success in communications and tracking, it has been more difficult to make headway in other areas. This contract was executed to better understand the barriers to commercialization. A draft report based on stakeholder interviews was utilized for the NIOSH response to MSHA docket on testing evaluation approval of electric motor-driven mine equipment and accessories. In this report the barrier taxonomy was divided into three different areas, economic, regulatory, and other (federal support, liability, and culture). A final report will be issued that will include results of a stakeholder workshop Rand has already held.

For the last several years, the NIOSH Mining Program has utilized interagency agreements (IAAs) to fund work through the NIOSH NPPTL (National Personal Protective Technologies Laboratory) on the possible next generation of closed-circuit escape respirators, focusing on a liquid oxygen storage module, or aerogel. Dr. Luxbacher reviewed some of the history related to the transition from Subpart H to Subpart O devices and the current state of acceptance within the industry. Earlier NIOSH work on a docking and switch over valve (DSOW), a face piece that permitted communications, high pressure oxygen cylinders, and a valve integrated pressure reducer (VIPR) was included in a request for information (RFI) published in the Federal Register to solicit interest in using these technologies in developing the next generation of closed circuit mine emergency respirators. No commercially viable responses were received in response to this RFI.

The Mining Program also has an IAA with the NASA Jet Propulsion Laboratory (JPL) related to develop a small-scale mine rescue robot that can meet permissibility criteria. That work is ongoing.

At the conclusion of Dr. Luxbacher's presentation he asked if there were any questions. Ms. Calhoun noted that MSHA would have definite interest in a permissible small-scale robot. Dr. Luxbacher clarified that the initial focus was on intrinsic safety rather than permissibility since it offered more flexibility with similar results. He offered to add MSHA subject matter experts to the Mining Program group coordinating the JPL IAA and Ms. Calhoun concurred.

Mr. Zimmer then asked the difference between permissible and intrinsic safety. Dr. Luxbacher explained that permissibility is a MSHA regulatory category and requires testing and approval by the MSHA Approval and Certification Center (A&CC) while intrinsic safety is an international determination that can be done through third parties.

Mr. Harman then asked when fourth generation closed-circuit escape respirators (CCER) would be available. Dr. Luxbacher noted that first-generation self-containers self-rescuers (redefined as CCERs under Subpart O) are still sold and that, given the small market and the emphasis on form factor (necessary for unimpeded wearing on a belt while working), it is difficult to introduce new technology.

EMP Research

Dr. Steven Mischler
Mining Engineer, HHPB, PMRD
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Mischler gave an overview on EMP research with a presentation entitled "Understanding elongate mineral particle exposure in mining". This presentation was developed to first provide background for the basis and underlying reasoning for this research and then to provide information on the research successes occurring in the first years of the project. The project team includes Steven E. Mischler, Taekhee Lee, Susan Wacaster, Rachel Walker, and Dylan Ritter. Dr. Mischler defined certain terms including asbestos and elongate mineral particles (EMP). Asbestos is a generic or commercial term given to six naturally occurring silicate minerals with a fibrous crystalline structure including chrysotile,

cummingtonite-grunerite asbestos (amosite), riebeckite asbestos (crocidolite), actinolite asbestos, anthophyllite asbestos, and tremolite asbestos. For this research, NIOSH is using the broadest definition of EMP available (chemical composition, fiber dimensions, etc.) comprising all particles meeting any definition of an EMP, including regulated asbestos minerals, amphibole cleavage fragments, erionite, palygorskite, etc.

NIOSH published the "Asbestos Fibers and Other Elongate Mineral Particles: State of the Science and Roadmap for Research" (Roadmap) in 2011 and the purpose of this document was to outline scientific research issues that need addressed to ensure workers are protected from health risks posed by asbestos fibers and other EMPs. The current research project was created using ideas from this Roadmap document and from the National Academies of Sciences review of the Roadmap. The Burden, Need and Impact are used to outline the importance of this research in solving issues related to miners' exposures. For burden, miners have higher than expected burdens of malignant and non-malignant interstitial respiratory diseases. In addition, EPA, OSHA, and MSHA all use different definitions for regulating EMPs and finally mineral fibers have been found in 21 different non-asbestos mineral commodities. There is a strong need for research on fundamental mineralogical properties relevant to toxicology, epidemiology, and exposure assessment along with a need for improved analytical methods, consistent nomenclature, comprehensive characterization of minerals and reporting in literature. The impact of this research will be a database of mine geologies which could result in EMP exposure, a repository of well-characterized reference samples, improved monitoring and analysis techniques, and improved miner protection and monitoring efforts.

In the past, there was not a specific organizational unit at NIOSH charged to conduct EMP research. Establishing a Minerals Research Team and Coordinating Group with this focus will assure sustained, coordinated cross-Institute efforts to address EMP-related issues. The Minerals Research Team and Coordinating Group will be a permanent "home" at NIOSH for EMP research. This home provides continuity, coordination, consistency, stable funding, and momentum for EMP research. It is based out of the Pittsburgh Mining Research Division (PMRD) and is supported by mineralogical, epidemiological, toxicological, geological, and engineering expertise, a strong track record of working across NIOSH DLO's, multidisciplinary strong relationships with stakeholders (industry, labor, academia etc.) and funding. The first phase for this research began with an initial project in FY2017 and FY2018 aimed at developing a research team and research laboratory. In 2019 the research project, Understanding Elongate Mineral Particle Exposure in Mining, began focusing on three specific aims. Specific Aim 1 (SA1) is to understand miners' potential exposure to asbestos and other EMPs by analyzing bulk material samples previously collected from copper, granite, gold, iron, limestone, sand and gravel, coal, and other commodity mines across the country. This analysis will be driven by geological knowledge of the deposits and their host rocks which will enable strategic characterization of EMP bearing strata. Specific Aim 2 (SA2) is to further elucidate the toxicology of the EMPs by creating new EMP separation methods to allow both in vitro and in vivo toxicity tests on EMP's of specific lengths, widths, mineralogy, and other characteristics of concern. Specific Aim 3 (SA3) is to investigate an application of qualitative and quantitative analysis of EMPs for end-of-shift measurement using newly developed and novel techniques for EMP analysis.

Research under SA1 entails creating a database and associated map of mine geologies which could result in EMP or other potential exposures. The characterization of material will be completed using previously collected mine samples and field collection of samples from missing mine types and/or

geologies. The digital mapping will use previously published digital maps of mineral deposits, facilities, mines occurrences. State level sourcing of data will also be used for building higher resolution maps of geology, EMP permissible tracts and locations, mineralogy, and geospatial analyses. Research under SA1 also includes developing a standardized classification for EMPs encountered in mining environments based on geology, geochemistry, mineralogy, and physical characteristics. With this work we will resolve imprecise terminology related to asbestos and EMPs that has hindered progress in occupational health and safety research. (i.e., Asbestos, Asbestiform, Cleavage fragment, fiber, etc.). By correlating detailed characteristics (geochemistry, mineralogy, crystallography, habit, etc.) of the EMPs, to exposure, epidemiology, and toxicology results, a unified classification may be developed. A unified classification of EMPs will allow for a reduction of exposure to workers as multiple agencies, industry, and the public will be able to adopt a consistent working definition into their exposure, monitoring, and control plans.

Research under SA2 is currently focused on creating an EMP separation technique that can effectively separate EMPs based on certain characteristics. The first characteristic for separation will be length and several different techniques were evaluated. An aerodynamic aerosol classifier (AAC) was found to be able to effectively separate EMPs by length however, this technique could not provide sufficient mass of separated materials to be used in toxicity studies. A second separation technique evaluated, the multi-cyclone sampling array, was not able to separate EMPs into distinct size ranges. A third technique using a combination of filtration and shaking was found to successfully separate EMPs and could produce the separated samples in large enough mass for toxicity studies. Using this technique approximately 95% of separated amosite were shorter than 5 μm (short fiber group) and approximately 80% of separated amosite were longer than 5 μm (long fiber group). During this SA2 work it was realized that counting fibers to measure the effectiveness of the separation techniques was a significant effort and took much time and consequently work started on creating an easier technique for measuring EMPs on filters. The first option was to use Image-Pro® software to make these measurements. Although the analysis procedure of EMPs with the Image-Pro® is not an automated procedure, it is a relatively fast and accurate procedure compared to the time-consuming manual fiber length measurement. A paper on this technique was published this year. Additionally, an investigation comparing manual measurements with the automatic feature analysis program that comes with the SEM software was completed. The takeaway from this investigation was that manual measurements are time consuming and laborious but establishing calibrated methods for automatic image analysis is also challenging. Additional work using this SEM software will continue.

Research under SA3 is based on establishing an application of qualitative and quantitative analysis of regulated asbestos and other EMPs for end-of-shift measurement using newly developed and novel techniques for EMP analysis. Monitoring EMP exposure presents unique challenges for development of field methods. Ideally a technique will result in information on chemistry, dimensions, and concentration in number count. There are different instrumental techniques that can be pursued but adoption of multivariate analysis techniques will be essential no matter which pathway is chosen. Multivariate data capabilities allow for streamlining “big data” and making it more accessible, interpretable and user friendly. Multivariate analysis of images makes it possible to analyze hyperspectral microscopy images which could lead to the goal of collecting information on all three metrics for EMP analysis: chemistry, dimensions, and concentration. This field of research is in the beginning stages and hyperspectral microscopy will need to overcome barriers including the cost of instrumentation and the need for a high level of technical expertise. This work has yet to begin but will

include data from both Fourier Transform Infrared spectrometry (FTIR) and fluorescence microscope analysis.

Dr. Mischler then asked if there were any questions.

Mr. Drysdale noted that resolution on maps is very important; an individual outcrop containing EMPs might not show on a larger scale map. He felt that the mapping scale must be detailed enough to project adequate information about exposures in a given area. Dr. Mischler stated that was a difficulty in the mapping project, particularly given the resolution in many of the geological maps currently available across the country. He welcomed further input and discussion in this area.

Mr. Harman asked to expand on improved miner protection and analytical technologies. Dr. Mischler noted that not a lot of sampling is done in underground mines concerning elongate mineral particles. Once the geologies and mineralogies that potentially could create EMPs are understood, methods are needed to determine if they occur in the environment and what type of control efforts are required to ensure that the miners aren't going to be exposed.

Mr. Stewart noted that there are other important factors to consider for toxicity including surface chemistry, surface area, elemental composition, and oxidative state of the elements, mainly Fe^{2+} versus Fe^{3+}. Dr. Mischler responded that the research has just started, and other areas will be explored in the future.

PMRD Health Hazards Prevention Branch

Dr. Clara Seamen **Deputy Branch Chief**
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention
Dr. Seaman provided overview of the Health Hazards Prevention Branch.

HHPB research focuses on the Mining Program Strategic Goal 1 (SG1) to reduce mine workers' risk of occupation illnesses. The cause of these illnesses can range from overexposure to hazardous airborne dust, diesel contaminants, and noise, to musculoskeletal injuries due to overexertion, slips, trips, and fall, or material handling. The research aimed at preventing these types of illnesses can be broken down into monitoring, assessment, and control and intervention. Monitoring and assessment research seeks to develop methods for quantifying a hazard and evaluating hazard control. Control and intervention research focuses on the development of tools and techniques to reduce or eliminate a hazard. The branch portfolio currently consists of 9 projects and 2 pilot projects to satisfy SG1. In addition to fieldwork, HHPB team members have access to a wide range of specialized laboratories and analysis techniques. The facilities are grouped into two overarching laboratory designations. The first is the Human Performance and Worker Health Laboratory. Some of the facilities include:

- The acoustic test chamber for precision measurement of total sound power.
- The hemi-anechoic can be used for pinpoint noise source identification.
- The Hearing Loss Prevention Unit is a mobile auditory lab for hearing assessments in the field.

