MINUTES

**MINE SAFETY AND HEALTH RESEARCH ADVISORY COMMITTEE (MSHRAC) MEETING
May 9-10, 2017, 9:00 AM – 12:00 PM
NIOSH MORGANTOWN FACILITY
1095 WILLOWDALE ROAD
MORGANTOWN, WV 26505**

COMMITTEE MEMBERS PRESENT

Mr. Ronald Bowersox, United Mine Workers of America, MEMBER
Dr. Jefferey Burgess, University of Arizona, MEMBER
Mr. Dale Drysdale, National Stone, Sand & Gravel Association, MEMBER
Mr. William Francart, Mine Safety & Health Administration, MEMBER
Dr. Kramer Luxbacher, Virginia Polytechnic Institute and State University, MEMBER
Dr. Aubrey Miller, National Institutes of Health, MEMBER
Dr. Priscilla Nelson, Colorado School of Mines, CHAIRPERSON
Mr. Bruce Watzman, National Mining Association, MEMBER (In person 5/9, By phone 5/10)
Mr. Michael Wright, United Steelworkers of America, MEMBER (By phone 5/9, In person 5/10)
Mr. Kyle Zimmer, International Union of Operating Engineers, MEMBER

Mr. Jeffrey Welsh, NIOSH, Designated Federal Officer

COMMITTEE MEMBERS ABSENT

Ms. Stacy Kramer, Freeport McMoRan, MEMBER
Dr. Richard Fragaszy, National Science Foundation, MEMBER

OTHER PARTICIPANTS

Mr. John Burr, NIOSH (By phone)
Ms. Marie Chovanec, NIOSH (By phone)
Dr. Maryann D'Alessandro, NIOSH, (In person)
Dr. Brianna Eiter, NIOSH, (In person)
Mr. Edward M. Green, Crowell & Moring (In person)
Dr. Emily Haas, NIOSH, In person)
Dr. John Howard, NIOSH (By phone)
Dr. Jessica Kogel, NIOSH (In person)
Dr. Laura Kurth, NIOSH (In person)
Dr. Eric Lutz, NIOSH (In person)
Dr. George Luxbacher, NIOSH (In person)
Dr. RJ Matetic, NIOSH (In person)

Dr. Mahiyar Nasarwanji, NIOSH (In person)
Dr. Jerry Poplin, NIOSH (In person)
Mr. Drew Potts, NIOSH (In person)
Mr. Adam Smith, NIOSH (In person)
Dr. David Weissman, NIOSH (In person)
Dr. Dana Willmer, NIOSH (In person)

Mr. Welsh welcomed MSHRAC Members and attendees to the meeting. He welcomed two new MSHRAC members, Ron Bowersox representing the United Mine Workers of America, and William Francart representing the Mine Safety and Health Administration, to the committee. They replace retiring members Dennis O'Dell and Jeff Kravitz. He also mentioned another new MSHRAC member that could not make the meeting, Stacey Kramer from Freeport-McMoRan. The MSHRAC also has a vacancy from the retirement of Sukumar Bandopadhyay that needs to be filled. Mr. Welsh explained that MSHRAC members participating in the meeting must be free from conflicts of interest. He asked members to self-declare any conflicts of interest that may come up during the meeting and recuse themselves from any discussion related to that conflict, and they cannot participate in voting for that particular matter. There were no conflicts from members reported. Mr. Welsh conducted a roll call to confirm a quorum. He then turned the meeting over to MSHRAC Chair Priscilla Nelson for the introduction, announcements and approval of minutes.

Introduction, Announcements, and Approval of Minutes, Dr. Priscilla Nelson, MSHRAC Chair

Dr. Nelson read the minutes from the last meeting, November 2017 in Spokane, Washington. There were no suggested changes to the minutes and they were approved unanimously.

NIOSH Director's Opening Remarks, Dr. John Howard

I would like to welcome MSHRAC committee members, and I thank you for taking time out from your busy schedules to travel to Morgantown and participate in this meeting. MSHRAC is a vital channel of communication that we rely on to give us advice about our programs. This morning, I would like to briefly discuss some administrative items. The FY17 budget was finally enacted recently, but at this time we do not have our budget numbers from CDC and HHS. The President's proposed FY18 budget is scheduled to be released to the public on May 22. What changes to the total NIOSH budget that will be in the proposed FY18 budget is uncertain at this time. A couple of other things that are happening in terms of administrative initiatives, one has to do with reconfiguring the government and reducing the federal civilian workforce overall. The Secretary of HHS has launched an initiative on reimagining HHS in terms of issues of duplication and consolidation, and some other issues. A 90-day hiring freeze was put in effect in January, and when that expired, HHS chose to continue the hiring freeze. At this time we are not doing any hiring from outside the government. There are processes of promotion and movement within the already existing workforce that we are able to do. In addition, the administration has interest in reducing regulatory burdens. NIOSH has ten regulations. Some of them involve the Mining Program in coal workers' surveillance. They are statutory, not our statute, but they come from the Mine Safety and Health Administration. The other regulations that we have at NIOSH are chiefly those that involve the World

Trade Center Health Program. We don't have any items on our regulatory agenda for the near future, so those issues don't really involve us. I again would like to thank committee members for your service on MSHRAC.

Report from the NIOSH Associate Director for Mining, Dr. Jessica Kogel

I would like to welcome everyone as well, and I appreciate the input that NIOSH gets from the MSHRAC Committee. This morning, my presentation will be a high-level overview to prepare everyone for the day and a half of presentations to come, and to provide some context. The central topic of my presentation is an update on where NIOSH Mining is with strategic planning.

Now that we have permanent people appointed to the key leadership positions within the Mining Program, we have begun the planning process to take the strategic plan, which has not been updated since 2008, and make it our own. The strategic plan is very important in that it gives us a script to work off of, so that we are unified in our approach, and it insures that we are aligned across the mining program, and with the NIOSH strategic plan, as well as with NORA.

The mission statement now reads, "To eliminate mining fatalities, injuries and illnesses through relevant research and impactful solutions." We also have a strategic management process in place that makes sure that we are executing the strategic plan on an operations level. We began by developing our long-range strategy, and right now, we are looking out about ten years. Both the Spokane and Pittsburgh Divisions have put together a ten-year view, and we are doing a similar exercise with our extramural program as well. The goal is to be sure that the extramural and intramural programs are aligned, and that everyone is communicating across the different pieces of the program. This long-range, program-wide strategy includes setting priorities— and that is very much where the MSHRAC Committee comes in, that is where our stakeholders come in as well. Priority setting is probably one of the most important and challenging things that we do. We set priority based on burden, need and impact.

Once the long-range strategy was in place, we started planning the research on a shorter timescale. This short-term planning takes place at the division level on an annual timescale out to three years. Part of the planning process is to align our resources with our research priorities. These resources include budget, human resources, and facilities. From there, we then execute the plan and the branches and teams are primarily responsible for execution. You are going to hear presentations from various branches and teams over the next day and a half that will focus on this part of the planning cycle. Finally, it is very important for us to measure the performance of this research portfolio and the projects that are part of this overarching strategic plan. Performance is based on impact, which is a key measure.

We have three overarching strategic goals. Embedded within those overarching strategic goals are intermediate goals that are much more specific to mineworker health and safety objectives. Intermediate outcomes that include milestones as well as a dissemination plan, with two types of outputs, comprise the next level of the plan. The two types of outputs include Science outputs such as peer-reviewed journal articles, and the other type of outputs are our translational outputs, which include webinars, publications in trade journals, apps, and a number of other things. Both are very important to us, both reach different types of audiences, and both have different types of impact.
The next item that we tackled was our vision, which is "Safe Mines, Healthy Workers". Next was the value

statements: relevance, impact, innovation, integrity, collaboration and excellence. In the remainder of my presentation I will go through each value and why each is important.

Relevance: What we do has to be relevant, and what we mean by "relevance" is our research must be relevant to stakeholder concerns. Each stakeholder comes to us with different perspectives and different needs. Sometimes they are overlapping; sometimes not. Sometimes they are in opposition and so it's really our job to, first of all, understand each of our different stakeholders' needs and concerns and then look for the places where we can work on common issues. We pursue research that addresses and is responsive to the most critical needs of our stakeholders, and critical needs is really what we're trying to identify, and that brings us back to how we set priorities.

Impact: The work we do must get into the mines to have impact. We deliver results in a timely way, "timely" means something different for different stakeholders. It has to be of value to our stakeholders, so that's the value-driven piece. And also we added cost-effective solutions.

Innovation: We always want to be on the cusp of innovation and understanding what is coming in the future. Especially if we are looking at a strategy that has a ten-year timeline. We need to have that vision. We need to have a view of what is coming, and over the last couple of years there has been rapid change in the industry and we need to understand that change. We need to also know how to respond to it and we need to understand how that change is going to impact worker safety and health. We have to create an environment that encourages forward thinking. Our strategy is to look towards the future, by being proactive and anticipating the future.

Scientific integrity: We are a science organization. We can't maintain the trust of our stakeholders if we don't do research with scientific integrity. It is one of our highest priorities. It's about accountability and trust. When we put that research out, it has to be of the highest integrity so that our stakeholders and all of the consumers of our research can trust that research.

Collaboration: Collaboration is very important to what we do and to our success as a program, and so we put a lot of effort into this. We continue to find ways to build new partnerships and to collaborate in new ways that really help inform the program. Some of the collaborative activities that are taking place include cross-sector activities, where we are looking at other sectors, particularly oil and gas as well as construction, for common ground where we can work together to more efficiently use our resources to solve problems. The other is cross-NIOSH with NIOSH DLO's. One of the reasons we held this meeting in Morgantown is because this location is a great example of collaboration across the institute. While we are here, you will hear from the National Personal Protective Technology Laboratory as well as the Respiratory Health Division, and you will have an opportunity to visit the facilities where mining research takes place. Another is our partnerships. We have five active partnerships which are vitally important to our process because they provide an opportunity to bring our stakeholders together to hear about the progress of the research, and also to have an exchange. This informs the research—we like to meet once or twice a year, some more frequently depending on how much we have that is coming out from the research in terms of information that we can share with the partners.

Last is scientific excellence and rigor: Without high-quality science, we can't advance research frontiers, and we don't want to just solve the problems we also want to advance research frontiers. What we aim to

do is to passionately pursue rigorous, high-quality and unbiased science in service of our mission.

Report from the Pittsburgh Mining Research Division, Dr. RJ Matetic

This morning, I will provide an update of the NIOSH Pittsburgh Mining Research Division (PMRD), including organizational updates, the current research portfolio, and new products and impacts. The total staff at PMRD is currently 169 employees, one more employee since the last MSHRAC meeting. The current staff who can retire within the next three years is 59, it was 55 six months ago, and that number continues to increase. The PMRD organization on paper has 205 positions. Since last MSHRAC, PMRD hired 12 employees, through the open continuous announcements for mining and mechanical engineers, some service fellowships, competitive job series announcements, and reassignments. PMRD also filled leadership positions as well—two branch chief positions, the Deputy Division Director and the Associate Director for Science. Although we hired 12 people in the last six months, only 1 was gained, because PMRD lost 11 people. To prepare for the future, a workforce development plan, a leadership development plan, and a technical competency plan for succession planning are being developed. In the workforce development plan, core and functional competencies associated with a researcher, an advanced researcher, a technician or an administrative person are included. Also, in the leadership plan, there's core competencies to be a leader, but then there are functional competencies associated with the position. And last, there are technical competencies for all of our employees. This is 95 percent complete, and it provides us with opportunities to look at our program, and to adjust and allocate resources the way that we need to for future requirements that may come our way.

The PMRD research portfolio addresses all mining sector types, coal, metal/non-metal, and stone, sand and gravel. In 2017 there are 20 projects, and 23 projects proposed for 2018. The difference from ’17 to ’18 is an increase in metal/non-metal and stone, sand and gravel research, and a little decrease in coal research. The new projects in 2018 include advancing exposure monitoring for airborne particulates in mining, advanced strategies for controlling exposures to diesel aerosols, elongate minerals particles research, system automation approach for sensor-driven machines, and increasing the effectiveness of targeted hearing conservation program elements. A total of five new starts are planned for 2018.

For our PMRD outputs, since last MSHRAC, 134 outputs were produced, 59 of those being science, 75 of those being translational (for science 44 percent, translational 56 percent). At the SME Annual meeting in 2017, PMRD had 33 papers and presentations. Program areas included: disaster prevention and response, ground control, dust control, and machine safety and human factors. Considering what the outputs were as far as applicability to different commodities: 42 percent were coal, 20 percent were stone, sand and gravel, 11 percent were industrial minerals, 9 percent were metal, 16 percent were all mining, and 2 percent were oil and gas. Other dissemination and stakeholder interaction activities include: the Underground Stone Seminar in December in Kentucky, SME annual conference, CONEXPO-CON/AGG in March which included our audiometric trailer where we provided free hearing tests to 200 people,

Proximity Detection Workshop in March, and a Hazard Recognition and Risk Webinar in March. Coming up we have a Breathing Air Supply Partnership June 7, a Refuge Alternative Partnership June 7, Longwall USA, Bluefield Coal Show, a webinar on Methane Control, and a Diesel Health Effects Partnership meeting.

I would next like to talk about new products since the last MSHRAC meeting. They include Helmet-CAM and EVADE. EVADE was the first software used to look at dust exposures, tied with a video camera. With the updated EVADE 2 software, any monitoring device can be used, noise, diesel aerosols, and other hazards. In addition, you can monitor multiple parameters at one time. Another product is a web app called Safety Pays where operators can input mining injuries that have occurred, and the software program will provide you with the direct/indirect costs associated with the type of injury. Through our Refuge Alternatives research work with MSHA, our research on temperature and humidity are now included in their approval criteria documents on apparent temperature. The Canopy Air Curtain continues to grow in use. The canopy air curtain sits over top of a roof bolting machine operator and it provides a curtain of air around the head of the person to remove dust exposures from that person. There are now 40 of these in mines The end-of-shift silica monitoring method will now be beta tested this calendar year, probably in the summer. It provides you with the silica exposure within two minutes after the shift.

Questions and Comments:

Dr. Burgess (Q) - Have you decided the extent to which you're going to have projects for oil and gas? So it was like 2 percent so far. Do you have a goal or are those all the proposals that came in for that topic? What's your strategy around that area?
Dr. Matetic (A) - We've met with oil and gas representatives and with construction representatives. What we are trying to do as a mining program is to first look at what do we have available that is out there that people are using that might be applicable to those particular sectors. For example, illumination or lighting that's applicable, that we develop for use in mining. That may be applicable for construction or oil and gas. We are looking at those kinds of products or technologies that we have already developed and then trying to introduce them into the oil and gas and construction sectors. Also, if there is a common need relative to issues in mining that are applicable to oil and gas—for example like the fracking process with silica exposure, we have technologies that might be able to help. So we're looking at the commonalities between, for your example, the oil and gas and mining—not only in what we do as far as a research product, but what do we already have that might be applicable. And I know construction with CPWR has a number of products that we have developed in hearing loss and lighting where they're actually putting those on their website for people to be able to get and use in that particular sector. So that's how we look at it—what are the commonalities and what can we work together on that serves us both.

Mr. Bowersox (Q) - Could you answer a question on Lake Lynn? It was brought up, real estate issues. That's something you think could be worked out or is there another site being looked at?
Mr. Welsh (A) - Yes, we are still actively looking for sites. We had an advertisement in the federal register

for proposed sites and we have looked at several different proposals and there are still proposals coming in that address our specifications for a Lake Lynn replacement. So it's still active and they're still looking for sites that meet our requirements.

Dr. Miller (Q) - I've just got to follow up a little bit on Jeff's question, because NIOSH actually helped to identify the issue of the silica on the fracking sites which I thought was interesting, and in terms of still identifying issues of concern within various industries, how is that being translated back to your program and then thinking about what you're going to bring to the table. Is that part of this connection with surveillance or how does that play out? Or is it just kind of thinking about what's available right now?
Dr. Kogel (A) – We have set up a working group and Jeff Welsh co-chairs that with Ryan Hill and David Caruso for oil and gas. In this case, it's a working group that meets every other month to have exactly these sorts of discussions. And we're interacting with each other in terms of our NORA sector councils and so we'll send somebody from mining to the oil and gas NORA sector council and then vice versa. We have built many bridges between those programs so that there are ongoing discussions to identify what the common issues are and when that information comes back into the divisions depending on what the results are from those discussions. With both PMRD and SMRD, if there's a particular topic that's been identified as a high priority for translating a particular technology that has already been developed, that might go back to PMRD or back to SMRD to then take it to the next step.
Mr. Welsh (A) - Their number one issue is silica exposures and that's one of the things we're doing. For example, in mining we have developed a dust control handbook, and we have a group in oil and gas looking at that and looking at what sections could be transferred and customized for the oil and gas industry for different types of dust controls and looking at the haulers who haul the sand and their exposures. And we're looking at maybe using Helmet-CAM to look at their exposures and where they're getting those and how we can take care of them.
Ryan Hill (A) - We also have collaborative projects that are spanning NIOSH divisions that are getting external funding, external to NIOSH but within CDC through competitive processes, for example, the silica bag house for the sand haulers. That's another example of how we have concrete proactive multidisciplinary teams that are tackling some of these challenges that are within oil and gas.

Dr. Nelson (Q) – As far as Construction collaboration, I know you met with Christine Branche, NIOSH Construction, and the other parts of NIOSH. But I recently was talking to Lou Ruzzi who runs the AASHTO Tunnel Committee, and we started sparking all sorts of ideas. I've shared those ideas with Dr. Kogel, and I think that two-way exchanges may be possible. These are low-hanging fruits so I encourage it. I know you look beyond the NIOSH connections but this is an area in construction that there are so many organizations that have their piece of the action but the state DOTs are really motivated to do some of these things. Regarding Safety Pays, are you looking at what the costs of construction industry accidents or incidents are compared to mining?
Dr. Matetic (A) - No, not at this time, the Safety Pays product is specific to mining.
Dr. Nelson (Q) - Is there such a database on construction incidents? It would be interesting to enquire to see whether that's the case.

Dr. Matetic (A) - I would think they might have something like that, and if they do, we could actually compare.

Dr. Nelson (Q) - Yes. I think that would be great. Another thing I want to bring up is how do make sure people are using your output? When I was talking with the AASHTO people, they find that single webinars just don't do the trick. They have to do something far more creative and sustained because webinars may not be effective. And also could use more journal papers – presentations at meetings cannot be cited, but actual publications can be cited and used. I think there is a discussion in NIOSH and CDC about the idea of different metrics. But yet we always are careful with metrics because you end up getting what you asked for. So think about trying to use some of the indexes that tell you about citations—who is using it and where—in terms of the papers or even the webinars. We have the same problem in academia so I can commiserate with this.
Dr. Matetic (A) - In many of the things that we do related to interventions and technologies that we develop, working with a manufacturer and working with operators and partnership committees is the key to introduce this technology and get it adopted. And then, really, the big question for the operator is, why should I purchase it and what benefit is it going to be for me? And obviously there's a health and safety benefit but we try to, through these translational pieces even put together business cases on why, if I'm an operator, why would I purchase this? And then we get into some of the costs associated with the injuries, fatalities. So we do that to show the benefit of adopting the technology.

Report from the Spokane Mining Research Division, Dr. Eric Lutz

I will provide an overview of the activities at the NIOSH Spokane Mining Research Division (SMRD). SMRD now has 43 FTEs. Eighteen months we were at about 28, so we've had significant growth over the last year-and-a-half and that's going to be evidenced by the volume of work that we've been doing. My presentation will cover four primary areas, current research projects, a dissemination plan for this year, facility improvements and capability expansion including the four teams, and highlights of what we've been working on and what we will begin working on in the new research cycle.

SMRD has four primary full projects across the division: 1) Smart ventilation to control airborne pollutants and physical stressors in underground metal and non-metal mines, 2) Detecting and managing dynamic failure of near-seam features in coal and non-metal mines, 3) Durable roof support for Western US underground mines, and 4) Alternative mining methods in challenging mining environments. SMRD also funded five pilot projects: 1) Computational fluid dynamics modeling in processing facilities - this is looking at the ventilation and the complexities that exist with how air flows around processing equipment to control dust exposures; 2) Feasibility study for a novel field portable DPM monitor; 3) Predicting heat strain in underground metal and non-metal miners; 4) Advanced mining seismicity processing; and 5) Blast damage control to reduce injuries from ground falls in underground western hard rock mines.
For the dissemination plan, this year SMRD really changed our focuses. We are in alignment with PMRD

and collaboratively working to really push the translational outputs—the webinars, the YouTube videos, the training materials. We're focusing on packaging some of our outcomes into outputs that are more digestible, that is we are working hard to develop those translational outputs in a way that can be used and applied immediately to operations. And we are even going back to the level of using YouTube videos and creating 45-minute sessions related to our outputs that can be used by lecturers or faculty members at the universities for those mining engineering students and health and safety professionals that are in school. This will allow them to add lectures to the incoming professional workforce that then they can apply the latest and greatest state of the art to their workplaces as operators.

Some of the facility improvements have been pretty significant in Spokane. We now have added a scanning electron microscope that, in the infancy of this program, has allowed us to already begin characterizing DPM and dust particles. We are already characterizing coal samples and ground support corrosion studies. Some of the interesting research related to the coal samples is we are looking at the chemical makeup and the percentages of various components within that coal to try to understand the relationships that may exist in relation to bumps. We have also added a Sandvik compact core drill, which is a customized drill that was designed specifically to our specifications that allows us to do more expanded geo-mechanics research. It saves time and money and gives us the flexibility to move this drill where we need it within underground mines without having to contract that work out and go through a lengthy and expensive procurement process. SMRD also added a radio frequency test chamber that allows us to conduct tests of wireless mine communication systems and also radio interference testing. It is one of its kind in NIOSH. In the construction phase is a 25 x 16 foot environmental chamber that will allow us to do physiological evaluations in controlled environments. Here we are looking at heat stress, as well as at cold stress. We are also expanding our industrial hygiene lab, which is a shared lab space with the NIOSH Western States Division (WSD). SMRD and WSD share the same building in the Spokane facility and our researchers work shoulder-to-shoulder to solve those exposure problems that the industrial hygiene teams deal with. And also we have added the capability of computational fluid dynamic ventilation modeling and this is in support of the processing facility project that I alluded to earlier.

Now for some of the SMRD team highlights. In the Metal Ground Control team there are two new projects this year—Durable Support Technology and Alternative Mine Methods for Deep Mines. The team has four new researchers. There are new partnerships with western mining companies, so the network of people that we are interfacing with, and access to mine sites is expanding for this team. They presented five papers at the Deep and High Stress Mining Conference in Perth. Twenty-seven high-energy, high-displacement shotcrete panel strength tests have been conducted this year with our partners—Barrick-Newmont, Turquoise Ridge and Hecla. SMRD's newest team is the Health, Exposure Assessment, and Monitoring Team. Team Leader is Jerry Poplin, who comes from the University of Arizona. The Miner Health Program is a significant program within this team that will be presented in detail tomorrow. Heat stress fact sheets have been developed, and they are available online. We have conducted training related to heat stress and heat strain and have trained over 400 miners at two different mine sites. New projects planned for this team include: Clinical and field data analysis, Fatigue, Hand/arm vibration, and

Heat stress and cognitive effects. That will utilize the environmental chamber. The third team is the Mining-Induced Seismicity and Stability Team. The team has been developing new partnerships across the West in underground coal mines. They are also developing aerial photogrammetry using a drone to study subsidence. New seismic analysis techniques to improve detection and location accuracy is also a new project within this team. The Automation and Technology Team is the new name for the previous Ventilation Team. The scope of this team has expanded. It is working on strategic planning with the mining program for safety research in emerging technologies and automation, to supplement the work that's being done in Pittsburgh, and to look at some of the most pressing challenges in the west, related to technologies in automation and what that means from a Health and Safety perspective. The team is also testing localized ventilation control under a partnership with the Colorado School of Mines' Edgar Mine. There are also 2 new projects being planned for the team related to: 1) Computational fluid dynamic modeling for improved dust control in plants and mills and 2) Development of a portable real-time DPM monitor.

