TRANSCRIPT OF PROCEEDINGS

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In the Matter of:                )
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MINE PLANNING AND EMERGENCY      )
SHELTERS WORKSHOP                )
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Pages: 1 through 290

Place: Washington, DC

Date: April 18, 2006

HERITAGE REPORTING CORPORATION
Official Reporters
1220 L Street, N.W., Suite 600
Washington, D.C. 20005-4018
(202) 628-4888
hrc@concentric.net

U.S. DEPARTMENT OF LABOR

In the Matter of:)
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MINE PLANNING AND EMERGENCY)
SHELTERS WORKSHOP)

Tuesday,
April 18, 2006

National Academy of Sciences
Auditorium
2101 Constitution Avenue, N.W.
Washington, D.C.

The meeting in the above-entitled matter was convened, pursuant to Notice, at 8:00 a.m.

BEFORE: JEFFERY KRAVITZ and
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P R O C E E D I N G S

(8:00 a.m.)

MR. KRAVITZ: Let me introduce myself. Jeff Kravitz, Chief, Mine Emergency Operations for Technical Support. We also have Guner Gurtunca.

MR. GURTUNCA: My name is Guner Gurtunca. I'm the director of Pittsburgh Research Lab, NIOSH.

MR. KRAVITZ: Obviously, there has been a change -- Mr. Howard will speak to that later -- about Jerry Finfinger. It's something good about that. The first good thing today besides all of you showing up.

Okay. It's my pleasure to introduce David Dye, the acting assistant secretary for MSHA. David came to the Department of Labor in June 2001, where he served as deputy assistant secretary for the Employment and Training Administration, the ETA. After coming to Washington in 1983, David served as counsel to the Senate Committee on Commerce, Science and Transportation; director of external affairs for the Maritime Administration, the U.S. Department of Transportation; and counsel for the chairman of the Federal Maritime Commission.

He returned to Capitol Hill in 1991, where he served as chief counsel for the House Committee on Resources, chief counsel for the House Committee on Agriculture, and chief counsel for the Senate Committee on

Energy and Natural Resources.

Prior to coming to Washington, David served as professional staff to two committees in the Alaska Senate, as special assistant to the lieutenant governor of Alaska and as a regional and urban planner with the Department of Community and Rural Affairs in Alaska.

David received his bachelor of arts degree in 1970 for the University of Texas at Austin and was admitted to the Alaska Bar after graduating from the Franklin Pierce Law Center in Concord, New Hampshire, in 1979. He resides in Bethesda, Maryland, with his wife and daughter. Please welcome David Dye.

(Applause.)

MR. DYE: Thank you, Jeff. Can you hear me all right? Good acoustics.

Well, good morning, all of you, and thank you for coming today. I know that all of you realize the importance of this workshop and its potential for saving lives, and I'm grateful that many of you took the time to come here and share your knowledge and expertise with us.

I also want to thank the mine safety experts at both MSHA and NIOSH for providing their technical support and expertise to help us set up and run the workshop today, and a special thanks to Dr. John Howard for agreeing to co-sponsor this workshop, for his untiring efforts to make mines safe in this country. Thank you, John.

The mine emergencies that we've had this year have shown us that we in the mining industry must focus on better, safer ways to evacuate miners when there is a mine emergency. It's clear that we must improve mine escape planning and reemphasize that the first priority for any underground miner in an emergency should be quite simply to evacuate the mine. That is important and bears repeating often. There is no doubt, just get out. When your life is on the line, get out of the mine. This is an important point that often becomes obscured in discussions of how to deal with mine emergencies and rescuing miners who may be trapped.

The cruel fact of mine emergencies is this: Because of the catastrophic nature of most of these emergencies -- fire and explosion -- miners who are able to evacuate the mine immediately or shortly after the emergency begins are dramatically more likely to survive than miners who stay in place waiting for rescue.

Our mine rescue teams in this country are the best in the world. They must obey, like all of us, the laws of physics. They will not be able to enter the mine after an explosion or fire until it is safe enough for them to do so. By the time the heat and lethal gases return to the levels which permit them to enter the mine, those waiting for rescue will often, unfortunately, have perished from those very same hazards. We must continue to emphasize that miners must make every attempt to evacuate a mine whenever possible during an emergency.

MSHA has taken some additional steps towards instituting other measures to protect miners who may become involved in a mine emergency. On March 9, we published in the Federal Register an emergency temporary standard. This is only the third time in the history of the Mine Act that we have done this. The emergency temporary standard contains provisions applicable to all underground coal mines on self-contained self-rescuer storage and their use, evacuation and training, and the installation and maintenance of life lines.

We believe that the availability of supplemental SCSRs can increase the supply of oxygen, added life lines to guide miners along evacuation routes when visibility is poor, more frequent evacuation drills to condition miners to escape quickly, and proper training on how to transfer from one SCSR to another will help ensure that miners have a better chance of escaping from a mine emergency.

The ETS also includes requirements for immediate notification applicable to all underground and surface mines. Mine operators must notify MSHA within 15 minutes of determining an accident has occurred so that coordination of appropriate mine rescue and other emergency response can begin as soon as possible.

We are beginning to hold public hearings on the ETS throughout the country. The upcoming ones include April 24 in Denver, Colorado; April 26 in Lexington, Kentucky; April 28 at our headquarters in Arlington, Virginia; and May 9 in Charleston, West Virginia. We will also accept written comments until May 30, 2006. You can find more information about this on our Web site. We welcome and encourage your input, just as we need your input here today.

Today, in this workshop, we plan to take a look at mine escape planning, including the recent history of mine escapes, warning systems, and the use of self-rescue devices and life lines. The tragedies at Sago and Aracoma Alma No. 1 have given us impetus to take another look at the concept of rescue chambers in coal mines. Today, we will discuss emergency shelters, including the history and use of emergency shelters, how mine design has changed since the 1980s, shelter placement in the mine, configuration and construction, life support instrumentation, communication, training, and other issues.

However, advocates of emergency shelter should keep in mind that coal is a fuel, and in a coal mine a fire has virtually unlimited fuel to consume. While the story of the miners in the potash mine in Canada who waited for rescue in their emergency shelter had a good outcome, it should be remembered that potash is a fire retardant, not a fuel.

There are unique and special issues surrounding the placement of emergency shelters in coal mines, and we must be careful that technological innovation does not endanger rather than help underground miners.

One thing I hope today that is discussed in detail is the concept of expectations training, in other words, training to better prepare miners for conditions they may encounter during a mine escape, including traveling through smoke and knowing what they will experience while wearing an SCSR. Miners must also be trained at how to exchange a used SCSR for a new SCSR in potentially lethal atmospheres -- no easy task.

Now, just how important this kind of training can be was brought home to me by an unsolicited e-mail I received just a week ago today. A coal miner in Pennsylvania with 35 years of experience in various mines around the state wrote to me to tell me of training he had received at a mine fire school. As part of the training, the mines were subjected to a smoke-filled environment. I want to relate to you the most important parts of the e-mail.

"During this exercise, we were to don the SCSR and find our way out of a small maze that was built in a van truck. I must say that this was the single most enlightening experience of my mining career. I had been around small mine fires before but nothing where I had to simulate an evacuation drill such as this. Even though I knew that I was in no danger, I became somewhat apprehensive. I soon realized that even with all of this training that I have received over many years, I am not fully prepared to escape in a severe mine emergency."

His concluding sentence was even more powerful: "Please take this into consideration because, speaking from experience, we are not prepared."

That e-mail really hit home with me. I hope it does the same for you. It's clear that we must look into requiring obscured-vision safety training for miners and make a strong effort to see that we can provide it. I'm convinced that it will save lives.

Now, while we're discussing the issue of mine escape planning and evacuation here today, we must keep in mind that however strong our desire to keep miners safe and healthy, we must use the best, proven technology available. There is a great deal of new technology out there and as many great ideas to go along with that as there are technologies. But great ideas and spiffy, new bells and whistles that sound good and look good may not perform when the chips are down. Technology grows by leaps and bounds. There is something new under the sun every day.