- The Human Performance Research Mine is large enough for life-size simulations of the work environment and large mobile testing equipment. It has a 40-camera motion tracking system and an overhead gantry with a fall arrest system for safety. There is also the capability to record motion using an inertial measurement unit-based motion capture and record electromyography (muscle activity).
- The physiology lab houses specialized systems to measure body composition using the Bod Pod and a K4b2 system to measure human metabolism including oxygen consumption.

The second overarching lab designation is the Air Quality & Particle Characterization Lab which includes:

- The Longwall/CM galleries replicate a mine face with appropriate ventilation and contain full scale mock mine equipment. They can be used to test control protypes before field deployment.
- The Diesel Lab allows researchers to operate diesel engines under different operating conditions to study the base line emissions and proposed emission controls.
- The Diesel Aerosol Generation space houses a Marple chamber where researchers can load filters with diesel particulate matter (DPM) in a controlled manner. The chamber can be used to validate sampling techniques and test analytical methods with mixtures of dust and diesel aerosols to mimic realistic mine aerosols. Aerosol size distribution, concentration, and source fuel type, which is important for methods validation and instrument testing, can be varied by the system as needed.
- The lab also has a system for conducting NIOSH 5040 analysis for analyzing filters loaded with DPM.
- In addition to a Marple chamber for diesel there is also a Marple chamber for use with mine dusts.
- The weigh room is temperature and humidity-controlled space housing microgram analytical balances to provide high-precision weight measurements of both lab and field gravimetric samples.
- PMRD also houses several methods to perform mineral characterization on different dust or particle samples including Fourier transform infrared spectroscopy (FTIR), X-ray diffraction, and microscopes including a phase contrast microscope, a polarized light microscope and a fluorescence microscope.

The Increasing the Effectiveness of Target Mining Hearing Conservation Program Elements and Surface Stone, Sand and Gravel Mining Operations project seeks to identify and remediate barriers to full implementation of hearing conservation programs at surface stone, sand, and gravel mines. The ultimate result will be a collection of interventions provided to industry and processes to evaluate the impact of those interventions. To date, a variety of tools, publications and presentations have been provided to the mining industry and potential research partners. This includes three workshops, a Coal Age article, a noise control info graphic, and an upcoming phone/tablet app, which will allow mines to create their own sound map to better understand noise exposures around their site.

The Advanced Strategies for Controlling Exposures to Diesel Aerosols project seeks to better understand the potential of novel control technologies and strategies to control diesel particulate matter exposures and translate technology to the industry. The emissions from three EPA Tier 4 diesel engines were tested to evaluate three approaches currently used to curtail particulate and gaseous emissions. The project has also tested the effectiveness of environmental enclosures with optimized filtration and pressurization systems for reducing exposures of underground miners to diesel aerosols. Finally, the canopy air curtain, which has been successful for dust exposures, has been modified to protect against DPM. A prototype diesel canopy air curtain has been constructed and is being tested to evaluate its effectiveness at reducing DPM exposures.

While EMPs have been shown to cause lung cancer and mesothelioma in humans in addition to fibrotic lung disease, there is little information available on the extent to which mine workers are exposed to EMPs based on the geologies of the materials being mined. The project Understanding Elongate Mineral Particle (EMP) Exposure in Mining will assess miners' potential exposure to asbestos and other EMPs by analyzing bulk material samples previously collected from different types of mines across the country. The EMP samples will be separated by their morphology. Once separated a combination of the microscopy and X-ray methods will be used to fully characterize their size and mineralogy. Separated EMPs will also to be used in toxicological evaluations through a collaboration with the Health Effects Laboratory Division of NIOSH. Finally, the project will evaluate various end-of -shift measurement techniques to establish a common measurement and analytical protocol to quantify EMP exposure.

MSHA accident, illness, and injury data show that handling materials is the leading cause of nonfatal injuries in mining. The Prevention of Manual Materials Handling (MMH) Injuries in Mining project seeks to improve safe MMH practices at mine sites, evaluate the efficacy of new or emerging technologies to reduce the physical burden associated with MMH, and to develop guidance and performance specification for effective hand and finger protection. First, mining program ergonomists determine applicability of publicly available tools, training materials and guidance on MMH for inclusion on the NIOSH Mining website. Second, available injury data, literature, and subject matter experts are used to identify performance specifications and gaps in knowledge around hand protection to prevent severe hand and finger injuries during MMH. Finally, the project will conduct studies to determine the efficacy of exoskeletons to reduce the physical demands of MMH tasks.

The Improved Float Dust Controls in Underground Coal Mines project is conducting both field and laboratory research across three aims with each aim focusing on a different type of float dust source control to reduce the accumulation of FCD, thus improving the efficacy of current rock dusting practices. This project has completed studies for source controls at a transfer point and on a longwall face. Currently, the project is focused on designing and testing a prototype water powered shearer scrubber. Overall, the results of this project have provided improved understanding of how water sprays can be used to control not only respirable dust but also float dust.

Automation is often associated with a reduction of risk to workers. As automation within the mining industry increases, there is a need to take a critical look at how mine workers interact with these systems. The first aim of the pilot project Utilizing a Human Centered Design Approach for Mine Automation will identify different levels of automation and synthesize them for use in mining by creating a pilot tool to evaluate an automated system to generate a possible list of human centered challenges that may need to be considered in the design or implementation of the automated system. The second aim of the study will identify a framework of potential health and safety issues for each level of automation. The framework will allow implementors to identify key health and safety issues and better understand how automation affects the entire system.

Many coal miners are developing advanced stages of coal workers' pneumoconiosis (CWP) and silicosis at younger ages. NIOSH has associated the early onset of severe disease with overexposures to respirable crystalline silica (RCS). HHPB has multiple projects addressing the health risk of RCS to miners. The project Advancing Exposure Monitoring for Airborne Particulates in Mining is aimed at developing advanced monitoring approaches as related to RCS, DPM and respirable coal mine dust. One of the major contributions of this project was the development of the Field Analysis of Silica Tool (FAST) software that uses data from portable FTIR instruments to provide RCS mass and concentration

from dust samples at the end of the shift. The software is available on the NIOSH website and the filter cassette holders used in this method can be 3D printed using drawings hosted on the NIH 3D print exchange. The project also engages with aggregates mining companies for the adoption of advanced monitoring approaches for respirable dust and crystalline silica.

The Developing and Improving Respirable Dust Controls in Coal Mines project builds upon existing dust control knowledge to improve the technologies and practices related to mine dust control with an emphasis on RCS. This research will largely take place in both laboratory and underground coal mine settings. First, this project will evaluate different water sprays for airflow induction and airborne respirable dust capture capabilities on RCS dust to identify applications that can lead to lower exposures to RCS dusts. Secondly, the project will examine flooded-bed scrubber systems to improve operation while maintaining performance when subjected to both respirable coal and respirable quartz dust. Finally, this project will evaluate aqueous foams to control dust emissions resulting from longwall shield movement, surface blasthole drilling, and the operation of stage loaders to determine the effectiveness of foam as a respirable dust control compared to the use of water alone.

The Emerging Respirable Dust Sensing and Control for Metal/Non-Metal Mining project seeks to leverage emerging low-cost dust monitors (LCDM), greatly expanding the application of real-time dust sensing enabling control technology to be highly targeted and metric based. To determine suitability, the project is designing experiments that evaluate the performance of the LCDM against reference grade dust monitors for a true side-by-side comparison. Recent lab testing has shown that the LCDM's tested offer similar performance to monitors that are twenty times more expensive. The next step is to quantify the performance of LCDMs in real operational environments to capture actual aerosolized mine dusts as well as shifting morphologies.

The Investigating Mining Practices and Respirable Crystalline Silica Exposures in Underground Coal Mines project seeks to fill knowledge gaps in potential trends in coal mining practices to determine the impact of changes in rates of rock extraction on disease hot spots and provide insights to researchers, MSHA, and mine operators on trends in mining conditions and approaches to reduce associated RCS exposures. The project plans to utilize production data, compliance data and inspector reports to identify possible changes in mine characteristics, especially rock extraction, over time. The information will be collected into a database to identify common characteristics associated with MSHA districts, geographic regions, and mining conditions and possible links to RCS overexposures. Using historic and current coal mine worker lung disease data from the NIOSH CWHSP, researchers will determine the extent to which factors identified in mine characteristic data are linked with rates of CWP across the U.S.

The pilot project Development of an Aerosol Sampler for a Wearable Respirable Crystalline Silica Monitor seeks to develop a wearable sampler that allows collection and assessment of RCS in a near-real-time manner over long shifts without need for changing a filter or moving filter position. RCS measurement will use a quantum cascade laser (QCL) mounted at the top of a custom cyclone. The aerosol sampler and QCL system will be evaluated to quantify RCS alone and in coal dust mixtures.

Dr. Seamen then asked if there were any questions.

Mr. Zimmer thanked Dr. Seamen for her presentation and noted the value of the handbooks, infographics and other outputs, highlighting the Simple Solutions handbook for the surface mine workers.

Mr. Bowersox expressed appreciation for the work being done regarding diesel exposure, particularly with the exposures related to the long, extended hours per day and six to seven days per week work shifts.

SMRD Miner Health Branch

Dr. Gerald Poplin
Branch Chief
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Poplin provided a general overview of SMRD's Health Branch (HB) structure and programming for research, communication, and evaluation activities actively pursued and anticipated in the future.

Established as an official branch in fiscal year 2021, and as described in the Federal Register notice, the primary functions of the HB are to: assess and track miner health and hazard exposures; develop and promote health solutions; maximize worker protection; minimize exposures; prevent disease; and improve functional health for the entire mining population. HB staff comprises of a multidisciplinary group of individuals across the realm of public health including but not limited to medicine, psychology, industrial hygiene, engineering, epidemiology and statistics. Prior to becoming a branch, our health team began with four researchers in 2016, and grew to include 23 employees, fellows, contractors, and student interns. Two teams are now embedded within the HB with complementing central themes focused on understanding health outcomes and mitigating exposures, respectively, and both with intentions to explore and implement the full spectrum of interventional research at the mine worker and organizational levels.

Helping inform the strategic planning for the HB is the Miner Health Program's Strategic Agenda – a programmatic effort coordinated out of the HB, but supporting objectives across the entire NIOSH Mining Program. The Strategic Agenda articulates goals and activities to progress over the 2020-2030 time period across three core functional areas (Research, Evaluation, and Community Engagement) identified from outreach efforts with mining community partners.

Five active (4 multiyear, 1 pilot) and two recently completed (1 multiyear, 1 pilot) projects were briefly highlighted and introduced.

Predicting Heat Strain in Underground Metal and Nonmetal Miners is a dual-arm study with both lab (environmental chamber) and field-based (surface and underground mines) components aimed at assessing the impacts of heat exposure on cognitive function, specifically if changes (impairment) in cognition can be predicted by heat exposure and as a precursor to heat illness, thereby aiding in its prevention.

The methods and design of this project are intended to help further understand differences in individual variability (i.e., how we each respond differently to the same heat exposure) and the potential health and performance impacts in relation to short and prolonged exposures. It is anticipated that projects results will inform new knowledge on what could be considered framing acceptable durations of exposures at different intensities.