Questions and Comments:

Dr. Burgess (Q) - I liked the protocol characterization. Have you considered adding some form of toxicity assessment in addition to your scanning electron microscopy?
Dr. Lutz (A) - Our strategic vision is that we will be moving in that direction. This has been a capability that's been desired in the division for a long time and so there is a queue of things that people wanted to work on and they had been contracting a lot of that work out. And so once we work through the backlog of things related specifically to the particles, we will transition to toxicity as well.
Dr. Burgess (Q) - I think they have activities here in Morgantown in the Health Effects Laboratory Division (HELD) that I think can do that type of work as well, so it seems to me to be a great opportunity for collaboration.
Dr. Lutz (A) - Yes, that's a great idea and we'll make sure that we reach out to HELD and integrate that into our work.

Participant (Q) - How does the ventilation smart monitoring and control (SMAC) work go beyond the current VOD technology?
Dr. Lutz (A) - What it is doing is it's taking the inputs from various measurement devices and integrating it into a single system. So related not only to particulates but also a gas level measurement, CO for example, general opacity and ventilation rates, and they're trying to integrate it across into a single system that can control multiple levels within the VOD. So it's not developing a brand new technology, but it's integrating the separate technologies that exist right now in pieces and parts into one single system. A lot of the work has been done on the programming side to really try to communicate with each of the proprietary pieces of software that exist into one single dashboard.

Dr. Miller (Q) - In terms of the induced sites in Mississippi I've seen a couple of presentations recently by USGS and I don't know if you partner with them but they also have been looking at it in terms of fracking

and deep-well injection and it might be a nice opportunity to partner with them as well.
Dr. Lutz (A) - Yes, and we actually do.

Dr. Nelson (Q) - Does the Spokane office do anything or does any of the offices do anything with tribal resource development other than the West ? Do you do anything special with them?
Dr. Lutz (A) - Not specifically targeted to the tribal governments. We worked at the San Juan Mine, for example, on the Navajo reservation—it's now Navajo-owned—but not specifically targeting the tribal government structure.
Dr. Nelson (Q) - I'm just wondering if there are any cultural differences that actually have impacted on safety.
Dr. Lutz (A) - Yes, absolutely. But those exist—those cultural nuances exist—not only within the native nations but across the country. And so as we disseminate our information it's important, that we pause and take a look at how to communicate most effectively to our audiences. And that's why we're transitioning to these translational outputs as opposed to just the scientific outputs. As we mature our approach to recognize what could be most valued by our stakeholders, that's where we have to make sure that we're giving due respect to how our consumers are going to hear and digest what we're trying to give to them, and make sure that we're communicating it best for them, not for us.
Dr. Kogel (A) - The Western States Division of NIOSH also has interaction with the native tribes.
Dr. Miller (Q) - I'm trying to think about that translational element to tribal communities. I know we fund a number of community-engaged partnerships with academia and tribal communities that might be able to leverage academic investments and relationships with tribal communities in a way that allows information to be translated in maybe some new ways, I'm trying to think about that translational element. It's a difficult one but there are some partners, groups and academics institutions that have those relationships that you could benefit from.
Dr. Lutz (A) - Yes, and I'm not sure what the best approach is.
Dr. Miller (A) - The University of Arizona has some.
Dr. Lutz (A) – Dr. Burgess could speak to this and he has current projects related to the tribes. But the same thing could be said for Appalachia, for the northeast, for the south. That brings up a really interesting point that we need to make sure that we're not doing a one-size-fits-all for everybody, that we have the capacity within the confines of the government structure of how we vet these outputs and how they have to be stamped-approved before we can release them for broad dissemination. Do we have the flexibility within that to adapt them just in voice—in tone, in language, but the content's essentially the same and I'm not sure we're there yet but that's an excellent point that I think we should consider.

Update on Experimental Mines, Mr. Adam Smith

I will give an update on the Bruceton Experimental Mine and Safety Research Coal Mine. I will start with some history of this facility. Over a hundred years ago, in 1910, the Experimental Mine was established under the US Bureau of Mines, through a land lease with the Pittsburgh Coal Company. One of the first

findings at this facility was that coal dust by itself is capable of propagating an explosion, even in the absence of methane gas. Shortly after, an oval test track was developed in the mine to conduct ventilation research related to the construction of the Holland Tunnel in New York City. This mine facility is still used today to conduct high impact research, including proximity detection that reduces injuries and fatalities related to human-machine interactions, developing reliable and safe refuge alternatives when self-escape is not possible, developing a real-time method to monitor ventilation effectiveness and detect underground mine fires, and enhancing the performance of underground communication systems in the event of emergency. Some of the first autonomous navigation systems were also tested at the Bruceton Experimental Mine.

This is a complex and unique research facility that requires support. The three main structures are the Safety Research Coal Mine, the Experimental Mine, and the old Explosion Control Center. These facilities are all part of the Pennsylvania Historical Landmark which is designated by a placard on site. There is also a Mine Office and a Mine Shop. The mine has four portals, two on the Experimental Mine side and two on the Safety Research Coal Mine side.

Routine maintenance is needed for the safe and continuous operation of the mine. These facilities require resource support just like any other active mine. The environmental conditions must be observed and addressed continuously. Support systems must be operational and repaired quickly when damaged, and research must coordinate with these maintenance and support functions to ensure the health and safety of the personnel working underground. Protocols must also be in place for employees and visitors that enter the mine as part of research, facility tours and special events, such as bring your kids to work day.

Transitioning into the future, the operations and maintenance of the mine has been transferred to the Pittsburgh Research Mining Division and we have formed the Mine Maintenance and Use Committee. This committee meets quarterly to discuss maintenance, facility upgrades, current testing, and potential future research. There is also a support contract that encompasses the current mine workers and immediate tasks to address some of the roof control and electric distribution concerns in the mine. The federal employees that were the mine workers in the mine for years recently retired. As part of the site facility maintenance and support contract, 2 mine workers have been hired to assist in the day-to-day operation of the mine. Long-term, there is one foreman planned and one experienced mine worker within the PMRD hiring plan.

There are several initiatives currently underway to address some of the mine infrastructure. One area that needs attention is ground support in the mine. There is currently a contract in place to address ground support and control problem areas in the mine. Another improvement needed is the mine electric power system. In moving forward, we are transitioning to modern, safe, and reliable power sources throughout the mine. Other recent enhancements to improve the research capability, include electrical upgrades, and upgrading the communication and tracking system. The communications and tracking upgrade now covers both the experimental side of the mine and also the safety research side of the mine. Another

consideration is the expansion of the mine entries to allow access for modern equipment. We are currently in the process of aligning the long-term future direction of the mine with the long-term strategic direction of the mining program goals.

Questions and Comments:

Mr. Watzman (Q) - Is there any prohibition of the institute accepting donations, for lack of a better way to put it, in terms of equipment you might want to upgrade or things of that nature? Are you allowed to accept from a company a piece of equipment as a donation?
Mr. Lutz (A) - Yes, we actually just went through this exercise recently at SMRD, so apparently they've paved the way to make this a little bit more efficient, but we can accept donations.
Mr. Watzman (Q) - What comes to mind is, with the restructuring that's going on in the industry, that there might be opportunity, if you have a list of equipment that you would like to acquire, whether I and others in the room, working with member companies, might be able to assist you in getting some of that equipment.
Mr. Smith (A) - Yes, absolutely. We are planning to purchase a roof bolter. However, the mine has unique requirements for machinery and equipment. We would have to sit down and specify parameters for it to make sense because of the narrow mine entries.

NIOSH/MSHA Interactions, Dr. RJ Matetic

In this presentation, I will talk about NIOSH Mining Program interactions with MSHA. MSHA and NIOSH have different roles in the common goal to protect mine worker health and safety. The NIOSH Mining Program provides national and world leadership to prevent mining work-related illness, injury, disability, and death by gathering information, conducting scientific research, and translating knowledge gained into products and services. MSHA, as part of the Department of Labor, is responsible for creating and enforcing workplace safety and health regulations for the mines. There are two different paths that each agency performs, but at the end of the day, it's one common goal and it's the protection of mine workers. There have been significant collaborations between NIOSH and MSHA in the past and are currently ongoing. We have five existing partnerships, not with just MSHA, but industry, trade associations, academia, other government agencies, operators, and union organizations. The topics related to these partnership include rock dust, diesel, refuge alternatives, breathing air supply, and proximity detection. In addition, almost every day, there are interactions between leaders and researchers in NIOSH and MSHA related to some worker health and safety topic. In addition, MSHA reviews NIOSH project proposals and publications. We also have generated task forces with MSHA to solve problems related to certain health and safety issues. We have developed joint best practice guides. An example of those is the metal/nonmetal filter selection criteria which was developed with a best practice guide between NIOSH and MSHA. For Requests for Information (RFI) from MSHA, NIOSH provides input based on our research for proposed rules and final rulemaking.
In addition to the above collaborations, there are other interactions such as laboratory sharing and testing with MSHA, including for example the NIOSH Mine Electrical Lab at Bruceton. For our human subjects

research experiments, MSHA is always there, involved in either watching or participating in the experiments to see exactly what we are doing. For technology exchange, one example is our robot technologies that we have developed through the Broad Agency Announcement (BAA) process in the mining program, which have now been transferred to MSHA for use in their mine emergency operations. Through working with MSHA and manufacturers in our partnerships, we make sure the design of equipment is appropriate to make a difference in a worker's health and safety. In addition, training is another example of collaboration with MSHA. NIOSH provides a lot of training in collaboration with MSHA, including the TRAM Conference for mine trainers, and other training on various topics such as ground control and ventilation where we travel to the MSHA Academy in Beckley, WV to provide the training.

Another example of a successful collaboration is the go/no-go meters relative to illumination where MSHA used NIOSH input to create more consistent lighting measurement guidelines. NIOSH worked with MSHA and provided presentations on photometry, and we also developed a luminance measurement field protocol in combination with MSHA. We validated the protocol in the MSHA dark room at Triadelphia, WV, along with testing in our Safety Research Coal Mine. The impact is now MSHA has information to issue guidance on improved luminance measurements.

Another example of a successful collaboration is the refuge alternatives research. Thru our apparent temperature testing, MSHA has used those results related to approval certifications for testing of mobile refuge alternatives.

NIOSH's portfolio is guided by surveillance data and stakeholder needs. We need MSHA input as well on what we should be working on. We hold quarterly meetings with MSHA to discuss ongoing and hot topics that are on the table right now. And we continually review and improve processes for better engagement. For example, how can we better engage with each other? Even though the engagement is good, there's always room for improvement, so we continue to look at that as well.

In summary, partnerships are sharing timely information, that is critical. Every one hears information at the same time and out of one voice. Our review process is gaining MSHA input for publications and products. Upcoming RFI discussions are using NIOSH science. Some potential areas for improvement might include - Identify injury and illness data collection needs, Improve the accessibility of the MSHA accident/injury/illness database, and Increase the interaction during the approval and certification technology development process. We are already having discussions together on these topics.

Questions and Comments:

Dr. Nelson (Q) - Does money from NIOSH come over to fund that? I mean, money from MSHA or NIOSH to fund this?
Dr. Kogel (A) – There is no exchange of money. We work with MSHA and we fund whatever needs to be funded on our side and vice-versa. The robot project was something that was done through our

extramural research program. Once the robot is transferred over to MSHA, then they will be responsible for any costs associated with the ongoing upkeep, operations and maintenance of those robots.

Dr. Luxbacher (Q) - I just think back to the Sago era. I think MSHA and NIOSH did a lot of good work together to help out for future, for better reminders. Well, for a dissenting view, I would say after Upper Big Branch, when I read all the draft legislation that came out, most of which eventually languished in committee, technically it was terrible. And I know that NIOSH people, if they had input, their input was not accepted because I know what NIOSH was working on and how they felt about a lot of those technical pieces. So I guess my concern is it seems like things are going well day-to-day, but if there's a major event, how do MSHA and NIOSH then engage? Because so much of our regulation is reactive. That would be my primary concern. I was really disappointed in the regulation that eventually went to committee after Upper Big Branch.
Dr. Matetic (A) - We do have self-escape and mine rescue in our portfolio. I think there's an opportunity to engage more with MSHA and their Mine Emergency Operations (MEO) related to mine emergency operations. I know Dr. Kogel and Dr. Luxbacher just went over a couple weeks ago to talk to the MSHA MEO people. That’s important and we need to be aligned in a way, just in case, and be more proactive than in a reactive mode.

Dr. Miller (Q) - Are there exchanges of workforce or even details between the two agencies? Because sometimes even just building those relationships at operational levels is really important just to create some fluidity and exchange. You know, we do have, you know, as you said, exchanges at more senior levels. Actually, today is the OMNE meeting in Washington which is, you know, a group that includes EPA and others. But just wondering about that kind of operational level relationship.
Dr. Matetic (A) - I think that detailing employees from NIOSH to MSHA for a certain period of time, like three months is not a bad idea. That’s not ongoing right now, but engagement of leaders within our program is happening. Dr. Kogel, Dr. Lutz, and I are always speaking to MSHA staff in Arlington regarding the research. At the researcher level, it's ongoing, sometimes two to three to four times a week, where they're engaging with either approval and certification or tech support on the research that we're conducting. So that’s all going well. The detail suggestion will be looked in to.

Mr. Francart (C) - Not a question, but a comment. We have worked very closely with NIOSH over the years. We have a number of our staff here today. We have personal relationships with the NIOSH researchers. Years ago I worked very closely with some of the mine fire people, Dave Litton in particular. One of our success stories, I think, is the fact that we were able to eliminate reportable belt fires in coal mines today based on the detection research that NIOSH did, the implementation of that research, and the improved belting that we have in coal mines today. So we've had a very good relationship. I think that has continued and I think we can improve on that. I agree that the detail opportunities may be a possibility, but we do have a very good working relationship and all of our people here have, like I said, very close working ties with the NIOSH researchers. So we have that, I think, maybe not in a detail sense, but we have people working very closely together.

Dr. Nelson (Q) - On Jessica's RIIICE slide that discussed innovation, there were a lot of words up there about IoT and artificial intelligence and sensing and robotics and all of these things, which we haven't heard so much about, in terms of what's actually being done. But this area of increased capability of sensing and real-time information flows has been driving changes in other regulatory agencies including EPA where now we can do something, now we can write a regulation on that sort of thing. So the dialogue back and forth as to this technology advancement that's happening very quickly and then how do you go about, between the two agencies, figuring out what can be done now that couldn't be done before? Do you have dialogues about disruptive technology or new kinds of technologies or information flows?
Dr. Matetic (A) - We do. You know, when we're proposing to do something into the future, those discussions occur. We discuss how can one help one another to move that forward as well? And I'm not just saying in a regulation sense, because there are a lot of people in tech support and approval and certification with MSHA that are very knowledgeable about sensors or equipment or things like that, that we can use their input moving forward. So proposing things moving forward, we address and allow MSHA to know what we're doing. As I mentioned, a lot of the times they are reviewing our proposals as well. So as far as a formal discussion, the rubber will hit the road here probably in 2018 when we start talking about things like automation and what that means to the industry and what are the health and safety risks associated with it? And that's where I think these discussions will be fruitful moving forward.
Dr. Nelson (Q) - And so MSHA might realize there's a new technology that can address a problem differently.
Dr. Matetic (A) - That's right.
Dr. Nelson (Q) - And perhaps better, and then initiate a request to NIOSH to actually do something on it? I'm trying to understand.
Dr. Matetic (A) - Right, yes. That has happened in the past as well, yes.

Participant (Q) - And it also happens at the top level because we do make quarterly trips to Washington to meet there as well, and often times these are the topics of discussion at that level too. So I would say that that's ongoing at multiple levels as far as that sort of interaction and information exchange.
Dr. Matetic (A) - And that is a good point related to automation technology, whether you have automated trucks or equipment, MSHA being at the mines may see some trends of these emerging technologies that are causing new issues, new health and safety problems, that could come back to us to take a look at.

Mr. Francart (C) - In fact, I do have a list of issues, RJ, I need to get to you on some things that we'd like to have you take a look at. And I made the mistake of asking for suggestions and I've got about 15 pages of them, so I'll be getting those to you.
Dr. Matetic (A) – Yes, please send them.

Overview of Research – Dust, Ventilation, and Toxic Substances Branch, Mr. Drew Potts

Today, I will present an overview of the research being conducted in the Dust, Ventilation and Toxic Substances Branch at PMRD.

The research portfolio falls within two strategic goals, one associated with reducing occupational illness and the other one associated with preventing mine disasters. For the intermediate goals, we have an intermediate goal to reduce exposures to airborne hazards and an intermediate goal associated with preventing disasters by reducing the accumulation of float dust in mine entries. For our intermediate outcomes, we have an intermediate outcome associated with overexposures to coal dust, crystalline silica, diesel, and also developing more accurate and timely monitoring for all those airborne hazards. The main focus associated with the primary goal for preventing disasters is to reduce float dust deposition in entryways.

In talking about the respirable coal mine dust controls, there are five tasks. The five tasks are: to investigate shearer-mounted water-powered scrubbers, to design shield spray systems to reduce dust generated by spalling in front of the lead drum on longwalls, to explore the use of foam on the longwall roof to reduce dust generation from shield movement, to explore canopy air curtain technology for shuttle car operators, and to investigate highwall drill dust controls.

For the first task, the shearer-mounted scrubbers, we did this in collaboration with the University of Kentucky, which was operating under an Alpha Foundation grant. Here we looked at the feasibility of capturing shearer dust with scrubbers that were mounted on the shearing machine. The primary factor there, as far as the effectiveness of the system, was scrubber airflow. At 11,000 cfm, you could get close to 70 percent dust reduction at the shearer face sampling locations. The tests were conducted in the longwall mine dust gallery at PMRD. The collaborator supplied the shearer model, as well as the scrubber, for this study. Going forward, the feasibility of actually implementing a fan-powered, flooded-bed scrubber on a shearer is unlikely because it would require major equipment modifications. However, we believe we can come up with similar airflows with water-powered scrubbers which are almost as efficient as the flooded-bed scrubbers. They are just a series of water sprays and tubes that, as the air goes through it, it eliminates the dust from the airstream.

For the underside shield spray system, we are trying to control the dust that spalls out in front of the main drum or the lead drum on the shearer. We have conducted tests at 90 inch and 112 inch roof heights in the laboratory. When you activate the splitter sprays, the dust levels actually increase a little bit, and that's because that dust that's coming off the head of the drum is hitting those sprays and then getting forced out into the walkway. Then when the underside sprays are activated, there is a dramatic reduction in the dust once those sprays are about 4.5 feet from the face. The laboratory study is completed, and we are currently looking for an underground operation to test these sprays on. Preliminary results showed

average dust reductions in the walkway at the end of the splitter arm ranged between 80 - 95 percent for spray pressures at 100, 150 and 200 psi with underside sprays at least 4.5 feet from the face.

For the task to develop foam applications to the longwall roof to mitigate dusts associated with shield advance, we are looking at both blowers and using compressed air. The blowers produce a better foam than compressed air, so we're probably going to be using the blower. It would mount on the shearer, and as the shearer is traversing up and down the face, it would spray the top of the roof of the mine with a layer of foam. The first step was to characterize the foam properties to determine what percentages of a mixture we'd need, what foams work better than others, and then we wanted to evaluate the dwell time. We figured we'd need about three minutes of dwell time to be effective and some of these foams are giving us up to 30 minutes. Current and future tasks are to simulate foam dust suppression potential in the laboratory, and to conduct field evaluation of the prototype foam unit.

The task to investigate parameters to reduce shuttle car operator exposure in blowing ventilation, the laboratory experiments to determine the efficiency of anti-clogging sprays are complete. Current and future tasks include, laboratory tests to evaluate changes in face parameters on dust concentration downwind of the continuous miner, and conduct field surveys to validate laboratory research. We are looking at different types of curtain setback distance, and different types of face ventilation. We've found that blocking sprays are very effective on exhausting ventilation to reduce dust, so we're going to be looking at blocking sprays for this particular study. The blocking sprays prevent dust from escaping under the boom thereby improving scrubber capture..

For the canopy air curtain research, this work is being done with JH Fletcher under an RFP. We're targeting shuttle car operations on blowing ventilation and here we’re using a canopy air curtain as you would on a roof bolter. It's taking mine ambient air, filtering it, and putting a fresh stream of airflow over the breathing zone of the operator. We've tested it in the laboratory, we're getting very good results with it. The next test will be underground testing and that should occur probably within the next six months.

One of the studies that we also did under a BAA contract, as a different approach to controlling dust downwind of the miner, is a stand-alone dust collector that takes the dirty air from the continuous miner, filters it, and then directs a clean airstream up into the bolter section. We saw about 90 percent reduction in the laboratory. In the field, it achieved about a 50 percent reduction. This product is currently being actively marketed by Fletcher.

For the float dust project, there are three tasks. One is to characterize the float dust found in mines, one is to evaluate methods for taking the float dust out of the air once it is in the air, and the other is to control float dust at the source. First we had to come up with a method to measure float dust in the airstream rather than through deposition, so that we had the ability to test different control interventions. We modified the OEM sampler to allow us to do isokinetic sampling. Since both float and rock dust are present in the airstream, we came up with a method of low temperature ashing that could differentiate

concentrations of float dust and coal dust. We have a cloud and aerosol spectrometer (CAPS) unit in the laboratory. What the CAPS unit allows us to do is tell us what the concentration of water as well as coal is, and it also tells the size distribution of the coal and the water. We can have coal dust in the airstream, we can activate a spray, and we can see how that spray actually knocks down the coal dust in the airstream. In field studies conducted so far, we have characterized float dust on continuous and longwall mining sections and in belt entries. The continuous miner and longwall shearer are the main sources of the float dust in underground mines. As far as the belt entry, what we're seeing is that float dust really isn't generated along the belt itself, but only at the transfer points. And then with the size distribution data, we'll use that to develop our control technologies. We tested different sprays for their effectiveness in knocking down float dust sized particles and we tested air atomizing sprays, full cone sprays, hollow cone, and flat fan, at a couple different pressures. What we found is that the full cone spray was the most effective at knocking down dust and we achieved up to 40 percent using one spray. Our thought is that we will come up with a spray array that will cover the area under the shield at the tailgate of the longwall to knockdown the dust before it enters the return entry, and we plan to test this in the longwall gallery this summer.

We are also looking at controls at belt transfer points. Here we are working with Tunnel Mine, which is basically a coal handling facility, and we're going to be looking at water sprays, partial enclosures, foams and surfactants for controlling the float dust that's generated at the transfer points.

Moving to respirable silica dust controls, we have basically five tasks. Looking at pressurization/filtration systems for control rooms, Helmet-CAM technology to assess mobile worker exposures and to develop interventions, engineering controls for bagging operations, and dust controls for the thermalling process in dimension stone operations. Also for people using Helmet-CAM and light-scattering devices to measure respirable dust, we would like to come up with some correction factors that could get you close to the compliance numbers, to make the Helmet-CAM information more relevant.

One interesting result when we compared MERV 16 filtration to HEPA filtration, looking at control rooms, mobile equipment, and crusher booths, is that, with the mobile equipment, there really was not a significant difference in the protection that a HEPA filter provided over a MERV 16. In larger areas like control rooms, we found that it was actually six times more effective to use a MERV 16 over a HEPA. The standard practice right now is just to insert a HEPA because it's the most efficient. The other important thing about this is MERV 16 filters last much longer, so the maintenance required isn't as great. Thinking about impact from the program, through the years, many of the guidelines that we've recommended have now been implemented pretty widespread in the industry, including the use of recirculation filters, using cab pressure monitors, and also pressurized intakes. Speaking of cab pressure monitors, one of the things that they allow you to do is to tell you when your filter is loaded to the point where it's reducing airflow, that it's not effective anymore. We've worked with Sy-Klone to get these results implemented into pressurization/filtration systems, and they have told us that they have marketed over 3,500 of these so far.

The Helmet-CAM intervention studies involved going to several different operations – Badger, Barrick,

Unimin, and Fairmont. We looked at where the exposures were coming from for mobile workers, and came up with interventions and tested those interventions. Some of the interventions that we tested were: clothes cleaning booth, housekeeping techniques on reducing dust, filtration/pressurization technology, and others. We are marketing our findings as, "simple solutions", basically toolbox talks. At one of the sites we evaluated the effectiveness of clothes cleaning technology and it reduced exposure levels by up to 88 percent, just by cleaning their clothes. The analysis software now lets you analyze two workers at the same time. One of the workers had very, very dirty clothes. The other one had clean. They were working side by side doing the same activity, and the exposure of the one with the dirty clothes was actually twice as high as the one with the clean clothes.

