Diesel Exhaust Health Effects Partnership
September 19th, 2017 Meeting
Comment Summary

A. Non-permissible Equipment in Underground Mines

Meeting participants did not specifically discuss non-permissible equipment.

B. Maintenance

a) Jeff Moninger (Mechanical Safety Division, MSHA) discussed the importance of engine maintenance [Moninger Presentation]:

- A maintenance program ensures emissions control methods are working properly. If you have a maintenance program that measures the diesel emissions when the engine comes in or during its working life, you know how it's being maintained and if you have issues with the engine or increased diesel particulate matter (DPM) during that engine's life.

C. Exhaust After-Treatment and Engine Technologies

Three presenters discussed exhaust after-treatment and engine technologies.

a) Dr. Aleksander Bugarski (NIOSH) discussed research activities relating to diesel exhaust exposure [Bugarski Presentation]:

- Specific research aim two will evaluate, in the laboratory and in the field, and will implement novel and emerging advanced engine technologies for heavy- and light-duty underground mining applications. That's how we can get more advanced engines in the underground mining industry.
- Another topic would be to develop and evaluate, in the laboratory and field, advanced disposable filter elements, because we have observed that these disposable filter elements have been around for many, many years and the same models are still being used. We would like to look into advancing that technology and getting better products on the market and also promoting the better products that are already on the market.
- We focused on diesel particulate filter systems and promoted those for almost two decades, and I guess that technology's advancing and is getting better and better, but it's not a universal way of dealing with DPM emissions in underground applications, and they have some downsides too.
- Diesel oxidation catalytic converters have some issues with NO_2—disposable filter elements (DFEs) which are good for on-road applications might not always be good for underground applications. We looked into how to develop products which are suitable for the underground mining industry.
- The second effort would be to characterize emissions from advanced engine technologies. MSHA engine certification has a limited scope. We would like to do a little bit more in-depth evaluation of these control technologies besides what this certification data is telling.
- We did a little bit of analysis on the underground mine diesel inventory. MSHA has a great database of all diesel-powered equipment in coal mines. Unfortunately, we don't have anything on metal/non-metal mines, but we can draw some conclusions. What we found is that state-of-art now is not much different than at the beginning of this century.

- There's still a lot of Tier 2 and 3 Tier engines, particularly in permissible and non-permissible heavy-duty equipment. Very few engines were purchased since the mid-2000s. Only 54 of 1,253 non-permissible, heavy-duty vehicles are powered by engines that were approved after 2010. Only approximately 0.5 percent of non-permissible light-duty vehicles are currently powered by engines that meet EPA Tier 4 standards.
- Regulations, for both metal/non-metal and coal mines, were introduced under the assumption that over time, older technology diesel engines would be replaced with modern engines. That's on a slow pace according to the analysis I have seen. Diesel engines are very durable, reliable, and they can be rebuilt. Tier 4 final engines emit about 99 percent less particulate than the engines we discussed in 2001. What we are planning to do about this is to help industry with selection of new, viable engines. Not all the engines are created equal. Not all the engines which are currently approved by MSHA or CANMET are producing the same effect on emissions reduction. Controlling emission at the source helps everybody.
- We want to prevent potential introduction of engines which introduce new, unwanted emissions. We have seen that with the catalyzed diesel particulate filters, when we saw a sudden spike in NO_2 emissions. We have seen that with the platinum catalyzed diesel oxidation catalysts (DOCs). We need to weed out those products which are not suitable for the underground mining industry. We have two engines in scope to test. At least one representative engine for heavy-duty applications and one for light-duty applications will be evaluated. We are planning to test here for final engine. The heavy-duty engine uses selective catalytic reduction (SCR)-based solutions, so there's no diesel particulate filter (DPF) on it. Those type of solutions are more palatable for the mining industry because DPFs are still relatively difficult to operate in the underground environment.
- On light-duty, we would like to test engines which are equipped with DOC and DPFs just to show that some of the Tier 4 final engines which are currently coming on the market which do not have those control strategies are not really that clean. The evaluation would take place in the NIOSH Pittsburgh Mining Research Division (PMRD) diesel laboratory. And on the right-hand side (of slide 19), we have two pictures of it.
- The engine will be operated at selected steady state and transient conditions. Detailed characterization of regulated and unregulated emissions will be produced. Special attention will be given to potential generation of undesired secondary emissions, like NO_2, N_2O, nucleation mode aerosols, metallic aerosols, and other pollutants.
- So then, if we successfully find engines which can be implemented and we find partners in industry, we would like to put the same or similar engines in an underground environment and test those in isolated zones or even directly in a production scenario. And then, as usual, we would publish this in peer-reviewed journals, and also disseminate information at conferences and workshops.
- Disposable filter elements, that's something that we have been wrestling with for a long time. DPFs are the workhorse of the coal mining industry. All the permissible, heavy-duty, vehicles and a substantial fraction on non-permissible, heavy-duty, vehicles and a small fraction even of light-duty vehicles (those primarily retired heavy-duty vehicles, which are turned into light-duty vehicles), are equipped with DFEs. This technology is very critical to controlling DPM in underground coal mines. In the 1990s it was

introduced by the U.S. Bureau of Mines and basically allowed controlling DPM emissions from heavy-duty pieces of equipment below 2.5 grams per hour.

- In all our testing, we found that aged DFEs with accumulated DPM in them are very effective. We know that those filters can reach even 99 percent efficiency. The only problem is we see that certain products might have some deficiency. There are more expensive, better products, but it's very hard to persuade why they should pursue those.
- We noticed issues with off-gassing, with a large concentration of aerosols in the ambient air during the initial heating up of the filter. Also, we noticed that the efficiency of these filters during the first couple of hours, before they have DPM collected on them, are not as stellar as in later hours.
- Work would be done at the PMRD diesel laboratory and we'll evaluate effectiveness of these selected DPF systems. We will benchmark them against existing products, and we will work also with some of these manufacturers to develop better products. And then, of course, we are hoping to put this technology in some metal/non-metal mines because we have limitation on how much evaluation we can do in coal mines. There are gassy mines in this country which use similar technology, and we can introduce this technology in those mines and try to demonstrate that also to underground coal mining industry. So we are looking for partners. We are looking for the comments, suggestions, and ideas.

b) Link Bowers (Technical Support, MSHA) discussed emissions reduction technologies [Bowers Presentation]:

- Emission reductions is basically reducing the amount of emissions coming from the engine itself—now you're looking at the source instead of trying to protect somebody from what's being produced. Now you're trying to just reduce the diesel particulate matter being produced. Diesel particulate filters can be used to remove DPM. Alternative fuels like biodiesel can be used to reduce DPM emissions. And maintenance programs to ensure that what you're doing is staying properly maintained and working properly.
- Here's an example of a newer engine compared to some of the older tier engines over the past few years. Newer tier engines produce lower DPM emissions. In an example of engines that are in the 175 to 300 horsepower class, in 1996, a Tier 1 engine would produce about .54 grams per kilowatt hour of DPM. The Tier 2 and 3s are similar for DPM emissions and they would be at .2 grams per kilowatt hour. And then, as you can see, in 2011, when the Tier 4s are coming out, that you're down to .02 grams per kilowatt hour, which is 27 times less than a Tier 1 from just several years before. So you can see the reduction from 1996 to 2011 of what's available. But, of course, you also have to consider the financial cost if you're going to buy a new piece of equipment.
- Another way to reduce emissions of diesel particulate is using diesel particulate filters, and there are several types. You have throw-away paper filters, and then you have other filters that can be regenerated, which means cleaning off the diesel particulate matter. There are passive regenerative ceramic filters that self-regenerate based on duty cycle. Active regenerative ceramic filters need a regeneration station, so you've got to take regeneration time into consideration. Some mines are more suited than others depending on their mining cycle. You also have a fuel burner with ceramic filter, and that one creates a high temperature as in a passive type system. You have sintered metal fiber filters, which use electrical heating on board for onboard regeneration. Then you have

disposable paper filters. But the paper filters, you have to have cooled exhaust in order to use those because they can burn if they get to too high a temperature. And then you have a high-temperature disposable filter and its filter life is based on the duty cycle and operating time. We have a MSHA filter listing also on our website and it's located below. [MSHA Filter Listing].

c) Jeff Moninger (Mechanical Safety Division, MSHA) discussed diesel engine technology [Moninger Presentation]:

- New technology diesel engines include exhaust after-treatment devices to reduce tailpipe emissions. By this, I'm talking your Tier 4 engines. They use either a diesel particulate filter that usually incorporates a diesel oxidation catalyst and some EGR (exhaust gas recirculation) with the engine to help lower the DPM. Or the other system used frequently is a selective catalytic reduction system (SCR), which injects diesel exhaust fluid or urea into the exhaust stream to help lower the NO_x emissions.
- This is a quick example of some diesel engines that MSHA has approved. The first one is a 185 horsepower engine at 2200 RPMs. The first engine, a Category B, emits about .22 grams per horsepower-hour, which exceeds the EPA Tier 2 limit for that horsepower rating, which would be .15 grams per horsepower-hour. However, we have some of those engines approved for MSHA Category A (gassy mines) using a dry system scrubber—basically, a radiator to cool the exhaust and then the exhaust is filtered. So, with a diesel particulate filter, the DPM is lowered to about .009 grams per horsepower hour, which is below the Tier 4 limit of .015. Also, we have a similar system that incorporates a diesel particulate filter and a diesel oxidation catalyst, which we believe, based on the calculated values, would drop it down to about .007 grams per horsepower hour. So even though permissible engines (Category A engines) may be Tier 1, Tier 2, or Tier 3, once you throw a filter on there, you're going to reduce the DPM and lower it below the Tier 4 limits.
- Another example is a Category B 215 horsepower engine at 2200 RPMs. This one didn't quite turn out as well. It's .13 grams per horsepower hour engine, which is, basically, either a Tier 2 or Tier 3 engine. But we have a similar engine approved under Tier 4 which incorporates a diesel particulate filter and a diesel oxidation catalyst, with DPM down to about .010 grams per horsepower hour. Similarly, we have a 200 horsepower system that incorporates diesel exhaust fluid, which injects urea into the exhaust, which also comes out with .010 grams DPM per horsepower hour. The Category B engines on this slide are all actual values from test data. The Category A engines are usually based on calculated data of what we expect the particulate filters to do.
- New technology diesel engines are available for metal/non-metal mines in pretty great numbers. Because they're not confined to using a MSHA-approved engine, they can just use any engine that's going to meet the health table (Table 57.5067-1), which is limited to Tier 1 and Tier 2. So, if you have a Tier 4 engine, you can buy it and bring it in.
- Coal mines are starting to have some newer technology diesel engines available. Unfortunately, it's a limited number just because of what the industry or diesel engine manufacturers have brought in to be approved. But we are starting to see some of that newer technology brought in for MSHA-approved Part 7 engines.

D. Monitoring MNM Miners' Exposures to DPM

a) Dr. Aleksander Bugarski (NIOSH Mining Research Division) discussed MSHA DPM sampling data [Bugarski Presentation]:

- What bothers me to some extent is that we have all this information for metal/non-metal mines, but we don't have any information on what coal miners are exposed to. Some hypothesis was introduced when regulations were introduced that controlling DPM emission at the source is going to help in reducing exposures. But I still believe as a researcher that we should verify that.
- There's very limited data available around the world, and probably one of the largest sets is from northwestern Australia and a recently published paper by Peters et al. MSHA collects about 500 samples a year. I looked through a period between 2012 and 2016. And, basically, on the left-hand side graph, it's showing the spread of that data. When you do averaging—I think statistically it might not be kosher—but you can do averaging and you'll see this trend where total carbon (TC) and elemental carbon (EC) concentrations are continuously dropping ever since regulations were introduced. A dramatic drop occurred after the 160 micrograms per meter cubed TC level was established (in 2008).
- On the right-hand-side graph, you can see the averages for industry, of over 500 samples that were collected per year. We're below 123 micrograms per meter cubed EC, which is basically equivalent to 160 micrograms per meter cubed TC. So, basically, if you talk about what more the industry needs to do to be in compliance, they don't need to do much more. They're already there.
- But about 18 to 28 percent of CD 560 (elemental carbon) samples exceed 123 micrograms per meter cubed. That means that in this period (2012–2016), we have pretty high percentages of these overexposures (over 160 micrograms per meter cubed TC).
- When you analyze this for occupation, you will find that certain occupations definitely are exposed more than the others. For example, we found that 30 percent in 2016 of all the samples on the blasters showed concentrations above 160 micrograms of elemental carbon. That's a pretty good chance that if you've blasted that you've been overexposed.
- It's not that bad for truck drivers and some other occupations where you have about a 5 to 10 percent chance that you'll be exposed. But for the blasters or some scalers and some other occupations, there's a pretty good chance that you're overexposed.

D3. Advances in Exposure Assessment to Reduce PEL

a) Monique Spruill (Chief of Health, Metal/Nonmetal Division, MSHA) discussed the benefits of using of real-time monitoring [Spruill Presentation]:

- One other remarkable thing that they were able to do was use a real-time DPM analyzer. And if you're able to use a real-time DPM analyzer, they were able to go and say "How is our equipment functioning on a day-to-day basis?" They were able to then monitor their ventilation and they actually corresponded this with exposure monitoring.