Mining Applications of Novel Interventions for Fatigue--Evaluating Safety Toolkits is a project of high interest with our community partners, and across most all NORA sectors. The sources or contributing factors of fatigue can vary across industries and occupations, but mining is unique in that most all sources of fatigue can be found in varying combinations; however, the factors contributing to fatigue will vary in both prevalence and strength from one mine site to another. Thus, this project seeks to establish a framework for operators and mine workers to understand those sources of fatigue in order to better measure and manage its impact(s) on worker health and safety.

Building an Evidence-Based Framework for Improving Miners' Health is often described as the backbone to the Miner Health Program. While the Mining Program is well established in ascertaining and describing the distribution and determinants of injuries and fatalities among miner workers, most notably through MSHA Part 50 Data, the same cannot be said for non-injurious health outcomes. This project aims to establish methodologies that make use of alternative sources of data that can help inform the entire mining community on the health status and exposure experience of mine workers. These may include data sources from complex national or state-based surveys or clinical settings, as well as exposure data from worksites (as a leading indicator of health). Each of these data sources requires different analytical methods and may represent different subpopulations within mining. As we learn what each of these data sources can contribute to our understanding of mine worker health or exposure, we will also be able to empirically deduce the attributes of health and exposure that are currently not well understood. Through our partnerships and collaborations, new and novel research can then be proposed to address any identified data gaps, improving the ability to target interventions and demonstrate health and exposure improvements over time.

Evaluation of Methods to Inform Development of a Near Real-time Monitor for Measuring and Reducing RCS Exposures in Non-coal Mines is a recently initiated project focusing on evaluating analytical methods that may contribute to the development of a real-time monitor for respirable crystalline silica (RCS). Two technologies – namely Fourier-transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD) have demonstrated promise for quantifying RCS; however, these techniques are lab-based and would reflect end of shift measuring. Several approaches toward the miniaturization of infrared spectrometry are being assessed with an initial focus on FTIR to address some of the known interference issues. To gain a more robust characterization of RCS and respirable dust levels, collaborating with a cross-section of metal and nonmetal mine operators is intended.

Identify and Characterize Health Hazards Associated with Surface Stone, Sand and Gravel (SSG) Mining and Processing is a new pilot research project that aims to assess the conditions or behaviors that are necessary for mine workers to identify or recognize health hazards, as opposed to the hazards more often associated with safety-related concerns. Specifically, the objectives of this pilot project are to revisit observational data collected from a previous safety hazard recognition project in effort to identify what health hazards are present among Stone Sand and Gravel workers, characterize what is necessary for someone to determine if a health hazard is present, how those health hazards are identified, and to characterize the known short and long-term effects of those exposures. This research is a new approach toward understanding cognitive processes or behavioral patterns that relate to the recognition of health hazards and has the potential to provide insight on updated training approaches for improving health hazard recognition.

Lastly, two additional research projects were recognized as having recently been completed: the development of analytical methods for portable monitoring of diesel particulate matter (Develop

Portable DPM Monitor), and a proof-of-concept study assessing the potential for a dual vibration exposure pathway to the hearing anatomy vis-à-vis acoustic and mechanical (or bone conductivity) vibrations (Inventive Methods for Evaluating the Translation of Hand-arm Vibration to the Ear Canal in Miners).

Dr. Poplin then gave a brief perspective on current strategic thinking and potential future research directions over the next five years, as provided, supported, and informed by research goals and objectives in the Miner Health Program Strategic Agenda, with an additional caveat as being subject to change based on evolving research priorities (with input from community partners) and capacity. Four thematic focus areas comprise the research directions. First is the continuation of systematizing the analytic methodologies and characterization of health and exposure of mine workers. Second, is interventional research that is focused on the mine worker – akin to active heat stress and fatigue research. The third focal area includes interventional health research aimed at the mine organizational level that may involve concepts related to healthy workplace design or the psychosocial risk factors of work with respect to substance use, recovery, mental health, and wellness. Research focused on leading indicators of health describes the fourth area of health research, aiming to improve the monitoring and control of health-related exposures, which can include interventional engineering designs with integrated behavioral or organization of work concepts. Supporting these efforts will also entail enhancing research methods and competencies in industrial hygiene, exposure science, geographic information system (GIS), and data visualization while also leveraging collaborative opportunities with other NIOSH divisions and our mining community partners.

Dr. Poplin concluded his presentation by asking if there were any questions.

Mr. Zimmer expressed his continuing concern about the opioid crisis and behavioral health issues.

Mr. Stewart asked both Drs. Poplin and Johns what the barriers are to getting industrial hygienists and industrial engineers onboard. Dr. Johns responded that he graduated from a large school of public health in Washington and has connections there in Industrial Hygiene, as well as other schools of public health. The difficulty is in identifying those who are interested in working for the Federal Government. Part of the SMRD recruitment efforts in 2022 will be for a senior industrial hygienist; NIOSH has added a strategic outreach recruitment coordinator to its staff, which should also help to facilitate this effort. In addition, there is an opportunity to utilize industrial hygienists at PMRD on projects at SMRD. The Mining Program, as part of its matrix management approach, tries to leverage its skill sets across both Divisions.

Day 2, Thursday, December 9, 2021

Dr. Luxbacher, as the DFO, and Chair Zimmer reconvened the meeting.

PMRD Mining Systems Safety Branch

Mr. Miquel Reyes
Deputy Branch Chief
National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

Mr. Reyes provided an overview of the Mining Systems Safety Branch.

With experience and the perspectives shared by our workforce through the reorganization and in the face of the pandemic response, as an organization, we've been able to anticipate some challenges, focus on strategic/succession planning, remained mindful of change management internally with the reorganization and externally with engaging with stakeholders, relied on creativity, flexibility, and good fortune and through it we've been able to remind ourselves that our stakeholders are our highest priority.

Our reorganization brought us from seven branches to three. MSSB is the outcome of combining the Ground Control, Electrical and Mechanical Systems Safety, and Fires and Explosions branches. Naturally, this became a multidisciplinary team that covers a diverse research portfolio. A lot of credit must be given to our branch leadership. Under the direction of Pete Kovalchik, we've managed to leverage what our individual groups were doing and added some new opportunities to focus on these five areas. The good fortune starts here in that we have some very experienced team leaders, and some aspiring leaders took on temporary details through the transition. This also extends beyond our leadership as our workforce consists of many subject matter experts in technical and administrative roles. The positions and disciplines available within the Branch allow us to perform targeted research in each of the 5 areas: ground control coal, ground control stone, mining technologies, fire prevention, and ventilation and explosion prevention.

We can perform research in all three strategic goals that focus on health, safety, and disaster prevention and response. This speaks to how diverse our branch is when it comes to addressing stakeholder needs.

The Improving Mine Ventilation and Reducing Contaminant Exposure in Large-Opening Stone Mines project is led by Vasu Gangrade. This 4-year project focuses on investigating parameters that influence ventilation within a mine and develop tools in the form of engineering controls and software to address exposure related challenges.

The Evaluation of Mobile Applications for Digital Contact Tracing project led by Jacob Carr ties closely to our expertise in communication and tracking and more so our prior research related to antenna orientation, communications protocols, environmental influences, and other parameters. In this project we are also relying on behavioral research scientists, within the program, on a component related to understanding barriers to adoption.

The Point-of-use Ventilation Systems to Prevent Exposure to Airborne Viruses project is led by Dave Yantek. This is a cross branch effort with experts from the health hazards prevention branch and aligns with similar efforts related to engineering controls such as the canopy air curtain to reduce respirable dust.

The Development of Engineering Guidelines for Shale Gas Wells Influenced by Longwall Mining project is a 4-year project led by Daniel Su and it looks to address potential injuries and fatalities caused by geologic instabilities as well as reducing the risk of fires and explosions that may occur as a result gas migration into mines due to the intersection of gas wells and longwall mining operations.

The Electromagnetic Interference and Compatibility in Underground Mines project is led by Chenming Zhou and this 4-year project to develop guidelines and recommendations to address electromagnetic interference in critical health and safety systems used in underground coal mines.

The Integrated Analysis of Coal Pillar and Entry Stability project is a 5-year effort led by Morgan Sears and focuses on stability analysis techniques which consider things like pillar, roof and rib stabilities and produce tools for the industry to better understand the relationships and then develop the framework to provide guidance on mine design recommendations.

The Validating Collision Warning & Avoidance System Detection Performance for Surface Mining Haul Trucks project is a 3-year project, led by John Homer. This project looks to increase acceptance and adoption of collision avoidance technologies based on robust system performance evaluations and validation. This aligns with MSHA's RFI on safety improvement technologies.

The Mitigating Fire & Explosion Hazards of Lithium-Ion Batteries project is a 4-year project led by Tom Dubaniewicz which focuses on battery safety, specifically lithium-ion batteries. The research investigates thermal runaway of battery cells and factors that influence battery ignition pressures within sealed enclosures and works toward developing recommendations that have been featured as part of international standards committees and technical panels like the Underwriter's Laboratories and the International Electrotechnical Commission work group on electrochemical cells and batteries.

The Improving Prevention and Suppression of Equipment Fires in Metal/Nonmetal Mines project is a 3-year project led by Davood Bahrami, which looks to evaluate and develop measures to prevent hot surface ignitions on mining equipment and produce software tools to evaluate the impact of mine fires on a mine's ventilation system.

The Flame Tube Exploration of Cross-Sectional Configuration Benefits of an Explosion Apparatus project which is a 1-year pilot led by Marcia Harris looks to leverage the technical expertise and previous research in this area to explore the impacts of cross-sectional configurations on explosion propagation studies. This will involve literature reviews and consultations with technical experts, on a global scale, to investigate the validity and efficacy of research conducted in experimental apparatuses designed to study explosion propagation.

The Methods to Reduce Potential for Massive Ground Collapses in Underground Stone Mines 3-year project led by Nicole Evanek. This project will consist of field instrumentations, physical measurements, numerical modeling, and data analysis to characterize factors responsible for massive ground collapses in underground stone mines. This project is particularly timely because it aligns with MSHA's Pillar collapse initiative which has been featured in recent safety alerts and quarterly calls.

With a portfolio this diverse, our stakeholders remain our main priority and they are critical to advancing these efforts. Each of these projects looks to leverage industry connections. In some cases, its developing collaborative agreements, presenting findings at industry wider forums, coordinating events, and contributing to standards and guidelines workgroups.

A few specific examples of our dissemination efforts include NIOSH researchers contributing to coordinating the Underground Stone Safety Seminar which took place 12/07 and 12/08, where NIOSH researchers contributed to developing the agenda, seeking presenters, and promoting the event. Another is involvement in standards committees and technical panels like IEC, UL, the Global Mining Guidelines (GMG) workgroups. Some other collaborations are our involvement in the Center for Occupational Robotics Research, the Robotics Interest Forum, and the Center for Advanced Subsurface Earth Resource Models which our technical experts are a part of in coordinating and consultation roles.

MSSB contributes to health and safety through dissemination efforts focused on stakeholder/industry needs. Project details and publications are accessible to stakeholders at the NIOSH Mining Web Page.

In closing, our program has undergone some recent challenges related to reorganization and pandemic response. MSSB, as has the industry, encountered a few hurdles along the way but Mr. Reyes credited the NIOSH staff and the support from the leadership, researchers, and support staff across the mining program, and especially the industry for their flexibility and continued interest in collaboration. He then thanked the Committee, noting he looked forward to their insight.

Chair Zimmer commented on the innovative ways the Branch was approaching projects.