The updated version of EVADE 2.0 can utilize basically any real-time measuring device. It also allows multiple sampling of contaminants and workers, so you could do noise and dust at the same time or you can monitor, two people at the same time. OSHA is going to be incorporating Helmet-CAM into their technical manual. They're working on that now and it'll be in the sampling measurement methods and instrumentation section. MSHA is also looking at using Helmet-CAM as far as their work in the technical support area operations.

We're working on a second edition of the NIOSH Dust Control Handbook. The first one was very successful for us, over 2,400 copies were distributed, 3,000 downloads. This is a collaboration with industry and associations, the main players being Andy Cecala who's a researcher in NIOSH and Andy O'Brien at Unimin. We're anticipating a completion date of 2019. The last one was 2012, so we have quite a bit of new material and content that we're adding to it.

Another of our Intermediate Goals covers three monitoring tasks: develop end-of-shift silica monitoring techniques, evaluate Tier 4 engines and their applicability to coal mining, and then the last task we haven't done a whole lot of work on at this point in time, is a potential deficiency for the DPM sampler that’s currently being used for metal/nonmetal.

For the end-of-shift silica testing, we are trying to eliminate the time from when you take the sample, till you send it to the laboratory, till you get the results back, and when there could be overexposures occurring in that two-week timeframe. In addition, also assessing the interventions. Lots of times interventions take several iterations until you find something that’s successful. Every iteration of testing an intervention is also going to require that two weeks waiting for test results. So the goal here is to come up with an end-of-shift silica technique that allows you to determine the silica concentrations at the end of the shift. This is the analytical method pathway and is based on the software that we're designing. The first calibration model would probably get you within 5 to 10 percent of the accurate silica measurement for coal mining. We're using FTIR. The next step would be to develop a calibration model based on the commodities and we're in the process of doing that. We're looking at copper, gold, coal, stone, sand, gravel, and granite mines. And then the next step in the process would be if you know your mineral confounders that are part of your mine, you could enter this into the software and it would get you even

closer. So the ultimate goal is to come up with a new NIOSH method for silica determination.
Some of the progress that we have made on that work—we have a Cooperative Research & Development Agreement (CRADA) with Zefon and we're working with the Spokane Mining Research Division. We have come up with a cassette that minimizes the handling, so this cassette fits into any kind of respirable silica monitoring device, and you put it in, you take it out, you slip it into the instrument, and within two minutes you'll get a reading. This is basically to eliminate handling the filter with tweezers and setting it up. The software has been developed for a number of mining applications, and we've completed this cycle for coal. We're in the middle of the cycle as far as for metal/nonmetal. Right now we're going to be beta testing this in coal mines. We're going to be doing all the beta testing, so there's coal, copper, gold, granite, stone, sand, and gravel. And that will be completed this summer.

For the diesel research, we had an opportunity to work with a trona operation out west. In the process of doing a longwall move, they got elevated levels of diesel particulate matter (DPM), and they asked us to do an assessment. We felt that this was good information to have with the ultimate goal of producing a guideline for when you're doing a longwall move, what things could you do to minimize the exposures to diesel particulate matter. First we assessed all the equipment that was being used. We characterized the aerosols at the inlet of the longwall panel, at the inlet of the recovery room, and at the setup face during the longwall move. The hypotheses that we looked at for this particular part of the study was to look at diesel-powered vehicles operated outside the longwall panel and their contributions to the concentrations, what was the contribution of light-duty vehicles as far as the concentrations of diesel aerosols on the panel, and also permissible LHDs. The second part of this study was an isolated zone study. This particular study allowed us to look at all the different type of equipment and technologies that were being used and to evaluate them for effectiveness. Some of the things that we looked at were the sintered metal filter systems, disposable filter elements, some small EPA Tier 4 engines, and some of the newer light-duty personnel carriers. We compared the newer personnel carriers to the older vehicles to see how much mass contribution and particle number concentrations were produced. We also evaluated the effectiveness of some HEPA filtration in cabs. In the future, we're going to be looking at the integration of Tier 4 engines into mines. Here we're comparing a Tier 2 engine with DOC technology, diesel particulate filter (DPF) technology, and comparing that to a Tier 4 engine, which is a heavy duty type engine, and seeing what the difference in the emissions are associated with those. We're testing those both at steady state as well as a transient operating cycle that was generated at a mine. Status in that research is: We have tested the Tier 2 engine with a DOC and with the DPF separately, and then we're hooking up the Tier 4 engine to the dynamometer, and we'll be testing that in Bruceton in May.

In summary, future intermediate outcomes will be: the second edition of the Dust Control Handbook, water curtain for float dust control on longwalls, float dust control at belt transfer points, canopy-air-curtain technology adopted for use in shuttle cars, use of the underside shield-mounted sprays to control dust generated coal spalling in front of the headgate drum, end-of-shift crystalline silica measurement methodologies for various types of mining commodities and segments, and integration of Tier 4 engines in the mine environment.

Questions and Comments:

Mr. Drysdale (Q) - Did you say that you're around 5 percent error level on the end-of-shift silica sampler?
Mr. Potts (A) - 5 to 10 percent even if you don't know the commodity. We can get much better than that if you know the commodity because there are certain confounders that are commonly found in the various commodities. And then you can get even better than that if you know what the actual confounders are at the time, and the software will have the flexibility to allow you to do that.

Mr. Drysdale (Q) - That's extraordinary and very good news, because when you compare it with what we typically think of the gold standard which is an accredited commercial laboratory, we've looked at the results of a lot of their performance tests, and many of the laboratories can't even meet the NIOSH accuracy criterion which, I think goalposts on those are pretty wide as it is.
Mr. Potts (A) - The experimental protocols that we design to test the quantification models in our method are structured with the idea of comparing the results obtained with the FTIR with the NIOSH 7500(XRD) method which is used by MSHA for samples collected in Metal/Non-Metal mines. To meet the NIOSH accuracy criterion, conditions of bias and precision must be achieved. The bias must be less than 10% independently from the type of sample, or in this case from the dust mineral matrix. We know we don't meet this requirement yet. But this is our goal. The request of adding a new method to the NIOSH Manual of Analytical Methods is independent from meeting the accuracy criteria. A method can be added with preliminary information and while still in development. It is our intention to do it in the next 12 months as a result of the instrument comparison effort we are working on.

Participant (Q) - Is work still ongoing to move to a silica sampling capability for the CPDM or is that shelved at this point?
Dr. G. Luxbacher (A) - Yes, we moved forward with it. We had an existing contract doing some work related to miniaturization, and we changed it over to a mass balance with the silica indication. The idea was not to get silica definitive, but we did switch it over, so it's a university contract that's in its early stages, but we did start that work.

Dr. Burgess (Q) - Some great dust control technology. The International Council on Mining and Metals had been focusing increasingly on critical controls and so there was a recent document they put out for occupational health risk assessment where they included critical controls. So is anybody within your part of the organization looking at defining any of these technologies as critical controls, specifically using that language and then therefore having performance metrics, et cetera, associated with it?
Mr. Potts (A) - Not particularly using that language, but we have come up with a lot of best practices type recommendations and so there are critical dust controls. You need water, you need air, ventilation, those types of things, but…
Dr. Burgess (Q) - It might be interesting to work with some of the more international partners that have implemented, and are really working on critical controls because that seems to be the state of the art for a number of them and think about how you could convert your findings into that language and SOPs

associated with that.
Mr. Potts (A) - Sounds like a good recommendation. Thank you.

Participant (Q) - On the shuttle car air canopy, is the operator enclosed in that one?
Mr. Potts (A) - There's no enclosure, it's just an air curtain.

Participant (Q) - I had a different point which was on your DPM monitoring, are you also looking for other emissions components, for example oxides of nitrogen, at the same time you're using your DPM?
Mr. Potts (A) - Yes, the characterization is pretty intense with the gases, the emissions, and hydrocarbons, carbon monoxide also.

Dr. Nelson (Q) - I know that there's been a lot of dust and ventilation research conducted by NIOSH and I think what they would like would be to have an open discussion that reflects the aggregate of what's been going on and thinks about what is to be done in the future regarding dust and ventilation. So if there's any comments let's continue the discussion. Jessica, do you want to say anything about your hopes for committee input?
Dr. Kogel (A) - No, I think that's really all we need to say at this point and I would invite discussion on any topic. I know that we put the discussion after this particular body of research, but I think any other discussion that might come out is ok too. So really just opening the floor to any other topics that you might want to bring up, any comments about what you've heard, suggestions, new guidance as far as particular direction.

Participant (Q) - Just a question that really kind of pertains to it. When the research is completed and it's getting out to the testing, what are the workers' feelings on the new technology that's coming out, how it affects their work and their perception of how it's going to benefit them overall?
Dr. Kogel (A) - Yes, the question you're asking is, as these new technologies get rolled out, are we considering the workers' response and viewpoint, is that a good paraphrase of what you were after?
Participant (Q) - Exactly.
Dr. Kogel (A) – You are going to hear a little bit more from our human factors branch in this meeting, but over the last say five to ten years, we've been moving much more towards that kind of model of looking at how are the workers going to accept these technologies. And integrating that into the research fairly early on, wherever we can because we don't want to end up at a point where we've developed a technology and then it's not considered acceptable. Things like usability studies, the Human Factors Branch gets involved and supports this type of research with the other branches. And now we're really promoting that model so that we don't end up at that point where the technology developed is not acceptable. That's very important to the research and carrying it out from the very beginning.
Participant (Q) - Spending an awful lot of money on research and then have it fail in the field.
Dr. Kogel (A) Yes, that is a very important point.

Mr. Bowersox (Q) - One of the things I think about is PDM, the weight, the size. That's a big concern.

Crawling around that coal mine with PDMs and tools and rescuers, it's tough.
Participant (Q) - Even a little thing like the Helmet-CAM.
Dr. Kogel (A) - Yes, it's another device. I remember miners saying to me, you know, "We feel like Christmas trees going underground, because you have all these things hanging off the miner's belt. And so we're very cognizant of that and that comes back to this whole idea of, real-time monitoring and sensing, putting sensors on miners. How do we do it in a way so that we're not creating Christmas trees? That in itself creates other hazards and issues. It's not a problem that we've solved. The CPDM was under development for a long time. What is out there in the mines now is the first iteration and now we're working towards making it smaller, lighter weight, more compact. As new technology comes out, and we can go more towards miniaturization, that's absolutely what we need to do.

Participant (Q) - I think beyond ergonomics and usability too, it's worker perception of technology, and one of the best examples I heard recently was ventilation on demand (VOD). A mine had installed VOD, they were very happy with it, they were saving money, they were putting less air in the mine, but better diluting their diesel particulate. But the miner's perception was there was less air in the mine, and they were correct, there was less air, but their health was being better protected, but they hadn't really educated them about the technology, why they were using it, and what it was doing. So I think sometimes it's just perception and education.
Dr. Kogel (A) - Yes, and really as part of the training, communicating that message is important. Yes, that's a great point.

Dr. Nelson (Q) - So let me ask you a little bit different question maybe. I feel a bit—this is not my field, but I feel a bit like we talk about dust, we talk about ventilation, and in fact, you put this together with temperature and heat effects and other things, you get interdependencies. I'm wondering what is being done to think about the interdependences instead of just siloing in on one agent or one test? Because there is an opportunity here for interference, if not interdependency.
Dr. Kogel (A) - Absolutely. And I think that's one of the challenges. The research is done with considerations of all those interdependencies and looking at it from a systems perspective, but often times when we talk about the research, we get that more granular view, especially when we're looking at engineering controls. I completely agree with you, it's very important to look at these things on a much more holistic level. And it does happen and that's always part of the consideration, but maybe that doesn't always come across in how we present it.
Dr. Nelson (Q) - Yes, that would—to my perception, research can get compartmentalized and we're not seeing places where you could have interference or overlap. So it also provides a perception of a presentation like that would allow the committee to maybe have more of a dialogue about what's next instead of just following on one track with one species of dust or something else, to look peripherally to see what's going on in other systems that are coexisting. And I think the committee could serve you well doing that.
Dr. Kogel (A) - And I think this is a good discussion we can have again at the end of this day and a half because I think you're going to have a different perspective. Right now you're starting to see some of the

parts, the bits and pieces, and then there's going to be a totality that's going to come out of this, that at the end, you may come back with a different view, and I'll be interested to hear that. So let's pick this up tomorrow in our closeout to see if you do in fact have a different view of things as a result.

Update from the National Personal Protective Technology Laboratory, Dr. Maryann D'Alessandro

I will provide an update on National Personal Protective Laboratory (NPPTL) research related to mining. Topics that I will discuss include the SCSR inventory, the Subpart O timeline (i.e. the regulation that was promulgated in 2012), the NIOSH long-term field evaluation activity, breathing air supply research, planned wearability studies, and next steps.

The NPPTL supports all industry sectors from a PPE standpoint. Primarily we focus on public safety, healthcare, and the mining industry. In the mining sector, our focus is now on escape respirators, respirator approval, evaluating the escape respirators through our Long-term Field Evaluation Program, and in looking at the next generation of breathing air supplies for these types of products.

The first topic I will talk about is the SCSR inventory. Self-contained self-rescuer (SCSR) distribution in the field as of February 2017 shows 219,365 units. MSHA establishes the inventory for the products that are in the mines. In 2011 there was another device, the SR-100 which was developed by CSE Corporation that has since been taken out of service as a result of an evaluation. At that time CSE had the market share with 70,000 of those units in the field. The largest unit, the Ocenco EBA 6.5, currently has over 148,000 in the mines, and this is primarily a cached unit. That device was approved in 1981, and what followed in 1991 was a 10-minute unit by the same company, the M-20. There are over 24,000 of those units in the field. MSHA requires 60-minute units be used in the field, but they have made some stipulations for 10-minute units to be allowed to be used before miners get to a cache. These units all were evaluated on human subjects under the Subpart H requirement in order to be approved. Now considered the only 60-minute belt wearable unit out there, also approved under Subpart H, is the CSE SR-LD.

My next topic is 42 CFR Part 84, Subpart O promulgation and update on Subpart H units. In 2012, a regulation was promulgated, after about 15 years of research and evaluation of the fielded units, and where a number of issues were identified. Some of the issues were that the unit should be more rugged because of the harsh mining environment. When NIOSH would pull the units out of the field they wouldn't necessarily meet the approval requirements. We often couldn't bring back collected units to evaluate because visual indications were that they should have been taken out of service.

Because of issues with ruggedization, and the fact that in evaluating with human subjects you're getting more of a qualitative assessment, not a quantitative assessment of the performance of that unit, we made

a decision in the early 21st century, that we would evolve the standard to use a breathing metabolic simulator to evaluate these units for certification purposes. We had a number of comments that came through our rulemaking process indicating that the rules we had put in place may result in larger units. We felt that it was achievable and that we were pushing the market; but that we weren't pushing it so far that it wasn't achievable. We were pushing the market so the miners would have a safer product that would save them in an event of emergency and be an improvement upon those designs that are out there now.

In 2012 a rule was promulgated. The units approved under Subpart H were no longer to be sold, manufactured, or labeled after March 2015. What happened was an outcry from MSHA and some stakeholders saying that there are no other units out there, so we extended the date to sell, manufacture, and label Subpart H units to January 2017. And then for the 10-minute unit, it would be until May 2016. The reason those dates are different is because in the guidance, what we stated, is that it would be one year after the approval of the first device approved under that particular type. So we had CAP 1, 2, and 3 20-minute and 60-minute units. There were essentially six different units that could be approved.

In February 2016, we had our first CAP 3 approval that was awarded. However, starting in January of 2017 those units could no longer be sold because the expectation is that the new Subpart O units would be sold. In the fall there was an outcry from MSHA and mine operators that there are no units under this new standard, and miners were being put at risk. We worked with our legal authorities, with MSHA and across the institute and made a decision that we would extend that time when those units are allowed to be manufactured, sold, and labeled until June 2019. Now we are continuing to approve the Subpart O devices, but we're continuing to allow the Subpart H devices to be manufactured, labeled, and sold until June 2019. Between now and then, our plan is to take a hard look at the standard that was developed and the requirements that we have in that standard, look at the previous requirements, look at our data from our Long-term Field Evaluation Programs and see what type of options we have. We've already begun assessing our options to see which path we should take, but we realized that we need to involve the stakeholders more, so that's one of the reasons the June 7th Breathing Air Supply Partnership meeting will be taking place to discuss this. We will be talking about the Subpart H, Subpart O units and where we go from here. And the biggest issue was that the currently approved CAP 3 devices are not wearable. So what do we do about that, and where do we go from here, since MSHA and the mine operators would like a 60-minute wearable unit?

My next topic is Long-term field evaluation of escape respirators. For the long-term field evaluation project, NIOSH uses the simulator that is now used for the certification process to evaluate the products once we bring them out of the field. Since they're closed-circuit units, you don't know if they're going to work until you put them on. In order for us to make sure that they continue to meet our approval requirements we evaluate hundreds of these at every phase, and in accordance with MSHA regulation, we look at performance, reliability, and user maintenance compliance data of the field-deployed SCSR units. We randomly select units through the MSHA inventory that we go to the field and pick up to evaluate. All of the data published out there right now was not randomized. It was a convenience sample where we would go

in and the miners would give us whatever units they didn't want, and we'd replace that unit with a new unit. So we didn't know if we were getting the worst units out there, and it was very difficult to make assessments based on the fact that it wasn't random, it wasn't a scientific assessment. Now what we're doing is randomizing the MSHA database, over-sampling to about 150 units, and hoping that we get to evaluate 100 out of that sample.

My next topic is the breathing air supply research. The breathing air supply research is an activity that was conceived in 2011 when a decision was made to look at innovating the breathing air supply system, using five design criteria. The first design criteria was that the next generation SCSR or closed-circuit mine escape respirator (CCMER), would have improved performance, efficiency, and ruggedization. And these are the requirements that are in the Subpart O regulation that was published in 2012. The second design criteria was that it would be one-hour in duration, and this is due to the MSHA requirement to have one-hour devices, one-hour wearable devices, not necessarily belt wearable, but a wearable device. And that there would be a seamless transition between devices without doffing, and this was a result of the Sago disaster where, if you had one unit you had to hold your breath to switch to the other unit. So how can we dock and switch-over to a unit without having to hold your breath, a seamless transition between devices without doffing. And then improved protections during verbal communications. Communications was not something that was in the MINER Act as a requirement in the SCSRs, but it was a stakeholder request in this design.

Other components were also assessed to determine how to improve upon efficiencies. One idea was to look at the cylinder in the system which is pretty big. If we can reduce the size of the cylinders, that could save a lot of room and make the system a lot smaller. Another design feature is to have a face mask to be able to not just have the mouth bit, but be able to have the user be able to breathe and talk to the other miners. This work commenced in 2012, and went on for three years at a very high pace with a lot of resources expended to conduct this work.

The work was turned over to NPPTL in January of 2017, and we made a decision to conduct a peer review on all of this work to see where we go next. We had ten peer-reviewers and the mean score from the reviewers was a 2.2, indicating that the strengths outweigh the weaknesses. One of the take-home points from that peer review is that there was a usability concern with the backpack. At our last meeting I had that backpack with me. While there was some testing and evaluation done to indicate that the backpack was the best configuration given Subpart O requirements, there was some concern indicated by the reviewers. However, nobody was able to provide any human subject data to support or refute that comment, and also there were no alternatives that were proposed to meet the design goals that we had. The alternative proposed was a belt-worn configuration through regulation or policy. So those are some of the things that were discussed at the peer-review which just took place in January 2017.

The potential policy and regulatory changes to achieve a belt-worn closed-circuit mine escape respirator are some of the things that we started to look at. When you look at the design goal for performance,

efficiency, and ruggedization, how can you achieve that design goal? One way is that you remove or revise the Subpart O requirements. That is something that we're looking at right now. Is that something we might want to do?

Then you have other considerations you have to think about. The ruggedization piece was something that we put into that regulation because we strongly believed this feature provided improved safety to the miners. And there are other considerations there as well. When you look at the one-hour duration, one-hour duration was a requirement during this whole design phase, but can we allow CAP 1 or CAP 2 devices to be worn by the miners with supplemental air within specified distances and caches? So that's an option through policy that we could possibly do rather than requiring just the one-hour units.

When it comes to the wearable device what we have done historically is when we evaluate the unit for wearability, we're making the unit operational, taking it out of its case, and somebody is wearing it and evaluating it while wearing it. However, we know that 97 percent of the time the miners are going to be wearing these devices when they're in their closed configuration before they get to the open configuration. So we decided to assess wearability, developing a draft wearability assessment plan and ultimately, a wearability standard where we can evaluate the unit to assess wearability, and perhaps wearability becomes a requirement. Right now it isn't a requirement. If you don't have wearability as a requirement there's no incentive to design to it. And there are a few ways that wearability could be put into regulations. It could be put into MSHA regulations, it could be put into design regulations. So these are all things we want to talk about as well.

When it comes to the seamless transition, through the breathing air supply research that occurred between 2011 and '14, and is still going on, dockable and switch-over valves have been developed and demonstrated on some of the old devices, but no manufacturers have made a decision to adopt any of these components into their system. Back in 2014 time frame, NIOSH Mining Division put out a solicitation to see if there was any manufacturer or anybody interested in taking all these components that were developed through the breathing air supply research, and developing them into one overall system that would meet Subpart O requirements and be a wearable product. Unfortunately, it was a non-responsive solicitation. I think that during that time manufacturers just didn't see the incentive for going into that work, with the mining industry declining, and then also they weren't sure where things were going with the Subpart O and Subpart H units.

The final design goal was the verbal communications piece. We think that no policy or regulatory changes are necessary to eliminate this from the design goal. This isn't explicitly required in the MINER Act, but it's something that's wanted. So we have to look and see is this is something that MSHA could require, or how could we require verbal communications going forward? So where are we with the breathing air supply research? Where we are is, as I mentioned, we have the wearability assessment planned and we are conducting the wearability assessment with the one-hour units, and the one-hour prototype units, and we're going to look at obtaining human subject data to compare the wearability of all these different

devices to see what are some of the requirements we should be having when we're looking at a wearability standard.

We also are going to further refine some of the CCMER components that have already been developed. The high pressure cylinders can really provide added value. They need to be certified by DOT for 5,000 psi. Right now they are authorized to be used at the 3,000 psi level, but we're looking at 5,000 and 10,000 levels at this point in time, and then further confine some of the other components as well like the Oxygen Delivery System; looking at producing data prototypes for the valve integrated pressure reducer and the demand valve; looking at the T-bit mouthpiece with integrated docking switch-over valve and how we can incorporate those into devices; improving the facepiece; conducting some bench testing; and then working on the backpack enclosures. What we're doing is just working on backpack enclosures from the sense of the wearability assessment, not to complete that design because the decision was made that we'd temporary halt that work.

Regarding the belt wearability, what we're going to do is take a look at the CSE SRLD, which is considered the gold standard right now, we're going to look at these devices in the non-deployed configuration and assess them for wearability using a number of different assessments that physiologists, ergonomists, medical doctors and engineers have compiled together. We'll be looking at the CSE, the Ocenco that's out there, and the Drager unit, and then the CCMER, the prototype device, that's an old version of what that backpack device looks like. It looks a little different know, it's a soft shell instead of a hard shell backpack. The proposed ergonomic study is going to include range of motion measurements; looking at force plate static postural balance measurements; gait testing; kinetics of gait patterns; and electromyography. And through all of these evaluations, over the next six months we'll be able to get a good assessment of how we would evaluate for wearability of a non-deployed unit. Our next steps are to determine the path forward for Subpart H and O; finalize our Long-term Field Evaluation strategy; and determine the path forward for the Breathing Air Supply Research.

Questions and Comments:

Dr. Burgess (Q) - These are still exothermic processes, right? They still generate heat, right?
Dr. D'Alessandro (A) - Yes.
Dr. Burgess (Q) - So for the one-hour use?
Dr. D'Alessandro (A) - Some of them. Yes.
Dr. Burgess (Q) - I was just going to say, is that going to be part of your wearability assessment for the extended duration ones and one-hour ones to actually look at temperature…maybe core temperature as part of testing?
Dr. D'Alessandro (A) - Oh, yes. They will be evaluated. They will have sensors and they will be evaluating them physiologically, including temperature.