Now, technology does have a central place in mine safety. However, we cannot afford to rely on unproven, untested technologies to save miners' lives. We have too much at stake.

Before I conclude, I want to remind you that Thursday and Friday this week, April 20 and 21, there will be a mine safety conference of international and national experts in Wheeling, West Virginia. MSHA and NIOSH will join the office of Governor Joe Manchin and the State of West Virginia in co-sponsoring the International Mining Health and Safety Symposium at Wheeling Jesuit University. This upcoming, two-day symposium will focus on different topics than this workshop that are no less critical to mine safety in this country. People interested in attending can register by calling the Robert C. Byrd Technology Transfer Center. Just ask anyone for assistance here if you're not already registered.

Once again, thank you for taking the time to come today and help us address this topic that is so critical to mine safety in this country. It's no exaggeration to say that people's lives are depending on what we can accomplish. Thank you.

(Applause.)

MR. GURTUNCA: I would like to invite Dr. John Howard to say a few words. Dr. Howard is the director of NIOSH.

(Applause.)

MR. HOWARD: Thank you and good morning, everyone. Welcome to Washington on this beautiful spring day. I want to thank you on behalf of all of my colleagues at the International Institute of Occupational Safety and Health and the Mining Safety and Health Program in Pittsburgh, Pennsylvania, and Spokane, Washington, for joining us here today.

In NIOSH, our job is to generate new knowledge and transfer that knowledge into practice globally, so it's entirely fitting that we're here today at the National Academy of Sciences to discuss the latest scientific advances and to push those advances into the future for miners throughout the globe. It's very important that you all know that at NIOSH we think that knowledge is more than just knowing. Knowledge is doing, and it's extremely important for us today that we realize that this is a workshop. We're all supposed to work today towards taking the knowledge that we have, identifying the knowledge gaps that we have, and move forward so that we can protect the safety and health of all miners.

It's very fitting that we're having this conference today here. This is the day that, at NIOSH, we celebrate the tenth anniversary of our National Occupational Research Agenda, and across town, at the L'Enfant Plaza Hotel, we're having a conference this afternoon to launch our second decade of the National Occupational Research Agenda. So it's extremely important that we hear from all of you today about what mining safety and health issues need to be added to that agenda, and I would invite any and all of you to participate in that agenda. The Mining Safety and Health Program has a research sector council that we would be happy to invite any of you to participate on, and if you need more information about that, please see me or anyone else here from NIOSH.

Lastly, I want to welcome our international visitors. This is going to be a busy week for all of us. As David said, we're having this conference today and another one sponsored by the governor of West Virginia later in the week. So this is a very important week for mining safety and health.

Again, I want to thank you for coming to our seminar today and our workshop today and invite you all to attend the West Virginia conference. Thank you very much for coming.

(Applause.)

MR. KRAVITZ: Thank you very much. A few more housekeeping things that you should be knowledgeable about. We're making a transcript of the proceedings today. That transcript will be available on the MSHA Web site. We are also going to put all of the PowerPoints from the presentations up on the MSHA and the NIOSH Web sites. I'm sure that we'll be doing that jointly in all aspects here.

We will also be identifying an agenda for research so we can feed that into whatever capabilities NIOSH has, depending upon their budget limitations, I'm sure, and we are going to jointly be doing a report for the whole conference trying to sum up and trying to identify those issues that need to be emphasized for the research agenda.

So we have a pretty ambitious proceeding after this conference, and we invite you to give comments along the way.

Our first speaker for the technical session this morning is Michael Brnich. Mike is employed with NIOSH, formerly Bureau of Mines, the Pittsburgh Research Lab, since 1984. For more than 20 years, he has worked in health and safety research where his principal interests focused on teaching and measuring mine emergency skills.

I've worked with Mike. He is a very capable person. Basically, he has authored and co-authored more than 50 technical presentations. Many of them are available on the NIOSH Web sites and go way back. Mr. Brnich holds a

B.S. in mining engineering from the Pennsylvania State University. He worked in the underground coal industry in various capacities, including a mining engineer, industrial engineer, safety trainer, shuttle car operator, and general inside laborer.

Mr. Brnich is a certified mine safety professional. He is a member of the International Society for Mine Safety Professionals and the SME and the National Mine Rescue Association. So, Mike, welcome aboard.

MR. BRNICH: Thank you for the introduction, Jeff, and good morning to all of you. My association with Jeff goes back many years, and we've spent a lot of time in the mines together on various issues on mine emergency response and self-rescue and escape.

Our presentation this morning is kind of the philosophy of mine escape, particularly as it relates to escape planning. This is an area that we had worked on for many, many years back at the NIOSH Pittsburgh Research Laboratory. Those of us who have worked in this area include myself, Dr. Kathleen Kowalski-Trakofler, whom you will hear speaking later this afternoon on psychological and training issues related to mine emergency escape; also Dr. Launa Mallett, Dr. Charlie Voigt, and Mr. William Weehagen back in Pittsburgh; and also a good, close friend and colleague of ours, now retired from the University of

Kentucky, Dr. Henry Cole.

Our principal work here has looked at issues related to mine emergency escape, and in the context of the work that we have done, we had the opportunity back in the early 1990s to interview 48 underground coal miners. Each one of those individuals escaped from one of three different mine fires that occurred in southwestern Pennsylvania.

We were particularly interested in the escape issues that these people encountered when they had to escape these mine fires. We weren't interested in particular details of the fire in terms of where it originated, what the causal factors were, but we were more interested in what these people go through when they have to escape such an event. This was something that no one, to our knowledge, had ever done before.

So we went out, and we interviewed these miners, and we asked them to talk about their escape experiences, and what we found globally was that their escape situations varied tremendously in terms of complexity. Some of these miners escaped with little, if any, difficulty when they had to escape the event, but others encountered some very complex escape scenarios.

When we looked at our workers, we were able to identify eight distinct escape groups, and these groups ranged anywhere from three individuals to as many as 10 individuals from one working section. At that time, these mines averaged in age at 42. They had an average of 17 years' mining experience. It was a pretty seasoned group of people. Most of them had at least 15 years' experience at the mine they were working at when the fire occurred.

We conducted these interviews. Two of us would go out into the field to interview these individuals. We interviewed them privately, pretty much one on one. These interviews lasted anywhere from 45 minutes to, in several cases, as long as two hours. We asked our miners to begin by telling us their experiences from the time they perceived that there was a problem until they reached safety outside the mine. We used a preconstructed interview instrument which we had particular questions we were looking to receive answers for, and then after the miners would tell us their story, we would go back and take a look at that questionnaire and fill in details where we wanted more information.

With the miners' permissions, we audiotaped each of these sessions and then had these sessions transcribed, and this resulted in over 2,000 pages of transcribed testimony. If you stack it up on the table, it's about this thick.

We then took all of the testimony, and the group of us involved in this began to read through all of this testimony, all 2,000-plus pages, and analyzed miners' responses for various things that they discussed.

One of the things we were able to do, and this is kind of the crux of what I'm going to talk about this morning, is we were able to construct what we call a "model of judgment and decision-making." That is the mental process that these miners go through when they have to escape. It looks like a pretty complex model, but when you look at it, it actually works out pretty simplistically.

Miners are always faced with what we call a nominal problem, the main problem they are dealing with, and that is the mine fire that's involved but factoring in what we call background problems and context filters, background problems being problems secondary to that main event: smoke-filled entries, toxic atmospheres, in some cases -- in fact, in a number of cases -- miners unfamiliar with the escapeways they had to travel.

Context filters; what are we talking about there? What we found, and this is typical human nature -- all of us do this -- is even though miners were beginning to receive cues that there was a problem going on, they tried to couch those cues in the context that this is something normal going on. For example, one miner we interviewed said, "I initially smelled work in my working section. I didn't think anything of it. I thought maybe the track crew was working somewhere out by and attaching bonds to the rail joints on the track rails coming in." So he never gave it much thought that something much more serious was unfolding.