Ms. Calhoun asked if the Mining Program was partnering or coordinating with academia on the issue of thermal runaway; noting that MSHA has received questions from the Colorado School of Mines about this subject and there was a recent related mine fire. Dr. Luxbacher responded that NIOSH has been in contact with both CSM and WIPP in New Mexico; CSM had referred WIPP to the Mining Program and NIOSH is currently exploring a Memorandum of Understanding (MOU) with them. In addition to our intramural projects, the Mining Program has funded several extramural contracts, primarily with research laboratories, in this area; the Global Mining Guidelines Group (GMG) is trying to pull some guidelines together currently. He noted there is a vast need for additional research.

Dr. Biscontin asked if the NIOSH Mining Program has a newsletter to stakeholders that the public can sign up for. Dr. George Luxbacher said that he and Dr. Jessica Kogel are considering that. Dr. Biscontin then noted that she is overseeing rock mechanics projects within NSF that could be interesting to NIOSH, and that academics that reach out to her would be interested in webinars on the NIOSH work in this area.

Mr. Stewart commented that some of the smaller producers or those working in commodities with lower profit margin may not be able to afford the current technologies in proximity detection.

SMRD Mine Safety Branch

Ms. Pamela Drake

Branch Chief
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Ms. Drake provided an overview of the Mining Systems Safety Branch.

The recent reorganization resulted in the formation of the two branches at SMRD. Her presentation covered the current research that is being conducted in the Geomechanics Team and the Automation and Technology Team. The Geomechanics Team is led by Tyler Emery and the Automation and Technology Team is led by Bob Bissonette. The Miner Safety Branch is currently doing research in both underground and surface metal mines, underground and surface coal mines, and stone, sand and gravel.

Ms. Drake then did a high-level overview of the six projects in the Branch, covering the purpose for each project, specific aims, accomplishments over the past year, and accomplishments planned in FY22.

The Managing Ground Support for Long-term Stability in Underground Mines project is led by Donovan Benton and has 4 specific aims:

1. Squeezing Ground - This research is for weak rock/ground that squeezes or squishes, such as the ground in many Nevada underground mines. NIOSH did some work in the past with squeezing ground that yielded some impactful results, but more work remains, and stakeholder input has placed continued emphasis on this area of research. Mesh testing was started originally to look for alternative meshes for rockbursting ground but has transitioned into being useful also for squeezing ground or corrosive ground conditions.
2. Corrosion - The goal is to develop a "suite" of tests that an engineer can run in a mine to then determine a corrosion rate or corrosion potential for an area. Then a series of bolt pull tests are conducted to determine the loss of ground support capacity due to different levels of corrosion so a rehabilitation plan can be developed by the mines before the factor of safety is too low. Corrosion continues to be a problem in numerous mines. Currently staff are working in the corrosion laboratory with samples and data from 3 different metal mines with different corrosion problems. The plan is to continue work at these mines in the spring/summer of 2022.
3. Backfill – NIOSH has done quite a bit of research in this area, but more work needs to be done, from developing more resilient backfills to withstand high stress and seismicity to QA/QC methods. Our researchers will also continue to do work with the Cemented Rock Fill, specifically an oversize study.
4. Seismicity - Continued maintenance on seismic system in a seismically active mining district which will include installation of a new seismic station next spring.

The Unconventional Monitoring and Design for Mine Stability in Sedimentary Rock project is led by Heather Lawson. The goal of this project is to provide operators with an arsenal of low-cost non-invasive assessment methods and evaluate geochemical markers for their potential as early indicators for risk of gas-driven dynamic failure events. This past year, the team conducted some preliminary testing with both the ground penetrating radar and distributed acoustic sensing (DAS), and this work will continue into 2022. The DAS system is an exciting area of research as it has potential for being a low-cost alternative to traditional seismic monitoring systems. The geochemical markers data analysis conducted this past year shows both the infrared and acoustic emissions peaks correlate with major and minor load drops. It also shows some correlation between debris velocity and mineral matter content as well as debris velocity and vitrinite reflectance. The researchers are currently going through a large amount of laboratory data that has been gathered over the past two years and developing a chamber for measuring the release of methane during compression testing. Seismic nodal deployments have become a very useful tool to NIOSH researchers, but many mines would also benefit from such an application, as it requires a lot less resources; equipment is available for rental, so mining companies can avoid the upfront capital expense.

The Open Pit Highwall Safety: Rockfall Catchment Design and Slope Performance Monitoring at Surface Mines project started as a 1-year pilot in FY21, and a full project began in October 2021. It is led by Sean Warren and has two specific aims: Update rockfall catch bench design guidelines for surface mines and quarries and Develop slope performance monitoring guidelines and develop improvements in current slope monitoring techniques. During the pilot project in FY21, the team prepared the synthetic rocks in the lab and conducted rockfall testing at Central PreMix. In FY22, rockfall testing will start with a local mine in the spring and then move down to larger open pit mines such as the Round Mountain Mine. The rockfall testing will be monitored from using rock fall dopler radar,

infrared/thermal imaging (in partnership with the University of Arizona Geotechnical Center of Excellence), photogrammetry by drones, and regular RGB cameras. Currently the team is using numerical rockfall modeling software to do a parametric study on pit geometry and geology for comparison to actual testing.

The Evaluating and Developing Emerging Technologies to Improve Conveyor Safety project is led by Bob Bissonette and has two specific aims: increase situational awareness during operation and maintenance activities on conveyors and related stationary equipment and reduce catastrophic conveyor failures and worker exposure to hazards through real-time data. This project addresses a persistent safety challenge in mining – entanglement in conveyors. Workers many times have to work in close proximity to moving conveyors and other machinery. Many safety practices are currently used like guards over moving components, lock out tag out procedures during maintenance, and emergency shut offs. But accidents still occur, and the team is looking at using new technology to improve safety. For instance, new sensor systems and mobile computing devices can increase situational awareness and improve lock out tag out procedures. The status of maintenance tasks, the lockout status of the motors, and worker proximity can all be available on a smart phone. This information can help prevent someone from starting up a conveyor when someone else is still working on it. Or it can warn employees of hazardous conditions before working near a moving conveyor.

The Assured Autonomy Safety Intervention System Technology (AASIST) pilot project is led by Michael McNinch. This pilot project plans to work with industry to identify a workable, scalable framework for a redundant real-time risk assessment system that would intervene (as a human would). It would model a machines environment from the machine's perspective, identify objects in that environment, project possible interaction between those objects with each other and with itself, and then intervene. Much of this work will be achieved by leveraging new developments in autonomous car technology. Assured autonomy is the ability to safely operate in the presence of humans. True autonomy is attained when machines can operate without human oversight. Long term, autonomous equipment must be able to operate safely when things go wrong and should not be overly reliant on communication systems. The path to assured autonomy would need redundancy in sensor data, the ability to evaluate any given situation and identify the effective control measure.

The Wireless Network Performance Requirements for Safety-Critical Systems in Mining pilot project was completed in FY21 and was led by Ron Jacksha. Wireless networks are used throughout mining and the applications are growing: communications, control, monitoring, automation, autonomous, and tele-remote equipment. However, the US mining industry has no regulations, standards, or even guidance for wireless network performance. Additionally, the technology in this area changes rapidly – Cellular 4G, 5G, soon 6G, Wi-Fi, etc. Wireless system coexistence is the ability of systems to operate in the same frequency, space, or time without significantly impacting the performance of any system involved. Fail-safe procedures are required that can safely shut down automated equipment. Safety-critical systems must be identified – determining what mining systems or equipment are safety-critical to miners and if these systems or equipment should use wireless networks. And then there's Lockout/tagout procedures – how to ensure wirelessly controlled automated or autonomous mining equipment cannot inadvertently be activated during maintenance of the equipment. Finally, mining activities change the geological environments and could have an influence on wireless system performance. The team is currently working on a new project proposal - Coexistence and Safety of Wireless Systems in Mining. The goals for this project are to determine best practices for the safe coexistence of wireless systems and provide guidance and recommendations to MSHA, stakeholders, and mining technology and equipment manufacturers.

Ms. Drake then recognized all the staff in the Miner Safety Branch that have been working hard, overcoming obstacles, and getting things accomplished over the past year and a half, noting that it has been challenging but they all continue to do great work. She then asked if there were any questions.

Chair Zimmer commented that he appreciated the NIOSH work on wireless networks and automation, noting that this work transcends into other industries.

Mr. Bowersox mentioned that he had seen the use of a drone in the anthracite region that identified major cracks in the highwall; the drone took 3D photos that had a resolution equivalent to standing in front of the cracks.

PMRD Human Systems Integration Branch

Dr. Amanda Azman

Deputy Branch Chief
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Azman provided overview of the Mining Systems Safety Branch.

The Human Systems Integration Branch (HSIB) intersects the work between PMRD and SMRD but has a formal reporting structure to PMRD. The branch performs research collaborations, program support, and its own research projects. Assistance is provided to research projects across the program that address issues of human integration with the health and safety solutions they are investigating. The branch also provides assistance to the Mining Program leadership.

HSIB is active across all mining program domains with a focus on the integration of social and technical systems. The branch plays a dominant role in two domains: Human System Integration and Shared Services. It also is the dominant actor in the Response portion of the Disaster Prevention and Response domain.

There are several branch-level research projects focused on developing solutions, guidance, or tools to reduce the burden of mining industry hazards, or hazardous operations.

The Characterization of Haul Truck Health and Safety Issues project is identifying and characterizing health and safety issues related to haul truck operation.

Data on haul truck use and operation and potential safety issues is collected from a variety of sources. It is then analyzed to identify hazard characteristics that lead to targeted solutions.

Another focus is a portable virtual reality mine rescue system being done in partnership with MSHA. This effort will produce a portable VR training system that allows mine rescue teams to train in simulate mine fires and other emergency situations without the need for an expensive physical training facility or to travel to the NIOSH VISLab facility in Pittsburgh.

Solutions from this project include simulated haul truck near-miss incident training material package. This is a collection of 3-4 videos recreating actual events and complementary training materials, which

will be co-branded with MSHA and immersive multi-player training application targeted to mine rescue teams to practice group decision making while reacting to an emergency, such as underground fires and explosions.

The main idea for the Human-Centric Lighting project is a focus on lighting in the mining environment and how lighting effects the health and safety of mine workers.

The first focus is area lighting to improve the illumination of hazards at mine sites. This is a part of ongoing work to improve lighting so that tripping hazards and other obstacles are more visible in the dark. The project continues to work towards commercialization of effective area lighting solutions, such as the most recent "Saturn" area light.

Another focus area of this project is investigating novel lighting interventions to address shift worker fatigue. For workers with non-daylight shifts, who often receive little natural sunlight, fatigue and other negative health effects are common. One promising technology involves lighted eyewear to synchronize circadian rhythms with the work shift. This has proven useful in other industries, so we intend to test it in the mining environment.

The project solutions for this are continued development of area lighting solutions for mine sites and guidance on the use of personal, wearable lighting solutions for mine workers.

The focus for the Inexperience as a Contributor to Workplace Injury project is researching the role inexperience plays in miners' risk of injury and illness and is investigating effective ways to reduce this risk. The project is applying a new analysis methodology using experience data collected by the branch's Surveillance and Statistics team to relate experience to risk of injury. It's been found that both experience at a specific mine and overall mining experience are both relevant to the likelihood of workplace injury. The project is also collecting information on the ways mines are onboarding new employees to improve the employee's ability to avoid health and safety hazards. The project solutions are communication and training materials focused on mine worker inexperience – for example the "New Until Two" infographic highlighting that workers are at a heightened risk of on-the-job injury and should receive additional guidance on tasks and hazards until they have reached their second year.