Mr. Watzman (Q) - Herein lies the problem that I see, and you and I have discussed this and, you know,

the industry has discussed this, repeatedly with the agency and with NIOSH and with the mineworkers and with MSHA, we're trying, at least in my view and I think many in the industry's view, trying to… how do I even want to say this? We're beholden to an unrealistic standard today, and we're trying to fit a square peg in a round hole as a result of that. We've always worked under the desire, laudable as it is to have a one-hour unit that is wearable on the miner rather than asking the… answering the question or looking at it in terms of what will technology allow us to do today that is truly wearable even though it may be less than a one-hour unit? So we've gone from the extreme of something that I don't know anyone in the industry who supports today the notion of a backpack, and I say that honestly. I mean, I talk to people in the industry. There is no one I know who is yearning for a backpack that miners will wear. We have the CSE unit which is not belt wearable, let's face facts. I mean, Ron Bowersox is not wearing that unit underground for a whole shift. And we have a 10-minute unit. So why are we beholden to the notion of a one-hour, laudable as it is, and I say that and I will continue to say that, why aren't we looking at something that is longer duration than a 10-minute unit and is truly wearable to allow a miner to get to a cache? Why is that not how we're driving research and technology rather than reaching for something that is not achievable in, you know, in what we know today?

Dr. D'Alessandro (A) - As I mentioned, in 2011 when these five design goals were established, and I think those design goals were based on discussions with MSHA that NIOSH leadership had, the 60-minute wearable unit was needed, and then the other four design goals, meeting Subpart O because of all the work that went into it to demonstrate the shock and vibration requirements were valid and the ability to evaluate it quantitatively rather than qualitatively.

Mr. Watzman (Q) - But if the design goals can't be achieved then shouldn't we not be asking ourselves the question, are the design goals realistic?

Dr. D'Alessandro (A) - Right. And that's why we have the peer review, and then now we see as a result of the peer review where we take this. So how far do we take what we're doing now to get some successes, and then to see do we have to take a different path. So those are the things.

Mr. Watzman (Q) - Well, I would say we should answer the second question first, do we need to be thinking about a different path before we continue to pursue design successes? I think the cart is before the horse, quite honestly. I know we have a partnership meeting coming and I hope we'll have an honest and, complete discussion about it which will provide some further guidance.

Dr. Willmer (A) – We have, in effect, hit the pause button and Maryann alluded to that because, you know, we're ten… well, maybe it's not ten years, I'm not sure.

Dr. D'Alessandro (A) - It was 2012.

Dr. Willmer (A) - Five years into this. So it's a good opportunity for us to stop and ask exactly these questions and do we need to be rethinking our path. Part of this, too, is that things have changed in the industry. So on the next presentation you're going to hear a little bit about what we're doing to learn about, what questions should we be answering and are we putting the cart before the horse because we've heard this feedback, and so we're now at the point of we've listened, let's do what we need to do to respond to it, and I absolutely agree, we need to have that very frank and open conversation because if we don't we'll be investing in something that's not going to go somewhere we want to be.

Mr. Watzman (Q) - Right.

Participant (Q) - I'm just curious, how much is a prototype backpack weigh?
Dr. D'Alessandro (A): How much does it weigh Rohan? How much does it weigh, the backpack?
Mr. Rohan Fernando (A) - The backpack at the current duration is basically estimated to weight about 6.7 pounds.
Dr. Luxbacher (Q) - The health effects of wearing these for 30 years. I mean, anecdotally I've had miners tell me… I used to work in a mine where we wore the big black Dragers, but they had bone spurs on their hips and these kinds of things, but I've never seen data to support it. I just wonder if there are any studies on the health effects of wearing so much.
Dr. D'Alessandro (A) - And I think that's one of the reasons that when the studies were done that the backpack seemed to be the most feasible.
Mr. Watzman (Q) - Again, being driven by the desirability of having one-hour on the person. Yes, but if I have a 30-minute unit that weighs half that.
Mr. Rohan Fernando (A) - But you see—this is the problem, because if you look at Subpart O, if you have a CAP 2 and CAP 3, and CAP 2 is a 30-minute, it doesn't scale linearly because if you think of it, you'd still have common components such as the breathing loop which is the same size whether it's a one-hour unit or a half hour. Right? The oxygen volume is different because you have different capacity tests that you apply to a 30-minute unit as opposed to a 60-minute unit. And so it's not possible to halve the size for half the duration. So that's one reason we cannot scale these units linearly, also it drives the size of the CO2 scrubber so you will have different sizes which, again, depending on the absorption rate that is different; which is fine, for a CAP 2 unit and CAP 3 unit. Then the other point is when it comes to design of breathing apparatus, the CO2 absorption at 44 L/min ventilation is driven by the dwell time. The dwell time means the resident time of the gas in the scrubber. Now if you push the gas through the scrubber faster as in a CAP 2 unit, the efficiency of the scrubber material, with the same type of material is reduced, so they're both… you might end up having the same size of the scrubber or maybe a little bit less, so you might have a ten percent smaller scrubber. So a 30-minute unit as opposed to one-hour unit is not half the weight or size. So you see it is a non-linear scaling issue for a number of reasons.
Mr. Watzman (Q) – I understand exactly what you are saying. I think about this from a different perspective and it's the person who's being asked to wear this every day, who's being asked to wear a CPDM, who's carrying tools, who's carrying a methane detector. You know, we can talk all we want about the scaling of the device, and I understand the importance of that, that's why I think—and I'm glad we're taking a pause here on this—we need to have a fresh discussion about all of this. Maybe the 20-minute unit is what we say, "This is the best we can do given the state of technology today and given how we need to address the overall ergonomic demands on the worker."

Dr. Miller (Q) - Just out of curiosity do we have an idea of what our other international partners, Canadians, Australians, and other are doing in this domain? I do not know. Do they have smaller ones or what do they do?
Dr. D'Alessandro (A) - No, they use the same devices that we do. And they also use open-circuit SCBAs.
Dr. Miller (Q)- I was just going to say, isn't that the Australian model that they just get to their caches and

then they use the standard open-circuit and then get out with those. Right?
Mr. Watzman (A) - Yes.

Breathing Air Supply Project, Dr. Dana Willmer

As the Chief of the PMRD Human Factors Branch, in my presentation, I will explore SCSR use and implementation. My Branch was asked to investigate what the current industry practices with SCSRs are, and what wearability means to the mining industry. To do that, we looked at two data sources, one being the emergency response plans (ERP) approved by MSHA for each active mine, and two, MSHA's SCSR inventory database. In looking at the ERPs we were interested in what units are carried or cached, and the distances between the working section and the caches. We collected the ERPs from the ten MSHA district offices, that is, 206 ERPs from the active mines, both from anthracite and bituminous coal.

We looked at the MSHA SCSR inventory, in terms of the units the mines have and what the expiration dates are. The expiration dates are important when you think about when the mines will need to replace the units, that is, when the turnover will happen.

The ERP data indicated that most mines are using the 10-minute belt wearable unit to get to the first cache. All mines are using those units to go less than 1,000 feet to the first cache. The lower seam mines (< 51 “) deployed the smallest unit that could be belt worn, the Ocenco M-20, and the higher seam mines (≥ 51”) did have variation in terms of what unit they were saying was belt worn. Some mines may keep the unit near them and not physically have it on their person.

We also looked at the MSHA data to get a sense if there are differences based on production, type of mine, as well as any impact of seam height. There are approximately 23,500 miners. The Ocenco M-20s are most worn in both the thinner seams and longwall mines. The Ocenco EBA 6.5 is cached with a combination of the CSE SRLD and the Ocenco M-20 wearable units to reach the cache. There's fewer one-hour units being carried, most are cached. The other thing we did is look at the MSHA SCSR inventory projections, which shows SCSR expirations are highest starting in 2021. With the two-year delay in implementation of Subpart O, you're going to see that number increasing through 2024, 2025, 2026, with the expectation mines will now be buying some units as they are able to do so.

In summary, we found that most mines are using the belt wearable unit with ten minutes of breathable air to get to the first cache from the working section. Also, the 10-minute belt wearable units will be expiring through 2024 based on Subpart H extension. The 2021 to 2024 time frame is target for transition to a CCER belt wearable, dockable, talkable unit with greater than 10 minute duration and 20 liter oxygen capacity.

We're interested in the stakeholder perspective to guide the development and implementation of wearable

units that are also dockable and talkable. NPPTL is working on the enabling technologies to fit some of those pieces of that goal, focusing on the components that are form-independent. They include approval of a valve-integrated pressure reducer that can work across different types of units, and very high pressure cylinders. Also a facepiece that integrates the dockable and talkable components that can work across different units from different manufacturers. Work has been deferred on the backpack, the open-circuit SCBA and the cryogenics research.

Questions and Comments:

Dr. Luxbacher (Q) - So I keep hearing about the backpack. I know this work has been deferred, but when you're in a mine you rarely see a miner wearing a backpack, and there's nothing stopping a miner from taking a backpack and throwing his tools in it and wearing it. So has anybody looked at why miners don't wear backpacks? Because it seems to me that the backpack looking at just gait if you're out walking around, that's a great idea, but there's a reason miners don't wear backpacks. Has anyone looked at that?
Dr. Willmer (A) - I don't know if anybody's looked at it specifically, but as we ask miners to wear more and more on their belt, the idea of looking holistically at the situation is important. If given the different seam heights and other factors, something that is going to be universally acceptable, a backpack is probably something that will be a challenge too.

Update from the Respiratory Health Division, Dr. David Weissman

Today, I will talk to you about the NIOSH Respiratory Health Division. First, I would like to welcome MSHRAC members to the NIOSH Morgantown facility. 2017 is the Respiratory Health Division's 50th anniversary. We started out as the Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) in 1967. The U.S. Public Health Service established a lab to look at occupational respiratory disease and focused it on detection and physiologic effects of coal workers' pneumoconiosis. It was located at West Virginia University. Then came the Coal Act of 1969 and the OSH Act of 1970 which are the legislative foundation of NIOSH, and NIOSH was established in 1971. ALFORD moved over to NIOSH and became the Division of Respiratory Disease Studies in 1977, and then we became the Respiratory Health Division (RHD) in 2015.

RHD is the part of NIOSH that focuses specifically on preventing work-related respiratory disease and improving respiratory health. We generate new knowledge and transfer it into practice; we plan, design, and conduct a national program of research and surveillance; and upon request, we do health hazard evaluations. We provide medical monitoring services to coal miners, and then, finally, we provide educational and training opportunities. RHD has two main branches. We have a Field Studies Branch that conducts health hazard evaluations and epidemiological investigations. We have a Surveillance Branch that does general population surveillance; runs our Coal Workers' Health Surveillance Program; and works on tools for respiratory health monitoring.

By way of introduction, I will say a little bit about health hazard evaluations and a little bit about our Coal Workers' Health Surveillance Program, and then I will provide an update on our Coal Workers' Health Surveillance. Health hazard evaluations are workplace evaluations that are done in response to requests from management or from representatives of workers like a union or from three current workers at a workplace, and they can be done in general industry environments, but they can also potentially be done in mining environments as well. They are focused on evaluating specific workplaces and making recommendations to help a specific workplace, and they are also useful for looking at emerging issues. If there is a sentinel outbreak, for example, of an unusual disease, it is a great way for us to understand it.

An example of a health hazard evaluation not from mining, from general industry, to give a sense for what the Health Hazard Evaluation Program does is the example of flavoring-related lung disease or "popcorn lung" which many people are familiar with. The state of Missouri asked us to provide technical assistance in the form of a health hazard evaluation. We looked at the popcorn plant and it was determined that there was a relationship where the higher the exposure to flavorings the lower the lung function of the workers, and workers were found to have this rare condition called obliterative bronchiolitis. It was a great way to evaluate the sentinel outbreak, characterize it, and find solutions.

Next, Coal Workers' Health Surveillance. Coal miners are required to have baseline respiratory health evaluations at entry into coal mining and then to be offered follow-up evaluations at about five-year intervals. The evaluations currently include work history, respiratory health questionnaire, chest x-ray, and spirometry. The surveillance testing is provided to miners in two ways. They can obtain testing through local medical facilities that are approved to participate in the program by NIOSH, or they can participate through NIOSH mobile outreach. NIOSH receives, processes, and reports the test results regardless of which of the two streams the information comes from. A big part of that is a standardized evaluation of the chest x-rays that's done by physicians called "B Readers", who passed a test given by NIOSH to show that they can use a standardized system for grading the presence and severity of dust-induced changes in the x-rays. That's called the International Labor Organization Classification System. The 2014 Coal Mine Dust Rule expanded the surveillance offered to include surface miners, and to add spirometry to the set of tests that are done.

The surveillance really covers all of the different kinds of diseases that are induced in the lung by inhaling coal mine dust. There is a group of diseases that cause, what are called, interstitial changes, pulmonary fibrosis, and that would include coal worker's pneumoconiosis, silicosis, mixed dust pneumoconiosis, and dust-related diffuse fibrosis, and these would be picked up by the x-ray screening. Inhaling coal mine dust is a risk factor for getting COPD and actually it and cigarette smoking are independent risk factors, and doing the spirometry is a way to screen for COPD. The program also provides information via the web and we have our main webpage that you can go to for information, and we have a query system that we update so you can see the current data that's generated.

Next, I will give an update specifically on Coal Workers' Health Surveillance. First I will show a video with a

miner who had progressive massive fibrosis. At age 21 he started in coal mining as a scoop operator; age 24 he became a continuous mine operator; age 52 he developed evidence of coal worker's pneumoconiosis and stopped working on the surface of the mine. He moved to a low dust job. By age 56 his symptoms had progressed to the point where he was too short a breath with exertion to continue doing that work and he stopped mining. At age 60 he underwent a double lung transplant. He died four months after his lung transplant. This is the human face of what we're dealing with here. These are hardworking people who want to work at really good jobs, that want to make good salaries, that want to support their families, but, as we know, mining is a potentially hazardous profession and this is one person who had a bad outcome. Unfortunately, he's not alone. When we look at our national surveillance we tap into various different data sources and one of the sources that was recently published looked at lung transplants for coal worker's pneumoconiosis in the U.S. Over the years there's been a marked increase in the number of lung transplants for coal worker's pneumoconiosis and pneumoconiosis which we think is also coal worker's pneumoconiosis.

There are many reasons why people file claims for black lung benefits. In recent years, there's been a marked increase in the number of new claims for black lung benefits. People can't get black lung benefits unless they're completely disabled. So these are people who are substantially ill if they succeed in those claims. And this has also been paralleled in our data that we've gotten from participants in our Coal Workers' Health Surveillance Program screening. Typically, we run between about 30 percent and 40 percent participation rates of our eligible population for surveillance. This graph shows the five-year moving average over time of progressive massive fibrosis versus time. In recent years the percentage of folks with progressive massive fibrosis—if you focus in on Kentucky, Virginia, and West Virginia—has risen to about five percent of those with more than a 25-year tenure in coal mining. That is an appropriate tenure to look at since it takes many years between first exposure and development of disease. We also have seen an increase in progressive massive fibrosis (PMF) in terms of absolute numbers of cases. It takes five years to do a national cycle of surveillance. In the five-year period from 2011 to 2015, we had 91 new cases of PMF that we found in active miners.

This graph shows a five-year moving average for different levels of tenure for having any pneumoconiosis, not just progressive massive fibrosis, that most severe form, but any severity level of coal worker's pneumoconiosis in coal miners. The graph is focused on Kentucky, Virginia, and West Virginia. In recent years, among the longest tenured miners, and after many years of drop, there has been an increase in the proportion of participants who had any level of pneumoconiosis. Nationally, the level is less, and the burden of disease is greater in Appalachia than in other parts of the country.

Mr. Watzman (Q) - Does that include the 2015 data? It's unclear.
Dr. Weissman (A) - No, this does not. This graph only goes through 2014. If you look at 2015, if you look at the query site, it's similar. It hasn't gone markedly up or down if you add that additional year. So in terms of understanding what people are exposed to that's causing disease, one of the most direct ways to understand is to look at what's in the lungs, is to look at the pathology. And this was a recently published

study that looked at biopsy and autopsy specimens from the lungs of miners who had rapidly progressive pneumoconiosis. There were 13 evaluated, and there were only 4 that just had simple coal worker's pneumoconiosis. Most had mixed dust disease or silicosis. And what was found in their lungs was a combination of respirable crystalline silica and other silicate minerals. And you can see the lungs here and you can see these rounded lesions. And if you looked at these blowups here you would see silicotic nodules. So it's not the coal that's doing it, it's the dust that's generated by cutting through rock, the crystalline silica. We don't know the potential role of the other silicate minerals in the rock, what role they might be playing. That's consistent with earlier x-ray work that we had done from the surveillance program that Scott Laney and others published several years back looking at what are called "r-opacities", which are a category of type of opacity on x-rays that are most associated with silica exposure. And as you can see in Kentucky, Virginia, and West Virginia over the 80s, 90s, 2000s those r-opacities increased in frequency giving an indirect indication of increased crystalline silica exposure consistent with the lung pathology shown previously.

This graph shows underground mine dust concentrations over time, both MSHA measured values and operator measured values. Over the years, exposure levels to coal mine dust have gone down. And, similarly, levels to silica dust have gone down. Hopefully, exposure here is a leading indicator in that this will be followed by reductions in disease which is a much more lagging indicator because it typically takes at least about, 20 years from first exposure to development of disease unless you have a lot of exposure, in which case it can happen faster. But there's still a need for surveillance, there's a need to make sure that that leading indicator of exposure is followed by the more lagging indicator of improvement in health. A big focus that we have had over the last couple of years has been implementing expanded surveillance. We expanded to surface miners, we expanded to add spirometry. And after the new regulations were put in place in August 2014, we added 1565 mine surveillance plans. Each mine files a surveillance plan, a major effort.

In 2016, we did 5881 chest x-ray screening examinations. Since the new regulations, we've done more examinations than ever. And mine operators and contractors have really stepped up to participate. As of April 2017, we had 96 percent of surface operations and 97 percent of underground operations compliant with requirements for surveillance plans. We've worked really hard to stand up from scratch a national system for spirometry surveillance. And we've worked very hard to establish high standards for facility approval. We currently have 21 facilities approved across the country to provide services, and we've developed all the infrastructure for secure electronic data transfer, coordinated with spirometer manufacturers for standardized data output, and developed a system to evaluate data and report results.

Another item is our efforts to improve the physician evaluation of chest x-rays. As mentioned earlier, we have the B Reader Program where we test physicians for their ability to use the International Labour Organization classification system to do the standardized grading of x-rays. It's really important to have trained people that are calling things appropriately. And so we've worked hard to take our B Reader examination and put it into modern electronic format, and we're also working to update the examination

and modernize it to use some of the more modern digital x-rays that are currently used.

We are also in the process of developing new surveillance partnerships outside of our own surveillance program. We're actively partnering with the Department of Labor, Black Lung Benefits Program to put together our CWHSP data and Black Lung Benefits data to look at questions like identifying risk factors, predicting which of our coal surveillance program participants might eventually wind up asking for Black Lung Benefits, and also to identify if there are pockets of Black Lung Benefits recipients who never participated in our coal workers' surveillance so that we can improve both programs. We're also partnering with the Health Resources & Services Administration or HRSA, Black Lung Clinics Program to evaluate their patient populations and characterize them to better understand the number of people out there with black lung because many of the people cared for in the black lung clinics are former miners or retired people who we wouldn't see through our screening program, which just focuses on active miners.

To conclude, although we've addressed a lot of issues over the last 50 years, improving the respiratory health of coal miners remains a central priority for us. And, hopefully, the reported reductions in exposures will be followed by reductions in dust-related disease. It's still important for us to maintain strong respiratory health surveillance to document what the trends in disease are and also to be able to target our interventions to where they'll have the most benefit.

Questions and Comments:

Mr. Watzman (Q) - It's not a question, it's rather a comment. David, you've heard me say this before so this won't come as a surprise. And it really struck me when you presented the video of the gentleman who tragically his life was cut short and that should concern all of us. But the next slide you presented what you titled as "Medical History," but this isn't a medical history. This is an employment history, and that's what bothers me, and I've talked about this before. Do we really know the medical history of this individual while he was working in the mines? Now, in this case he may have participated in the x-ray surveillance program routinely. I don't know if he did or not. But we don't know the medical history and that's what troubles me and that's what troubles people in the industry. Yes, we need to do all we can to eliminate dust at the source, and I'm thrilled like you are that the dust concentrations are dropping, but we still have people, we still have active miners who today we don't have the basic knowledge to take intervention steps to prevent progression of the disease because we don't have 100 percent participation in a voluntary surveillance program or we don't have a mandatory program. I mean, you've heard me say this. I just want to say it again, you know, I think we're at the point where if we're going to tackle this, if we're going to beat this we need to use every tool we have. It has to be intervention, it has to be engineering, and that's just a disagreement that the industry has with how the program is managed today.
Dr. Weissman (A) - Well, Bruce and I have talked about this many times and, as you know, we follow the regulations to provide surveillance, which are based on the law as the law is written.
Mr. Watzman (Q)- Understood.
Dr. Weissman (A) - I guess what my feeling on it is, is that it's very hard on the miners who live in places

like this state where your economic opportunities, your job opportunities are so limited, and if you lose your job in coal mining it can mean that you can't pay your mortgage or you lose your car, or your kid doesn't go to college. And so I think to really, truly address this issue even if we went to mandatory screening, even if that happened it would be so important to have medical removal benefits for people to help them to get retrained. And even broader than that have initiatives to help people get other jobs. For example, tax breaks to private sector employers who hire those people or preference for hiring into government jobs or give people other opportunities so that they can move on to do other things. I think this is a really big social issue. We need to throw everything we have at it.
Mr. Watzman (Q) - I agree.

Dr. Miller (Q) - So, interestingly you showed a trend that was increasing over the past several years after going down for a long time, and I was recently at a meeting, Australia is also seeing some of that too. I'm just wondering is there a change in exposure? What do you think is kind of playing into that? Is it because we've played out different seams and we're into different kinds of mining now?
Dr. Weissman (A) - I'll give you our thoughts, and then maybe Bruce may want to follow too, but it's particularly an issue in Appalachia, and Scott Laney and others here have done research to show that mining in small mines, you know, employment less than 50 is a risk factor. Our concern is that the big, wide coal seams are largely mined out and you're now dealing with thin coal seams where you don't just cut coal, you also cut rock and you generate a different kind of aerosol that's more hazardous. The other issue is the organization of work, the number of hours per week that people work. The exposure limits are established for a 40-hour work week, and people don't work 40-hour work weeks, people work much longer, and so those kinetics may have an impact as well. And I think looking at the pathology I think it's pretty clear that it isn't just coal that's doing this, this is also silica and perhaps other silicates.
Dr. Miller (Q) - Silica. Yes.

Early Detection of Respiratory Disease with Spirometry Longitudinal data Analysis (SPIROLA) Software, Dr. Laura Kurth

This afternoon, I will provide an overview of the spirometry longitudinal data analysis software or SPIROLA, which has been developed, and is maintained by NIOSH. SPIROLA helps the user look at the lung function of a worker over time to detect abnormal lung function early on. Occupational exposures contribute to COPD and other occupational lung diseases. Recommendations for preventing occupational lung diseases include primary prevention efforts which are focused mostly on identifying, reducing, and preventing harmful exposures and secondary prevention efforts, which include monitoring a worker's respiratory health, to detect disease through respiratory questionnaires, medical examination and/or lung function testing which is commonly done with spirometry.

The spirometer measures how much air a person can blow out and how fast he/she blows it out. Two lung function measurements captured by spirometry are the forced expiratory volume in one second or the

amount of air he can blow out in the first second of his exhalation. Another measurement is the forced vital capacity, and this is the amount of air he could blow out during the entire length of his test. The ratio of these two measurements is also used to assess lung function. We tend to focus on the Forced Expiratory Volume in 1 second ($FEV_{1)}$ since it's the most repeatable and the least variable measurement of these two. It may also be reduced when a disease causes lung function impairment.

A slide was shown that demonstrates how a person's lung function declines naturally as part of aging. Starting around the age of 25 or 30 the FEV_1 starts to decline. Smoking and other exposures, including occupational exposures, can cause a person's lung function to decline at a rate that's faster than normal. From ages 25 to 75 those unexposed, never smoked, naturally lose about 20 to 30 percent of their lung function. The lung function of a smoker has a steeper rate of decline. By age 52 the smokers have a lung function equivalent to that of a 75-year-old never smoker and they will likely have disabling lung disease around the age of 65.