People will then move into what we call the problem perception phase. That is where now they are starting to take all of the information that's coming into them -- it might be verbal information that's communicated, sensory information, smells, smoke, whatnot -- begin to put all of this together and make a diagnosis right here that there is a major problem going on. Once they have determined that there is something serious happening, now they begin this phase of looking at all of the possible options that they have in order to deal with the situation, but we find that other factors affect this, especially the diagnosis. Information uncertainty affects it.

Of the 48 miners that we talked to, two of those miners knew where the fire was. Two knew. Forty-six other miners did not know where the fire was. That simple lack of information had a profound effect on choices that people ultimately had to make. As a result, stress factored in. Complexity of the escape factored in.

Once mines looked at all of the options that they had, in some cases they had no choices and had to come back and do more diagnoses before they could actually make choices about how to proceed during the escape and then executed their decisions.

A very complex process that they went through, and this is not a one-time process. All during their escapes -- in some cases, these escapes were 45 minutes to 55 minutes in length -- this process continued throughout their escape process.

What were some of the things that we learned initially? First of all, we learned that people tended to perceive the problem in adequately at first. In other words, many people, even though they were starting to get important information, important cues, they really did not take these situations seriously. We found that the diagnosis that people made about what was going on was definitely affected by the warning messages that they received. In some cases, one group of three miners received a message simply, hey, back the machinery out of the working phases; we're going out. These three miners had no idea that there was a fire in the mine.

Choices that people had to make were heavily impacted by their knowledge of the mine and the quality of the information. In at least one of these mines, a number of the workers affected were working in areas of the mine that they had never worked in before, so they were not familiar with the working areas, and they were not familiar with escapeways.

We found that the quality of leadership affected decision-making. When we look in the context of a normal, everyday work day, we typically look to the supervisor as being the leader, and under normal production circumstances, they probably are good leaders, but what we come to find was when these emergency situations started to unfold, some of the individuals who may be good leaders on a normal work day were certainly not the best leaders when having to escape these fires.

And, finally, we found that the actions that these escapees took varied in quality.

Some observations we made: Without a doubt, workers will form a group. In no case did single workers come out alone. They always came together and formed a group, whether it was a group of three or a group of 10. Generally, people will actively participate in the process of judgment and decision-making. As we talked to these crews, these individuals, we asked them, what was going on on your section when you talked about this? Pretty much everybody had input in terms of what the crew was going to do. However, we found that individuals, even though they might have a difference of opinion, generally they would go along with what was decided.

A very important one right here: Miners will take risks to help each other, and that is something you have to be prepared for. It happens. What are we talking about? We're talking about miners at one operation, three of them, when the crew reached safety out by the fire, they realized one miner was missing. Three mines donned fresh SCSRs and went back in looking for that miner. It happens.

In another case, a miner went down. The crew decided, we're going to stay back with this miner; the rest of you go ahead. It takes a lot of guts to stay behind in smoke with a miner who can't make it out, but, again, we know that this happens.

Also we found that when leadership breakdown occurs, usually you're going to see leaders emerge. In fact, in some cases, some of the leaders who emerged were some of the last people that you would expect to emerge as leaders in the event.

Some recommendations we can talk about: One thing is that mines have to be aware of that time element involved. You don't have all day to procrastinate and decide what you're going to do because fires can move very rapidly. I think it's important to talk with individuals about the ramifications of keeping your groups together as opposed to splitting up. There are pros and cons to this. Again, you have to be prepared for the fact that people are going to help each other if a fellow miner has problems.

It's also good to look at individuals who identify leadership qualities, especially who could function as good leaders under emergency situations.

So let's talk a little bit about how all of this plays into escaping a mine fire. What were some of the background problems that people had to deal with? Well, again, they include smoke-filled entries, and these smoke-filled entries varied in situations where people had visibility as much as 30 to 40 feet but, in some cases, less than five feet. They had toxic atmospheres that they had to deal with. Miners had problems wearing their SCSRs. It wasn't because the SCSR didn't work; they did work. It's simply that miners did not know what to expect in terms of how those apparatuses work when they wear them, and, of course, leadership breakdowns occurred.

Context filters; again, as one miner said, he thought the track crew was out installing bonds at the track joints.

Another miner, who was a fire boss, he discovered one of the fires. He initially was walking the track entry, and he smelled smoke. He said, "I didn't think it was anything. I thought maybe we just had a hot conveyor belt roller on the conveyer." He said, "I continued on down the track." He went for another 1,000 feet before he hit smoke, and then when he hit smoke, he realized there was something more than just a hot roller on the belt.

Again, information uncertainty: a big problem for a lot of these people simply because they did not know where these fires were located.

Miner has to endure stress. David Dye alluded to this in his presentation, the miner who sent him the e-mail. For most of these miners, this was the first time they had ever been in smoke. In fact, of the miners we talked to, only two of them had ever been in smoke before, and those people were former mine rescue team members.

People didn't know how far they had to travel because they didn't know where the fire was. They didn't know if they had 2,000 feet to go or two miles to go. Again, miners had very limited knowledge of escapeways. Again, several of these crews, the mine had realigned crews, and the miners were sent to different sections that they had never worked on before, and so they were not familiar with that area. They had limited visibility.

I think a very important one is that miners encountered smoke in areas where they anticipated it not to be. A good example of this: One crew, a three-entry, longwall development section. Smoke had already made its way up on the section through the intake airway. The miners said, Well, we knew the smoke was going to be going back down the return airway. Ah, we're going to go out the belt line because we know the belt line is on a separate split of fresh intake air. Well, that crew started down that belt line, went about 600 feet, and all of a sudden hit a wall of smoke, and now these miners start to experience even more stress. They are saying, How did this smoke get in this belt line? It shouldn't be here. So some of the things that people have to deal with.

How about decisions? These are just a handful of the kinds of decisions people had to make. Who should lead the group? Is the foreman the best person to lead the group out or someone else?

I talked about breakdown of leadership. One crew started to escape. Actually, it was this crew that was coming out of six west mines here. That particular crew had a boss who was not familiar with that area of the mine. He finally reached a point where he said, I don't know how to get us out of here. The last person you would expect to step forward was the continuous miner operator. He had been a former fire boss or mine examiner. He knew the mine. He said, I'll lead us out, and that is who emerged as the leader.

Miners have to decide how to go out of the mine. Should they ride out on the man trip or personnel carriers or should they walk out? What routes should they take? Should they follow their designated escapeways, which is what we teach people? In some cases they did, but in other cases they decided to follow the haulage track. Some followed belt lines. Some even followed return airways.

Very importantly: When to don their self-contained self-rescuers? As I said, a lot of these miners didn't now where the fire was, and many of them delayed donning their SCSRs. In fact, they delayed donning them and, in some instances, traveled in smoke for about 15 minutes before they put the units on simply because they didn't know how far to go, and they knew they only had a limited supply of oxygen.

Whether or not the group should split up, and whether or not to leave a disabled miner behind. At one of these mine fires, a crew was coming up that was the crew that followed the belt line up. They traveled about 900 to 1,000 feet when one of their miners went down, a large man. I interviewed him. He was about six, three, about 300 pounds. He went down, and he said he just could not continue. Now you have to make a choice: Do you leave this miner behind, or do you leave? What this crew decided to do, they split the crew up. Three miners stayed behind with the downed miner. The other four headed out to try to get help, a very critical decision that they had to make.

Some basic conclusions we can come to: First, it's important that we teach our miners critical judgment and decision-making. Miners have got to know what they are going to have to be dealing with. We have to train our people to know our escapeways. When I worked underground, we would walk our escapeways regularly, and we always had miners who said, I don't feel like walking today, but guess what? This boy did. I knew my way out of that mine.

Conducting smoke training -- imperative. Anybody that's never been in smoke, you don't know what it's like. I've been there, a former volunteer firefighter. I know what it's like to be in heavy smoke.

Train miners in communication skills. This is very important also. We talked about communications systems. We talked about communication equipment, but even with the best communication equipment, if you don't give good information, that equipment or system is not going to help you at all.

Finally, identify potential leaders, especially people who would make good leaders in the event of a mine emergency.