E. MNM Miners' Personal Exposure Limit (PEL)

Three presenters discussed existing control strategies that have been effective in reducing miners' exposures to DPM.

a) Dr. Aleksander Bugarski (NIOSH Mining Research Division) described research efforts at NIOSH [Bugarski Presentation]:

- We are starting this new project which is going to have five specific aims. And we discussed quite a bit what we can as NIOSH do to address existing exposures and what we can do to advance our knowledge.
- The first specific aim is related to development of evaluation technologies and strategies to prevent overexposures to DPM over critical affected occupations in underground metal/non-metal mines. We want to look a little bit deeper and try to address some of these specific occupations because we have seen from MSHA data that, on average, industry is okay. But we are still seeing a relatively large number of overexposures.
- For those of you who are not familiar with DPM sampling, three types of samples were collected in underground metal/non-metal mines and they are under Contaminant Code (CD) 560, 561, and 562. Two first codes are compliance samples. CD 562 is non-compliance samples, which is ambient sampling used to establish the mine-specific TC/EC ratio. These are not random samples: inspectors, typically, are trying to target those with the highest exposures.

b) Link Bowers (Technical Support, MSHA) described several strategies for limiting miners' exposure to DPM [Bowers Presentation]:

- DPM reduction depends on exposure controls and emission reduction. Your exposure controls are ventilation, environmental cabs, and administrative controls. Emission reduction depends on the diesel engines—on engine maintenance, biodiesel fuel, and after-treatments. Almost all mines will require a combination of these controls to obtain compliance.
- DPM reductions from ventilation improvements would depend on the nature of the upgrade, whether it be increasing your air or maybe even just tightening up your ventilation controls. Improvement will be roughly proportional to the increase in your air flow.
- Another set of controls are administrative controls: controlling DPM exposures through operating procedures and work practices. Some examples of those are minimizing engine idling and lugging so you're not making DPM that you don't need to. You want to keep your fuel and lube oil clean. That'll help DPM emissions go down. And if you can, utilize traffic control and production scheduling so you can keep heavy traffic downstream from miners who work outside of cabs. Like your powder crew: since they're not protected by a cab, usually it would be good if you can schedule so they're not getting the exhaust from other equipment going by if you can. Route haul trucks in return air is another one that you can do. Also, schedule blasters on non-load haul shifts so that they could be working when there isn't as much diesel haulage going, but that just depends on the mine itself and its mining cycle.

- Limit the horsepower in the area based on available airflow so you don't stress the ventilation system, this will help dilute the DPM. Also, keep doors and windows closed on environmental cabs so that they're doing what they should be doing, protecting the miner.

c) Monique Spruill (Chief of Health, Metal/Nonmetal Division, MSHA) provided a summary of MSHA sampling data and exposure control success stories for metal/nonmetal mines [Spruill Presentation]:

- We'll be discussing our DPM levels in our metal/non-metal underground mines. Let's look at our average concentrations. The top blue line shows total carbon, and the bottom red line is elemental carbon. Let's look at 2008, when our final rule was being implemented for 160 micrograms per meter cubed. We can see that, from 2008 to 2016, there was a 42 percent decrease in total carbon levels. This is consistent with our elemental carbon levels, that have decreased by 47 percent. Our average concentrations of DPM keep declining over time.
- Between 14 and 19 percent of our samples are exceeding the PEL. We're collecting about 500 samples per year. Over this five-year period, a lot of our samples, we can say they're really compliant.
- Now let's go over our miner occupations. We're going to concentrate on the first five occupations. There were 438 samples collected. For your blasters, 31 percent of our samples exceeded the PEL. Your front-end loader operator, 11 percent; your scalers, 9 percent; your truck drivers, 7 percent; and your mucking machine operators, 6 percent.
- Blasters (also known as powder gangers) have direct exposure. They're working in the face. They're working in areas with poor ventilation. They're working in areas where they're not in enclosed cabs. Also, they work in areas where equipment is running right next to their work location.
- Now let's go on to look at our front-end loader operators. They're also working at the production phase. They're spending time mucking and they're spending time idling while they're loading and dumping. They're working down through the motor while they're dumping. They work in open, also in enclosed cabs. But we want to see why would they still be number two of our samples that exceeded this PEL. They also work with machines called skid steers that are completely open without a windshield. So that level of protection that you would get in an enclosed cab, we're not seeing those.
- Let's go on to our third category, a mechanical scaler. They're also working at the face. They're working in both open and enclosed cabs. They're working areas with poor ventilation, and they also spend time idling with this equipment while they're scaling.
- Now we'll go on to our fourth category: truck drivers, still 7 percent of our overexposures. They're primarily exposed to diesel equipment. They spend time idling while they're loading. They work downwind from the motor and they're also passing other trucks. So our truck drivers are exposed to other diesel engines while they're passing other trucks.
- Now let's go on to our mucking machine operators. They work at the face. They have their engines idling while they're dumping. They work downwind from the motor and

while they're tramming. So, if you're going from point A to point B, you're going to have your engine idling at point A and also at point B.

- Now we're going to go on to look at commodities, particularly four different commodities: our crushed and broken limestone, gold ore, zinc, and lead zinc. Now 47 percent of our samples exceed the PEL for crushed or broken limestone, but they also make up 31 percent of our underground mines. Gold mines make up 21 percent of our underground mines, whereas our lead zinc and zinc mines make up 3 percent of our underground mines.
- So, for crushed and broken limestone mines, what have we noticed? They're large-scale underground productions. They have ventilation challenges. They have some older equipment and with this poor ventilation, as this mine size expands, we know that the main fan is having problems getting air flow all the way back to the production face. Also, a few of our mines are still using natural ventilation, which is affected by seasonality. We know there are temperature and barometric pressure changes. Also, they're using is this room and pillar extraction method. So you get these large open excavated areas in which ventilation is a challenge. Also, they're normally working on a year-round basis, so our miners are constantly being exposed. Also, we know that there are some maintenance procedures that they need to have in place, and that we need to increase helping our operators look at their maintenance schedules with these mines.
- Next, we'll go on to gold mines. We've noticed that they've had poor engine maintenance and ventilation. A lot of our gold mines are using some older engines. They're operating diesel equipment with no filtration and with open cabs. And they're having some direct exposure. One process they're using is extracting the ore through tunneling or shafts, so that's another ventilation challenge. Also, we have to remember altitude. Where do we optimize our engines for altitude? That's normally at 3,000 feet per max altitude designation. So, when you're doing particulate matter or maintenance schedules, we also have to consider altitude for our gold mines. It's another challenge that they have to overcome.
- Now let's look at lead zinc ore mines. The biggest thing that we're looking at is the single entry drifts that we have as a ventilation challenge. The miners need to access ore core deposits. This commonly known as "chasing the ore": chasing across your vein, creating tunnels and drifts along the vein. This is the major cause of the ventilation challenge. We also see elevation changes within the same drift.
- Now we've also noticed the lack of ventilation at the face. When you're obtaining air, you're trying to bag off air from the main ventilation using booster fans. Ventilation tubing may not be adequately sweeping the face, and that's another ventilation challenge that we've noticed. Now zinc mines also have this; they have the same type of mining activities as lead zinc mines. We're still chasing this vein. However, our zinc mines were actually shut down for a while. When our zinc mines reopened, we noticed that they did have some newer equipment running at that time. For fleets with this newer equipment, zinc mines are overcoming a lot of their challenges.
- But what do we have to do? Our biggest thing is to have this multi-faceted approach, as we mentioned earlier. We need to control DPM at the source. We're also controlling our gases and other pollutants.