This graph shows how the rate of lung function declines in smokers, who for example stopped smoking at age 45, have slowed compared to those who did not stop smoking. Relatively early smoking cessation prevented the lung function decline of these individuals to disabling levels later in life. A similar trend is thought to exist for workers with occupational exposures. If we can identify workers with excessive rates of decline early on and intervene before their lung function declines to symptomatic level we can hopefully keep them healthy and working. This idea is the crux of purpose for SPIROLA. Features of SPIROLA include helping a user interpret periodic spirometry to see how an individual's lung function declined over time and how it compares to their own prior tests and to normal ranges. SPIROLA also helps monitor spirometry quality for a worker, groups of workers, or for a spirometry technician. SPIROLA can also be used to record and evaluate interventions which have been implemented to prevent further excessive lung function decline such as initiation of respiratory protection or removal of a worker from hazardous exposures.

Shown here is the FEV_1 of a fictional individual in the SPIROLA program who has six spirometry tests over about five years. The first test was around age 34 and his lung function is declining, but without a reference point we can't really tell if this decline is at a rate that's normal for his age or if it's considered excessive. Next SPIROLA adds in some additional information to help us to decide if his lung function is within a normal range. His last FEV_1 is approaching the ACOEM limit which is the American College of Occupational and Environmental Medicine limit. ACOEM considers lung function decline excessive if the annual rate of decline is greater than 15 percent from the baseline value. SPIROLA calculates this from the baseline lung function value and it also accounts for the quality of the spirometry test performed, and about a ten percent annual decline. By intervening and investigating potential exposures and risk factors of this worker, we may be able to slow his rate of decline.

SPIROLA also provides a summary of the graph. It alerts us that this individual's last FEV_1 and FVC were below the limit of longitudinal decline. SPIROLA also provides an interpretation and a suggested action

which tells us that we should examine the quality of the spirometry test, and if the quality is good, this individual's rate of decline may be excessive and we should consider further evaluation, more frequent testing, and possibly an intervention.

Based on user feedback we are building a more flexible SPIROLA application using a web-based approach. The web-based SPIROLA application maintains most of the same basic functions as the desktop version. It runs on Internet Information Services web server and uses Microsoft SQL Server for database support. It can be accessed using a web browser, so it is no longer limited to just PCUs as the desktop version is. Users can run it on their own server or as a standalone and NIOSH has no access to any of the spirometry data that the user downloads to SPIROLA. It has the advantage of a single or a multiuser access. Multiple users within a clinic or worksite can look at lung function data at the same time from different workstations. The web-based version also has a new capability of evaluating groups within a population by looking at different companies, plants, jobs, or exposures, and looking at the lung function trends and spirometry quality within those groups.

We have used SPIROLA in the past to assist different stakeholders. For example, we have used it to help a fire department monitor the quality of their spirometry tests and we are also working with a heavy construction company that performs triannual spirometry on their workers and uses SPIROLA to identify at-risk workers. We intend to use SPIROLA to monitor spirometry collected as part of the Coal Worker's Health Surveillance Program and as more spirometry results are collected we may be able to identify miners early on who are at-risk for excessive lung function decline. SPIROLA is freely available on the CDC website for download and the desktop version is currently still available and will be available throughout our release of the web-based version, hopefully, this summer.

Questions and Comments:

Dr. Miller (Q) - How many repeat measures do you need to start getting a pretty good feel for it?
Dr. Kurth (A) - If they're good quality they recommend between about four to six, six to eight years of follow-up is good too.
Dr. Miller (Q) - And mainly it's using last FEV_1 or using all three?
Dr. Kurth (A) - We actually can monitor both with SPIROLA. I just chose the last FEV_1 because they can do the same thing for FVC as well.

Participant (Q) - Do you know how widespread the use of this program is like downloads or feedback from users, or anything like that?
Dr. Kurth (A) - We do. We get downloads every month, and I think we have about 300 or 400 downloads from the past year. It's a variety, it's clinics, it's worksites. We've presented at the ACOEM meeting and at some of the smaller regional meetings. And so it's surprising when you answer e-mails or phone calls to see who is using this, but we do get feedback from them and a lot of that is used in creating our new web-based version.

Participant (Q) - Do you have a users' group?
Dr. Kurth (A)- We don't have a users' group.

Dr. Burgess (Q) - So for practical application… first of all, great stuff. I think it's really important. When they change spirometers how do you take that into account? Number one. Number two, if someone has a respiratory illness or something and when I was doing surveillance for firefighters in Seattle, all the time they'd have a low value, a really low value the last one, and then maybe this kind of takes into account, and then you bring them back in and they were higher than they were before because of that temporary condition. So have you dealt with those two issues, spirometer changes and kind of temporary conditions?
Dr. Kurth (A) - The spirometer change is an interesting one because, we can look at quality of spirometry data and we can look at within person variation over time, and sometimes that changes and the data precision will change after you change a spirometer, so you can monitor that and take that into account when you're looking at your longitudinal data quality component.
Dr. Burgess (Q) - So just so I understand then, it looks at the whole group not just at the individual. It uses the whole group to help understand.
Dr. Kurth (A) - Right. You can look at individuals and you can look at the group.
Dr. Burgess (Q) - But does it automatically look at the whole group… I mean, if you were to see a big drop would the user need to know to look at the whole group to understand that?
Dr. Kurth (A) - The software provides a slope, a general group slope for your population, but to look at the effect of the change of a spirometer you would probably want to be looking more at, the data quality component, and that would probably be where you could see the differences from switching the spirometer.
Dr. Burgess (Q) - So the data variability I think is what you would look at.
Dr. Kurth (A) - Right.

Dr. Burgess (Q) - And the second part of the question, Illness. So temporary conditions.
Dr. Kurth (A) - And we do see that, especially with asthma. Somebody might improve, and then they'll decline. We can use those, the lower limit of normal and the basic reference values to look at do they start out where they should be, or did they start out below or above. But that's something that we've been working with even here and how to address that.
Dr. Burgess (Q) - And you can exclude data points.
Dr. Kurth (A) - Right.

Dr. Burgess (Q) - If you know a task, if you know the person was sick that day you can exclude that data point and it will recalculate your reference path points
Dr. Kurth (A) - If it's something simple like acute bronchitis or a respiratory infection, those people should be ruled out initially before they take their spirometry test in the prescreening before, as one of the questions they ask before you take your spirometry.

Dr. Miller (Q) - Related to smoking, it generates expectations based on smoking, right? So you put in

information about the intensity of the smoking and when they first started and the duration, and it actually calculates what would be expected in terms of loss that would occur?
Dr. Kurth (A) - Additional fields on smoking status and smoking intensity can be entered into SPIORLA for each participant. This information would be stored in the database so a clinician reviewing a worker's SPIROLA record would be able to see smoking information. However, SPIROLA does not calculate expected decline based on smoking.

Dr. Miller (Q) - So it doesn't analyze the expected change based on smoking, so then you can see how much more it might be from the occupational?
Dr. Kurth (A) - Right.

Mr. Wright (Q) - When I learned spirometry. it was 40 years ago and all the equipment was basically mechanical and analog. When I had a lung function test of my own a couple of years ago it seemed like the equipment could gather a lot more data than just FVC and FEV_1 and, of course, the ratio. But I wondered if that's true of the kind of work you're doing. I'm not sure what those parameters are, whether there is any use for them if you keep them?
Dr. Kurth (A) - Yes, you're correct. There's a lot more parameters that are collected. The FEV_1, the FVC, and the ratio will be primarily used to look at lung function… or lung disease in this setting.
Mr. Wright (Q) - Yes. But would any of the other stuff be useful to correlate with declining lung function or it's really the best and the only thing you used, the FEV_1?
Dr. Kurth (A) - With spirometry primarily the FEV_1, yes.
Mr. Wright (Q) - The second question. Have you looked at essentially improving the predictive value of the software especially by looking at sort of later declines in lung function than earlier declines to make the sort of earlier data that you collect more predictive for the gap in software, take into account the final…or with outcomes? You know, on the later…?
Dr. Kurth (A) - For the predicted regression that is only calculated when you have four years of follow-up data, and then it accounts, if you have 20 years it'll account for all of those points when it's calculating your projected regression line. We haven't looked back at with SPIROLA looking at your last 10 to 20 years of decline compared to 4 to 10 years. That could be something that we could do looking at the slope from 4 to 10 years versus 10 to 20, but that's not something we have done.

The meeting portion of the day was over at 2:30 PM. For the remainder of the afternoon, tours of select NIOSH Morgantown laboratories were provided for MSHRAC members. The tours adjourned at 4:30 PM.

Day 2, Wednesday May 10, 2017

Mr. Welsh, DFO welcomed everyone. In addition he introduced and welcomed Rear Admiral Margaret Kitt, the NIOSH Deputy Director for Program, to the meeting. Mr. Welsh also conducted a roll call of members and confirmed a quorum.

Partnership Updates, Dr. RJ Matetic

This morning, I will give you an update on NIOSH Mining Program partnerships. Partnership forums facilitate productive information exchanges: NIOSH research to Stakeholders, Stakeholder needs to NIOSH, and Stakeholder to Stakeholder interaction. We have five ongoing partnerships in the mining program: Rock Dust, Refuge Alternatives, Proximity Detection Systems, Diesel Health Effects and Breathing Air Supplies. Since 2011, we have had at least one partnership meeting a year, with four in 2016. Our partners and stakeholders that participate include mining companies, industry associations, labor unions, universities, manufacturers and other government agencies.

FOR THE ROCK DUST PARTNERSHIP: We have conducted six meetings since 2011 of the Rock Dust Partnership. One of the topics that was addressed at this partnership included additives to keep dust dispersible - If you don't add something to the rock dust when wetted and dried it will cohere to form a cake. And if it cakes, like plaster, there's no way that it can disperse. It is important to make sure that the rock dust can disperse to inert a coal dust explosion. We were looking at additives, like a stearate, to rock dust to make sure that it maintains its dispersibility.

Another topic was making sure that the rock dust particle size is correct to inert as well. There were discussions regarding if it should be a specific surface area, and what particle size it should be.

Another concern was once you introduce your rock dusting practice in a mine, when you are sampling for respirable dust, will it be reintroduced into the PDM as rock dust and potentially be over the limit of 1.5 milligram. We looked at foamed rock dust as an opportunity to spray something on the roof and floor, let it dry, and still disperse.

Another topic was toxicity related to the additives regarding rock dust. If we're adding, for example, a stearate to a rock dust, what does it mean regarding toxicity. We worked with our Health Effects Laboratory Division in NIOSH to do some tests relative to treated rock dust and untreated rock dust to get an understanding if there are any issues associated with an additive.

Respirable exposures was investigated. You have to be at an 80 percent incombustible level relative to the application of rock dust. As you are rock dusting, it's entrained in the air and are we reintroducing that into a respirable dust sample. We did some testing with operators to look at that potential.

REFUGE ALTERNATIVES PARTNERSHIP: Since 2015 we have had two meetings. One of the topics that we looked at was heat and humidity buildup in a mobile refuge alternative (RA). How much heat and humidity actually occurs given differing mine air and mine strata temperatures? Our underground measurements within mobile refuge alternatives and mine air and strata temperatures will be introduced into a model to determine apparent temperature within a mobile refuge alternative. We have also done a

lot of air contamination tests, related to ingress/egress of the refuge alternative. All of this work has been done with NIOSH, MSHA and also the partnership to make sure that if miners seek refuge that it will be okay once they get into a mobile refuge alternative or a built-in-place shelter.

PROXIMITY DETECTION PARTNERSHIP: we have had two meetings since 2016. Recent topics included mobile haulage issues. We have addressed the continuous mining machine proximity detection system. The next thing we were looking at is, how does that system interact with mobile vehicles that are in an underground environment, and are there any issues or concerns. I mentioned EMI, electromagnetic interference, regarding a CPDM and a Proximity Detection System. This was all conducted via the partnership as well providing input to them regarding where we are at with the current research and is there anything we're missing that we need to address. The partnership provides great opportunities for field testing, being there's a lot of operators at meetings that raise their hand to allow us opportunities to do these kind of tests.

DIESEL PARTNERSHIP: We held one meeting in December of 2016. The purpose of that meeting was to develop a charter. We shared the charter with the partnership. We asked the partnership if there were any things missing in this charter that they think needed to be added, or needed to be removed. We then discussed an action plan moving forward with the partnership.

BREATHING AIR SUPPLY PARTNERSHIP: The next meeting will happen on June 7th. Topics will include, Identification and Characterization of Mine Emergency Response Plans, along with some input from stakeholders on future directions and research topic scenarios.

Some of the keys to success with mining partnerships include: maintaining open communication, face-to-face contact, getting the stakeholder's point of view, giving everyone a stake in the outcome, engaging manufacturers, obtaining end user (the miner) acceptance, considering economic factors, and listening to and responding to feedback.

Questions and Comments:

Dr. Nelson (Q) - You have certain groups that are part of the partnerships, and I'm wondering to what extent the industry as a whole understands about partnerships, and if there's just a standing invitation for other people than are on your list that are currently in the partnerships to join. What do you think about the permeation of this partnership concept into the industry?
Dr. Matetic (A) - I know Bruce Watzman is on the phone. He could share his views because he has attended most of them. Some of these, Dale, and others in the room have participated. I think the word does spread relative to the topic and what's being addressed throughout the industry. We try to hit as many people from our contact list to make sure they're aware. We then share with the people that are attending a partnership to "Please share this with the people that you know that might benefit from coming here and listening and engaging in the topic to promote miner health and safety." So I think we do a pretty

good job of that. I don't think it's 100 percent complete, meaning we haven't got everybody that we possibly can. But a lot of the times the situation is that someone can't make it, and then we have conducted webinars for those who might not have been able to participate, For example, WebExes have been conducted, so that if you couldn't come, at least there is an opportunity to listen to what's happening, so we have done that as well. So I do believe that it's permeating throughout the industry. And, at every partnership meeting that we have, there usually is a new representative or a person that comes to it.. So I think it's going well.

Dr. Nelson (Q) - So, just following up on that, I guess the question, when you create something like this, is: When would it ever end? Sort of like, something's yellow light, would you ever turn it to green? And I'm not sure that we ever do. So the idea of "When is the work…?" Are these to be considered standing committees or are these ad hoc committees where there's an end in sight for the duties of that partnership and then a new partnership might start up?
Dr. Matetic (A) - I think it depends on the topic and what the topic represents. For example, if it's Refuge Alternatives, there's rulemaking regarding Refuge Alternatives and there are end dates coming up regarding things that the industry needs to finalize. So this partnership is really helping in that regard, where we're looking at technologies and interventions to meet that expectation of the whatever date is coming down the road, so that's one. So it depends.
Dr. Nelson (Q) - But do you see, after that date, there being an end to the formal partnership?
Dr. Matetic (A) - Yes. For example, the Diesel Health Effects Partnership has arose again. And one of the main reasons for it was a potential new rulemaking regarding diesel. But we've had a diesel partnership back in the '80s and '90s previously. And it ended because the partnership felt that we were in good place, there was no reason to continue. But we will maintain contact if new developments occur. Another example, there was a noise partnership back in the '90s where we were looking at control technologies to remove noise from machines. And that's when a new regulation came into effect. I think it was '99 or 2000. So we developed a partnership to do that. Well, that ended. So they do end. But it depends when and why it needs to end.

Participant (Q) - I've just got to add on with where Priscilla is going about kind of the strategic nature of the partnerships. And it sounds like you guys are giving that a lot of thought. And I really appreciate the face-to-face emphasis on establishing those relationships. And, I guess, as you think through what's the value of the partnership, how do we best maintain it, and then how do we leverage those relationships over time and being able to go back and forth. And I'm not quite sure if you guys thought about how to maintain it, is it websites, is it newsletters, those kinds of things, but I think those have great value to you. And obviously these relationships and the investment of time to establish those relationships are of immense value to the institute. One thing as well, as you mentioned, about keeping the miners in mind, and I guess part of my question goes to that, is how do you, then, reach out to the mining community, the workers, in a way that allows their feedback to then be incorporated into this? Is it because of folks that can participate? Or is that when you go out to mine sites you pulse them? How does some of that work for you guys?
Dr. Matetic (A) - I think it's both that you mentioned. And you'll hear from Emily today on going out to the

mine sites and getting feedback regarding newer technologies that have been introduced. And, of course, the people in the room, obviously miners are welcome too. But there's a lot of times they can't make it. But we do look at opportunities to address miners throughout the year on where they might be, in certain conferences or whatever, to provide these topics to them also. But we have studies that we directly interact with the miners themselves and you'll hear about some of those today.

Mr. Wright (Q)- This is probably an unfair question, RJ, because I was not at the December meeting of the Diesel Health Effects Partnership. But when we first learned about the diesel partnership my impression was it was not going to be confined to health effects. It was really going to look at things like feasibility, which, from a regulatory standpoint, is a much more interesting kind of endeavor. Except for the question about whether it's essentially the mass in the lung or whether it's the surface area in the lung, which is still kind of unsettled. The really important questions are not health effects questions, they're really feasibility questions. So why is it a "Diesel Health Effects Partnership" as opposed to a general diesel partnership?
Dr. Matetic (A) - That's a really good question but, to answer your question, all of that will be taken into consideration, from control technologies to feasibility regarding that partnership. Now, the first meeting was to provide a draft charter and the partnership had an opportunity to look at the charter and to add to it. Some of the things mentioned were added to the charter. But there is more to the title than just "Diesel Health Effects".
Dr. Kogel (A) - Yes, this is actually our first ever partnership that's co-chaired between NIOSH as well as MSHA. And I'm sure we came up with that title collectively. It is feasibility, but it's in the context of worker health. So that's where the "health" comes in. And we'd be happy to send you the charter so that you can see exactly what's in it. And, obviously, having input from you as well would be very important. Because we're still at that early stage where we're looking to the partnership members to provide that kind of input. But you interpreted it correctly. It is very much focused on the feasibility piece. So don't interpret that title to mean that we're just focusing on the health. It is about the technology intervention and what technologies are available. But, again, with the context and the central theme being worker health. So that's why "health" came into the title.

Mr. Bowersox (Q) - I'm just going to comment on how we reach out to miners. Twice a year we have training classes at the Beckley Mining Academy and NIOSH comes down and puts programs on for us there. We attend meetings like the June 7th meeting and we have quarterly meetings. We also get with the safety committees and pass that information on. So that's how we reach out a lot.

Mr. Watzman (Q) - Well, I don't have a question. The only thing I would do is reinforce RJ's comment. We try to make it, and I'm involved, and when a partnership meeting is held, I try to get the word out. And I think it's fair to say that the attempt has been to make them as inclusive as possible. If a company decides not to participate that's their choice. It's not because this is an exclusive club, if you will. The coal industry is a very diverse industry, especially geographically. And not everybody can participate. Everyone understands that but if someone wants to they've been welcomed.

Miner Health Program, Dr. Eric Lutz

Today I'm going to talk to you and give you a brief update on our Miner Health Program. I'm first going to discuss the context of chronic diseases in the US. One of the primary questions is: Do US miners have similar health exposures and outcomes, i.e., chronic disease, as compared to other US workers? And, if not, why not? And what does it mean? And what difference, if any, exists between sectors and commodities? The NIOSH Miner Health Program is designed to help answer some of these questions. And that's the kind of framework with which we're going to apply this very general continuous improvement performance monitoring paradigm.

The implications of chronic diseases in the United States: Half the US population suffer from chronic diseases encompassing 86 percent of the health care spending in the country. Seven out of the top 10 causes of death are chronic diseases. Most prominent are heart disease and cancer, which together make up almost half of all deaths. It's pretty significant as far as the general population.

What does this mean for mining? Does chronic disease impact half the mining workforce? We don't know the answer to this question. Do chronic diseases account for 86 percent of a company's health care spending? There could be interventions there to reduce that burden on those companies. Are miners within sectors more or less healthier than comparable groups of workers in the US population? And how does it vary between sector? Are heart disease and cancer the leading causes of death? What are the relationships, if any, between working environment and miner chronic diseases? And these could be protective factors as well, we don't know. That's the motivation for moving forward.

The challenge with what's been done to date is the generalizability between sectors. There's been significant work done here, most significantly in the coal sector. But how generalizable is that to the other sectors? Industrial minerals, for example, has a very limited amount of research specific to that sector. Metal mining, of course, and stone, sand and gravel as well. Not all mining looks alike and there's a lack of existing data. Self-reported exposures to vapors, gas, dust or fumes among mining, oil and gas industries is significantly higher than for all US workers. That work has been done previously. Another study emphasizes how respiratory disease is a primary focus of most studies on miner health. Some populations of miners have elevated risk of lung cancer and nonmalignant respiratory disease. But what does that mean, across other sectors? Top five causes of death among metal/nonmetal miners are similar to the US population, specifically heart disease, cancer, chronic lower respiratory disease, cerebral vascular disease and unintentional injuries. Lastly, in a sample of miners evaluated at a State Miners Clinic, the prevalence of respiratory disease, cancer and arthritis varied by sector. Metal miners had a higher risk of cancer and arthritis compared to coal miners, and coal and uranium miners had a higher risk of respiratory disease compared with metal/nonmetal miners.

There's a need for health and exposure data by sector to systematically assess the health of miners. As

one example, I'm going to walk through some hearing impairment work that's been done. In a 2004 assessment of noise and hearing loss amongst sand and gravel miners found that miners' noise exposures exceeded recommended exposure limit for 69 percent of the workers. Significantly higher noise exposures occurred among employees of small companies and 48 percent of subjects reported never using hearing protection. And hearing impairment was present among 37 percent of those workers.

This was excellent work that was done but what came of it? It just was put out there, a site that partnered gained a benefit of these results, perhaps put into some controls. But no post-study evaluation was done. We don't know the effectiveness of any of those controls that were put in place. And the dissemination of this information didn't lead to any follow-on prevention of hearing loss more broadly.

I present to you today that making better use of existing audiometric data will really be a powerful way for us to extract the power of all of the investment made in these research studies. For example, assessing change in individual hearing over time in conjunction with new controls, equipment and technology. It would be great to confirm or contrast what is reported to MSHA. Assessing what job tasks or exposures may benefit most from focused interventions. And this is where EVADE 2 can come in and really benefit a lot of this work. Identify, or improve PPE technology, design of equipment to dampen noise. Maybe we can leverage some of the advancements that's been made in noise canceling headsets that allow for communication as well. And then, identify what technology controls are best. And then, most importantly, disseminating this broadly back to industry through those translational outputs and not just those scientific outputs that we talked about yesterday.

The objective is to use this information, that in many cases already exists from prior work that's been done, in a more useful and powerful way. So that leads us to this program: a more programmatic approach to the health work that's being done. And the vision of this would be to benchmark and follow changes in the health status of all US miners for the duration of each worker's career for the purpose of reducing miner morbidity and mortality. That is really where we're shooting for. But the objective, the more short term objective, is to really just understand the relationship, if any, between occupational exposures and disease status for the US mining workforce to improve their health. Outputs from this would incorporate enabling mining operations to make informed decisions that mitigate organizational, operational and miner disease risk.

Related to the vision we would like to achieve a reliable, systematic, multifaceted system that can monitor health and exposures. For the objective we see addressing specific questions using both new and preexisting data sources and involving a collaborative, engaged partnership with industry. We can't do this without partners. And we've begun the process that I'll talk about on the last slide that outlines our approach to incorporating feedback from our partners across all sectors.

Lastly, our outputs. We have to have industry as partners, to invest best practices, technologies and control strategies and give us that feedback loop to allow us to evaluate how effective these things are

when they are put into practice, how that impacts their operations, both in a negative and a positive way; looking at the financial implications of many of those controls, not only from the cost of doing business directly, but indirectly related to health benefits and health care costs and things like that. And, ultimately at the end of the day, keeping our eye on the prize which is improving worker health and performance.

This is our roadmap for how we're moving forward. Our first phase is to hold stakeholder meetings. We've begun this process. And we're continuing to have these meetings with our specific stakeholder groups throughout the summer and into the fall. And what we're really looking at is digging up the data that's sector specific related to health studies that have been done and reporting those back to those individual sectors so that they can understand that, both, there is minimal data available, if any, and what data is available isn't necessary current. Which motivates investment of resources into looking into these questions.