I've given you just a brief overview. This is an area that I probably could give you about a two-hour workshop on, but we have published a document called Behavioral and Organizational Dimensions of Underground Mine Fires. I only have about four copies of it out on the information table. I do have one more copy in my satchel. It is available. All of the things I talked about plus other topics as well -- leadership issues, information uncertainty, miners' experiences in smoke, miners' experiences wearing SCSRs -- can all be found in this particular document. If you want a hard copy, if you see me sometime today, I'll be happy to take your business card and get you a hard copy, or you can come to the NIOSH mining Web site, and right here is the link that will take you right to the PDF. You can download the entire presentation from there.

Jeff, that's all I have, and if anybody has any quick questions for me. Yes, Bill?

BILL: Mike, I presume that thousands of copies of your study have been distributed in the industry. If these same questions were asked today, would you expect different answers?

MR. BRNICH: I don't think so. I think if we looked at other events, even the more recent events, I think we're going to see the same patterns. I really do.

(Applause.)

MR. KRAVITZ: Okay. One other feature we've incorporated into this workshop, we have John Gibson, Tim Rehak, who will be circulating up and down the aisles. They are going to be passing out index cards, if you raise your hand when you see them. John, could you stand up, and Tim? We're going to ask you, if you have any questions, please put them on the index cards. The final session will be a panel devoted solely to answering all of your questions. We'll try to do that as best as possible. If there is time between sessions, if we have some extra time, we'll try to sprinkle some of those questions in there, too.

Okay. Our next speaker is going to speak on the recent history of mine escapes, mine emergencies, a very knowledgeable person, Mike Kalich. Mike has been with MSHA for 19 years. Primarily, before that, he was with U.S. Steel for 14 years. He has a master's degree in safety from Marshall University, a bachelor of science in mine engineering from WVU. Certifications include the SME; certified electrician, State of West Virginia; certified mine foreman, State of Pennsylvania; certified assistant mine foreman, State of Pennsylvania; and certified mine safety professional. He belongs to the SME A-17 Committee for Mine Elevators, a member of the SME, and he is a former mine rescue team member, so very knowledgeable.

Mike, please come forward.

(Applause.)

MR. KALICH: I'm Mike Kalich, and I'm a senior mining engineer for Mine Safety and Health, and I will be speaking on the recent history of mine escapes, and I have six mines that I will be discussing, being Sago, Alma, Leverage, Willow Creek, Jim Walters, and Quecreek. The Sago and Alma discussions will be limited, though, due to the ongoing investigation.

The Sago mine explosion will be first. It occurred on January 2, 2006. This is a map of the mine, and it shows the mine entrance, the route of travel into the mine, and the two working sections being the two left sections and the one left section.

On the morning of the accident, the mine was preshifted, and prior to the men entering the mine, the mine was found safe to enter. At 6 a.m., the one-left and two-left crews entered the mine, the two-left crew being a few minutes ahead of the one-left crew, and the two-left crew had already entered the two-left section. As the one-left crew approached the entrance to one-left, the explosion occurred.

The one-left crew was able to successfully escape from the mine, and MSHA and the state and the mine rescue crews were called, and mine rescue crews entered the mine and systematically explored the mine and made their way to the one-left section where they explored the entrance to the one-left section. It was then determined to advance toward the two-left section. Again, the mine rescue team set up a fresh air base near the mouth of the two-left section, and exploration proceeded from that point.

The mine rescue teams found the first victim in this area near the mouth of the two-left section, and they then proceeded to the sealed area where the seals were constructed and found that the seals had been destroyed by the explosion. The mine rescue teams then entered the two-left section, and they discovered the man-trip car that had been used by the two-left section crew. They also found evidence of the SCSRs that had been opened and had been used.

The crews then proceeded toward the face area of two-left searching for the crew, and they subsequently found the crew in the face area behind a barricade. One miner was alive, and he was brought to the surface and transported to the hospital, and the other 11 crew members were found deceased in the face area, and they were also brought out of the mine.

The next mine I have is the Aracoma mine. This was a mine fire, and it occurred on January 19, 2006. The fire occurred near the Number 9 long-walk conveyor belt. The underground mine personnel proceeded to exit the mine. However, 12 miners were on the 11 head gate development section, and those miners also exited the mine, but they encountered heavy smoke, and two of the miners became separated from the group. Despite the initial rescue efforts, the two miners could not be located. The mine rescue activities began, and the two missing miners were discovered deceased on January 21. That's a photograph of the belt conveyor that was involved in the fire.

The next mine I have is Consolidation Coal Company, Leverage No. 22, and this was a mine fire that occurred on February 14, 2003. It occurred near the Sugar Run Portal Slope Bottom. The underground mine personnel were safely evacuated from the mine in this instance.

The fire reportedly started when a mine car loaded with garbage contacted the trolley wire. Miners at the scene attempted to extinguish the fire but were not successful. One of the miners received burns to his hands and suffered from smoke inhalation. All of the openings to the mine were sealed, and water was pumped down the slope in an attempt to extinguish the fire.

A map of the area in question. Coal was transported out of the mine by belt conveyor to the Sugar Run Slope Bottom. It is then transported by conveyor up the slope to the surface where the preparation plant is located. The track system is used for supplies, and the fire occurred in this area. As a mine car was being pushed into a side track, it derailed and contacted the trolley wire and caught the contents of the mine car on fire.

The next mine I'll talk about is Plateau Mining Corporation Willow Creek Mine. On July 31, 2000, a series of four explosions occurred on the D-3 longwall. While attempting to extinguish the flames behind the shields, another explosion occurred that fatally injured two of the miners. The entire mine was evacuated, and the surviving eight miners on the D-3 longwall received various degrees of injuries. Two of the miners were severely injured and could not be evacuated with the other miners, and they remained behind on the D-3 longwall section. That was done due to the injuries of the other miners. They just were not able to carry the other two miners out of the mine with them.

The mine rescue teams entered the mine, and they were able to rescue the two injured miners that were left behind. They also recovered the two bodies of the deceased miners.

The D-3 longwall section; it is a two-entry development, and the head gate is located right in this area. The initial explosion was believed to be in the head gate area caused by a roof fall that ignited methane and also ignited hydrocarbons.

The men on the section attempted to extinguish the flames but were not successful, and a second explosion occurred that fatally injured two of the miners. Another miner that was on the face was able to use his 10-minute SCSR. Everyone at the mine carried 10-minute SCSRs. He was able to don his 10-minute SCSR, escape off the face to the head gate area where a cache of self-rescuers was stored, and he was successfully able to transfer to a 60-minute SCSR and escaped the mine. Other miners on the section also used the 60-minute SCSRs. The two miners that were left behind also used SCSRs while they awaited the rescue from the rescue teams that came back in.

A personal emergency device system was also in use at this mine, and this system, the PED system, enabled text messaging to be transmitted to personnel underground. The use of this system was instrumental in alerting the miners underground of the need to evacuate. The miners in the active and remote areas of the mine at the time of the explosion were notified through the PED system and were able to safely evacuate the mine.

A photograph of the PED system. It's an LED readout mounted to the top of the cap lamp, and it says, "Everyone needs to come out. Fire."

The mine also had an approved SCSR storage plan. On the longwall, 60-minute SCSR caches were maintained on both the head gate and tail gate and on the man trips. All miners carried 10-minute SCSR units. Some of the miners on the 3-D longwall donned the SCSRs, as I mentioned earlier, and were able to safely escape or await rescue.

The next mine is Jim Walter Resources No. 5 Mine, and this accident, explosion, occurred on December 23, 2001. It occurred on the four section. While attempting to rescue one miner who was too injured to make it out following the initial explosion because he was left behind in the initial evacuation, 12 additional miners from various parts of the mine had assembled and were going to the four section. These miners were fatally injured in a second explosion. Of the 32 miners that were inside the mine at the time of the explosion, 19 escaped, and mine rescue teams entered the mine and rescued one injured miner who later succumbed to his injuries.