Ongoing shared services provided to the program's science-based strategy and delivery of solutions to its stakeholders. HSIB has a hand in nearly all outputs that reach the public, from the mining program, and strong participation in many internal, program actions. HSIB provides data to aid in research projects, and tools to disseminate research to our stakeholders.

The health communications shared service provides support for the planning, implementation, and dissemination of the research findings of the NIOSH Mining Program. Editing, graphic development, conference planning and staffing, output development and guidance, 508 compliance, and photography are just some of the services. We strive to deliver the information in the best formats for our mining audiences to use. The health communications shared service takes the research done by the experts in the mining program and packages it into useful formats and events for public consumption and integration.

The software solutions shared services develops and applies computational tools and techniques that advance the understanding and mitigation of mining health and safety problems. This service is like the communication shared services in that we provide those services to the various branches based on their needs to translate research into impact. This service also specializes in delivering software to

stakeholders and working with internal IT processes and requirements. The EXAMiner and FAST applications are two recent products of the service's software designers. Computer programming and software design is critical to providing customers and stakeholders with current, usable, and novel computer or other technology -based programs.

We also deliver advanced IT solutions outside of the program. For instance, our software designers responded to a request to assist CDC's COVID-19 response by developing a PPE Tracker mobile app in just a few weeks. They continue to maintain, track, and improve the PPE Tracker app as the pandemic response evolves.

We also do the programming for the NIOSH mining website. The content is provided by experts through the program, but all programming for the platform is done though software solutions programmers. One of the highlights of the website is the keyword-searchable content, which is an advanced feature no other CDC program can claim.

The surveillance and statistics shared service supports the Mining Program with sound surveillance, statistics, and economic models and procedures.

It guides the program with health and safety data for strategic planning and advises program researchers on methods and analysis. In addition, they evaluate the program's effectiveness and impact and deliver data and visualizations to stakeholders. The team provides statistical support and consultation to the rest of the mining program. They collaborate with research teams and co-author publications about the research they've participated in. They handle the surveillance data for the entire mining program.

The escape and rescue shared service supports the Mining Program through development and application of mine escape and rescue solutions. This shared service maintains our expertise in mine escape and rescue. We provide that expertise to the VR mine rescue component of the haul truck project and interface with mine rescue teams and mine rescue contests throughout the US. Thankfully, the US mining industry has not had a major disaster since 2010. Still, history has shown that vigilance and preparedness are essential as long as the potential for disasters continues.

The training solutions shared service specializes in delivering training through training outputs or through consulting with projects across the program. The training solutions shared service touches all training applications that are needed to achieve research aims of the program. This is the specialty of the experts within the training solutions shared service, taking the program's research findings and making actionable, relevant, and impactful training solutions.

In summary, HSIB provides the integration of shared services, human integration collaborations, and standalone research projects for developing impactful, relevant health and safety solutions.

Concluding her presentation, Dr. Azman asked if there were any questions.

Chair Zimmer commented that there has been stagnation across the board with changing the culture of safety and a more human approach is required, as NIOSH is proposing.

Dr. Mattson agreed with Chair Zimmer's comment and then asked about the evaluation plan components around the health communication efforts. Dr. Azman responded that she would put Dr. Mattson in contact with the responsible person.

Chair Zimmer the commented that during his tenure on MSHRAC he has observed that the research takes into account its impact, through dissemination and utilization - it must land with each individual worker, and not be an overall umbrella. Everyone who enters the workplace needs to understand how it's going to affect the individually in their workplace, reinforcing the need for cultural change.

Mining Program Partnerships, NORA Ming Sector Council Interaction

Dr. George Luxbacher
Deputy Associate Director for Mining
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Luxbacher gave an update, on behalf of Dr. Kogel who was unavailable, on the Mining Program partnerships, noting that intramural collaborations with other NIOSH DLOs (divisions, labs, offices) would not be covered due to a lack of time. The formal partnerships started 5-7 years ago and currently include:

- Breathing Air Supply Partnership - The breathing air supply partnership was started when NIOSH NPPTL, the (National Personal Protective Technology Laboratory) began to revamp subpart H covering the evaluation and approval of self-contained self-rescuers. Meetings were held in 2012, 2014, and 2017; with the indefinite extension of Subpart H, it's currently inactive.
- Diesel Exhaust Health Effects Partnership - This partnership is joint with MSHA. It was created in 2016 and has had four meetings over time, the last being in 2019.
- Rock Dust Partnership – This partnership has had three meetings, 2017, 2018, and 2020. The meeting in 2020 was to present large-scale test results of treated and foamed rock dust conducted in Poland.
- Refuse Alternative Partnership - This partnership was started in 2015 in response to MSHA requirements for refuse alternatives. It ran through November of 2021 and has been closed, although research work is still ongoing and will be presented in papers and conferences.
- Proximity Detection Partnership – This partnership was formed in response to MSHA proposed rulemaking for underground coal to extend proximity detection to other pieces of equipment. It held two meetings in 2017 and 2018 but has now been incorporated into the Automation and Emerging Technologies Partnership.
- Respirable Dust Partnership – This partnership initially was focused primarily on respirable crystalline silica and was started in 2020 with a kick-off in Washington, D.C. at MSHA's offices and a follow-up meeting later that same year. This is a joint partnership with MSHA; since MSHA has proposed rulemaking in this area, we have temporarily delayed any further meetings pending that proposed rulemaking.
- Automation and Emerging Technologies Partnership – This extremely active partnership has already held 3 meetings, the first in October 2020, the latest in August of 2021.
- Miner Health Partnership -The kickoff meeting for this partnership was held in November 2021. This partnership was covered in Dr. Poplin's presentation.

Both the Automation and Emerging Technologies and Miner Health partnerships are outgrowths of MSHRAC work groups.

The NIOSH Mining Program also has a number of other formal and informal collaborative mechanisms for interaction with our stakeholders. These include:

- U60 Grants
    - Western Miner Safety and Health Training Program (UA, CSM)
    - Underground Mine Evacuation Technologies and Human Factors Research (MUS&T, NMT)
- Interagency Agreements (IAAs)
- NORA Mining Sector Council
    - MSC meetings at SME Annual Conference & Expo
    - National Mining Research Agenda
    - Webinars
- Annual meeting of NIOSH-funded Respirable Mine Dust Characterization Researchers
- Annual meeting of the NIOSH-funded Capacity Build Researchers
- Center for Advanced Subsurface Earth Resource Models (CASERM)
- Global Mining Guidelines Group (GMG)

Collaboration is critical to the sustainability of the Mining Program research for the following reasons:

- Addresses expertise and funding gaps
- Considers multiple perspectives
- Provides the opportunity for multidisciplinary research teams
- Increases the likelihood that NIOSH research is relevant to stakeholders
- Facilitates implementation of new technologies at mine sites
- Expands opportunities for field-based research
- Raises awareness about OSH within the broader mining community

At the conclusion of the presentation Dr. Schafrik asked about the difficulties in a restart of the Breathing Air Partnership. Dr. Luxbacher responded that, if MSHRAC felt it was required, it could easily be restarted, noting, however, that this was a small partnership given the topic, consisting of primarily manufacturers and a few of the larger coal mining companies. Dr. Schafrik then asked why maintain rather than close the Breathing Air Partnership? Dr. Luxbacher noted that the manufacturers offer a number of options outside the U.S. that might have applicability; NIOSH monitors those options and might, at some point, plan a partnership meeting to discuss research requirements.

Mr. Stewart asked about why the Respirable Dust Partnership had been put on hold. Dr. Luxbacher then noted that MSHA, as a joint partner in the partnership, had requested that future meeting be delayed pending a proposed rulemaking; he noted that the two meeting that were held were well attended and there was a lot of enthusiasm from stakeholder to continue the Partnership.

Mr. Stewart then asked about the respirable mine dust characterization researchers meeting. He felt that metal/non-metal operators want to explore the different ways that respirable crystalline silica might be generated, and then in turn how that manifests itself toxicologically; this meeting might be a good platform for that discussion. He also noted he couldn't find anything online for the respirable mine dust

characterization researchers group. Dr. Luxbacher responded that there is nothing available online regarding this group, since it is an informal collaboration of researchers that have NIOSH BAA contracts in this area. Mr. Stewart indicated he would pursue this discussion later with Dr. Luxbacher.

Mr. Stewart asked if NIOSH funds students who are interested in pursuing a career in industrial hygiene, either at the undergrad or grad level. Dr. Luxbacher responded that, while other parts of NIOSH might, the Mining Program does not, although we have funded at least one student under the Capacity-Build contracts that is working in mining IH; he also noted that NIOSH has the capability to provide internships, and that internship can be leveraged into full-time employment upon graduation.

Mining Program Strategic Plan

Dr. Lisa Steiner
Senior Advisor to the Associate Director for Mining National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Steiner provided an overview of the Mining Program Strategic Plan and the updates since last year. She addressed the basics of the plan, the information can be gathered from it, and how it operates as a roadmap to the Mining Program (MP) priorities, goals and outputs, as well as the updates and enhancements as the MP moves towards a document that better provides direct association to the outcomes and impacts of research both holistically and by individual projects.

The Mining Program Strategic Plan (MPSP) was created and is maintained to show NIOSH Mining's current activities and future plans and provide a portfolio of priority health and safety concerns in the mining industry. The MPSP also provides insight as to applicable solutions we are providing and who will be impacted by these solutions as well as provide many active links to related or referenceable documents.

Mining health and safety research is guided by and aligned with 3 major plans: the NIOSH Strategic Plan, the NORA National Mining Agenda, and the MPSP. The MP makes sure that its Strategic Plan is aligned with all three of these when prioritizing its work. The NIOSH Strategic Plan is broad and addresses all industries, but its plans are within the resources and capabilities of the agency to achieve. The NIOSH Mining Program Strategic Plan is specific to mining and the plan and its research activities fall within the capabilities and resources of the MP to achieve. Finally, the NORA Mining Agenda delineates the concerns of mining health and safety for the nation as a whole. Stakeholders, academia, and regulatory agencies are involved with setting this agenda and the needs are not specific to the capabilities or comparative advantage for NIOSH mining to achieve. Others can choose to use this information to conduct research or provide interventions that address health and safety concerns for the mining industry.

Along with these three plans, we are also influenced by several entities/information sources when setting the priorities of our research plans. Surveillance activities including injury and fatality data, established burden and need, stakeholder and partnership discussions, in-depth reports, program evaluations, etc. These discussions and feedback are considered when determining where to spend our efforts and resources as well as building capacity.

The MP portfolio is updated by the information received from these influencers. It is common for the MP to take a broad look at the industry and the problems that need to be addressed. The timeframe is in the future 10 or 20 years – these are "Future Directions" the MP is monitoring, and they are presented at the end of each Strategic Goal's section in the MPSP. There are also emerging issues which are more eminent and are what the MP expects the mining industry to be impacted in the near term (1-3 years). Often there is a need for a more detailed understanding and these issues appear in the "Ongoing Challenges and Emerging Issues" in the beginning of the MPSP when they are first investigated, usually through pilot projects. Pilot projects give researchers one year to take a deeper dive and see if and what NIOSH's role should be in this area. Some of the "Agendas" start as a pilot efforts.