The next part of the roadmap is we're going to hold an NAS (National Academy of Sciences) facilitated miner health workshop. This will be a broadly disseminated invited meeting where we want stakeholder input as we lay out this program to really look at, (1) what do we know now - let's establish kind of a baseline of where we are related to miner health today, and (2), where are the gaps. And then that will help us to prioritize moving forward, and to take a more systematic approach to data driven decision-making.

Lastly, formalizing research partnerships both internally and externally. And this will certainly internally incorporate RHD, construction, oil & gas within NIOSH. And then partnerships with the external groups such as, NMA, the unions and operators as well.

As you can see from the time-line we are taking a phased approach at this. We're going to start in the west and migrate east, ultimately, then, aggregating the entire country together into the program. We see doing this primarily with three, 3- to 5-year phases, and in the initial phases, with three dedicated FTEs.

Questions and Comments:

Dr. Nelson (Q) - Just straight off, for that miner health workshop, I think there might be some people on this advisory committee that would be interested in attending and be able to report back or comment back to the committee. And that would be a good thing if that's possible to arrange.

Dr. Burgess (Q) - So I'm excited. Necessary, so I applaud you for putting this together. I think it's really important. When I speak with industry partners about some of the projects we've done, they always have a concern about the health data being used by MSHA for purposes that kind of may harm them in some fashion. How do you look to address that concern?
Dr. Lutz (A) - So we're aware of that concern. And so, what steps we've taken is to establish an assurance of confidentiality (AOC) or a framework, a formal…similar to like an IRB. It's a contractual protection for

that data that's generated under the research project that falls under the Miner Health Program. That's established. And I believe our AOC is the only one that exists in NIOSH. It's a CDC program that oversees only five in all of CDC. And NIOSH's single one is the one for this program. And we've been working very hard. Dr. Kristin Yeoman specifically, in getting this AOC established and to actually broaden to incorporate the Miner Health Program breadth of work that we're going to do. And the fact that it's going to be made up of multiple projects. And so the AOC office has had to take a broader look at this, that it's not specific project-focused but it's actually programmatic, but that's been successful.

Dr. Luxbacher (Q) - I'm glad to see the noise studies going on and the work with that data. When I look at long-term health effect for miners, lungs tend to win every time. Right? And I think noise hasn't gotten quite enough attention. And one of the things I've looked at that I think would be really interesting is the sort of holistic effect of noise on people in terms of stress and decision-making and how they're able to do their jobs, not just the harm to the ears. And I wondered if you're going to look at some of that because it really hasn't been done much in an industrial setting.
Dr. Lutz (A) - No, it hasn't. And there is some interesting data. It's similar to those more holistic approaches like heat strain where we're starting to actually… We have a project starting here in the coming months looking at heat strain and the cognitive impairment that's associated with heat strain. The same thing with noise. But what's interesting is when you start looking at over a full career, because hearing loss occurs at a gradual rate over time, what is the cognitive implications, the stress levels, the immune response changes, or the immune changes that occur, related to hearing loss over time because of stress. Those things are needed. And I foresee that we will have specific projects within this program that will look at questions like that.
Dr. Kogel (A) - I think it will have great impact on the other industries as well, construction, for example.
Dr. Lutz (A) - Absolutely.
Dr. Kogel (A) - Most of the studies I've seen have looked at effects of noise in hospitals on patient health, the beeping, so I think that would be a really good area to explore.
Dr. Lutz (A) - Yes. And the advantage of this is that we're taking a very long term perspective on this. Again, if you look at that vision it would be really great to be able to follow individual miners through their entire career and help optimize their health through controls and prevention. And noise is one of those things that's kind of a boot stomp for me, that we've been studying it for a really long time but yet made no progress. And it's a bit ridiculous in my opinion.
Dr. Kogel (A) - Yes, I think it's a low hanging fruit and it's because lungs win every time when you start to look at long term health effects.

Dr. Miller (Q) - Yes, and just to add on, I really applaud the strategic vision for this and kind of the focused way of trying to implement this over time. I think the national academies, and that's also including the systematic review, I think, on the mountaintop mining, I think those types of efforts where you're doing systematic reviews by sectors to look at all the data that might be available is going to be really useful, as much to identify the gaps and the areas that you have some data like noise induced hearing loss, which is really kind of a sentinel of other things you can look for. And I think that's a really useful construct in which

to build those partnerships in ways to be able to look forward. I think the inclusion, too, of all the sectors, from my perspective there's a lot that's missing in various sectors. And it'll be really interesting, as you especially can start in the west, and our mining in certain areas, just because of the virtue of the mineralogy they're going to have higher arsenic or something else, that's not a primary thing that they're mining for but it could be an ancillary problem that you may be able to pick up on if you're able to kind of look at that and have those relationships and those discussions. So I think this is incredibly valuable and it's an exciting effort.
Dr. Lutz (A) - Thank you. Yes, and I'm hopeful that taking this approach will allow us to gain some efficiencies. So as we are identifying challenges and the fact that we're looking at this in a multidisciplinary approach, and inclusive of construction and of oil and gas, that there may be some things that we can really leverage in a faster timeline to try to make sure that our outputs are having impact; not only in the long term but in short little wins along the way, will ultimately show benefit for keeping miners healthy.

Dr. Nelson (Q) - I'm really interested in this particularly as it comes down, thinking about noise and stress and heat and all these things, coming cross-sector. And so, I'm just cautioning that there's an opportunity here for that cross-sector partnership because the data is needed in the heavy construction industry, the data is needed elsewhere. They have exactly the same problems and the same lack of retention. So, I mean, this is one of those cases where you've got existing partnerships. As some phase out there may be other ones that you can come in/bring in and see that benefit. I think the future technology of actually understanding stress and being able to measure stress with the new technologies of sensing, and whether they're personal or other kinds of sensing, is phenomenal if you know what the question is that we want to ask.
Dr. Lutz (A) - If you think about it from a practical perspective there's no way that the mining program can handle the breadth of everything that we really want to look at in this. And so, it's only through those partnerships, it's through partnership with NIH, it's through partnership with other divisions within NIOSH, it's partnership, perhaps, with CDC divisions.
Dr. Nelson (Q) - And OSHA.
Dr. Lutz (A) - And OSHA and, perhaps, and academia, certainly, as well, that's going to really help us to achieve the goal for this. We're going to need those partnerships.

Participant (Q) - And sustained focus is such an important element and you know, keeping your eye on that ball and keep moving that trajectory because that's what happens. You start the whole thing and everybody kind of goes this way and that way. But by keeping this really a strategic vision it'll allow you to be successful.
Dr. Lutz (A) - Yes. Agreed.

Health Exposure, Assessment, and Monitoring Team Research, Dr. Jerry Poplin

Today, I'm going to give you a snapshot of what we're doing in terms of framing some of the initial projects and scope of work that are going to fit into that long term view and that system approach. Our mission is "To develop and promote health and safety solutions that maximize worker protection, minimize exposures and prevent disease, while improving functional health for the entire mining population." Those are the long term objectives that we want to push towards. And a couple of key words in this mission are "health," but also "exposure." And you heard yesterday, with respect to the coal research and the respiratory health research, is those exposures being a leading indicator of outcomes. And that's what systematically isn't being done right now with respect to all of disease. Not just respiratory disease but some chronic diseases that Eric was hinting at. And so we want to try to put that into play with different sectors and different health outcomes.

And the key term that I included here too was "functional health." And this is something I've incorporated from my previous research in the Fire Service. One of the things that a lot of the firefighters told me when asking, "Why are we doing this? Why are we doing this preventative research for injury and things like that?" And they gave me very good feedback, "I want to retire with function." When you keep that in mind of what we're doing and why we're doing it, it really is so that these miners can retire with function. And how do we do that? How do we measure that and how do we ensure that we're providing that opportunity? So I try to incorporate that into a lot of the work that we scope out.

With respect to the roadmap, we want to be able to measure the burden systematically and continuously, we want to be able to look at the data and analyze it for what it is, and know its limitations and how it can be used smartly. And, through that, can we identify and actually characterize risk, whether it's qualitative, semi-quantitative. And then, with that, set priorities with stakeholder input. Next, mitigate those risks and reduce them down through engineering design. Next, measure efficacy, both in terms of reducing exposure and improving health. That's kind of the big picture.

Projects I want to talk about that we've been framing over the last six months that fall underneath "the umbrella program of the Miner Health Program." I'll talk about four different projects. The first one is basically doing clinical and field data analysis of miner health. We rely very much on the MSHA database for understanding mostly injury but also there are some health aspects. But it's very limited in its nature in terms of what gets reported. And so, what other health are out there that we can capitalize on in order to describe what's going on in this population and subpopulations within the mining sectors, and what does that tell us. I'm going to give you a couple of examples of what we're talking about. Beyond MSHA data we can look at some national survey based data. The Behavioral Risk Factor Surveillance System (BRFSS) program, the National Health Interview Survey (NHIS), are nationally sampled populations. It might be possible to do sub-analyses with respect to mining population to get to some of those questions in terms of how much chronic disease exists within this mining population. Does it affect half the workforce? How

costly are they? And then there's what we'll call clinic-based data sources like from the Wyoming Miners', the Miners' Colfax Medical Center in New Mexico, and Kennecott Utah Copper. These [Wyoming Miners' Clinic] are insurance claims type data approaches. And if you look at these individual sectors, and actually in these pockets of the population that are region-specific, do you get different rates of certain diseases? We can start characterizing things a little bit differently, ask different questions. So we've gained access to these six data sources. And over the next year/year and a half we'll be looking at them basically to see what type of information exists within these data sources, so that we can start framing specific questions and going about answering some concerns from industry. We don't want to be dependent on just one data source to set up our priorities. We want to have some ability to describe what other data are necessary to answer the questions that we're looking at from a strategic standpoint. It's going to directly inform the Miner Health Program and what those priorities are.

Next, I would like to talk about fatigue. About 50 percent of operations have shifts over eight hours. I think 18 percent are over 10 hours. Mining has one of the longest commutes to and from different worksites. And there's a known history of poor rest, poor sleep, etc. Fatigue is a known issue within many industries. It's an increasing issue that's been brought to our attention from industry. We're going to scope out a pilot project that looks at Fatigue Model & Management Systems that can be implemented within operations. What we want to know is how do these systems exist within mining, how can they characterize fatigue in mining, because they really haven't been applied and we haven't really characterized fatigue in a useful way at this point. Initially we will figure out what systems exist, what fatigue management systems exist outside the population in other industries, and how might this look and be applied within mining. We plan to work with some key stakeholders to get some expert opinions on how this might actually be implemented in an occupational setting, specifically the mining setting. And then our goal is to set up a fatigue management system, like a conceptual fatigue management system, that we can then go and do an experimental design, and implement it within a company or a number of companies, and then figure out does this concept actually apply, is it useful, what other factors do we need to account for? And then have that apply to a wider spectrum of the mining workforce.

A lot of time the dual exposures with hearing loss are talked about with respect to chemicals and noise induced hearing loss. There's been a handful of studies done - more animal modeling - that showed that vibration could contribute to hearing loss as well. Mining maintains one of the highest prevalence of hearing loss, despite a lot of research being dedicated to designing programs to mitigate and protect the exposure to noise. And yet that prevalence has pretty much maintained itself. We want to look at other forms of dual exposure, primarily vibration. We're going to use hand-arm vibration, how does that propagate through the arm and shoulder complex and get to the ear canal. How does that translate if you're using a jackleg hammer drill, can we characterizes vibration through the hand to the shoulder to the ear - can we measure that? That's the objective of this pilot project, fundamentally can we measure it, can we characterize vibration with some of the equipment, the large, heavy equipment that is used in mining? That'll enable us to simulate that within a lab setting and then start to do some feasibility studies or proof of concept studies on does this potentially lower an individual's threshold, both acutely and chronically,

with noise complementing the vibration. Because that's essentially what noise is doing in the inner ear. We need to come up with new, innovative ways to address this problem.

Finally, our fourth project is Predicting Heat Strain in underground miners. The pilot project for this has been going on for about a year. We're about to conduct in-field data analysis and data collection procedures. But this is also helping inform a longer term project. And I want to kind of contextualize it with this question: When does heat strain begin to negatively affect a worker's ability to perform his or her tasks safely? And then, can you use a cognitive assessment tool to demonstrate this potential association applied in a mine? What we're basically doing is we're going to evaluate simultaneously the environmental, the physiological and the personal risk factors that help predict cognitive impairment while working. We're going to be doing some direct measurements, both of the individual heat stress, we're going to be looking at the environmental factors that influence heat stress. Some of these deeper mines get up to over 100 degrees with 80 percent or more humidity. In addition to the heat exposures from the equipment and the fluctuations in ventilation, the heat exposure can be quite high and quite acute. And we want to look at individual cognitive performance during these heavy exposure to heat and then can we quantitatively assess that. And then we're trying to get ahead of the curve. Because when heat strain actually shows its symptoms, can we design measures to help improve the work-rest cycle during the shift and give individuals the ability to maximize their performance while on shift. We've been working on this at a pilot project level for the last year. We have developed some fact sheets and training materials already and we delivered some heat stress training during annual refreshers to over 400 miners earlier this year. And we're going to continue to keep working on some of those training materials.

Questions and Comments:

Dr. Nelson (Q) - I worked on the Alaska Pipeline, eight weeks on, two weeks off, and I fought a continuing battle with strep throat. I came back healthy from each leave, but at the end of an 8-week tour, I was down with strep again. So I know about these chronic things and they're extremely important. But when you look at the emergency response, post-disaster kind of thing, there's an extreme condition, not the chronic condition, that actually can trigger a lot of things. Most of the data that's available will be for leading to a chronic understanding, but I think thinking about those extremes as triggers and they may be extremely important in actually causing health impacts and probably should be approached differently. That's what occurs to me.
Dr. Poplin (A) - That's absolutely right. I think that's the beauty of doing field data analysis and working with the individuals and actually getting to see them in their environment and how they actually go about their actual job tasks. And we can start contextualizing what might be leading to some of these outcomes however we want to characterize them. So it goes back to what we talked about just engaging with industry and having them be a partner in the research. And they inevitably help inform us. Because if I just work off of a database I'm going to come up with a very skewed perception of what reality may be.

Dr. Nelson (Q) - There's research in that emergency response area dealing with the effect of those

extremes on people's function. So it's definitely far from mining but there is…
Dr. Poplin (A) - It's not that far because actually some of the original scopes of works that we have for the environmental chamber we want to start working with some of these emergency responders within mining and the rescue teams. They're our primary target to get basically our fundamental projects going within our region. Once the environmental chamber is operational, our first project that we want to target is with rescue miners.

Mr. Zimmer (Q) - I just want to applaud you for your presentation and your work. I think a light bulb went off over Jeff Burgess and I's head at the same time when you made the comment "to retire with function." And this is going to transcend, not just for mining, but all workforce. One of the things that I've been looking at and I've been really hitting a wall with is the work of fatigue. I represent operating engineers in the heavy construction industry and part of the problem that we have is, especially from the northeast, our work season is limited. So we try to chock full as much time as we can into a very short time period. And we have crane operators that are working 80-90 or more hours a week. And I would be very interested on the data that you find for mining and transcending it into heavy, and highway and building construction. I applaud you for what you're doing and welcome.
Dr. Poplin (A) - Thank you, I appreciate it.

Mr. Wright (Q) - I kind of want to follow up with what Kyle just said. We're also really interested in fatigue because we represent people in oil refineries where the Chemical Safety Board has identified fatigue as a contributing factor to a number of catastrophic accidents that have killed multiple, multiple workers. But I was struck by the Fatigue Model & Management System. And maybe I'm missing something but to us, I mean, the most important factor is hours of work, that where people are working double shifts like they do routinely in refineries, there is no way to manage that fatigue. The only thing you can really do is to try to avoid it by reducing the hours of work, which is controversial, both among the workers and also among, management. But that seems to me like it ought to be something that's really part of the model.
And I think the other part ought to be whether the excess hours are voluntary or involuntary. I'm not sure this has been published but one of our employers did research on its own workforce about 15 years ago and discovered… And all they did is they looked at the accident rate among people who worked less than 60 hours and the accident rate among people who work more than 60 hours. And they found there was about a threefold increase. So what they did is they banned work over 60 hours, for the most part. There were some emergency exceptions but for the most part they said nobody can work more than 60 yours, which we were all in favor of. But what they ended up doing is taking people who were willing to work more than 60 hours and basically replacing them with people who were not willing to work over 40 hours but who were forced to. Okay? So what they did is they lowered the amount of work hours that any one person could work but they substituted involuntary hours for voluntary hours. And the accident rate didn't budge. It actually went up a little bit. So whether the work is voluntary or involuntary is an important part of the model, it seems to me. And the other important part is what the work actually consists of. So in refineries—and I can't prove this but this is what everybody believes, that—a board operator whose job is to sit at a desk and look at the parameters on a big screen, and if he or she does something wrong,

something goes very wrong in the refinery, they tend to get more fatigue than people who are out doing heavy maintenance work. So all those things seem to be important to research, important parts of the model, but they don't seem to be there unless I'm missing something.
Dr. Poplin (A) - No, you're not missing anything. This type of approach is listing conditions that promote increased potential of fatigue and this is just a list of them, whether it's dim lighting, increased temperature, or whether it's hours worked, things like that. And this model is just an example. So this is non-exhaustive, but this is just a framework of what latent factor modeling looks like. And we do need to figure out what factors, what boxes do we need to fill in for mining, because this has not been well characterized. And, we do need to do this, both at a system level, but also at a job task level. Because looking at those job tasks and where a health and safety manager might know that these are the folks that seem to be most fatigued and how we characterize fatigue. Whether it's hours lost or whether it's fatigue or whether it's work induced, just fatigue from working too hard, versus being in a static position looking at a monitor all day. Like there are different ways to get there. And this model needs to be designed so it can be scalable and flexible to those parameters. So hopefully we can give you something that's more reflective of the mining environment.

Dr. Miller (Q) - And just to add to what you were saying too, I think in addition to the hours worked is the shifts, so people are switching from night shifts to day shifts is really another important consideration. I wanted to go back to the epi side of your consideration and you had a slide which showed the RFSS and other data sets. And I think it's important to also consider potentially the context of the communities in which this work is also occurring. So these communities also have challenges and they have elevated health risks as well within those community domains. So being able to compare the workers to their communities, and then those communities to others, as well as other work populations is going to be really important. And you might also think about the opportunity to use some of those community-based and environmental health data sets to help try to see if you can't leverage an understanding of the workers within those populations. CDC, NIH has the Environmental Health Tracking which allows you kind of quick snapshots of communities. You could also, like even around the fracking stuff there's been some interesting studies that have been done comparing counties that have fracking to counties that don't. But they're using like entire medical data sets, like Geisinger, all the medical records. And, I haven't seen them try to parse it between workers and non-workers, but they could at least have some of that and I think that would also strengthen your ability to look at some of the epi.
Dr. Poplin (A) - It's a great point. Thank you for that. That's a good idea. And ideally this is just the beginning. So this is basically what we can handle over the next year and a half. And then we want to add to it and create a pretty rich data warehouse that we can answer all these questions.

Mr. Bowersox (Q) - Fatigue is a good study, just like a lot of shift work. But our miners are basically the ones that are producing the coal. They have to wait until the oncoming crew comes in. So some of them are working 10-12 hours a day, minimum, six days a week, some seven. So that is a big, good study.
Dr. Poplin (A) - Yes, thank you.

Mr. Watzman (Q) - I just have one question, and I may be missing something here. But when you're talking about heat strain why the focus singularly on underground miners?
Dr. Poplin (A) - It's more of a convenience for this pilot study just because that's where, it's local in terms of the mine that we're working with. They have known issues that they came to us with. So it was a both convenience and a complement to what our research interests were. For the long-term project that we're scoping out right now, this is a multiyear, multisite project that will entail both surface and underground.

Hazard Recognition at Stone, Sand and Gravel Mines, Dr. Brianna Eiter

Today, I am going to be giving you an update on the project Enhancing Mineworkers' Abilities to Identify Hazards at Stone, Sand and Gravel Mines. We are in the third year of the project, moving towards our fourth and final year. We have some really exciting things that we're working on and that we plan to have as outputs at the conclusion of the project. A couple of years ago the metal/nonmetal mining sector experienced an increase in the number of fatalities at mine sites. Then Assistant Secretary of Labor, Joe Main, identified inadequacies in workplace exams as a potential reason for this increase in the number of fatalities that was occurring. Therefore, one of the goals of this project to address this concern is to create a Workplace Examination Tool to increase mine workers' abilities to perform effective workplace exams. We are focusing specifically on hazard recognition and risk assessment ability for this tool. The work that we are doing is focused on identifying ways to improve mine workers' abilities to identify or recognize worksite hazards and to more accurately assess the risk associated with those hazards.

Hazard recognition is a critical skill for all mine workers to have. Within this project we've conceptualized hazard recognition as having three separate processes. The first, identification; the second, understanding; and the third is mitigation. Identification is the process of identifying a hazard in the workplace. Understanding is knowing what makes an object or what makes an event a hazardous event or object. Mitigation is the process of fixing or eliminating a hazard once it's been found. To study hazard recognition we designed a laboratory study. The first part of this study was to create our materials. Our materials consist of 34 panoramic images. To create these images we established a relationship with a mining company, a surface limestone company that had multiple locations. They allowed us to go to one of their locations to take our pictures. We worked to stage as many of the hazards that we wanted to include in the pictures as possible. Those hazards that we were unable to stage, we created after the fact through photo editing. The pictures include 102 hazards. The pictures are of the pit, the plant, the shop and the roadway. All pictures were evaluated and vetted internally by NIOSH employees, as well as externally by subject matter experts, before any participant saw them.

We collected all of our data in our virtual immersion simulation laboratory. This laboratory has two rooms. One is a 360 degree theater and the other is a room with a very large curved screen. The bulk of the work was conducted in the 360 degree theater. This is where participants started for the hazard recognition task. They performed the search task in this room. To complete the search task we outfitted our

participants with a couple of different tools. The first was a set of eye tracking glasses because we were really interested in how people search through their work environments to find hazards. We also had them wearing motion capture markers so that we could keep track of where they were in the environment as they were performing the task. And, finally, they held a little button and they just pressed the button as soon as they found a hazard as they were searching. Once they completed the hazard recognition task we moved them over into the curved screen room and we spent some time debriefing the task. During the debrief we gave them information about what hazards they found, which hazards they missed, and we also asked them to perform our risk assessment on each of the hazards that we included. From start to finish it took us about three and a half hours to complete the task so we had three and a half hours of one-on-one time with each of our participants. We got to spend a lot of time talking about hazards. Everybody who came in found this to be a very useful experience.

We collected data from four different participant groups. This includes safety professionals, experienced and inexperienced mine workers, as well as student volunteers. We hypothesized that we would see differences in accuracy in our hazard recognition task based on work experience. And, we supported this hypothesis, so the safety professionals performed more accurately on the hazard recognition task relative to the other three groups. An important thing to take away is that the safety professionals were only performing at about a 60 percent accuracy rate. So, while they did perform better than the other three groups, there's still a lot of room for improvement on their performance. The work that we are doing really is necessary.

Two other points to take away in terms of identification. Participants in our study were least accurate at finding hazards along roadways. One reason for this could be that mine workers are not typically asked to perform workplace exams along the roadways. Another point is that participants were most accurate at finding hazards categorized as machinery, hand tools and hoisting. And they were least accurate at finding hazards categorized as ignition or explosion or fire. We are still working our way through our data analyses but these are the first set of results that we have available.

Workplace exams and pre-shift inspections are critical to the health and safety of mine workers. Because we are interested in better understanding the hazard recognition process, we thought another critical point would be to go out and talk to stakeholders to figure out who they think should be performing workplace exams. And to figure out what skills they identify as necessary for performing these exams. We went out and we talked to safety professionals and we asked them these questions. When we asked them what skills they thought were necessary for performing workplace exams the safety professionals that we talked to indicated, that being detail oriented and having knowledge of the area in which you work, those are critical skills to have. Other critical skills include being able to predict how changes in the work environment, changes in the workplace, can cause changes that may result in hazards that you might not anticipate. Another point in terms of skills is that mine workers, people out in the workplace, if you find something you have to be willing to fix it. And you have to be able to fix it immediately, or know who to talk to, to make those changes.