A map of the mine shows the portal entrances. It's a shaft mine, direction of travel to the four section. This is the area where the explosion occurred. A detailed map of the area shows the location of the battery-charging station was in this crosscut. The mine roof was initially permanently supported with 72-inch, fully grouted bolts, and what occurred here was the roof conditions were deteriorating in this area, and four miners were assigned the task to install additional roof supports, and they were in there building cribs at the time of the explosion.

The roof started working while they were in there, and a roof fall occurred at the battery-charging station. When the cave-in occurred, it released methane from the strata, and believed it was ignited by the battery. In the roof fall, the battery was damaged, and it resulted in an explosion, ignition to the methane. During the initial explosion, it damaged a number of the ventilation controls in the section also.

Just a depiction of the battery charger and the battery. As I mentioned earlier, the methane was released from the overlying strata, damaged the battery, and the arcing ignited the methane.

A photograph of the battery shows the damage. The lids, the covers, were damaged, which caused arcing on the battery terminals, which ignited the methane.

Two of the miners donned SCSRs and traveled out of the section to get help. The dust and smoke impaired their visibility, and a third miner also escaped off the section. These fellows were unable to carry the fourth miner out because of the injuries that the other miners had received, so he was left behind. They met the other 12 rescuers that were coming from various areas of the mine en route to the four section. Other miners deenergized the high-voltage power, but they failed to deenergize a block haulage light system that was used at the mine.

As I mentioned earlier, the initial explosion damaged critical ventilation controls and disrupted the air flow to the section and allowed methane to accumulate. The 12 miners that were traveling to the section to attempt to rescue the lone injured miner that was left behind, as they approached the section, it's believed that the block light system was activated and resulted in a second explosion that resulted in the fatal injuries to the 12 miners that were attempting the rescue.

This is a depiction of the second explosion, believed to have occurred near the end of the track on the block light system. It traveled into the face area and picked up coal dust and additional methane, and then the explosive forces traveled back out of the section to the front of the section and over toward the three east area and resulted in the fatal injuries of the miners that were attempting the rescue.

Nineteen miners successfully exited the mine, and mine rescue teams were organized, and a rescue effort was initiated. Mine rescue teams found one severely injured miner and three deceased miners located out by the mouth of four section, and the injured miner was transported to the surface, where he later died from his injuries on September 24.

On the morning of September 24, it was concluded that the missing miners could not have survived the effects of the explosions, and the rescue efforts were abandoned due to fire and other unsafe conditions. After lengthy recovery operations, the 12 remaining victims were recovered by November 8.

The last mine is the Quecreek Mine, and that was a water inundation, as I'm sure everyone is probably aware. It was opened into the upper -- coal seam. The coal is approximately four feet thick and accessed from four portals from a box cut.

On the afternoon shift, on Wednesday, July 24, 18 miners entered the mine. Nine miners were in the two-left section, and nine mines were in the one-left section, and the one-left section was approaching the old Saxman Mine, but the mining projections that were available indicated the mine was just developed to this area when, in fact, it was extended further into the Quecreek reserves. The one-left miners accidentally cut into the Saxman Mine, which resulted in water inundation. The water flowed into the mine and flowed toward two-left. The one-left miners notified the two-left miners that they had cut into water, and the two-left miners narrowly escaped the rising water, and they were able to make it out of the mine.

The one-left miners were unable to evacuate, and they took refuge in the face areas, which was the area that had the highest elevation in the mine. By 2:30 a.m., the water was reported about at this level, and eventually the water built to the point where it was to the outside of the mine and filled the box cut.

A six-inch bore hole was drilled into the mine to attempt to locate the miners, and at this time, contact was not able to be made with the miners, but an air compressor was installed on the surface, and compressed air was injected through the bore hall. It created an air bubble which prevented the water from rising to the level where the miners were located. A number of pumps were installed, and a major effort was made to pump the water out of the mine.

By Thursday, the water was at 1,852 feet and had stabilized, and we were gaining on the water. The water was starting to recede. A rescue bore hole was drilled near the six-inch bore hole with the intent of lowering the rescue capsule into the mine to be able to bring the nine trapped miners to the surface. During this time, there were some problems with the drilling. The drill bit had broken. It had to be removed from the hole, repaired, inserted back into the hole.

Of course, during this time, a second rescue bore hole was started with the thought that it may penetrate the mine before the first rescue bore hole. But as it turned out, the water, during the time that these rescue bore holes were being drilled, they had gained enough on the water where it was just about to the level where it was felt that it would be low enough where the miners could safely reach that rescue bore hole. In the interim, the water was again pumped down to a safe level. The rescue bore hole was holed into the mine. The miners were contacted. At that point, communication was established with the miners, and they were told to go down to the area where the rescue bore hole was, and they would be hoisted out of the mine on the escape capsule.

One of the many photographs that I'm sure you've all seen where the miners have been brought to the surface. That's one of the miners brought out of the capsule. Another photograph of another of the individuals. Again, another photograph of a miner in the rescue capsule that was successfully brought to the surface.

On July 28 at 2:45 a.m., all nine miners had been successfully rescued and brought to the surface. That concludes my program. Thank you.

(Applause.)

MR. KRAVITZ: Okay. Mike is on staff here in D.C. at our Arlington headquarters. John Radomsky is also on staff. He is the action investigation program manager for Metal and Nonmetal. He is a certified mine safety professional who holds a bachelor of arts degree from -- Scott College. Prior to entering college, he worked in shaft and slope development in underground coal mining.

In 1975, John began his career as a mine inspector for the Mine Safety and Health Administration. He was promoted to supervisory special investigator in 1984 and to assistant district manager for the South Central District in

1991. John was promoted to the present position as action investigation program manager in 2002. Please welcome John Radomsky.

(Applause.)

MR. RADOMSKY: Good morning. On behalf of Felix Quintana, who is the acting administrator for Metal and Nonmetal, I want to thank you for inviting me to participate in the conference this morning.

The program talks about recent emergencies in Metal and Nonmetal, and Jeff has asked me to speak about a couple of things this morning, kind of throw them out there for everybody to comment on and think about.

In the early seventies, in Kellogg, Idaho, there was a tragedy that occurred at the Sunshine Mine that resulted in the death of almost 100 persons who were trapped by carbon monoxide and smoke following a fire that initiated from spontaneous combustion. Metal and Nonmetal regulations, under 30 C.F.R. Part 57, contain stipulations in 11050 which deal with escapeways and refuges and in 11052 which specifically identify what refuge areas -- we'll take a quick look at 11050 first.

As I said, 11050 under 57 pertains to metal and nonmetal mines, but it stipulates that there must be two separate, properly maintained escapeways from the lowest levels which are so positioned that damage to one shall not lessen the effectiveness of the others. A method of refuge shall be provided while a second opening to the surface is being developed.

Now, as David Dye explained to us this morning, and we all realize, things are a little bit different with coal. Coal, being a fuel and very combustible, poses very different risks.

The regulation under B further stipulates that in addition to these two separate escapeways, if miners cannot reach the surface within one hour's time from their work area, then a method of refuge shall be provided for these miners.

11052 talks about some of the criteria for these refuge areas. There are not a lot of guidelines. However, it does say fire-resistant construction, preferably in untimbered areas of the mine, large enough to accommodate readily the normal number of persons, constructed so they are gas tight, provided with compressed air and water lines.

I think we can all be proud of the mining industry's efforts to improve safety over the past couple of decades. I know it's a pleasure to go into the mines today compared to when I worked in them more than 30-some years ago, and probably the greatest advancement to the prevention of fires in metal and nonmetal mines is the fact that we're using methods other than large timber sets to control the back and control the ground.

Presently, out of the 220-some metal and nonmetal mines that exist in the United States today, 18 of those mines are required to maintain refuge areas because the miners at the locations where they are assigned cannot reach the surface within one hour. However, as a credit to the metal and nonmetal folks in this country, 21 additional mines that are not required to maintain refuge areas have installed them in an effort to provide an extra measure of safety to the men and women that work there.