- We've noticed that scrubbers are being used in our smaller metal/non-metal mines and they may reduce DPM concentrations up to 20 percent. Our operators are also using filters. Paper filters may reduce your DPM concentrations by 85 to 90 percent, we've noticed. Also, your sintered metal filters may reduce your DPM concentrations by 50 to 90 percent. And ceramic filters may reduce your DPM concentrations by 85 to 95 percent. We've also noticed that generally they're using diesel oxidation catalysts, which may reduce your DPM concentrations by 20 percent.
- Let's go on and see what other things that they're doing successfully. They're using selective catalytic reduction, which is reducing your nitrogen by up to 90 percent. They're also using low emission engines. From speaking with our health specialists, we know that the majority of our mines are now using Tier 3 engines or higher. Also, as we've said earlier, there are environmental cabs on removable equipment.
- Let's go on to compare some of our success stories. I want to tell you about three different mines:

    - We have a crushed and broken limestone mine that was a multi-level mine. Back in 2008, this mine had concentrations that were over 230 micrograms per meter cubed. They were able to lower their DPM concentrations and also their exhaust concentrations. Their DPM concentrations fell below 100. How did they do this? They placed DPM filters on older equipment. They replaced and rebuilt their fuel pumps. They refurbished their engines and really did go about re-tooling them. They also purchased newer equipment; they purchased fans and tubings to ventilate those dead areas.
    - Next is another crushed and broken limestone mine, it's a single level mine, and they had the largest room of pillar mining method. They had concentrations of DPM over 250. But after 2009, they had no DPM concentration exceed 111, and their average DPM concentration by that time was 41. So what did they do? One of their steps, was to purchase newer equipment. They put in improved mine ventilation. They tightened all their stoppings. They added auxiliary fans behind the shot crew. They moved production faces from the back of the mine closer to the portals. They're using biodiesel fuel; they're also using ultra-low-sulfur diesel fuel. They have rebuilt engines to improve engine performance, and they're using diesel particulate filters. Particularly important is that they're changing the filters out after 500 hours. Before that, they were leaving their filters on.
    - Now let's go on to a lime mine—another multi-level mine. Back in 2009, they had concentrations that were higher than 267; they've been able to go below 40. We wanted to find out exactly what they did. for the curtains, they did a lot of repair and maintenance work. Instead of having stripped curtains, they installed full-size curtains. They also put fans into their stoppings. They use biodiesel fuel. They also use ultra-low-sulfur diesel fuel. And they ventilated their deadhead areas and all of their stagnant areas for air.

F2. Diesel Exhaust Partnership

Meeting participants discussed the role of the Diesel Exhaust Health Effects Partnership.

a) Ms. Patricia Silvey (MSHA Deputy Assistant Secretary) began by noting that—the question of rulemaking aside—the partnership had agreed to share information on best practices, strategies, and innovations in diesel exhaust control. She stated that MSHA and NIOSH could gather and post these best practices on their websites.

b) Dr. Jessica Kogel (Associate Director of Mining, NIOSH), explained that NIOSH has several years of experience with partnerships like this one; it has found them to be a good forum for bringing together stakeholders, exchanging information, and getting feedback that informs research. This is the first partnership co-chaired by MSHA and NIOSH. It reflects the two agencies' commitment to promoting and advancing mine worker health and safety. Dr. Kogel stated that the next step for MSHA and NIOSH is to develop a list of topic areas for working groups, and areas for comment. She also encouraged all interested parties to provide input to MSHA and NIOSH regarding ways to organize future efforts to advance the work of the partnership.

c) Dr. Aleksander Bugarski (NIOSH Mining Research Division) stressed the importance of industry participation in NIOSH research, because NIOSH does not have direct access to mines or exposed workers. To assess operations with overexposed workers and develop solutions for these occupations, NIOSH needs to find willing partners in industry, through venues including this partnership or MSHRAC or mining associations like NMA, IMA, or NSSGA. NIOSH would disseminate information on novel technologies and workplace strategies, for reducing exposures through partners and the wider mining industry. Dr. Bugarski also stated that, having heard NIOSH and MSHA give presentations at this second partnership meeting, he would like to hear from industry, "because I always believed in the past when we achieved some success that input from industry was the most important." He gave the example of high-altitude engine performance, which NIOSH and MSHA had dealt with 10 years ago, but which has come up again recently as an issue needing further solutions. Dr. Bugarski suggested the most effective way forward would be to work as subcommittees with pre-defined tasks. He also stressed the difficulties in reaching smaller operations, such as stone mines and underground sand and gravel operations, where a lot of the overexposures are occurring. He wondered if these smaller operations are represented in the partnership, and stated that exposures in these operations should be a focus area for the partnership.

d) Dr. R.J. Matetic (Director, Pittsburg Mining Research Division, MSHA) encouraged interested parties to provide input regarding how to move the partnership forward. Regarding topics that the partnership needs to consider, he asked, "what are the things that keep you up at night that need to be addressed?" Dr. Matetic described the benefits of operators sharing best practice information to advance the science. He noted that working groups would make sense. Dr. Matetic also observed that, once we've identified the tracks that we need to move towards, then we need to get the right people into the partnership to move forward.

e) Edward Green (Senior Counsel, Crowell & Moring, LLP) suggested that NIOSH and MSHA should issue a memorandum summarizing the events of the day's meeting. This would be different from the charter, and could be used to set out next steps and develop working groups. He noted that many exposures still exceed the current PEL, and suggested exploring

those more closely. He also suggested seeing what could be done to help engine manufacturers with meeting the differing EPA and MSHA requirements. He stated that the objective of this partnership should be to see how we can proceed without developing regulations. The partnership should try to accomplish everything possible short of regulations, he said, and that means that industry needs to be responsive to MSHA's RFI. He noted that the partnership needs to produce something that MSHA can point to as an answer to the RFI, and that NIOSH can use to guide its research activities.

f) Mark Ellis (Industrial Minerals Association, North America) challenged the premise that partnerships need to end up in a regulatory outcome—he noted the President's two recent executive orders about new regulations. He advised that partnership members draw on their different perspectives to seek other ways to improve miner health, for example through results-oriented prioritization: What equipment is out there producing the greatest contribution to diesel exhaust emissions? What occupations have the highest exposure? He encouraged sharing of best practices, and suggested holding separate sessions to dive into specific subjects in more detail—for example, the topics that Link Bowers and Monique Spruill had discussed. Mr. Ellis agreed with Ed's suggestion to develop a summary of the day's meeting—to lay out MSHA's and NIOSH's ideas for working groups, and topics for those groups to address, and as a vehicle to get feedback from stakeholders.