If an emerging issue is worthy of the program portfolio, researchers develop a full project proposal during the call for project concepts in the Fall and with the goal of getting priority funding. Other ways a project can be initiated is from projects that are already part of the portfolio, but more research is still needed to solve the problem or another related discovered issue. In all cases, the priority funding opportunities are scrutinized given that our time, money, and skills resources are limited. These concepts are compared to current portfolio research in terms of priority considerations. All projects must be aligned with the strategic plans and agendas mentioned earlier. In some cases, NIOSH is not the right entity to do the research and, if determined critical, other mechanisms are considered such as Broad Agency Announcements, Request for Proposals, or other contracts/grants mechanisms. At that point, topic area research for external contracts is requested and proposals are considered every Fall in the same cycle as the internal funding projects proposals.

Once a project is selected, it necessarily aligns with the Strategic Goals (SGs) and Intermediate Goals (IGs) of the MPSP and essentially the NIOSH plan. SGs are the strategic goals, which are the highest-level goals in the MPSP and reflect the new organizational structure rolled out last year. IGs are intermediate goals representing relevant concerns our MP is committed to solving and are selected due to their critical path to the SG. To further define our actual activities that work towards these goals, is the most basic level – Activity Goals (AGs) which are tied to the IGs and they are the activities that move the research through from research to practice. As an aside, the IGs can be updated and retired. Revisions can be made to broaden the topic to include new areas of research but, for the most part, these IGs remain steady each year.

This Strategic Plan Structure gives a perspective of where the MPSP meets the Project Plans level. At NIOSH, Strategic Plans are written at the program level but since this is a public facing document, an intentional decision was made to relate the project level work, end user applications, to the project level so that the user can easily see how the program goals are accomplished through the practical and scientific work in the projects.

Each project is guided by the hierarchy with the End Outcome being the result that the MP hopes to accomplish from the research conducted and resources spent. For example, an End Outcome may be to "reduce the exposure of respirable crystalline silica (RCS) to underground mine workers" which is supported by achieving the intermediate outcomes (IOs). Intermediate outcomes are the actions stakeholders take from the research and outputs NIOSH provides. The outputs are associated with the activities at the project level to create and interpret outputs for the industry so that the stakeholder can take action. That would be the interventions, training, infographics, workshops, presentations, and publications.

Also, we are interested in measuring the effectiveness of IOs and End Outcomes to show the science-based evidence of the impact our research and its applications. This effort requires additional evaluation planning as the product or process is implemented and changes to the workplace are made. This is where collaborators and stakeholders can help us to implement these interventions and provide for longer term evaluation of the effects. These impact and evaluation plans to conduct to provide science-based evidence are introduced in the beginning of the project during the planning stage; formally this is new, but this has certainly been achieved at times informally. However, it is time consuming, costly, and may not be where the MP should spend its resources so careful consideration for a balance of cost benefit is required. Is it better to solve more problems or prove the problems we solved are working? Decisions of the level of impact and evaluation are considered for each opportunity given limited resources. Evaluation of impact will provide the transparency and evidence of End Outcomes. In short, it is about taking project outputs and End Outcomes to another level to get meaningful evaluation of the influences the research products have on health and safety at the workforce level.

Activity Goals, the level closest to the Project outputs in the MPSP, have four types of research activities: Basic/Etiologic, Intervention, Translation, and Surveillance Research. These categories are defined in the SP and are helpful to developing impact planning and evaluation techniques appropriate for these categories. They also help to quickly determine what type of information would be expected at the end of the project and who would be most interested. Intervention research is the most common type and then Basic/Etiologic research the next most common and is research where learning the basic scientific knowledge is needed.

In the MPSP, each IG is paired with a table detailing the project work associated with the IG along with a link to the project pages for further information. The AGs support the accomplishment of that particular IG. A description of the AG in the table gives you more description of the focus area. the benefactors, and the project link to learn more. When a project ends, it is removed from the table and is found (and linked) in the Appendix of the SP as an archive of projects, where it is kept through several MPSP revisions. Below the table, there is a burden, need and impact section for each IG and for the overall SG. This justifies the priority and how the work is expected to impact the industry. The summary pages included in the MSHRAC pre-meeting package also serve this purpose.

The MP updates the MPSP each year and add features from feedback and ideas. These updates include:

- Hyperlinked new projects/removed old projects
- Updated activity goals and verified existing activity goals
- Updated statistics and other data with MSHA Injury and Illness data so that is current and linked to how the source
- Updated Partnership data and links to new partnership pages
- Updated future directions, emerging issues (some of those pilots that were in there the year before having now become new projects and part of the portfolio), and updates to the project pages.

The MP has future plans to enhance the MPSP and to represent how the MP research is conducted and to enhance utility. As prioritization of emerging issues and future directions are integrated into the current portfolio, resources are often limited, and decisions are made around those constraints.

- More prominence of the impact and evaluation planning throughout the plan will be included.

- Enhanced project pages – the summaries provided in the pre-meeting package are part of what is on the project pages but listing and linking project outputs and any related outputs from previous work may enhance the use of the plan and help to navigate the website.
- Keyword searches may be helpful and are likely to align with the sub domains presented earlier in the organization of our work presentation. This might be a place to start and will allow for overlap of concepts and issues as we take this holistic and systems approach towards research.
- NIOSH is interested in Logic models at the IG level and the MP is interested in logic models at the domain and project levels. This will help to visually sort out the overlaps and provide clear quick representation of those levels of planning. These may be in the plan and or at the project pages.

Impact and evaluation, as mentioned earlier, are being ingrained in the MP starting at the beginning of the project planning and portfolio prioritization. As partial fulfillment of the Foundations for Evidence-Based Policymaking Act of 2018, which is a requirement of all federal agencies, there is a need to provide evidence of our impact. NIOSH has developed a learning agenda, Evaluation Capacity-Building Plan 2021-2025, to guide its DLOs. Ultimately, the MP will follow this agenda however, the MP is already poised to provide the NIOSH OD with guidance and input to this plan. The MP has some tangible evidence of evaluation and impact, and we can contribute our influence on the plan design and implementation at the NIOSH level to help achieve this goal and requirement.

Dr. Steiner and Evaluation Expert Fellow Carol Nixon, based at SMRD, are providing the MP with a guidance document to help our researchers and lead team build their logic models, create appropriate IOs, and set a process for determining the level of impact an effort may experience to benefit the mining sector, covering the spectrum from simply writing a publication to applying, tracking and measuring an intervention at one or several mines to show evidence of our impact.
Dr. Steiner concluded her presentation by thanking all who provided input to update this plan each year, and the support to make the MPSP what it is today – an interactive, valuable, and useful tool that is used are using rather than sitting on a shelf. The revised plan will be available in late-January to mid-February as parts are under review and then will be published to our website; an update announcement with a link will be sent out at that time. She then asked if there were any questions.

Dr. Mattson commented on the tradeoff between spending the time working on evaluation components before moving on or advancing to the next project, noting it's worth it because if you can show the impact through evidence, it gives you more confidence in moving on to that next project and incorporating previous research methods.

Dr Steiner responded that traditionally we do publications, but that doesn't always show impact, so it is necessary to move beyond that by planning for the evaluation and impact. The evaluation results may demonstrate impact and justify additional evaluation. It's getting more and more critical that we show the impact and for mining companies as one of our stakeholders to say our work is required. It's important to get good collaborations from the very beginning of the project.

Dr. Luxbacher noted that all of the new project proposals now incorporate the logic model up front, since potential impact is part of the project justification. Dr. Steiner also noted the importance of comparative advantage in project selection; careful consideration of whether an intermediate outcome will be adopted is also critical.

Dr. Luxbacher encouraged the committee to read the 2-page summaries of each project.

Mining Program Partnerships, NORA Ming Sector Council Interaction

Dr. George Luxbacher
Deputy Associate Director for Mining
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Luxbacher gave an update, on behalf of Dr. Kogel who was unavailable, on the Mining Program partnerships, noting that intramural collaborations with other NIOSH DLOs (divisions, labs, offices) would not be covered due to a lack of time. The formal partnerships started 5-7 years ago and currently include:

- Breathing Air Supply Partnership - The breathing air supply partnership was started when NIOSH NPPTL, the (National Personal Protective Technology Laboratory) began to revamp subpart H covering the evaluation and approval of self-contained self-rescuers. Meetings were held in 2012, 2014, and 2017; with the indefinite extension of Subpart H, it's currently inactive.
- Diesel Exhaust Health Effects Partnership - This partnership is joint with MSHA. It was created in 2016 and has had four meetings over time, the last being in 2019.
- Rock Dust Partnership – This partnership has had three meetings, 2017, 2018, and 2020. The meeting in 2020 was to present large-scale test results of treated and foamed rock dust conducted in Poland.
- Refuse Alternative Partnership - This partnership was started in 2015 in response to MSHA requirements for refuse alternatives. It ran through November of 2021 and has been closed, although research work is still ongoing and will be presented in papers and conferences.
- Proximity Detection Partnership – This partnership was formed in response to MSHA proposed rulemaking for underground coal to extend proximity detection to other pieces of equipment. It held two meetings in 2017 and 2018 but has now been incorporated into the Automation and Emerging Technologies Partnership.
- Respirable Dust Partnership – This partnership initially was focused primarily on respirable crystalline silica and was started in 2020 with a kick-off in Washington, D.C. at MSHA's offices and a follow-up meeting later that same year. This is a joint partnership with MSHA; since MSHA has proposed rulemaking in this area, we have temporarily delayed any further meetings pending that proposed rulemaking.
- Automation and Emerging Technologies Partnership – This extremely active partnership has already held 3 meetings, the first in October 2020, the latest in August of 2021.
- Miner Health Partnership -The kickoff meeting for this partnership was held in November 2021. This partnership was covered in Dr. Poplin's presentation.

Both the Automation and Emerging Technologies and Miner Health partnerships are outgrowths of MSHRAC work groups.

The NIOSH Mining Program also has a number of other formal and informal collaborative mechanisms for interaction with our stakeholders. These include:

- U60 Grants
    - Western Miner Safety and Health Training Program (UA, CSM)

    - Underground Mine Evacuation Technologies and Human Factors Research (MUS&T, NMT)
- Interagency Agreements (IAAs)
- NORA Mining Sector Council
    - MSC meetings at SME Annual Conference & Expo
    - National Mining Research Agenda
    - Webinars
- Annual meeting of NIOSH-funded Respirable Mine Dust Characterization Researchers
- Annual meeting of the NIOSH-funded Capacity Build Researchers
- Center for Advanced Subsurface Earth Resource Models (CASERM)
- Global Mining Guidelines Group (GMG)

Collaboration is critical to the sustainability of the Mining Program research for the following reasons:

- Addresses expertise and funding gaps
- Considers multiple perspectives
- Provides the opportunity for multidisciplinary research teams
- Increases the likelihood that NIOSH research is relevant to stakeholders
- Facilitates implementation of new technologies at mine sites
- Expands opportunities for field-based research
- Raises awareness about OSH within the broader mining community

At the conclusion of the presentation Dr. Schafrik asked about the difficulties in a restart of the Breathing Air Partnership. Dr. Luxbacher responded that, if MSHRAC felt it was required, it could easily be restarted, noting, however, that this was a small partnership given the topic, consisting of primarily manufacturers and a few of the larger coal mining companies. Dr. Schafrik then asked why maintain rather than close the Breathing Air Partnership? Dr. Luxbacher noted that the manufacturers offer a number of options outside the U.S. that might have applicability; NIOSH monitors those options and might, at some point, plan a partnership meeting to discuss research requirements.