We're going to look at a couple of refuge areas that I've got JPEGs on. The first refuge areas that I'm going to show you are maintained at an underground platinum mine in Montana. Access and egress is provided by declines to the mining levels. Each of the refuge areas is located so that miners can reach them in 30 minutes or less. They are provided with water, air, telephone, tools and materials; however, there are no carbon dioxide scrubbers or food.

You can see that they mine on the 500-foot level, the 1,300-foot, and the 3,200-foot. The first refuge area that you can see is a portable unit, six feet wide, 10 feet long, and six and a half feet high, mounted on skids so it can be relocated. A close-up of the air and water line connections. This mine also maintains a leaky feeder communications system, and this is part of what they use to notify all miners in the case of an emergency.

Metal and nonmetal mines, as I said, we have a large variety. In the underground sector, we mine everything from gold to stone to talc to potash to trona to zinc, lead, salt. This particular refuge area is in an underground limestone in Kentucky that mines on multiple levels and uses decline entries for access and egress. But because there is limited egress from the lower development level, they established a refuge area.

Now, true, limestone is not combustible, but in today's modern mining we use large mobile equipment even underground: 75-ton haul trucks, large front-end loaders. These are big areas, and if this equipment does catch on fire, it generates tremendous amounts of smoke and heat, oftentimes burning for more than 24 hours before they extinguish themselves.

So the hazards in metal and nonmetal, although in a noncombustible ore body, for the greatest part, are still significant. When one of these fires does occur in a metal and nonmetal mine, because of the size of the entry and because of the ventilation configuration, ventilation is often disrupted, and smoke is transported in areas that normally are fresh air intakes.

This refuge area has not been used in any actual emergencies, as was the case in the one that we showed you from Montana. It contains water and air lines, a telephone to the surface, and it's located about 100 feet from the work areas. The inside of it is kind of spartan in appearance, but it's got the essentials that every miner would appreciate if his ability to get out of that entry were blocked by a piece of equipment that had accidentally caught on fire.

The third refuge areas that we're going to look at this morning are being maintained in an underground zinc mine in New York accessed by two vertical shafts. None of these refuge areas have had to be used in any actual emergencies to this date. As you can see, there is a portable unit at the 3,900-foot level and one permanent and one portable at 2,500 foot, and mining takes place on five different levels of this multilevel operation.

Toilet facilities, first aid supplies, additional bottled water, tools, and material are also provided by this mining company, which is more than the criteria called for in the regulation.

This is most typical of a metal and nonmetal refuge area that we're going to view. Most of them are built by drilling and blasting into the hanging wall or foot wall, establishing roof bolts and wire mesh, building a wall out of noncombustible material, putting a metal door on it, and meeting your air-tightness and fire-resistant requirement in this manner.

Now, the next picture is the inside of Refuge Area No. 3, which is similar to Refuge Area 5. You can see that they have blasted this in a large configuration, secured it, and have everything they need inside. Now, when they move from this level to another level, they will simply leave it. They may take the door if they have no plans to come back here because they can reuse that when they build the next one, but this is typical to the permanent types of refuge areas in metal and nonmetal mines in the USA: some of the supplies and equipment inside some of the refuge areas.

Now metal and nonmetal does not have a requirement that mining companies have to provide self-contained self-rescuers for their miners. The metal and nonmetal miners wear filter-type self-rescuers. The filter-type self-rescuers provide the ability to convert carbon monoxide into carbon dioxide by adding, through a chemical process, another oxygen molecule. There are a few metal and nonmetal mines that have elected to purchase self-contained self-rescuers on their own, but this number would be less than a handful.

Here is a look at a portable refuge area that's also in the same mine in New York. As you can see, they made this one themselves. It's kind of spartan on the inside but built air tight and would be welcome, indeed, following any emergency.

Let's talk about some recent emergencies. Fortunately, in metal and nonmetal we haven't, in the recent decade, had a situation where we have had a death following a mine fire or an explosion, but we have had what we consider emergencies.

On February 2, we had a mobile scaling unit catch on fire in Missouri. This mine uses a stench system where they dump into the intake ventilation air ethylmorcapidan, which is easily recognized by its odor, and that's the signal to get out. The miners in this case did not need to use their self-rescuers.

The scaling unit was not equipped with a fire-suppression system. The operator of the scaling unit had a hand-held extinguisher but was unable to put the fire out.

The next day, at an underground gold mine, we had a mobile jumbo drill catch on fire. Again, the operator was unable to extinguish it with a hand-held extinguisher. He went to the phone, called outside. The stench was dumped in the ventilation, and in 12 minutes all six miners working underground were able to evacuate. Two of the miners, however, did utilize their self-rescuer as they had to drive through smoke-filled entries.

February was a busy month in metal and nonmetal.

We had a mobile scoop unit catch fire at an underground salt mine that mines at a depth of 2,300 feet. This unit was equipped with an automatic fire-suppression system; however, the system was unable to put the fire out. This mine maintains and utilizes a leaky feeder communications system. All miners were notified immediately through the communications system. All 40 people working underground got out within one hour. Am I right, Barry?

BARRY: Yes.

MR. RADOMSKY: Thank you. The miners did not have to use their self-rescuers.

No matter what system we design or install, and no matter how well we train our miners, the key to being safe and preventing an emergency, I believe, rests with maintaining our equipment in A-1 condition: the elimination of hydraulic leaks, the proper maintenance of insulation on electric wiring, and a good preventive maintenance program that keeps our equipment in A-1 shape, including our fire-suppression systems, including our seal-monitoring systems. We wouldn't think of operating our personal automobile with a basic safety feature malfunctioning or nonoperative. Nor should we allow these conditions to exist in the mines where we work every day.

The industry is to be commended, I think, for the progress they have made. I think their record is very good.

However, I think there is still room to do a better job. We can do a better job as inspectors identifying and suggesting ways that you can strengthen your safety process.

Jeff asked me to talk a little bit about the Mexican mine disaster. I was not there; however, Felix Quintana, who is the acting administrator for metal and nonmetal, was there for a week, along with Chuck Campbell, who is a senior ventilation engineer with our technical support group. Who else did we have down there, Jeff?

On February 19, at around 2:30 a.m., a methane explosion occurred in an underground coal mine that's located about 85 miles south of Eagle Pass, Texas. They had been mining coal here at this mine for more than 20 years. The depth of cover, I think, was somewhere around 550 or 600 feet, as I recall. Eight miners were able to evacuate. Some had burns. Some had some fractures and minor injuries. Seventeen major ground falls were caused by this explosion.

On February 22, the Mexican government, through the State Department, contacted and asked if MSHA could possibly provide assistance. They needed some help with establishing the constant gas monitoring and also asked for help, some guidance and some input.

As you can see, this area was all mined out, and right in this area they had driven some entries and mined it out, and they hit this fault. When they pulled back out, they did not build any seals in here, and so whatever methane was being generated in this mined-out area was simply coming out in the mine atmosphere, and the red is the return entry, dumping into the return. Right in this area there were two belt tenders. This was a belt transfer point, and the rest of the 64 miners who were unaccounted for were working in these areas right here.

Now we're looking at a close-up of this mined-out area and the fault line. When MSHA folks got there a few days after the explosion, they said there were 60-some people working here in a frantic effort to dig through and make passable some of these entries that had caved in. The methane concentrations that our folks found when tests were taken ranged from 6 to 8 percent. They recommended that those people be withdrawn and that activity ceased. That's the decision that was made because of these gas concentrations right in here.

The red areas indicate where the major falls occurred that were totally impassable. The yellow areas indicate where the falls occurred that people could get past or over top of. As you can see, there was no possible way in those entries to get past those areas until those falls were cleaned up.

What complicated matters, according to Felix, was that most of the ground support in this mine consisted of large timbers supporting steel I beams, and when the explosion occurred, it knocked all of the legs out. The timber legs were blown out, and many ground falls occurred.

One of the things that was decided here was that they would drill a hole here and degasify some of this mined-out area, put permanent seals where you see the two black marks, and where you see the green, they would be erecting temporary seals or ventilation curtains. The idea was to block off that gas from migrating in there and to reestablish the fresh air and then to reestablish the ventilation controls that were blown out between the different intake and return.