g) Larry Patts (NIOSH) noted the value of sharing success stories, but also noted that finding out what doesn't work for the industry is important.

h) Joe Betar (Classic Motors/Chrysler) said that uncertainty about future DPM regulations for engines is creating an enormous burden at a time when manufacturers are preparing to redesign engines. They do not know what engines to approve or to seek approval for. Since the time from conceptualization to production is so long for vehicles, manufacturers might approve engines that turn out not to meet new regulatory requirements. Therefore, Mr. Betar said, staying away from a regulatory solution would be immensely helpful.

i) Evelyn Stirling (Cummins Engine Company) echoed Mr. Betar's comments. Her company is beginning some next-generation work that will ultimately reduce emissions, but may not meet the Tier 4 requirements. A regulatory requirement to meet Tier 4 emissions standards on any future engines, she said, would put a heavy burden on engine manufacturers. Ms. Stirling described continuing research to improve engine emissions. She described preparing for stage 5 in Europe, which will be a simpler engine, allowing the manufacturer to take off some of the after-treatment, such as the EGR system, and still meet Tier 4. Ms. Stirling also described work on cleaning up older engines and getting a lot of them over Tier 3, including some Tier 4i and some engines that are basically Tier 4 but without the after-treatment approved in the system. She stated that some of the improvements over time have happened when miners took out some of the Tier 0, Tier 1, and maybe Tier 2 engines and put in Tier 3 engines, which are repairable. She noted that original equipment manufacturers (OEMs) and mines often request to get Tier 3 products certified, and that it is frustrating not knowing whether MSHA will require Tier 4.

j) Sheila McConnell (Director, Office of Standards, Regulations and Variances, MSHA) requested input from mine operators and engine manufacturers in defining specific subtopics. Examples of possible topics include biofuels, ventilation, coal versus metal/nonmetal mines, and best practices in general. She stated that we should look at the RFI as a vehicle by which the stakeholders can submit information, data, cross-data, and best practices that would allow us to help miners' health. She emphasized that there is room for improvement within the current regulatory framework. She stated that MSHA plans to add a link for submitting comments on its website, because the RFI will close.

k) Joe Sbaffani (JAS Mine Consulting) observed that many improvements have resulted from mines using cleaner engines. He pointed out the importance of the fact that equipment manufacturers are asking for direction. He stated that MSHA and NIOSH have the expertise, but they need to begin providing that direction.

F3. Low-Sulfur Fuels, Additives

Two presenters described using biodiesel fuel to reduce DPM emissions, and two discussed other fuel additives.

a) Link Bowers (Technical Support, MSHA) described biodiesel fuel blends as another way to reduce DPM emissions from an engine [Bowers Presentation]:

- Biodiesel is a registered fuel with the EPA. It's a fuel additive—and has fuel additives added in. It has ultra-low-sulfur diesel fuel. It is made and derived from vegetable oils and animal fats. And sometimes it's blended with standard petroleum-based diesel. So sometimes you'll have a B20, which is a 20/80 mix, or you'll have a B10, which is a 10/90 mix, different mixes, and they significantly lower your elemental carbon emissions. Some people have also seen NO_x go up with using it, so you've got to be aware of that when you are thinking about using that.
- If you transition from standard petroleum to a biodiesel product or a high-biodiesel blend, you have to consider cost, the quality and availability, its low-temperature properties (some of them will gel up earlier than normal diesel), solvent effects on some of your equipment. There may be some scrubbers that it'll react with that regular diesel wouldn't. And microbial growth: that means bacteria can actually grow in the biodiesel, so usually they'll put an additive in for that they wouldn't in a normal diesel. So that's your long-term storage stability also.
- Biodiesel fuel usually doesn't have as high an energy content as conventional diesel fuel, so you're going to use more gallons of biodiesel than you would with regular diesel in some cases. Also, your oil change intervals may go down because of using biodiesel.
- In summary, there are three exposure controls that you need and four emission production controls. For the exposure controls: ventilation, environmental cabs, and administrative controls. For emission reduction: the type of diesel engine you're using, the engine maintenance, your biodiesel fuel, and your after-treatments, which are your filters. And usually you're going to have to use a combination of these seven things to get in compliance.

b) Jeff Moninger (Mechanical Safety Division, MSHA) explained that alternative fuels reduce DPM emissions [Moninger Presentation]:

- Most of the time people think of alternative fuels, they're thinking of biodiesel fuel. The higher concentration of biodiesel fuel you have, the greater reduction you're going to see in total carbon. However, if you're going to use like a B99 or B100 biodiesel fuel, I'd recommend that you use a diesel oxidation catalyst and incorporate that into your system to help remove the organic carbon or organic compounds that you're going to have with the biodiesel.
- For Tier 4 approved diesel engines that incorporate diesel particulate filters and the diesel exhaust fluid, basically, they're coming from the manufacturer with very low DPM, so there's not much, if anything, to be gained by using biodiesel fuel in those type of engines because they already have low DPM. Along with that, if you're going to incorporate fuel additives with Tier 4 diesel engines, even though MSHA's guidelines require them to be EPA-certified fuel additives, we recommend that you check with the manufacturer to see if it's going to have any alternative effect with the after-treatment system.

Mr. Moninger also addressed a question from Mr. Raymer, who participated by webinar:

- *Mr. Raymer:* I was just wondering if they had done any tests with the fuel additives and some feedback that you can possibly extend some regeneration cycle times and reduce some DPM filter issues by having some additives with the fuels.
- *Mr. Moninger's response:* Yes, there's been some testing done, more just in general with the fuel additives, but there's never been enough extensive research done to show one way or the other if they would increase or decrease the life. Again, we do know there's some issues with the Tier 4 engine, possibly with fuel additives maybe being a little detrimental to their after-treatment. So that would be something to look out for, maybe one of the things NIOSH could look at with their testing.

c) Monique Spruill (Chief of Health, Metal/Nonmetal Division, MSHA) described use of fuel additives [Spruill Presentation]:

- They're also using ultra-low-sulfur diesel fuel and cetane improvers; what they're doing is measuring that at 42 or greater and that's our target. They're using oxygenated additives, detergent, dispersant, surfactants; for biodiesel, we've seen in metal/non-metal mines that they're using a blend up to 75 percent.