When we asked who should be performing these exams, safety professionals indicated that the person who is performing these exams should be the person with the right skill set. This person should also have a high level knowledge of the area in which they're working, or the area in which they're performing these exams, so that they can put all of the pieces together to make the best decisions for how to mitigate a hazard if it's been found. And, finally, as many people as possible really should be involved in the examination process because health and safety should be distributed across everybody who's working at the mine. So trying to incorporate as many people as possible is critical.

We also asked a couple of questions to identify gaps. These are gaps that we are going to be working to address through the remainder of our project. We asked specifically whether safety professionals were evaluating their examiners as they were performing the workplace exam. The people that we talked to indicated that, no, at this point in time they're not evaluating how their mine workers are performing these exams. And one of the reasons why they're doing this is they don't have an assessment instrument to use. So this is something we're going to be working to address as we move forward in the project.

We also asked them a couple of questions about standardized processes and standardized procedures. And one of the things that we asked them to talk to us about is how their examiners were making decisions and how their mine workers were making decisions about imminent danger: Do you have a standard process in place when you go to identify this? And the people that we talked to indicated that right now they're not using a standardized process to do this.

So our goal is to address these gaps that we identified through the outputs and through the products that will be created through the remainder of the project. To date we have created two products. One is a series of Safety and Health Toolbox Talks. These Toolbox Talks include 13 talks. We are working right now to transform what we currently have, which is available through the mining website, into a web application that you can download from the app store. You can put this on your phone and take this out into the field and you won't need internet access to access the talks later. The other product that we are currently working to finalize is what we are calling the Hazard Recognition Challenge. This is really kind of a mini preview of the Workplace Exam Tool that we are going to be creating. This challenge includes four of our panoramic pictures with instructions for how to perform the hazard recognition search task. After the user has gone through, searched all of the pictures, found hazards, missed hazards, we give feedback. We tell them how they performed. In addition to accuracy feedback, we also are going to give supplemental information about things like prevalence of this type of hazard in the work location, as well as tips for how to mitigate hazards if they're found.

We are working to finalize our Workplace Examination Tool. We anticipate making this tool available to stakeholders to use and to evaluate by the end of this calendar year. This tool is going to include all of the panoramic images that we have created, instructions for how to perform the search task, as well as training modules that we are developing to address issues related to hazard recognition and risk assessment. We are also going to be including a means to evaluate user performance, a test for your

mine workers as you're using the tool. We think that this tool will be useful, not just for stone, sand and gravel mine workers, but for miners across all sectors. We anticipate it being useful across NIOSH sectors as well, being able to recognize a hazard in the work environment isn't something that's specific to mining. It could be useful for people in construction, and oil and gas as well. The Hazard Recognition Challenge should be finished in early June.

Questions and Comments:

Mr. Wright (Q) - Yes, first off I want to really commend you for this research. I had a chance to be in a couple of the rooms at one of the last meetings. And it was really amazing. I found myself in the room with a shop wanting to walk over to one of the workbenches to take a closer look at stuff. And I know it's a panoramic image, it's not a real room, so I couldn't do it, but I'm a little curious … What exactly is the tool going to be? Is that going to be something that's on a tablet or like a sort of a checklist on steroids? Or is it a…?
Dr. Eiter (A) - No. Well, the tool is going to be software, so downloadable. And it's going to include our pictures so it's going to include a search task. We are going to make all of the pictures available and you can either perform the task individually or in a group.
Mr. Wright (Q) - So it's more of a training tool?
Dr. Eiter (A) - It's more of a training tool, yes. The pictures can be used to practice, practice finding hazards in the shop environment or practice finding hazards in the pit. And the training materials are going to be specifically related to findings that are coming about through our data analysis now. So what we're finding in the pictures that we've developed is that people have trouble identifying multiple hazards in one location. Meaning that if there's, I'll just say, "a bunch of stuff" in a location and there's multiple issues in that area, we're finding that participants really will only find one or two of those multiple issues or multiple hazards. And this is critical, especially in a place like a shop where you have a lot of business going on.
Mr. Wright (Q) - Let me ask you if you have any sort of insight into one of the things that really is kind of controversial with us about how do you do these inspections. And I'm not talking about just mine inspections. Half of our staff thinks that we ought to be developing a lot of checklists so somebody who's actually going around and doing an inspection can sort of check boxes off. The other half of the staff thinks, no, that's going to lead to sort of pencil whipping it and it will inhibit creativity because people will not think to look for things that might not be on the checklist. Can your research give any guidance on that issue? Have you looked at using checklists versus not using checklists any?
Dr. Eiter (A) - To this point we're still in the stages of development for that aspect of the tool. But I can see what you're saying. I have talked to a lot of people about pencil whipping. It's a big problem. Our tool, as I envision it, is going to be a hybrid of tips and instructions as well as probably a checklist. Because there are certain things that you should be looking for as you go out and you perform these exams. Those checklists serve as a reminder to do those things. So, if part of your exam is to make sure that you've inspected the fire extinguisher, having it on a checklist I think is of benefit because it just reminds you to go over and do it. Whether you do it the right way is different than whether you've done it.
Mr. Wright (Q) - Yes. Thank you.

Preventing Slips, Trips, & Falls at Surface Mines, Dr. Mahiyar Nasarwanji

Today I'm going to talk about a project to help prevent slips, trips and falls in the mining industry. Slips, trips and falls is the second leading cause of nonfatal injuries, accounting for approximately between 20 and 25 percent of nonfatal injuries every single year. So that is something that we should all be really interested in; trying to figure out how we can make a difference to prevent these incidents from happening in the mining industry. In this project we are looking to identify, investigate and help remediate slip, trip and fall hazards. We're looking at the environment; at personal protective equipment, which is the footwear and the boots, and we're also looking at equipment-related injuries. I'll go into detail about each.

There are many different areas that we could have an impact. We have picked three of them which we think we can actually make a difference. The first one is environment and environmental hazards. Sometimes there are challenges associated with identifying some of these slip, trip and fall hazards in the environment. And we've found there's a lack of tools developed specifically for the mining industry that can be used to help remediate some of these hazards. The second one is the shoe-floor interface. This is where the slip happens. When your foot slips, your heel, or the toe or the base of your foot is sliding on the foot surface. If we do not understand this interface correctly we cannot prevent slips, trips and falls. That's another area that we would like to focus on, looking at the boots. The way we're looking at these boots are in two different ways, the first one is the actual wear on the boots, how quickly do they wear and how much do they wear, and the second is the kinds of boots that you'd normally be using. The third one is mobile equipment. In the past, NIOSH has done a lot of research on mobile equipment. Ingress and egress from mobile equipment is an important issue that keeps coming up. We know it's an issue but we haven't really done too much to figure out why it's an issue and what we can do about it. So that's an area that we'd like to approach and try to figure out what the problems are.

We have a number of specific aims that I will go into the details on. The first one is the environmental piece. The objective is to develop tools to identify, report and remediate slip, trip and fall hazards. The one big issue we find in mining is that hazards are everywhere. The problem is we do not take an adequate look to find out what are the slip, trip and fall hazards in these kinds of environments. The first step that we like to do is figure out what are these hazards, how do we identify them correctly. To do this we are developing what we call a Hazard Taxonomy, which is just a simple classification of hazards. The Hazard Taxonomy developed so far, is based on field visits. We have done field visits at different local mines in Pennsylvania, Virginia, and Ohio. This is also based on MSHA injury data. We have also looked at standards, not only the MSHA's 30 CFR but we looked at OSHA's 29, ANSI and other standards as well, to see what the gold standard is for identifying slip, trip and fall hazards. We have done this with three different areas, walkways, stairs and ladders, because that's what you find in most mining industries. We have completed the taxonomy. After we completed the taxonomy we realized that there was a need to break up these hazards into three different categories involving design issues, maintenance issues, housekeeping issues and policy issues. The reason why we thought about this is that when you design

something it's good to think about it in advance, and figure out how you want to design it. But maintenance and housekeeping issues, which we see a lot, can actually be remediated and fixed very quickly. In fact, housekeeping issues can be fixed by the workers themselves and this is something we'd like to encourage if you can identify them.

Now that we have a list of hazards what do we do with it? The plan is to use the list of hazards and go out in the field and actually do a hazard assessment. The way we plan to do that is through field assessments and actually shadowing employees as they work. We have a smartphone application we have developed where we can follow an employee around and basically make notes of these hazards while they're actually doing their daily tasks. The benefit of doing this is we can find out what kind of hazards they actually do encounter in the industry. We also find out the frequency as they encounter these hazards; which can then help with some of the tools and the trainings that we develop in the future. That work leads to us developing tools and trainings and ways to help workers report and remediate these hazards.

Some of the tools that we're going to develop include infographics and posters and information cards. And also education and training on what kinds of slip, trip and fall hazards they commonly see and why they are actually hazards in the environment.

The second piece is the reporting part. It is important, especially for areas like maintenance issues, that management knows that it is present, that it is either tagged or has a sign across it if nothing else. Here we plan to extend the smartphone application we currently have, the ErgoMine app was used as a framework to develop a second smartphone application that can be used to help report these hazards to management.

The final stage is that there's no point in reporting if you can't remediate the hazards. And that's, again, where the taxonomy will help develop solutions to fix the hazards that can also be fed back to the mine as part of the smartphone application that we develop.

The next topic I would like to talk about is boots, or footwear. The one big thing that's happened in the mining industry is the use of metatarsal boots. Underground coal requires it in West Virginia. At many surface mines, the maintenance workers are now being required to wear them. In some mines everyone wears them. But the problem is we don't know the risks associated with using some of the metatarsal boots. We know they could lead to a limited ankle mobility. There could be some issues with gait associated with them. There potentially could be a trade-off between the safety of the boot and the slip, trip and fall risk of the boot.

To address this situation, we have taken these boots into the lab to test them. We are testing both hiker style boots and wader style boots. We are comparing metatarsal boots to regular safety toe boots, and also to a regular pair of sneakers, to see how there's change in gait. We are testing them on staircases, inclined walkways and regular flat walkways as well. So far, we have finished the stairway tests. We're still

doing some of the analysis right now, but one result so far is that there is no difference in toe clearance when ascending stairs. The next step in the study is inclined walkways and the level walkways.

The second aspect of boots is boot replacement. Most mines that we go to when we ask when they replace the boots, the response is “Oh, every year.”, “Whenever we feel like it.”, “Whenever the employees tell us to.” There is really no science behind when they should replace the boots. The problem is we also don’t know at the end of the life of the boots, are the boots adequate to prevent any kind of slip that might be present. And there’s no information available on if there is differences between employees. For example, a truck driver who sits in the cab the whole day versus a maintenance person who walks around the mine all day. To help address that issue we are conducting a longitudinal study where we have 24 pairs of boots currently at a mine in Virginia and we are tracking wear over the life of the boot. We would also like to do a similar study at another mine site. If anyone knows of a mine that would be interested in working with us, come and talk to me.

At the end of this study, we would like to provide mines with recommendations about how long they should keep the boots, how long the boots are useful in terms of slip resistance, and when they should replace them. We would also like to provide information if there are differences between occupations within the mine as well.

The third part of the boot study is identifying what we call desirable or undesirable features of the boots. These are things that come up as part of mining that we haven’t really acknowledged that we could do future research on. For example, one that we’ve heard a lot about is that, we know our boots wear a lot but the problem is not really the wear, the problem is water gets into the boots. Damage to the outer part of the boots also needs to be considered as part of this. If your foot slides in the boot or your feet are wet that could also affect the way you slip. The second item is material contaminants, limestone or cement caking into the bottom of the boot. Even though you have tread on the boot, the material may be caked completely flat.

The third item is mobile equipment. We have focused on ingress and egress. We have looked at MSHA data, and we have read the narratives of the incident. The one factor that we found looking at 20 years of data is that, egress, getting off the equipment, is a lot worse than getting on the equipment. Nearly 75 percent of the injuries happen during egress as compared to ingress. When we did an analysis of ladders, we found out that most mine equipment has a bottom flexible step to prevent it from getting ripped off while driving around in the mine. Many of the incidents happen on or around the bottom step. What this tells us is that for ladders on mining equipment, the transition zone from the ground onto the ladder might be more important than what we expect it to be. The ground is stable, the flexible rung is moving around, and then you go onto a fixed rung on top of it. Maybe the transition zone should be bigger.

To understand ingress and egress factors, we have taken some ladders into the lab to study them. We are looking at cable sided steps, and at rubber sided steps. Also fixed ladders. We will use tools like

motion capture and EMG to figure out what the differences are between these three.

The last part of the study is to conduct interviews and focus groups with equipment operators and ask them the same questions we have been talking about: Where do slip, trip and falls occur? What part of the egress/ingress system is challenging for you? Then, we plan to go to mine management and ask them how they make purchasing decisions. Next, we will go to the dealers and ask them, "How do you sell equipment?" And last, we will go to the manufacturers ask them how they design the pieces of equipment. The reason for doing this is we want to find out if there are gaps in this entire process, are the people who are buying the equipment just not asking about ingress/egress systems. Are the dealers not even selling it. And then, finally, the manufacturers might be developing it but it's not part of what they give to the dealer to sell. So we're trying to figure that part out as well. We have finished about 21 interviews with mobile equipment operators and other ones with mine management and staff.

Questions and Comments:

Mr. Drysdale (Q): Are you looking at what the operators are carrying when they get out of their vehicles or when they climb into their vehicles?
Dr. Nasarwanji (A): Very good point. What the interviews are telling us is that all operators know about three points of contact. Are they doing it? We don't really know. The one big recommendation that we have—not only for mobile equipment ladders, but for all ladders—if you are climbing up a ladder, what are you doing with the load, put it into a backpack or have a strap around it that you hook around your shoulder and then walk up. Some equipment operators mentioned that for larger pieces being carried, if they are doing maintenance, they use the buddy system. We have an infographic coming out in two weeks about ladders that covers some of these issues.
Mr. Drysdale (Q): You might ask the manufacturers that too, is there some mechanical means of hoisting the stuff up.
Dr. Nasarwanji (A): People have pulleys and other assists that they use, but how often are they used? That's something to definitely look into, thank you.

Mr. Wright (Q): It looks like most of your research has been on falls from grade and falls from mounting equipment. Have you done much on falls from height?
Dr. Nasarwanji (A): Yes, we did. It was part of the taxonomy where we did an evaluation of fall fatalities and pretty much all of them were from heights. We had recommendations based on that as well as on how to prevent falls from heights. Guarding is a big issue. People know to use fall protection. For example, a hole on the floor that people walk onto all the time and that's really very dangerous. Making sure it is guarded, making sure there are gates around it. It is hazard recognition as well as knowing there's a hazard there and understanding there's a hazard there. That's what we found. Another situation that we found for fall fatality from heights is unexpected movement of equipment. Something happens, the equipment shakes or jerks, the worker is not tied off correctly and they go flying off.
Mr. Wright (C): We should talk afterwards about the design of fall protection equipment because we've

had some issues with that.

Work Organization and Safety Culture, Dr. Emily Haas

Today I will present on a topic that was proposed by the MSHRAC committee, Work Organization and Safety Culture. We currently don't have a project just focused on Work Organization and Safety Culture. However, we do have a project that is halfway complete that is addressing three related topics, safety climate, technology integration, and effective health and safety management system implementation. In my presentation, I will discuss what we have done that addresses Work Organization and Safety Culture.

What is work organization? It is basically the control of work and division of labor. That is, the tasks performed; who performs the tasks; how the tasks are performed; and the pace of work expected to complete the tasks. A lot can effect work organization in the mining industry such as: innovation and integration of new technology; combined jobs and multi-tasking; use of temporary and contract workers; current production quotas; and health and safety system and management structure. The potential impact on worker health and safety if reorganization of work is implemented poorly includes: MSDs; increased physical hazards and psychologically stressful conditions; increased time pressure, fatigue, and safety risks; low job control; and low social support.

A common definition of safety culture is the way we do things around here even when nobody is looking. A working definition of the NIOSH Safety Climate and Culture Committee is that safety culture is the shared and enduring values, attitudes, beliefs, behaviors and products of an organization that are supported pertaining to safety and health. This definition pertains to both safety and health. The work organization and safety culture are both products of the strategic Health and Safety Management System (HSMS) implemented within the company. What are some key concepts we can and should address about the effectiveness of an organization's strategic implementation of elements to improve work processes, culture, and performance? Organizations should be assessing and responding to leading indicators throughout the implementation of their HSMS. Here is a linear model where you have the strategy: What is your HSMS? How are you implementing it? That is going to affect aspects of work processes and practices onsite, ultimately impacting worker decisions and performance.

I will be talking about worker performance a lot. Performance, how we are measuring it and talking about it with workers, is their proactivity on the job and their compliance on the job. In terms of proactivity, how likely are they to notice a hazard, bring it up on the job, try to mitigate something before it happens. And then their compliance in terms of likeliness to follow rules on sites and seek out someone if they have a question. And this all leads to the outcome. You're all probably thinking lagging indicators, what are the incidents/injuries onsite? We are measuring it by asking workers: In the last six months how many near misses have you had? How many incidents have you had that have required first aid, medical attention or lost days on the job? Getting more access from sites about what some of the actual incidents are would

be helpful.

Some of the questions that we are addressing: When determining effective implementation of a site's HSMS strategy, is there a relationship between specific organizational processes and worker performance? Does the HSMS and organizational framework you adopt actually impact individual performance? What interventions (strategies) are effective? What is the relationship between organizational factors and links to incidents? Do we have the ability to change internal percepts to align with the organizational strategy? In terms of external factors, what practices improve performance? In terms of overall strategy, is there a difference in the effectiveness of implementation among commodities sand, stone and gravel, industrial minerals and coal? What can we learn from any differences?

First, we had to establish and validate leading indicators so we could measure the effectiveness of some of the site-specific implementation on organizational culture, and individual performance. We have taken a quantitative and qualitative approach. We have a survey that we have been using for a couple years, our Organizational Health and Safety Survey. The survey has 58 questions. We piloted and validated the survey for internal consistency at three mine sites before we went out and distributed it elsewhere. All the questions have a six point scale with 6 being the best. We also developed interview guides that we have used one-on-one with workers and managers or in focus groups that get to a lot of the aspects of an HSMS.

Some of the organizational leading indicators that we measured and discussed through our survey and interview are: organizational health and safety support; supervisor support for health and safety; supervisor health and safety communication; coworker communications, with coworker communication being found to be the biggest predictor of worker decisions on the job; worker engagement/involvement; and health and safety training adequacy.

The internal leading indicators that we have been measuring are, and it's all worker perceptions: their adaptability on the job; risk tolerance/avoidance on the job; thoroughness on the job; their own sense of control on the job; and health and safety motivation and knowledge. These are all predictors of health and safety performance. Proactivity and compliance are predicators for outcomes or near misses in our incidents.

For our quantitative efforts, to date we've been to 21 mines, of which 14 were sand, stone and gravel mines, 6 industrial mineral mines, and 1 coal mine. We have 11 stone, sand and gravel mines confirmed for this summer, and 4 coal mines lined up to go in 2018. We have had a lot of interest for participation, with over 1,400 workers who have participated to date. We're about halfway done with data collection. When all is said and done we should have about 3,600 workers who have participated, both salary and hourly. Our breakdown at each site tends to be about 25 percent salary, 75 percent hourly, who take the survey.

For our qualitative efforts we have been to 12 mines, 4 sand, stone and gravel mines, 2 industrial mineral mines, and 6 coal mines. We have also gone to many health and safety regional meetings to participate and talk with members in higher level management about their health and safety management system structure. We have been to corporate regional offices to get that different perspective. A number of the sites are where we have done technology integration interventions. We have interviewed 83 workers and 56 members of mine management to date.

Going back to our overarching research questions proposed at the beginning. We wanted to know: When determining effective implementation of a site's HSMS strategy, is there a relationship between specific organizational processes and worker performance? It's important to know this: Are there organizational frameworks that can be adopted to help improve and support workers on the job?

I want to give you a couple of examples that we have found so far. First, concrete leadership roles have a positive impact on health and safety practices; and subsequently over time the safety culture. Second, organizations designed to promote individual autonomy have higher levels of reported health and safety practices and subsequently, safety cultures, than those who follow standard organizational processes. From our interviews, some autonomous work strategies and processes that improve worker perceptions and performance include: ability to choose and change their work and shift schedule; ability to provide input into job design, tasks, and processes; more authority to make job decisions; involvement in hiring of new coworkers; and responsible for rating supervisor and coworkers in work performance.

Another research question in terms of understanding the relationship between organizational factors and links to outcomes: Do organizations have the ability to change or support workers' internal perceptions to better align with the organizational strategy? When workers have more job control, they can make and are involved with more decisions, they do experience higher levels of health and safety performance on the job. However, a couple of problematic things that we've found is that 44 percent of workers feel that most problems they experience at work are out of their control; and 28 percent of workers feel that they're not involved in health and safety rules and initiatives on site. As sense of control goes up so does worker performance. There are also correlations that exist between the perceived level of organizational and supervisor support and workers actively taking risks on the job. Out of the 3 mining commodities, 40 percent of sand, stone, gravel, 25 percent of industrial minerals, and 40 percent of coal miners felt they had impossible production pressures. The more that workers feel pressure to produce, the more likely they are to take risks. Also, the more workers feel that their supervisor does not notice if they do their job safely, the more likely they are to take risks.

Organizations do have the ability to measure site-specific weakness, and improve the implementation of their health and safety management system strategy and dissemination of values. Here is an example of the Pre- and Post-assessments for one site's intervention efforts to improve health, safety and risk management. We spent about a year working with them on implementing different interventions at their site. We helped them improve their near miss reporting tool that really no one was filling out. We helped

them do some risk avoidance modules that were done at pre-shift safety meetings, and then were included in their MSHA annual refresher training. They brought in leadership development on-site. They took control of some of their MSHA annual refresher training and included improving employee communication and leadership risk tolerance. One year later, there was quite an improvement shown through leading indicators. Workers now have a higher perception of the organization and also of their own sense of control and their knowledge.

We have learned that we can do things to support workers' internal perceptions and how they perform their tasks on the job. In terms of understanding the relationship between organizational factors and links to outcomes, what specific practices improve performance? First, health and safety has to be a visible priority; managers should always do what they say they will do. Acting through positive reinforcements can enhance workers' trust in work processes and create felt accountability on behalf of workers. Survey data supports that the higher supervisor support goes, workers are more likely to be compliant and follow rules on the job.

Knowing how and leading by example is a key aspect of performance management. Another finding was the importance of fostering good chemistry on site through specific and consistent actions. Everyone is given and abides by the same rules. Our survey data shows that as supervisor communication goes up, the likelihood of avoiding risks goes up as well.

Another finding is that quality over quantity in daily communication is critical. We are all bombarded with different communication mechanisms throughout the day but really the quality of those interactions is what workers desire when they talked to us. Our survey shows that, encouraging joint decision-making and consensus increases buy-in and accountability. The more that engagement goes up, the more worker performance goes up.

In terms of overall HSMS strategy, is there a difference in the effectiveness of implementation among commodities? For all the leading indicators we measured we have the cumulative average and the individual number for stone, sand and gravel, industrial minerals, and coal. A lot of the averages are close together. What's interesting is that you have some larger differences in the organization, but when you come to the workers' internal perceptions those are all really similar. It tells us something about our mining population in general, and that there are some differences in organizational implementation. If we look at these differences and discuss why the differences are here, there may be something that one industry can learn from another.

To summarize, is a focus on leading indicators a better way to go to improve the overall strategy, process, and practices in the mining industry? There are aspects of organizational and supervisory support that can improve worker performance and their risk-taking behavior. Similarly, the organization can work to leverage aspects of their HSMS to improve perceptions of workers, which subsequently improves performance on the job. And, further insights into the complexity, job design, regulations, and previous

challenges of the commodities could be helpful in improving aspects of implementation at mine sites.

Here is our entire survey database as seen on this graph, so you can see where the industry is as a whole. Organizational climate is on the "x" axis and worker performance on the "y" axis. We are trending in the right place, people do have a pretty high perception of organizational climate and their own performance on the job. But there are definitely intervention points for improvements.

Today I have talked about leading indicators and some outcome data, but it is self-reported data. We don't know the true picture until we can bring some of the lagging indicators that mine sites track into the mix to truly assess the impact on incidents, accidents and illnesses. Our data so far has shown us that for every point risk avoidance goes up, a worker's likelihood of getting in an incident goes down about 30 percent. If we could bring some actual data from a mine site in to support whether or not that is true, that would be great. That is where we are in the project right now.