Mr. Stewart asked about why the Respirable Dust Partnership had been put on hold. Dr. Luxbacher then noted that MSHA, as a joint partner in the partnership, had requested that future meeting be delayed pending a proposed rulemaking; he noted that the two meeting that were held were well attended and there was a lot of enthusiasm from stakeholder to continue the Partnership.

Mr. Stewart then asked about the respirable mine dust characterization researchers meeting. He felt that metal/non-metal operators want to explore the different ways that respirable crystalline silica might be generated, and then in turn how that manifests itself toxicologically; this meeting might be a good platform for that discussion. He also noted he couldn't find anything online for the respirable mine dust characterization researchers group. Dr. Luxbacher responded that there is nothing available online regarding this group, since it is an informal collaboration of researchers that have NIOSH BAA contracts in this area. Mr. Stewart indicated he would pursue this discussion later with Dr. Luxbacher.

Mr. Stewart asked if NIOSH funds students who are interested in pursuing a career in industrial hygiene, either at the undergrad or grad level. Dr. Luxbacher responded that, while other parts of NIOSH might, the Mining Program does not, although we have funded at least one student under the Capacity-Build

contracts that is working in mining IH; he also noted that NIOSH has the capability to provide internships, and that internship can be leveraged into full-time employment upon graduation.

Extramural Mine Dust and Silica Research

Dr. George Luxbacher
Deputy Associate Director for Mining
National Institute for Occupational Safety and Health Centers for Disease Control and Prevention

Dr. Luxbacher gave an update related to extramural mine dust and silica research. He started by reviewing some of the data related to the resurgence of coal worker pneumoconiosis and the evidence that silica is the primary driver.

Intramural research work is focused primarily on controls with some work on measurement, both in coal as well as metal/non-metal mining. Of the 34 active technology contracts, 16 or 48 percent are related in some aspect to respirable dust. Of the seven active capacity build contracts, three are related to respirable dust and one is related to ventilation of large openings as found in a non-metal mine. Much of the focus for these intramural contracts was driven by the 2018 National Academies' consensus study report entitled Monitoring and Sampling Approaches to Assess Underground Coal Mine Dust Exposures.

After executing 4 technology and 2 capacity-build contracts in 2019 that dealt with respirable coal mine dust characterization, the Mining Program formed an informal group from the contract principal investigators. The intent of this group was to facilitate organic interaction, collaboration (technical; facilities; data collection), and cooperation; three meetings have been held thus far and the results thus far have exceeded our expectations. The group was provided the materials from the U.S. Bureau of Mines funded Generic Mineral Technology Center (GMTC) for Respirable Dust that had been produced from 1983 through 1998.

Extramural contracts related to mine dust and silica were then classified by focus:

- characterization,
- measurement, and
- control

This was followed by a brief review of our contracts by status and year of origination:

- Completed (4 measurement, 2 control)
- Active Contracts 2018-19 Origination (4 characterization, 2 measurement, 1 control)
- Active Contracts 2020 Origination (4 measurement)
- Active Contracts 2021 Origination (1 characterization, 3 measurement, 1 control)
- Active Capacity Build Contracts 2019 Origination (2 characterization, 1 control)

Summaries of all contracts are available on the NIOSH Mining Program website and additional details on any contract are available upon request.

To demonstrate the development time required for new measurement techniques and equipment, the development timeline for the continuous personal dust monitor (CPDM) was described. Between 1970 and 1990, the U.S. Bureau of Mines researched different technologies for use as a short-term dust monitor in underground mines, settling in 1990 on direct mass measurement using a tapered element oscillating microbalance (TEOM) as the most feasible and accurate solution. The initial design was for a continuous miner mounted unit however that approach was halted in 1999 and reoriented toward a personal unit. Test units became available in 2004, followed by commercially available units (the 3600) in 2009, with certification following shortly thereafter. In 2014, the second-generation unit)3700) became available and its use was mandated in underground coal by regulation in 2016. NIOSH is currently funding the development of the 3rd-generation unit, addressing some of the shortcoming identified over time, and it should be commercially available in the 2022-23 timeframe.

NIOSH, building on USBM research (1992 USBM IC9309, *Research Toward Direct Analysis of Quartz Dust on Filters Using FTIR Spectroscopy*, Don Tuchman) has developed FAST, a field-based RCS monitoring approach using a portable FTIR analyzer. Unfortunately, this method relies on a gravimetric filter for analysis and, with the 2016 requirement to use the CPDM for personal sampling in underground coal, a separate sample would be required. To address this issue, NIOSH funded to contracts in 2021, one with Thermo Environmental Instruments LLC (manufacturer of the PDM 3700) and a second with the Desert Research Institute (affiliated with the University of Nevada, Reno) to develop a filter media and holder for the Personal Dust Monitor that are compatible with the FAST method.

Dr. Luxbacher then briefly reviewed the 2022 Broad Agency Announcement: Development and Demonstration of Mine Safety and Health Technology which includes as one of its focus areas Coal dust and/or silica characterization, measurement, exposure assessment, instrumentation, or control. He then asked if there were any questions from the Committee.

Mr. Bowersox asked about the contract for the development of an underground mine diesel particulate monitor. Dr. Luxbacher explained that this contract (Underground Mine Diesel Particulate Monitor Network, with NOMADICS, Inc., 2010-12) was a portable unit that utilized a spooled filter for analysis; it is currently on loan to Virginia Tech. He also noted that SMRD is currently doing some work with microAeth Labs also looking a diesel monitoring technology.

Public Comments

Chair Zimmer then opened the meeting for public comments.

Bruce Watzman asked the Lake Lynn replacement, noting that while he was with the National Mining Association he had advocated for this project, however since then NIOSH has found they can still undertake the necessary research without such a facility and that the mining industry has changed. With the replacement in use date still at least five years away, questioned if there was an alternate path forward and suggested a stakeholder dialog. He felt this was particularly critical given the flat funding the Mining Program has experienced for over a decade, the cost to construct and operate a new facility, and the expenses of maintaining the aging PMRD infrastructure (particularly the Experimental and Safety Research mines).

Dr. Kogel responded that his comments reflect internal discussions we have had within the program. Our stakeholders have been extremely supportive of the Lake Lynn replacement, and she sees value in

bringing the stakeholders together to make sure that, even with the industry changing, we maximize value and maintain the ability to do full-scale research. The facility needs to be designed with two primary priorities: first, large-scale Lake Lynn type explosion testing and second, the research needs of the other industry sectors that also require unique facilities. While we have initiated the discussion related to the second point internally, stakeholder input and views would be extremely beneficial.

Dr. Luxbacher then commented on the difficulties of applying full-scale testing from elsewhere such as Poland, is difficult because of the differing opening geometries. The same issues arise with scaled work done in explosion tubes. While we have data from Lake Lynn still available for analysis (from tests conducted from 1983 through 2008), much of that data was collected with instrumentation that now would be considered out-of-date. While computer modeling of explosions, as NIOSH has funded through the University of Maryland, shows promise, additional full-scale data is needed for validation. He then noted that automation in underground metal/non-metal is a topic that could be addressed at a Lake Lynn replacement facility with some changes or additions to its underground layout; we could then do research without impacting production in an active mine. There is also the potential for research at the surface portion of the site.

Mr. Watzman thanked Drs. Kogel and Luxbacher, then noted that he had attended a technical session on automation at MinExpo International earlier in the year. While the traditional focus of automation is on Fully autonomous operation, he felt that there was little to no emphasis on the transition from autonomous mining to truly artificial intelligence in the mining industry. He asked about NIOSH's plan for work in this area.

Dr. Kogel responded that we have established the Automation and Emerging Technologies Partnership to begin to address these issues, with an interest in understanding the health and safety impact of introducing automation in the broadest sense into the mining environment, and understanding how the human-machine interface, AI or other system, may create or mitigate health and safety risks within the mine environment.

Dr. Luxbacher noted that much of what Mr. Watzman was referencing is being dealt with by equipment manufacturers during development and reemphasized that our focus is worker health and safety. The NIOSH Mining Program is trying to find those issues and aspects of automation and autonomous equipment that relate to worker health and safety that can be addressed by our research programs, including identifying additional expertise we may need.

Chair Zimmer also commented they are seeing adoption of autonomy, both from the AI perspective and from operator control to a central location, in the construction industry at a rapid pace. The manufacturers are driving adoption.

Dr. Luxbacher noted that the NIOSH Mining Program has contracts with both Komatsu (Joy Global Underground Mining LLC) and Fletcher for automation projects related specifically to alleviating potential health and safety risks to miners.

Dr. Schafrik then asked what the timing was to get Mace (if the acquisition is completed) up and running for research purposes. Dr. Kogel responded that it will be 3 to 5 years. Dr. Schafrik then asked if NIOSH had a bridge plan for the interim. Dr. Kogel responded that we plan to continue tests in Poland, recognizing the limitations of that approach. NIOSH also plans to continue working with our academic partners who have facilities where some aspects of our research can be carried out. Dr.

Luxbacher noted that we have upgraded the Bruceton Safety Research and Experimental mines to maximize their utility during this period as well.

Dr. Schafrik then commented on automation efforts in the United States, noting that rather than full autonomy without miners in the area, it is instead more partial autonomy where miners may be present; this supports the NIOSH focus on human factors in the human-machine interface.

Chair Zimmer asked about the logistics for a stakeholder meeting regarding a Lake Lynn replacement. Dr. Kogel responded that this would probably be an informal meeting of stakeholders conducted over Zoom during the first or second quarter of 2022. Dr. Luxbacher suggested that planning for this meeting be deferred until the Mace site purchase was completed.

Dr. Azman of NIOSH asked if NIOSH had any discussions with some of these other large experimental mines such as the Sanford Underground Research Facility. Dr. Kogel responded that she had visited SURF, we have funded some work at the South Dakota School of Mines and Technology that involved work at SURF, and that NIOSH is aware of the available capabilities. Dr. Azman noted that one of the large equipment manufacturers has developed an autonomous research area there.

Mr. Bowersox asked about access to the Poland research mine. Dr. Kogel responded that she believes the facility would be open to visits from any of our stakeholders.

Dr. Biscontin mentioned that she is responsible for tunnelling research at NSF and would be interested in potential collaborations with NIOSH at Mace; Dr. Kogel was supportive of that concept.

Mr. Harman asked about the dust collection unit developed under contract by Fletcher as well as the status of the air canopy curtain for shuttle cars. Dr. Luxbacher responded that the dust collection unit was developed for bolter operation downwind of the continuous miner and, while Fletcher offers the unit commercially, to his knowledge none have been sold. The shuttle car canopy air curtain contract has just been completed and it is too early to look at the commercial adoption, although Fletcher has sold a number of roof bolters with a canopy air curtain. If the mining section uses a blowing ventilation scheme, the shuttle car can be in dust-laden air and the curtain has proved effective in our trials. There is current interest in the use of canopy air curtains to address diesel particulate matter (DPM) as well.

Mr. Harman then asked if NIOSH researchers were back on site in our facilities yet. Dr. Luxbacher responded that we are in a voluntary return to work phase currently, with no firm date for a total return to work yet. Dr. Luxbacher then discussed the difficulties in conducting field research without the ability to travel, relying on our collaborative mines for data collection and the difficulties in dissemination when we can't travel to conferences that have returned to an in-person mode.