F4. Environmental Enclosures and Air Curtains

Two presenters discussed isolating workers from contaminated air by using cab enclosures or air curtains.

a) Dr. Aleksander Bugarski (NIOSH Mining Research Division) described NIOSH research initiatives [Bugarski presentation]:

- Evaluating canopy air curtains as a control strategy is a specific research aim. We know from experience with cab enclosures that filtration systems which are typically used on cabs to control dust exposures are not efficient in controlling DPM exposures. We would like to try is to evaluate this technology, develop it, and improve performance to provide better protection from DPM. We see the potential of this as a control strategy for some occupations like scalers or someone who cannot be put in environmental closure, but has some workspace where we can form this canopy air curtain. We are probably going to fund some of those efforts under contract.
- Environmental enclosures are extensively used by a number of the mines to control exposures not only to DPM but also to the elements, noise, and dust. Our group of researchers found that certain improvements could be done to these enclosures to make them suitable for protecting underground miners from DPM.
- The filtration system would need to be upgraded, along with better pressurization of the cabs and preventing leaks. And then, of course, education of the operators to prevent misuse and maximize benefits of enclosing them in the cabs. People are not really taking full advantage of those cabs. There's a lot of openings on the cabs which are unnecessarily open and provide leak points and penetration of the dust.
- This research will be executed in a partnership with OEMs and aftermarket filtration and pressurization companies to find solutions for the existing cabs because there are a large number of existing cabs which are not suitable really to provide any protection from DPM. And then, of course, we need to work on defining what a cab which is supposed to protect miners from DPMs should constitute. The effectiveness of enclosures in reducing exposure of operators to diesel and other aerosols will be tested in an underground environment in cooperation with industry partners. Findings will then be disseminated to the partners.

b) Link Bowers (Technical Support, MSHA) discussed environmental cabs [Bowers presentation]:

- Environmental cabs can give up to 80 percent reduction, we have seen 800 micrograms per cubic meter reduced to 160 inside a properly maintained and sealed cab. The only problem with cabs is some people's job requires them not to work in the cab, so they can't use them for that condition.
- Environmental cabs help reduce exposures to silica, DPM and other dust exposures, and also noise exposure. Environmental cabs need to be tightly sealed with no openings. They need to be operated with the windows and doors closed because, if you have the windows and doors open, you're basically negating the use of the environmental cab. If you have something broken, like a window or a door seal, you need to fix it. You want to make sure the cab is pressurized with filtered breathing air, and usually the change-out schedule for those filters is about 250 hours. You want to design them for one air change per minute. So, if you have a 100 cubic foot cab, you want a 100 cubic feet per minute (CFM) fan to do that air change. And you also want to make sure they're maintained in good condition.
- One way that to test a cab for positive pressures is to close all the doors and windows in the cab, and turn on the A/C fan blowers that are pulling the air out so it's pressurizing the cab. Then take a Magnehelic® gage and attach flexible tubing to it, open up the door

on the cab, and then close the door to make sure that the hose doesn't pinch so you can see the differential pressure. We usually use a half-inch Magnehelic® gage to do that with, and we want to see about a 0.1-inch water gauge or more pressure differentials that show that air can't infiltrate the cab. You have positive pressure trying to keep the air outside out.

F5. Ventilation, Equipment Allocation

Two presenters discussed ventilation improvements to reduce miners' exposures to DPM.

a) Monique Spruill (Chief of Health, Metal/Nonmetal Division, MSHA) described improvements used in several mines [Spruill Presentation]:

- A lot of mine operators have been able to lower their DPM exposures by placing booster fans at the face. Operators are also making sure ventilation does not pass through a working area too many times, and directing this active ventilation. Operators have replaced a lot of their rigid tubing so that the tubing is installed around the working area, channeling this fresh air to the operating face. Ventilation bags are being replaced with a hard-line smooth vent to reduce friction and lost airflow. Operators are doing ventilation studies with single entry drifts and other mine types. Operators are installing curtains, brattices, tubings, stoppings, and bulkheads. They're also adding fans or increasing the number of fans that they have, for main fans, auxiliary fans, booster fans, and exhaust pulling fans. And they're filtering any type of re-circulated air. They are also installing more permanent solutions, using steel ductwork.
- In one mine success story, they contracted a ventilation specialist and mine engineers, who reviewed the mine's ventilation plans and made modifications. They were doing four-directional mining, so they had to develop some type of connection system. In that connection system, they used bidirectional fans. They also repaired and established new ventilation controls, and used stoppings and curtains. In addition to ventilation surveys, this mine used low-sulfur biodiesel fuel. With these improvements, working with MSHA, exposures went from greater than 230 to below 100.

b) Link Bowers (Technical Support, MSHA) discussed mine ventilation as a DPM exposure control strategy [Bowers Presentation]:

- So, if you double your air flow, you're going to cut your DPM in half. Increasing the ventilation, though, can be costly, especially if you use major upgrades. Sometimes you can just change the conditions in the mine or your ventilation controls to make your ventilation system more efficient. But if you were just increasing power itself, when you increase the airflow by 25 percent, you're going to double your cost. And if you increase your air flow by two, you're going to have eight times your electricity cost. But usually, you can just make your system that's in place more efficient. Place your fans in the right positions, advance your tubings, make sure that you have everything the way it should be.
- While boosting your airflow is a good start, you also need to direct where the air is going with wall stopping doors, et cetera. And you also want to make sure that you don't have recirculation or short circuits and that you ensure that your air reaches the working areas

and faces of the mine. In the ventilation system layouts, you want to try to avoid adjacent intake and exhaust openings, so you don't have re-circulation. You want clean air to come in, pick up the diesel particulate and move it on. You don't want re-circulation, or the concentration will just keep on going up throughout the day because you're not sweeping the air out.

- For distributing air underground, auxiliary fans and ducts, rigid or flexible, are needed for development ends. You need your end one to be on fresh air and you want to maintain your ductwork, make sure it's advanced to where you need it to be. Plus, make sure it doesn't have leakage. Maintenance is a big thing on some of these mines to keep up.
- Also, if you're using free-standing fans without tubing, you want to make sure they're properly placed so that you move the air where you want it to go to sweep across and move your diesel exhaust on. In some mines, make sure your brattice lines are properly maintained so you're moving the air where you want it to move. When using a free-standing fan, you want to make sure to set up where it's going to sweep over the operator and back out. So the angle off the rib and fan placement are critical parameters for a free-standing fan.
- On an auxiliary fan that has ductwork, you can bring the ductwork up closer to the miner where it's needed. Your critical parameters are your fan placement, your fan horsepower, the duct length and diameter. Duct bends, corners and leakage also come into effect when you're calculating what size fan you may need.
- The particulate index (PI) is defined as the air flow quantity needed to dilute DPM emissions to 1,000 micrograms per cubic meter of diesel particulate matter. So, if you increase your air flow, you're going to basically cut down on your diesel particulate emissions. We have the listing of the PIs for each engine on this website: [MSHA Diesel Engine Information]

    - As an example, if you had two 50 horsepower engines, one's a Tier 1, one's a Tier 3, and the PI for the first engine's 23,000 CFM, the PI for the second engine is 4,000 CFM. As you can see, to get to your 160 DPM concentration, you're going to have to have 115,000 CFM for the Tier 1 engine, as opposed to 20,000 CFM for the Tier 3 engine.