As they progressed toward the location where the two belt tenders were known to be working, they had to clean up all of these falls in order to get entry, and the progress was very, very slow. Because of the political pressure, it was decided that they would not use mechanized means to remove this fallen material, that they would do this all by hand. So at this point in time, it's projected that it may take another nine to 10 months to totally recover those folks that are missing.

Okay. This is going to conclude my presentation this morning, and I thank you for your patience.

(Applause.)

MR. KRAVITZ: Thanks, John.

Next is Kobus Zyl from South Africa. I'm glad that you could make it, one of the few South Africans that could. He received a bachelor's in mechanical engineering in 1992. He is a member of the Mine Ventilation Society of South Africa and the South African Institute on Mining and Metallurgy.

He joined CSIR in 1994 and is currently research group leader for mine occupational health and safety. The current main focus of the group is silicosis eradication in South Africa, noise-induced hearing loss reduction, and ergonomics in the mining industry.

Past experiences include coal mine headings ventilation design for methane and dust control, design model implementation for success, and simulation of ventilation systems and various mining conditions. He is working on a tool for coal mining -- strategies, which we do a lot of here, and I can't say; a system for the detection and control of flammable gases in hard rock underground mines. He is also a manager of the Perbos explosion test facility, and a very interesting project he has headed for a long time, the self-contained self-rescuer testing facility at CSIR. Please welcome Mr. Van Zyl.

(Applause.)

MR. VAN ZYL: Thank you, Jeff.

Good morning, ladies and gentlemen. Thank you for this opportunity to present some studies in South Africa and being part of this workshop. Listening to the previous presenters, it would appear that the issues we have in South Africa are not much different from the issues that have been discussed here today.

Basically, my talk will just be an overview as a start-off for a discussion point of how South Africa can actually approach emergency preparedness and then response. In the talk, you'll see that there are three main focus areas in South Africa. Basically, as we said earlier, once you have an incidence of -- atmospheres, i.e., fire or explosion, you need to get the miners to a fresh air situation, which in South Africa is on the ground. Then there's two issues associated with it. How do you get miners to that fresh air situation, and then, thirdly, how do you get them out of it, underground rescue back to the surface?

Basically, in the talk, you will see it divided up into these three main areas. Discussing current practices; it's not in detail. It is just an indication of what South African practices are, as practices differ from mining after mining. Research that has been done in the past; you'll see that there hasn't been a significant amount of research, although there is a definite needs. And then also it is not a formal study, but in a discussion with mining owners and workers, what are the critical needs that South Africa feels we need to address in emergency preparedness and escape? And then just a couple of concluding points.

Basically, the South African mining industry is regulated by the Mine Health and Safety Act. This act requires that the mine operator has identification and a risk assessment and then develops strategies to mediate the risk. The point I'm trying to make is that fires and explosions are a different risk, the whole process in South Africa is risk based, so it is on the onus of the mine operator to prepare an emergency preparedness and response protocol.

In practice, what does it mean? As I alluded to earlier, we need to get miners to fresh air as soon as possible. In South Africa's case, they opted for underground fresh air. This is the case both for hard rock mines and also for our coal mines. It was decided about 20 years ago that the establishment of rescue bases as close to the working place as possible will be the best way for South Africans to approach the incidents of fire and explosions. The reason for it, as far as I can establish -- I was not a part of that decision -- was based on the changeover of self-contained self-rescuers. It was felt that it would be safer to don a self-rescuer and get to a fresh air base where from you will be rescued.

As I said earlier, this has three issues related to it. First of all, what are the design criteria for an underground fresh air base? Where do you put it? What equipment is required, et cetera?

The second issue is how do I get a miner to the fresh air rescue area? As we heard earlier today, exactly the same experience: smoke inundation, low to zero visibility, nonfamiliarity with the section, et cetera, et cetera. We've had various incidents in South Africa where people followed exactly the right procedure, donned their self-rescuers and then tried to reach a rescue base, where in some cases people were found literally four or five pillars away from the rescue base, which would have saved their lives. So this is a very big issue in South Africa: How do we get the guys to the rescue base?

And then, thirdly, once these guys actually reach the rescue base, how do you get them out? Fortunately, in South Africa, the mine rescue service has an excellent track record in getting people from underground mines. That's both for hard rock mines and for coal mines. Again, I have to say that the size of South Africa and the location of most of these shafts allow for that rescue brigade to be centralized and actually have a very effective impact.

First of all, if you look at underground fresh air basis, what is the current practice? Basically, in hard rock mines it is stated that all miners must be able to reach a rescue bay within 30 minutes. This is based on the prescribed duration of self-contained self-rescuers in South Africa. Just some basic requirements: Again, the Department of Mineral Energy, which is the custodian of the Mine Health and Safety Act, does not prescribe what are the requirements for a rescue base.

Again, as mentioned earlier, there is scope to improve exactly what must be in a rescue bay and where it must be positioned. Typically, you will find that there will be compressed air feed in the hard rock mines to supply fresh air. There must be water, communications, and first aid, and the size basically dictates the amount of workers that needs to enter into this rescue bay based on its position within the mine.

In coal mines, it's slightly different. Again, based on a 30-minute duration of self-contained self-rescuers, it is generally accepted that the rescue bay will be within 1,400 meters from any given workplace. I didn't put that into feet. I apologize. It was one this morning.

There are two types. You get fixed cubbies that are established and also portable units. The idea of the fixed rescue bay is that due to the shallowness of South African -- they will be linked to the surface -- which will supply the necessary communications, water, fresh air, et cetera.

In some cases, it has been found that due to the overlying strata depth, occurrences of lakes, et cetera, that these rescue bays could not be reached from the surface. Current practice in South Africa is to use oxygen candles. There is basically a chemical reaction that is started once the miners enter the rescue bay to supply oxygen for at least 24 hours. Again, this is based on the mine rescue service's indication that they will be able to reach any rescue bay from the shaft, given proper access, within 24 hours. Again, portable rescue devices, again, supply a 24-hour duration and mainly using oxygen candles, again, to supply fresh air.

Most of these portable rescue chambers are OEM designs, people taking the initiative and supplying a product to the mine where we feel that maybe the mine operator should have a bigger input into exactly what are the requirements of these portable rescue bays.

For the rest of this talk, I'm just going to focus on collieries as to currently what is the best practice. Research has been done in the past. As I said earlier, most rescue bay designs and layouts are enough, but even guidelines exist, so there is scope to actually improve the guidelines on what is required in a rescue bay. Related research has been done by the Mine Health and Safety

Council, which is a public-funded mechanism whereby mines pay a levy to the Department of Mineral Energy, and they put money available for research. Over the past 10 years, I could identify typically three projects that were specifically based on emergency preparedness and response.

Again, as I said, assessment of design of rescue bays in coal mines. What I've been saying earlier is that there is scope to actually increase what is required within a rescue bay. If you read this document, which was published about eight to nine years ago, it is very vague to what should be in a rescue bay and not clearly stating what must be in there in specific terms. We also looked at the feasibility of using radio-assisted location in rescue bays. Again, it was a guidance document. Currently, it is not practiced in South African underground collieries. Also, a manual on base practice for emergency response procedures; again, it's a very generic document, and we've found that in industry, if you look at the different mining -- each mine and mine operator uses its own interpretation of the work done.

Potential needs to be identified for underground rescue bays; as I indicated earlier, there are clear guidelines on the maintenance of rescue bays, the location of these rescue bays, again, the issue of sealing. Some of these mine operators are not convinced that the sealing mechanism used on their mines is proper. Again, they comply with the law and say, we have a rescue bay, and it's got air-tight doors. Again, how do we ensure that that is actually the case?

Some of the mines using oxygen candles as the main supply; the compressed air line is not favored because it's not used in collieries. There are issues around these oxygen candles catching -- being an exothermic reaction. They have also had incidents of these oxygen candles being stolen by the miners. Again, there's issues that need to be resolved there.