Committee Discussion and Feedback on MSHRAC

Chair Zimmer asked if we could review the planning for the next meeting. Dr. Luxbacher asked the Committee to identify any topics they would like to see covered at the May 2022 meeting. He also asked if the Committee found value in the one to two-page summaries for each intramural project that were included in the meeting packet – if so, these would be included and updated for future meeting. Chair Zimmer, Mr. Stewart, and Mr. Duffy all thought they should be included going forward.

Mr. Bowersox noted the presentations were helpful and that Chair Zimmer did a good job running the meeting.

Dr. Luxbacher then commented that the next meeting will either be in Pittsburgh or Spokane on May 15-19 or May 24-26. The agenda will be built around the facilities and projects conducted at the chosen location. If possible, there will be a field trip to a mining operation scheduled for the day after the meeting. Dr. Kogel suggested that we focus on Pittsburgh for the next meeting so that RHD and NPPTL can both give presentations. Chair Zimmer and Mr. Duffy both indicated interest in hearing from these other NIOSH groups.

Mr. Stewart noted a topic he would like to see covered is slips, trips, and falls related to walking and working surfaces. That was supported by Dr. Brickey, who noted the impact of distractions. Dr. Kogel stated we would include both slips, trips, and falls and automation and situational awareness on the agenda.

Mr. Stewart then suggested a discussion on getting miners to wear hearing protection and understanding the long-term impacts of noise, suggesting NIOSH consider having seasoned miners who have suffered hearing loss to give testimonials. Drs. Kogel and Luxbacher both then commented on the need to research to show how behavior can be changed from situational awareness.

Dr. Schafrik suggested if the meeting is at Pittsburgh a visit to the MSHA Mine Emergency Operations (MEO) group should be considered. Ms. Calhoun noted MSHA would be willing to include MEO in a tour during a Pittsburgh meeting.

Mr. Stewart and Chair Zimmer then had a conversation about the low vaccination rates for COVID-19 in mining and construction. Dr. Mattson noted that the outgoing director of NIH suggested social science research is necessary to understand why vaccine hesitancy is so high.

Dr. Luxbacher, in response to a query from Dr. Schafrik, reiterated that NIOSH is already addressing the occupational safety and health issues associated with the extraction of rare earths and critical minerals as part of our normal research activities, however we are not doing work regarding processing. Mr. Stewart pointed out that if there is federal support for research in these areas, NIOSH should participate; Dr. Kogel assured him we were part of that discussion. Dr. Schafrik noted that there are a lot of opportunities for NIOSH to partner with universities and other in this area.

Ms. Calhoun reminded the Committee that MSHA was having their quarterly stakeholder call on December 14th and invited all to participate.

Appendix

Name	Affiliation	Dec. 8	Dec. 9
Mark Ellis	IMA-NA	Yes	Yes
Wayne Palmer	IMA-NA	Yes	Yes
Kyle Zimmer	IUOE	Yes	Yes
Thomas Harman	NMA	Yes	Yes
Dale Drysdale	NSSGA	Yes	No
John Ulizio	NSSGA	No	Yes
Libby (Elizabeth) Pritchard	NSSGA	Yes	Yes
Christina Stalnaker	MSHA	Yes	Yes
Deborah Tomko	MSHA	No	Yes
Elizabeth Way	MSHA	Yes	Yes
Jason Stoltz	MSHA	Yes	Yes
Joanna Moore	MSHA	Yes	Yes
Melanie Calhoun	MSHA	Yes	Yes
Wesley Shumaker	MSHA	Yes	Yes
Ron BowersoYes	UMWA	Yes	Yes
Tom Duffy	USW	Yes	Yes
Laura Reynolds	NIOSH - DFSE	Yes	Yes
John Howard	NIOSH - OD	Yes	No
Lore Jackson Lee	NIOSH - OD	Yes	No
Pauline Benjamin	NIOSH - OD	Yes	Yes
Berni Metzger	NIOSH - OD Mining	Yes	Yes
David Snyder	NIOSH - OD Mining	Yes	Yes
George LuYesbacher	NIOSH - OD Mining	Yes	Yes
Jessica Kogel	NIOSH - OD Mining	Yes	Yes
Lisa Steiner	NIOSH - OD Mining	Yes	Yes
Randy Reed	NIOSH - OD Mining	Yes	Yes
David Blackley	NIOSH - RHD	Yes	No
Noemi Hall	NIOSH - RHD	Yes	No
Scott Laney	NIOSH - RHD	Yes	Yes
Alan Mayton	NIOSH - PMRD	Yes	Yes

Name	Affiliation	Dec. 8	Dec. 9
Alan Zhang	NIOSH - PMRD	Yes	Yes
Amanda Azman	NIOSH - PMRD	Yes	Yes
Andrea Pascoe-Conteen	NIOSH - PMRD	Yes	Yes
Andrew Cecala	NIOSH - PMRD	Yes	Yes
Angela LaFollette	NIOSH - PMRD	Yes	Yes
Bob Randolph	NIOSH - PMRD	Yes	Yes
Brandin Lambie	NIOSH - PMRD	Yes	Yes
Brent Slaker	NIOSH - PMRD	Yes	Yes
Candace Wolf	NIOSH - PMRD	Yes	Yes
Carin Kosmoski	NIOSH - PMRD	Yes	Yes
Cassandra Hoebbel	NIOSH - PMRD	Yes	Yes
Chenming Zhou	NIOSH - PMRD	Yes	Yes
Christina Bedilion	NIOSH - PMRD	Yes	Yes
Clara Seaman	NIOSH - PMRD	Yes	Yes
Curtis Robinson	NIOSH - PMRD	Yes	Yes
Dana Willmer	NIOSH - PMRD	Yes	Yes
Davood Bahrami	NIOSH - PMRD	Yes	Yes
Donna Opfer	NIOSH - PMRD	Yes	No
Emanuele Cauda	NIOSH - PMRD	Yes	No
Eranda Perera	NIOSH - PMRD	Yes	Yes
Eric Watkins	NIOSH - PMRD	Yes	Yes
Gerrit Goodman	NIOSH - PMRD	Yes	Yes
Heather Dougherty	NIOSH - PMRD	Yes	Yes
Hua Jiang	NIOSH - PMRD	Yes	Yes
Jack Trackemas	NIOSH - PMRD	Yes	Yes
Jacob Carr	NIOSH - PMRD	Yes	Yes
James Rowland	NIOSH - PMRD	Yes	Yes
Jay Colinet	NIOSH - PMRD	Yes	No
Jeffrey Peterson	NIOSH - PMRD	Yes	No
John Homer	NIOSH - PMRD	Yes	Yes
John Potts	NIOSH - PMRD	Yes	Yes
John Sammarco	NIOSH - PMRD	Yes	No

Name	Affiliation	Dec. 8	Dec. 9
John Hrica	NIOSH - PMRD	No	Yes
Joseph Bickson	NIOSH - PMRD	Yes	Yes
Joseph Galanko	NIOSH - PMRD	Yes	Yes
Justin Johnson	NIOSH - PMRD	Yes	Yes
Justin Srednicki	NIOSH - PMRD	Yes	Yes
Kathleen Braunegg	NIOSH - PMRD	Yes	Yes
LaTasha Swanson	NIOSH - PMRD	Yes	Yes
Launa Mallett	NIOSH - PMRD	Yes	Yes
Lauren Chubb	NIOSH - PMRD	Yes	Yes
Lihong Zhou	NIOSH - PMRD	Yes	No
Liming Yuan	NIOSH - PMRD	Yes	Yes
Lincan Yan	NIOSH - PMRD	Yes	Yes
Linda Chasko	NIOSH - PMRD	Yes	No
Lynn Alcorn	NIOSH - PMRD	Yes	Yes
Mahiyar Nasarwanji	NIOSH - PMRD	Yes	Yes
Marcia Harris	NIOSH - PMRD	Yes	Yes
Mary Ellen Nelson	NIOSH - PMRD	Yes	No
Matthew Girman	NIOSH - PMRD	Yes	Yes
Michael Murphy	NIOSH - PMRD	Yes	Yes
Miguel Reyes	NIOSH - PMRD	Yes	Yes
Morgan Sears	NIOSH - PMRD	No	Yes
Nick Damiano	NIOSH - PMRD	Yes	Yes
Paul Schmidt	NIOSH - PMRD	Yes	Yes
Pete Kovalchik	NIOSH - PMRD	Yes	Yes
Rebecca Geromi	NIOSH - PMRD	Yes	No
Scott Klima	NIOSH - PMRD	Yes	No
Stephen Sawyer	NIOSH - PMRD	Yes	Yes
Steve Schatzel	NIOSH - PMRD	Yes	Yes
Steven Mischler	NIOSH - PMRD	Yes	No
Suzanne Alison	NIOSH - PMRD	Yes	Yes
Ted Klemetti	NIOSH - PMRD	Yes	Yes
Thomas Dubaniewicz	NIOSH - PMRD	Yes	Yes

Name	Affiliation	Dec. 8	Dec. 9
Tim Beck	NIOSH - PMRD	Yes	Yes
Valerie Coughanour	NIOSH - PMRD	Yes	Yes
Yousef Elmashae	NIOSH - PMRD	Yes	Yes
Yuting Yesue	NIOSH - PMRD	Yes	Yes
Aaron Sussell	NIOSH - SMRD	Yes	Yes
AleYes Johnson	NIOSH - SMRD	Yes	Yes
Brianna Eiter	NIOSH - SMRD	Yes	No
Cara Halldin	NIOSH - SMRD	Yes	Yes
Carol NiYeson	NIOSH - SMRD	Yes	Yes
Donovan Benton	NIOSH - SMRD	Yes	No
Douglas Johns	NIOSH - SMRD	Yes	Yes
Gerald Poplin	NIOSH - SMRD	Yes	Yes
Heather Lawson	NIOSH - SMRD	Yes	Yes
Josef Bourgeois	NIOSH - SMRD	Yes	Yes
Joseph Seymour	NIOSH - SMRD	Yes	Yes
Melody Janse van Rensburg	NIOSH - SMRD	Yes	Yes
Pamela Drake	NIOSH - SMRD	Yes	Yes
Robert Bissonette	NIOSH - SMRD	Yes	Yes
Ronald Jacksha	NIOSH - SMRD	Yes	Yes
Samantha Wilson	NIOSH - SMRD	Yes	Yes
Samir Sbai	NIOSH - SMRD	Yes	No
Shilpi Misra	NIOSH - SMRD	Yes	No
Tim Bauerle	NIOSH - SMRD	Yes	No
Todd Ruff	NIOSH - SMRD	Yes	Yes
Tyler Emery	NIOSH - SMRD	Yes	Yes
Vaibhav Raj	NIOSH - SMRD	Yes	Yes
Zoe Dugdale	NIOSH - SMRD	Yes	Yes
Andrea Brickey	Public	Yes	Yes
Bruce Watzman	Public	Yes	Yes
Dylan Stroman	Public	Yes	Yes
Giovanna Biscontin	Public	Yes	Yes
Josie Gaskey	Public	Yes	No

Name	Affiliation	Dec. 8	Dec. 9
Kelly Bailey	Public	Yes	No
Kristina Behringer	Public	Yes	Yes
Marifran Mattson	Public	Yes	Yes
Steven Schafrik	Public	Yes	Yes
Matt Stewart	Public	Yes	Yes
Jeff Welsh	Public (Retired)	Yes	Yes

I hereby certify that, to the best of my knowledge, the minutes of the December 8 & 9, 2021 meeting of the Mine Safety and Health Research Advisory Committee (MSHRAC) are accurate and complete

_____ _____

Date

Chair, Mine Safety and Health Research Advisory Committee