- Natural ventilation is mostly used in metal/non-metal mines. Natural ventilation is impacted by differences in air density and elevation. That's what drives the flow. And it's most significant in mines with limited mechanical ventilation pressure and large differences in elevation. And with natural ventilation, you can have air reversals possible because of just natural conditions there at the time.
- Mr. Bowers also described restricting the amount of diesel-powered equipment and total engine horsepower operating in a given area so that you don't tax your ventilation system that's in place.

F6. MSHA Diesel Information and Requirements

Two presenters discussed existing MSHA regulations, as well as information currently available to and through MSHA, such as MSHA's diesel equipment inventory. The second presenter fielded questions from three people after his presentation.

a) Jeff Moninger (Mechanical Safety Division, MSHA) explained MSHA requirements for diesel engines used in underground coal mines [Moninger Presentation] :

- MSHA regulates diesel engines differently in underground mining for coal mines. Underground coal mines must use an MSHA-approved engine, Part 7. In addition to that, the engines also must meet the Part 72 health standards for the diesel particulate matter. Underground metal/non-metal mines have the option, they can use a Part 7 MSHA-approved engine, or they can use an engine that meets the particulate matter in Table 57.5067-1, which is basically a Tier 1 or Tier 2 DPM limit for the engines depending on the horsepower.
- What's an MSHA-approved diesel engine? MSHA approves diesels underground into two categories, Category A (used in the gassy areas of the mine or permissible areas) and Category B (engines used in outby or all the other areas). A listing of the engines for Category A and Category B is available on our website. You can go under this link or through the support and resources equipment Approval and Certification Center and then the Approved Diesel Engines.
- DPM emission limits for underground coal mines date back to the health standard, Part 72, requiring permissible equipment and heavy-duty equipment to be limited to 2½ grams an hour. Basically, that means a diesel engine underground, as everyone's talked about, would have to be filtered to get down to that 2½ grams an hour limit. Light-duty equipment is limited to 5 grams an hour or it can meet the table listed in Part 72.502, which is a DPM limit based on Tier 2 engines. So, if you have a Tier 2 engine, Tier 3 or Tier 4, it's going to exceed that and be okay to use, along with being Part 7 approved.

b) Greg Meikle (Chief of Health, Coal Mine Safety and Health, MSHA) discussed data available through MSHA's diesel equipment inventory [Meikle Presentation]:

- This presentation is a snapshot in time, and that time was in May of 2017. It's a dynamic inventory. By regulation, the mine operators have a seven-day time frame to make corrections in that diesel inventory. The inventory can include errors of input from the mine operators. It could have even errors in the information that was given. We'll talk about some of that that might even show up on this snapshot and our review of the information that is in there.
- It'll also just be a presentation of the raw numbers. The information in the diesel inventory is not necessarily a correlation to exposure to DPM by underground coal miners. The information on the pieces of equipment does not indicate how that equipment is utilized, how long, where, so the information in there is a potential. We should use that information and be educated to what it represents.
- Let's look at the diesel particulate or the diesel-powered equipment by state or by district and by the numbers of pieces of equipment. And when you look at this information, the numbers of diesel-powered equipment by far fall into two different districts: District 8 and District 9. And then it is broken down by the numbers in the light-duty, heavy-duty, and permissible categories. We also have a category that we say is a number of other diesel-powered equipment, and other diesel-powered equipment would be equipment that shows up in the inventory, but when considering some of the time lags and other things that we find in the inventory, they really don't fall into a particular category.

- When you sort by district, where the equipment in numbers are and how they're being categorized. So the top 10 types of underground diesel-powered equipment, 90 percent of which is represented by 10 different types. Now, in the inventory during this snapshot, we've inventoried 36 different types. But the majority of the equipment falls into 10 different types, and you can see personnel carriers far and above all the other categories or different types are the numbers of equipment that we have in underground coal mines.
- Now, when you take that information and bring it into the types of diesel-powered equipment categorized as light-duty, you can see the personnel carrier again is the highest number of pieces of equipment in underground coal mines. It then potentially would represent the highest number of advances in protections. And you can see then utility trucks, forklifts. But these five different types represent 91 percent of the light-duty equipment or those that are categorized as light-duty equipment in the diesel-powered inventory.
- For heavy-duty equipment, this is just heavy-duty equipment, and there's 10 different types of heavy-duty equipment that represent 92 percent of the heavy-duty equipment in the inventory. Load-haul-dumps represent the lion's share of it, but then locomotives and so on and so forth. So, for heavy-duty equipment, we see this sorted by the numbers of equipment we find in the underground coal mines.
- Permissible equipment—those that were inventoried as permissible. There are five types that represent 92 percent of the diesel equipment in underground coal mines. And, again, load-haul-dump is the largest number of equipment that we have in underground coal mines.
- Now we want to look at the numbers of mines, with diesel-powered equipment and after-treatments by state. We sort these by the percentage of the diesel-powered equipment with after-treatments, and what you find is those three states that's been previously mentioned in the prior presentations would lead the way. So, in West Virginia, Pennsylvania, and Ohio, they require diesel-powered equipment going underground to have after-treatments. And so we would then expect that those pieces of equipment going in to mines in those states to be compliant. ... when we see these by percentages for after-treatments, we see the potential that can be utilized in trying to protect or increase the protections for miners that are working in underground coal mines.
- When we look at the after-treatment filters on light-duty equipment, we see that, again, the personnel carriers is at the top of the list. And you see what those filters look like, what they're categorized. And so we see, after-treatment manufacturers are unknown. Again, getting back to the input information given by the mine operators, did they know that information and fail to convey that information or some other explanation. Now we added that last column to represent those that did not have after-treatment, and that would tell us that 1,743 light-duty personnel carriers didn't have after-treatment. Again, the potential where we might help with protections to underground coal miners given that these pieces of equipment are still in the coal mines and can be utilized maybe just as stringently, if you want to call it that, or as much as heavy-duty.
- On heavy-duty equipment, we see the load-haul-dump as that, on the top of the list. There's 12 different types, though, that represent 95 percent of the heavy-duty equipment with after-treatment, and you see how they have been classified and, again, the total number that do not have filters. We would expect that number to be much lower, but,

again, there are some problems in the transfer of information in this diesel inventory and the requirements then that are specified in 72.520.