Questions and Comments:

Mr. Drysdale (Q): I'd like to follow up on your last point. Between your two organizational structures, the traditional and the hierarchical, did you have enough of a sample size to look at lost time or just their injury and illness, primarily injury rates?
Dr. Haas (A): I did look at that for that organization, and that's what actually proposed me to make that last point. Because I worked really close with that company and they wanted to see "what is the difference between our incidents." There was a significant difference between their own near misses on the job, but also incidents. We lumped incidents together for them, to include their days lost, medical and first aid because there weren't many, and there was a significant difference. The average was pretty close so you can say, "Is this practically significant?" Maybe, maybe not. But, yes, and that's what prompted me to continue doing some regressions with the whole data set to see if that was true for the industry as a whole.

Participant (Q): First, I think you've done a really good job on this. We've been a big critic of the term "safety culture" in the past because it means so many different things to so many different people. It's become like the term "sustainability." It's kind of meaningless at this point. But the way you've defined it and the way you've used it make a lot of sense. So this is really good research. The one thing I would suggest maybe looking at is that the graphic you've got with the three arrows and the four, that seems to indicate that safety culture only kicks in when we're talking about worker performance. And we've seen lots of examples of companies where there may be a decent safety culture among workers but where top management, including the board of directors, doesn't share it. And that can go downhill really fast.
Dr. Haas (A): Yes.
Participant (Q): So really it's the way you defined it, it really ought to apply to the whole organization.
Dr. Haas (A): Yes, absolutely. And, from our perspective, we just finished writing our approach up. And we portray it in more of a Venn where things are overlapping. For the purposes of this presentation it seemed

a bit easier to organize it in a linear fashion. I'm glad to hear your point that how we're operating is a good way to go.

Dr. Nelson (Q): There's a tendency to have some measure of homogeneity in the population and that causes a "like think" process. If you run into a situation where you have different cultures, separate from safety cultures or different languages, you can really change your data. So are you monitoring that?
Dr. Haas (A): We are. Every site that we go to, the companies don't hand out the survey for us. We go out to every site and there are a couple sites we've gone to where the health and safety manager knows that there are a couple of people who can't read, for example, so we read the survey to them. There have been a couple people who couldn't speak English and so they just didn't fill out the survey. And then we've had issues where we know people didn't really fill it out because we have reverse scored items on the survey. So if you have someone putting "6" down the line, especially when you get to the near misses, and they say they've had six or more incidents in the last six months where they have days off from work, we know that they're not filling it out in true honesty. We disregard those. And then when we put it into SPSS we can do a lot of tests for outliers in the data set too.
Dr. Nelson (Q): Right. What I'm thinking is the fact that you've got a more mixed community of people on the job may lead to a more mixed response to your survey.
Dr. Haas (A): Yes, thank you. We do have a whole list of demographics we can ask too. And we're starting to learn different things about subgroups on the job which has been helpful too.

Mr. Watzman (Q): Emily, great work. I find this quite exciting and very encouraging. I will follow up with you separately.
Dr. Haas (A): Good. Thank you.

Participant (Q): I think it's really fascinating. And especially the little bit of the case study that you included where you worked with the particular site that wanted to improve. I think you could almost at the end of this publish a handbook, maybe, with a few case studies that say, "Look, you can do this yourself. You can see what the culture is in your operation. And here's how you can improve it. Here's how you can really take action." I think it's really commendable.
Dr. Haas (A): Thank you. In the end we want to publish a NIOSH RI, or other publication that we can release. We have a couple goals. First, what our results were, what are the norms for each of these. And then for making the survey public to provide information for how they can do it themselves so that they can assess and reassess. We will provide instructions so they can see where they're at with the norm that we collected. We want to provide some solutions too. That is why we're going out and doing this work so we can provide, "If you are low in worker engagement, here's what's worked." and, "If you are here, here's what has worked." Thank you.

Mr. Zimmer (Q): I think this is very exciting, very well done. One of the issues that I've been having in the construction end is the measurable effect of changing safety cultures and this just nails it. We all talk about, to Mike's point, and everybody has a different perception, the way I relate it is you can only do so

much MSHA training on regulations, OSHA training on regulations. We need to take those regulatory type trainings that we do and get a tool to put them in place, so effectively effect the accident rates/the incident rates in the industry. So, great job and I'm looking forward to seeing that, again, transcend into other areas of the industry.

Dr. Burgess (Q): It's really important stuff. I'd like to relate an experience I had looking at London Fire Brigade's data. Again, not mining, but the British have been doing risk management, proactive risk management, for many years. And we were looking at individual interventions that they were doing and no individual interventions had an effect with the rate in anything you looked at. Vehicle crashes, slips, trips and fall in station, training injuries, etcetera were all just going down over time, very clearly, looking at the data. And I really believe it's a safety culture change where they accepted risk management. So that was really a clear demonstration of the importance of this. So I take two things out of that statement. Number one, I think that if you really want to understand places where they've instituted effective changes, I would look at the UK, because they've done risk management extremely well through every industry. I think they lost their last coal company recently so I'm not sure they have much mining but they'll have sand, stone and gravel, etcetera, of course. It would be interesting to look at that. The other thing that they do that I think would be useful is you're looking at all of the factors in the very organized research fashion, excellent. They actually have the fire departments talk with each other and compare their injury rates which they actually have a standard way of looking at. So they compare and they share best practices and they have data to back it up. So I think that's extremely powerful, where now it's on to the industry and they're kind of, I wouldn't call it a competition, but in a way it is.
Dr. Haas (A): Yes.
Dr. Burgess (Q): I think that if you could consider that in a future step, where you actually get them to talk about the things they've done and actually provide data, either their own or MSHA's, to be able to look at it would be incredibly effective. It would just be hard, obviously, to find the proper venue for them to do that.
Dr. Haas (A): Yes, thank you.

Mr. Wright (Q): One thing that might be a little threatening but might be useful at some point is to develop an assessment tool for safety culture as practiced by management, including upper management. We can maybe help with that. Because we've had a number of cases where a company has come to us, not just in mining but other places, and wanted workers to sign a pledge that basically says, "I will always use my protective equipment. I will always look both ways when I come to a crossing." All the standard stuff. Which all makes sense. But we have said, "Okay. We'll do that as long as management is willing to sign an equivalent pledge that says things like, 'I will never discipline a worker for in good faith refusing to do a job which he or she believes is unsafe.'" And, at the board of directors' level saying things like, "We will always assess the safety and health impact of new technology and new equipment." Sadly, no management has ever been willing to sign that pledge, which tells you something. But that sort of thing might provide a guide for what could be in a management safety culture kind of survey and that would be useful to have, I think.
Dr. Haas (A): Yes, I would like to follow up with you on that. It's interesting because after we do the survey

I go out and I share the results back with the workforce at their pre-shift meetings to say, “So, you did this a couple of weeks ago. Here’s why.” I also share it with the site level management. And I’ve actually gone to a lot of corporate institutions to talk about, if they had several sites participate. But on the site level they’re always interested because there’s always huge differences between hourly and salary. And I’ve been impressed that at a lot of these sites their interventions have started with salary in terms of, “Okay, so why is there such a big difference here?” And so, they’ve come up with things they’ve done site specifically, so maybe talking about some of the things that these sites have noticed about why there are some discrepancies between salary and hourly. And, if we could come up with something that we could standardize to assess that for management, that would be a great follow-up tool for our participating sites and for the industry.

Mr. Bowersox (Q): One big thing you did do, commented on shutting equipment, and that’s a big problem in our industry. I’m glad you addressed that.
Dr. Haas (A): Yes.
Mr. Bowersox (Q): The other thing is, maybe to look at, we talked about, the last two days, reduction of workforce with the mining industry. It used to be a lot of guys would work on that same crew their whole career. Now you’re lucky if you work the same job twice in a week. A lot of people are doing different jobs now. They used to maybe just run a shuttle car, now they’re running a roof bolter or doing all kinds of different jobs. So that’s a good study. I appreciate that.
Dr. Haas (A): Yes. We do ask, and I have a copy of the survey if anyone wants to see it, the amount of time in current job, time at that mine, time in industry. There’s big differences in each of those three, so, to your point on that.

Public Comments

Mr. Green: Ed Green with Crowell & Moring law firm. I wanted to congratulate the committee for a very, very interesting and, I think, productive day and a half of meetings. Terribly useful to hear all the activities that are going on at NIOSH. I want to make two substantive comments. One is to just strongly endorse and remind the committee how important these partnerships are to NIOSH’s relevance and validity to the industry. I think that also speaks to all participants including labor unions and academia. All of the partnerships that have been described by RJ in the past day and a half are vital to the industry’s ability to deal with some very complex regulatory issues that have been proposed or are in the process of being processed by MSHA. Candidly, the knowledge base of the industry is not as strong as it used to be. I think that also applies with MSHA. I don’t say that critically. It just is a fact of life that institutional memories change. And some get stronger, some get weaker. But NIOSH is the constant for the most part and the ability of NIOSH, and NIOSH’s management in particular, to reach out and accept the notion of partnerships is just vital to our success, our collective success. And I just wanted to make a comment about that. And, going a bit further on the same topic, it strikes me that the Miner Health Program, which is awfully interesting, but in some ways are as nebulous as could be, would benefit greatly from a partnership. It strikes me that all the topics that are there could benefit from input from industry at the earliest stages, also input from other stakeholders. And I think the best way to do that is to establish a

miner health—whatever you call it, a miner health—partnership, and get stakeholders involved sooner than later, like now, and make sure that things are heading in the right direction so that NIOSH doesn't find itself out on the limb with no place to go. So that's my comment.

WRAP UP AND COMMITTEE DISCUSSION ON FUTURE AGENDA TOPICS AND DATES

Dr. Nelson: Let's recap some actions to be considered. One thing I would ask for is, can you put numbers on slides so that we can refer to them more easily? That would be helpful.

Another one is metrics. Issues about the importance of a program, or a findings or an outcome or an output, the sense of which they address critical needs and the sense to which they've been applied. So that sense of "applied" which goes to something in published journals that might be citations as opposed to numbers of published papers. Who is using the data/the information that's coming out of the programs?

On collaborations, this committee has been very strongly supportive of collaborations. And we have observed the great advances, the partnerships and what's been happening. And I think the committee strongly supports that with more to come. I'd like to see/encourage a continued development/interaction with other kinds of organizations, such as oil and gas. And maybe thinking about tribal. The tribal extractive industries have their own perspective on what their problems are in terms of making decisions about what can be mined and what can't be mined.

On the "safety pays," the idea of doing some cross-sector data checking. Instead of just focusing on incident rates and costs of incidents for mining industry, to look at it in the context of heavy construction and all sort of extractive industries.

For Sukumar, combining heat and cold throughout was interesting. I think one thing that the committee needs to discuss for sure if there's the pause on the personal protective PPT. We had discussions on the 10 minutes versus the 60 minutes breathing air supply, what's going on and what needs to be addressed. And, as opposed to 10 or as opposed to 20 minutes. And the overall strategy of what are we trying to do here and where should the investment be. Should we/do we encourage the continued work on 60 minutes in terms of the air reform?

Dr. Luxbacher: I have two points on the breathing systems. The first is that we seem to be willing to sacrifice miner health for safety in that we're willing to basically give miners a very unwieldy piece of equipment if it will work for 60 minutes that could have long term impacts on health. And I don't know that that's the right approach. The technology doesn't seem to be there for a 60 minute wearable piece of equipment. So I don't know whether we stick with 60 minutes or we go to a 30 minute, or a 20 minute, or what the answer is there but that's something that struck me. The other thing that stuck me is that NIOSH should be applauded for taking a systems approach to a lot of this work. But when we look at that breathing apparatus there is no systems approach there. I don't think we're looking at the work that miners

are doing and the other things they're wearing on their bodies. It just doesn't strike me as a systems approach.

Dr. Burgess: I just want to add to what Kray was talking about. So I think that it may be useful, both for this topic and others, for the next meeting to have a highlight on international partnerships and examples. So, specific to this setting, it really would be nice to talk about what the Australians do and get an idea of how have they handled the problem. And then maybe have some data behind it as well. But that could be said broadly. We did talk a little bit about international at the very beginning of the meeting but then we never really came back to it. So and maybe there's some examples we can learn from in different areas.

Dr. Kogel: So, Jeff, you're thinking of a benchmarking exercise against what is being done specifically for this? Or are you talking more generally as far as what our engagement is internationally?
Dr. Burgess: I think probably both. You could do both. But if we have this particular question which is a very thorny one—I mean, as you brought up, it might be nice—sometimes when you're in a setting and you have a difficult issue to look at the way other people have addressed it can be informative. So I think that you could come back to that very issue about the self-rescuers looking at it from a broader perspective what are other folks doing. So maybe that informs kind of the "stuckness," if you will of where we are on that. But I think in general, too, just a little bit of highlighting of how NIOSH is working with other organizations and what are the benefits of that, how is it being done, would be something that I personally would like to hear.

Dr. Miller: Just a follow-on and just an observation and it's not my area, but by what he's suggesting, looking at the international spectrum, one would increase the opportunities for industry to develop something if there's more buyers in the game. As well as it seems that a lot of folks don't want to wear this. I mean, it was a heavy unit that came by, we had that experience yesterday, and if they're not wearing it, it's not serving the purpose so, not only is it not efficacious, it's not being utilized. So, we do have to find something that provides whatever makes sense in terms of the workers, and then work toward opportunities as the availability of a new technology presents itself. But I think in order to accomplish what we want if it's 10 minute rescue and then putting stations that are, or caches, locally that might be the best solution, versus being regulated into a 60 minute box.
Dr. Nelson: So, whatever is the best. I think what the committee would maybe say is that the 60 minutes should not be assumed as being the goal.
Dr. Miller: Yes.
Participant: Right.
Participant: Right.
Dr. Nelson: And that the whole thing should be reopened and said, "From a systems approach what are the alternatives? So even if the technology permitted 60 minutes, is that what we need to do?" I don't think we necessarily know.
Dr. Miller: Right.
Participant: And the paradigm that Aubrey just mentions, that's standard in the chemical industry where

you've got SCBAs set up every 50 feet or so but you're not asking people to carry them around all day long.
Dr. Nelson: Right. And if you persist on the 60 minutes and nobody is making them, or it becomes noncompetitive, they're not cheap, I mean, it reaches the point where I don't know that it would ever be used or people would buy them, from that perspective. To a certain extent is there something similar going on with the refuges? The sense of people not being prepared to use them? Miners saying that they will not go in there?
Mr. Bowersox: That's a last…very, very, very last, resort. I mean, you want to get out of that mine so a lot of miners say they'll never get in one but you never know that. Being at Sago for nine months, that particular crew would probably be here today if they had that. So you can never say, I guess, never but it would be a hard decision to make to go in that rescue shelter.

Dr. Nelson: But if you had to consider a finite amount of money to invest in research, which effectively is what we have, now we sit and look at priorities and say where should those fundings be, in terms of developing refuges, in terms of… This is sort of the question that I think the committee can be considering, one of priorities and where would the best investment be.
Dr. Kogel: I think this is a really important comment. I think the systems approach is really critical. And we have to also remember we've got regulatory mandates and constraints that are driving some of what we're having to do. And so, I think that's also another piece that Maryann brought up yesterday. And I think she went through each of the components of the system and indicated which ones were regulated and we have to do this, versus those where we can make a choice. So we're going to have to also consider that when we look at this systems approach. And it's really good to have MSHA here as part of that discussion as well.

Dr. Nelson: I do understand that. But one of the purposes of the advisory committee is to actually be external looking at that and providing, not to say we have to comply with every regulation, but that have to really consider the regulations themselves. I think that's in the purview of the committee.

Participant: I want to ask about the shelters. Can people get in or not get in or will they get in? I didn't know which was the case.
Dr. Nelson: What I had said. Well, I hear just from the input here that there's pros and cons and culture things that are involved in this. My question is, we're here, one of the things we're asked to do is to make recommendations on research, right, in terms of what research is necessary. So it becomes a case of the discussion on the, like 60 minutes versus non-60 minutes was a discussion. And there is a suggestion that comes out of the committee. So "Should there be continued work on the shelters?" is the question because there was discussion by the committee when we had that.
Mr. Wright: And, just on shelters, that might also be a place where we could benefit from some international experience. We had an accident in a potash mine in Saskatchewan about two years ago. And I think it was a fire. I don't remember exactly but I think it was an underground fire. And people used the refuge and used it successfully. I don't know if they're required there or if the company simply decided

it was a good idea. But you might look at what some other countries have done with refuges.
Dr. Nelson: That's good. That might be just interesting to simply tabulate what the experience has been.
Mr. Bowersox: The shelter I think you're talking about, Mike, was a built-in shelter. It wasn't one of the other ones.
Mr. Wright: I believe it was a built-in shelter, yes. Yes, it wasn't one of these portable things that gets brought in.

Dr. Nelson: This also gets over into the fire and tunnel kind of scenario where you've got shelters which is where they overlap. So maybe that idea of trying to summarize what has been the case, reports on use of different kinds of shelters in terms of effectiveness. We heard a lot at the meeting today that NIOSH and MSHA are working together and they do share information. One thing that occurred to me was… And I know we had this with advisory committees when I was at National Science Foundation, each of the divisions had their own advisory committees and sometimes the advisory committees would meet together, which provides a cross-disciplinary sort of look. but MSHA does not have an advisory committee. Is that true?
Mr. Francart: No, but we have employees that work very closely with the NIOSH people and they advise on ad hoc basis.
Dr. Nelson: But I'm just saying that, if MSHA did have an external advisory committee like this one is to NIOSH, then there can be that external advisory board consultation which tends to be interesting. But that's up to MSHA's decision.
Mr. Francart: It's just we do that in a way where we have a request for information to go out to the public and to industry and to all our stakeholders. We get input from them when we develop regulations.

Mr. Wright: There's an NAS committee currently looking at control of coal mine dust. I don't know the logistics or even the legality of getting the two committees together in some way but it might be something to think about.
Dr. Nelson: It's a National Academy Ad Hoc Committee that's actually a study committee. And NIOSH is funding that study.
Dr. Kogel: They've had a number of meetings and the next meeting is coming up. And some of those meetings have a public forum where the public can be involved. I would have to go back and look to see if we have a date set for it yet but I think it's the end of June.

Dr. Nelson: I think we had some input into the Miner Health Program as potentially a new partnership. There was a lot of interest in the Miner Health Program and so maybe an update on that, could be on the agenda for the next meeting so we see how it's progressed from where it is now. And do you want to have the work organization safety culture reporting update at our next meeting as well?
Participant: Yes.
Participant: Yes.
Dr. Nelson: Yes. Good. And so, we also have the international partnerships and then the benchmarking on shelters. I would love to have some brainstorming about Jessica's "innovation" slide that had "AI" and "big

data" and "analytics". And overall very little of it had permeated into the program. So I guess the opportunity to say if that's the big "I" the "innovation" there, where should it be, thinking about permeating into the program? Where are the opportunities? And that would be an interesting discussion kind of thing. It might or might not be a presentation.
Dr. Kogel: I think it probably will be a presentation. Since last October we've had a group of people from both SMRD and PMRD working together to put together a scoping paper and a roadmap for how we will do exactly what you're referring to. Our MSHRAC meeting in the fall would be a great opportunity for us to roll it out. Jeff talked about it at the last MSHRAC meeting but now it's going to be at a point where we could really show you something that's going to be substantive and more tangible.
We will definitely have that on the agenda.
Dr. Nelson: Great

Dr. Luxbacher: I have a comment on the RA benchmarking. I feel like that's been done. I feel like I've read some literature on a lot of that when the RAs were being developed. I don't know how fruitful that conversation is. I know when the RAs were being developed I've seen lots of publications on what China was already doing, what some of the metal/nonmetal mines were already doing with built in place shelters. I think there's a lot of that already out there. I'm not sure what we're aiming to get at with that conversation at the next meeting.
Dr. Matetic: Within the United States, we do have an idea who has them or not and who's using them. We have done a lot of work and testing on built in place shelters as well in lieu of using potential local RAs, because of the concerns and issues associated with them. That could be an update for the next meeting on where we're at with built in place shelters as compared to mobile. Internationally, we don't really have, as far as I know, all of the data relative to what other countries are using regarding shelter in place. But, for the industry within the United States we have a clear identification what they're using, why they're using it and how they're using them.
Dr. Nelson: And when they have been used, with what outcome.
Dr. Luxbacher: I just want to ask, what's the aim of this RA conversation that we're discussing for the next meeting? I don't understand.
Dr. Burgess: I would look to NIOSH in this particular case, to see whether that discussion helps guide them in any program development that they have right now. So if it does fit, great. And, if it doesn't, then we should not include it. We can use the time for other topics.

Mr. Zimmer: I would like to see, we had a minor discussion yesterday on sharing information with other agencies such as CPWR, just continue that conversation. I'm very familiar what they've done with their Foundations for Safety leadership and the safety culture issue. I'd just like to expand a little more on that just so we can share some more information and make that program grow up.
Dr. Kogel: We could do an update on our interactions with them. And we're meeting with them fairly regularly. I'm meeting with them next week. So we'll update this committee with what things we've put in place.
Participant: Good.

Mr. Welsh: Certainly you're always welcome to give me ideas over the next month or so as they may come up, topics for the next meeting too.

Dr. Nelson: Do you want to discuss the next meeting?
Dr. Kogel: I would like to discuss the next meeting, first of all in terms of the format. For this committee I think this is our third meeting and so I wanted to check back in with the committee to see how things are working in terms of the formats and the frequency of the meetings, get your feedback. From our perspective meeting twice a year has been very beneficial. I would like to continue that. And I would like to continue the May timeframe and the November timeframe, so the spring and the fall meeting. What we did the first year, is we had one mandatory face-to-face meeting being the spring meeting, and then we had the fall meeting being one where if you didn't want to travel you had the option to call in. After doing that in Spokane I felt like from our perspective we didn't get as much feedback from the meeting by phone. I've been on many conference calls where people in the room tend to have a very different interaction than those that are on the phone. I would propose that for the second meeting to consider this option, either we're all face-to-face or we're all on the phone. That way everybody kind of has an equal sort of footing, so to speak. I want to make sure that we're hearing from everybody, because everybody has great input and I always feel like on the phone it is a bit of a disadvantage.
Dr. Nelson: And when you say "on the phone," a web meeting also, a web format.
Dr. Kogel: Yes. So, two questions, One, is the committee happy with continuing with two meeting a year? And two, what works for the committee in terms of a second meeting, everybody meeting in-person somewhere, or everybody meeting remotely by phone and/or web?
Dr. Nelson: I think face-to-face, on the charge for this committee, is always preferable than a webinar teleconference. If we can't get a quorum face-to-face then you'd have to do something else.
Participant: I agree that face-to-face is preferable, if possible.
Mr. Drysdale: I agree also. I think the venue sometimes can be a little complicating. Spokane—
Dr. Nelson: Was complicated.
Mr. Drysdale: It was complicated. Just getting out and getting back was a two and a half/three day ordeal. Not that it's not an important place to go but it's more difficult.
Dr. Nelson: I know last time for November we had talked about whether it was going to be Spokane or Denver.
Dr. Kogel: What I would like to do is rotate around. I would like to have one east and one west. I think Denver would be the next logical place.
Dr. Nelson: And then maybe Washington in the spring.
Participant: In Denver, in terms of laboratories and facilities, we couldn't do a tour like we've been able to do.
Dr. Nelson: We could go to Edgar Mine. Or, Henderson will still be open. We haven't been there.
Participant: If you could let us know as soon as possible the dates for November that would be good because calendars fill up pretty quick.
Participant: Absolutely, and if there's anybody here who knows that there's certain November dates that

are not going to work for them please let Jeff know and we can consider that as we set the dates.
Dr. Miller: I think that APHA runs into early November.
Dr. Nelson: Last time it was the week before Thanksgiving week. And Denver sounds like it.
Participant: The only other question is whether, for people like me yesterday, and Bruce today, who just can't make the meeting, I would like to have a call-in option at least, not a preferred one.
Participant: Yes, I think we should have that option because things do come up. I'm comfortable with that if everybody else is.
Dr. Nelson: Yes if we could use a WebEx type system and people would be able to call in with stuff.

Meeting adjourned at 12:00

I hereby confirm these Summary Minutes are accurate to the best of my knowledge.

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Priscilla P. Nelson, Chair

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Date