- Permissible: there are six different types that account for 95 percent of the permissible equipment that have after-treatments. Now we see that permissible and ceramic may be somewhat conflicting because, in previous presentations, we said, well, okay, these things, they actually operate at temperatures that wouldn't be conducive to permissibility. Again, the information on this inventory is what has been supplied by mine operators. Now there's a lag in us verifying, getting it cleaned up. So, again, we understand those things. But here, we have permissible, we have with after-treatment, and what classifications of these applications that mine operators are actually utilizing. So we see what works if you use this information and look at it.
- For the engine manufacturers, we see that Deutz is the number one, and the second leading manufacturer that's being utilized is less than half of what Deutz has got in the underground coal mines. Does that necessarily say anything? I'm not sure. For those of you who know the economics, who know the performance, who know the longevity, all of those different input factors of why that engine manufacturer is being selected would be a good thing to start if you're trying to make an informed decision. And the top 10 manufacturers represent 97 percent of the diesel equipment, powered equipment underground in coal mines.
- So now we want to look at what does the inventory say about heavy-duty diesel engines and how they equate to the diesel particulate and the tier system that EPA has. Now 90 percent of all engines in heavy-duty diesel-powered equipment meet DPM levels for EPA Tier 4 engines, but that's based upon the package that includes the after-treatment. And we see a Tier 0, and a Tier 0 would represent equipment that really pre-dates the Tier system or before that designation or definition was set forth. Now what does that tell us from the inventory? Well, coal mines have a way of utilizing their equipment, they get good equipment that'll last and they keep it. So, for future, when we put it in a coal mine, they want to use it a long, long time. So a good choice up front for a long, long time, it would be a really good choice.
- Same thing for light-duty diesel engines and their designations, the difference being that 22 percent of all engines in light-duty DPM meet DPM levels for the EPA Tier 4 engines based upon after-treatments. Getting back to an earlier slide, not many of the light-duty personnel carriers have an after-treatment. Now they can meet our standards, 502, 72.502, and be utilized. How it relates to miner exposure, it's a potential. Seventy-seven percent of all engines in light-duty DPE meet the DPM levels for EPA's Tiers 2 and 3.
- For permissible diesel engines and EPA engine standards, we see that 98 percent of all the engines in permissible DPE meet the standards based upon Tier 4 engines based upon their after-treatment (for permissible equipment, it's a requirement to meet the MSHA 2.5 g/hour limit). So we see a high percentage of those meeting those standards, and for those that do not, we understand that it could be some complication with the conveyance of that information to the inventory and some other things.
- The last slide we want to look at relates to another presentation slide—understanding what is being used, what is needed in underground coal mines—what size engine do I need in order to do the work I want it to do? And we see, for 97 percent of the diesel-powered equipment being utilized underground, they have an engine of 250 horsepower

or less. So, it's the new engine technologies being introduced, smaller engines and whatnot. The industry can utilize those smaller engines, at least in the coal mines.

Mr. Meikle also addressed questions from three people:

- *Question from Mr. Betar (Classic Motors):* I just wanted to point out, I guess this is both a question and a statement, but three times you mentioned that personnel carriers represent perhaps the largest potential for environmental exposure to diesel particulate. And your basis, it seemed, was simply due to them being the largest number of units in operation. But I think what you probably need to consider is that those units by their very nature are also operated at the very lightest duty cycles in the mine, as opposed to a piece of equipment that's engaged in actively moving materials or rock or things like that. And, in fact, several years ago, I studied the fleet of personnel carriers at one of the largest operators of these types of units in the west, and, on average, those engines were operating at 12 percent of their rated load. So I guess I would just want to include the fact that simply by nature of the sheer numbers of units and the fact that these units are not equipped with after-treatment doesn't necessarily mean that you can conclude that they may be an opportunity to greatly reduce diesel particulates because of the fact that these units are operating at such light-duty cycles.
- *Mr. Meikle' response*: I agree. And I would add to that in many of the mines that I've gone to, you know, the personnel carrier will take men and materials to the section and then be shut off, and then they will reverse that in the evening or the end of the shift. So it's not only the duty cycle, but it also would then have to consider, okay, the time of use. But it even goes further than that. The potential could include, okay, these others that are already meeting Tier 4, though, are very, very low and how they are bring utilized, the time frames and where and when and all the other things. So duly noted, what you just said. These are just numbers of equipment.
- *Question from Dr. Bugarski (NIOSH):* My question would be related to your estimate that your Tier 0 engine, after 20 years standing in the mine, just by applying their [DFE] on it would meet Tier 4 final standards. That's a little bit of a stretch, because, I mean, end use emissions from those engines are probably twice as bad as the new engines. And they are rebuilt like three times meanwhile, and nobody checks on the parts that are rebuilt, for example. So basically it's kind of a little bit of a stretch to say that they're equivalent to Tier 4 final engines.
- *Mr. Meikle's response*: If I did equate them to Tier 4, I didn't mean to. Now they're in our inventory as not 2, 3, or 4. Okay. Zero, 1, that's where we put them just to say, okay, this is what we have in the inventory. But as to what controls can be applied to them, what controls are being applied to them, we only have in the inventory what we have. And again, you know, I think that my way of thinking is, as we pick equipment, looking at how old that equipment is probably could be an indication of how long the equipment being purchased now will be utilized. As to, you know, its miners' exposure source, you can't look at the inventory and even estimate that, other than we know the sheer numbers of those that are in the inventory at any given point in time.
- *Comment from George Saseen (MSHA):* to expand a little bit further on I think what you were saying and then to tie in what the gentleman on the phone just said. Yeah. As far as the duty cycle on those personnel carriers, a lot are pickup trucks and they are used

lightly, and also, you know, mines have reported, the record showed years ago in the original rule, mines reported a lot of use of their light-duty equipment and a lot of mines reported very little use on their equipment. But remembering that the rule, the coal rule slide was based off of technological feasibility. And I think what you were trying to say, Greg, to enhance that is any effort that we have as the technology has advanced since, obviously, 2001, where we were talking only about Tier 2 engines because 3 and 4 didn't exist, but now they do. So any advancement on the technological front of advancing that will help exposures, like you were alluding to. So, yeah, it may not be because, yeah, we don't see a high duty cycle made with these machines. Some of these trucks, pickup trucks have larger engines in them, so it does not take a lot for them to haul, you know, a man or a crew in and out because if it's, you know, not a steep climb in or out of the mine. But as far as technological feasibility, any advancement will help, as you alluded to, help the exposure, lowering exposure to the miners. Thank you.

- *Mr. Meikle's response*: Thanks George, that's right.

G1. Regulatory Reform

Roslyn Fontaine (Deputy Director, Office of Standards, Regulations, and Variances, MSHA) provided background on recent executive orders*:*

- The RFI was published in June of 2016, and, of course, since then, the President has issued two Executive Orders. In Executive Order 13771, Reducing Regulation and Controlling Regulatory Costs, Section 2-A requires MSHA to identify at least two existing regulations to be repealed before we publicly propose for notice and comment or otherwise promulgate a new regulation.
- In Executive Order 13777, Enforcing the Regulatory Reform Agenda, Section 3-A directs MSHA to seek comments on its recommendations to repeal, replace, or modify existing regulations from the public and entities significantly affected by *Federal* regulations, including state, local, and tribal governments, small businesses, consumers, non-governmental organizations and trade associations.
- MSHA is informing our stakeholders that the agency is seeking stakeholder input on its regulatory reform initiative during forums such as these, partnership and alliance meetings, quarterly training and stakeholder calls, walks and talks, and conferences. Information provided by stakeholders will help improve the health and safety of miners and assist MSHA in determining the appropriate regulatory action.