The issue of flame-proof or intrinsically safe, portable rescue bays; the DME states that no nonflame-proof and nonintrinsically safe equipment will be used closer than 800 meters from any working area in a fiery mine. This prohibits the mines from actually getting these rescue bays as close to the working place as possible, so there are some issues there that need to be resolved.

Again, the minimum design criteria for portable rescue bays; these are product driven instead of being driven by the requirements of the mining operators, and a significant issue is once we've entered the rescue bay, it's been sealed, and we've activated the oxygen candles, how do we get a miner that was not there when the team entered the portable rescue bay? There is a knock on the door. What do you do? You've got a limited amount of oxygen candles. Do you open the door? Then you most likely will significantly reduce the duration of your life support. So these are some of the needs that we feel that we need to start looking at.

Current practice around getting mines to rescue bays; I've divided this into two areas. In South Africa, we have what are called the "section waiting places." The reason for that is that from your section waiting place there are different guidance systems to get to the rescue bay. To get to these guidance systems or potential caches of oxygen-giving devices, all South African underground collieries are issued 30-minute-duration, self-contained self-rescuers.

What is unique, or what came to the fore through research, is that each miner is issued his dedicated self-contained self-rescuer. In the past, due to the shifts, three miners located a self-contained self-rescuer. During our testing, it was found that this practice reduces the durability and the life-saving potential of the self-contained self-rescuers.

This brings me to the next point. It was identified in the middle nineties that we need to be sure that self-contained self-rescuers will provide a 30-minute life-saving ability because all of our escape and rescue strategies were based on this. The DME then instructed that an annual testing program would be launched. CSIR was the custodian of this. It basically consists of a self-contained self-rescuer being tested on a mechanical lung, prescribed breathing rates. One percent of all self-contained self-rescuers deployed in South Africa currently go through this testing annually.

The success of the program has been significant, in that issues identified with refurbished units, issues identified with the composition of the chemical base polarization, et cetera, has been picked up through the program and has been addressed at the OEM level. So in South Africa, we are pretty convinced that if you are issued a self-contained self-rescuer, the likelihood of having a 30-minute life duration is very, very good.

Just touching on the test criteria for the self-contained self-rescuer, it's both on oxygen supply, CO_2 scrubbing and also on breathing resistance. The committee consists of a tripartite technical committee that oversees the testing and sets guidelines. The tripartite is the state, original equipment manufacturers, and labor. The committee provides, as I said earlier, technical guidance on issues that have been discovered. How long can one use a self-contained self-rescuer? Five years? Ten years? This program is busy answering these questions.

The current practice to get from the section waiting place to the rescue bay; two types of systems, the guiding rope system and audio systems, have been used in South Africa. The guidance rope is typically used all over the world with a cone and is currently the favored system.

A Moses system was used by one of the mining houses where an audio beep was sounded from the section waiting place to the rescue bay sequentially so you would follow the sound. Although the concept did work very well, the maintenance of the system proved to be too expensive and too cumbersome, and it couldn't be guaranteed that the system would actually survive an explosion or be functional in an explosion situation, so currently that system is not being used anymore.

Rescue bays are marked, both audio, visually, and physically. Audio, there is a siren that is fitted outside the door so if you get in the vicinity, you should be able to reach the rescue bay. Visually, reflective -- they have got strobe lights, et cetera. Also what they do is they hang a conveyor belt in the road. If you actually walk past the rescue bays in very low visibility, you will actually hit this, and hopefully you will know that the rescue bay is there.

Maybe just a comment is that it has been found, as I said earlier, that people actually did miss rescue bays. They were in the vicinity but could not locate it. Again, we need to relook at these systems that have been put in place specifically from a durability point of view. Some of the mines, being concerned with this, have a cache of long-duration units, 60 minutes plus, both chemically and compressed air, oxygen, that would ensure that people would be able to reach a second rescue bay in excess of two kilometers to try to alleviate this issue of looking for the rescue bay.

Research was done, again, by the Mine Health and Safety Council into the use of ultra-low-frequency communication to be able to communicate with miners after an incident. Again, this work was done six or seven years ago, but we've also looked at in Australia, and I see that it is also in the States, the PED system that needs to be investigated because communication, early warning, is one of the critical factors, we believe.

Also work that was done is how do you overcome the disorientation and visibility after an explosion? Basically, this research said that no matter how well you know your situation, if you're disoriented, and you're in zero visibility, you're going to have a problem to get out of the section on your own. In this case study, a miner that had been working in the section for 30 years was asked, and he said, I will get to my rescue bay within 10 minutes. They blindfolded him. It took him an hour and 40 minutes and a couple of bruises to actually find the rescue bay.

Need. In discussions with mining houses, this is the most critical area we feel that we need to start focusing our attention on. The biggest concern is that although most of the regulations require that quarterly escape drills be held, it was found unofficially that in excess of 50 percent, if not higher, of the people in the section when they are just blindfolded, when they are not subjected to the stresses, to the -- environment, if they are just blindfolded and say, please get to the rescue bay, only about 30 to 20 percent of these people will actually make it. Again, this is unofficial information by just talking to miners, and this is also a very, very big concern as to how do we ensure people get to the rescue bays.

Again, early warning systems, as we heard earlier today; the quicker you know there is a situation, the better your chances of survival. Again, when do we don our self-contained self-rescuers? Some of the mines do use the stench gas or aromatic gases. When it enters the air stream, once a guy smells this, there is no question. Don your self-rescue and go to your waiting place before the situation gets out of hand. There are some mines that employ from the surface where they actually stop the belt. On inquiry, the miner will find out there is an issue. We need to get out. Again, there is a 10-to-15-minute mine delay. There are mine communication systems -- the EWAC system is used by one of the mining houses. A very good system, but what is the human response once an emergency is declared?

Nonvisual against visual guidance; are we going to go for a system on audio, or are we going to use just the guide rope? Are we going to try to get a person a pair of goggles? Some of the mines are talking about getting infrared equipment. I don't know how feasible that is. But, again, human response: If you can't see anything, you start to panic. So these issues need to be resolved or looked at more carefully.

Again, we've heard today preparedness training. In discussions with teams that were evacuated or safely made it to rescue bays under emergency conditions, you will find that in the majority of cases an experienced brigadesman was part of their team, so there was no panic. It was exactly the same sort of training that was discussed earlier this morning by Mike.

Some of minuses. We need to incorporate a goggle within the self-rescuer unit that's belt worn. The question is, will it actually make a difference? Again, we need to look at the human response factor. If I can at least open my eyes, if it's not burning, even if I can't see anything, my psychological state might be much more relaxed.

Needs: To get from the section waiting place to the rescue bay, effective systems. Do we need to engage more than one system, and if so, how, and which ones do we focus on? Again, looking at the reliability of systems not only after a fire and explosion but also general maintenance that was also raised today.

Current practice of the mine rescue services; I'm not going to elaborate too much on it. The bottom line is the mine rescue services work very, very well in South Africa. Again, because of -- South Africa, the location of the mines. The system is volunteer based, and it's region and countrywide. It's an independent organization that establishes its own training criteria. It also is contacted in the case of emergency and responds professionally by calling on the brigades within that area. So the coordination is done by the Miners Consulting Service, mine rescue service itself, by calling on volunteer brigadesmen. These brigadesmen undergo a rigorous annual assessment, and at the age of 42, you're not allowed to be a brigadesman anymore. As I said, a very good track record.

Again, it's a system of continued improvement. The current focus is on human physiological response, specifically, working in heat environments. We're trying to get systems in place where they can monitor their own workplace. You don't want a brigadesman to go in and overexert himself and in the process get himself in trouble. Also, working in teams in low visibility areas is emphasized significantly.

I call these challenges more than needs. MRS; they are basically just advancing the current system. They are currently looking at the equipment they use, especially the oxygen supply units, the physiological response, communications, et cetera, et cetera. They are trying to incorporate all of the new technologies into being a more effective unit.

The biggest concern is the declining numbers of brigadesmen. People do not want to volunteer to become brigadesmen anymore.

In conclusion, the biggest issue, in discussions with the mining industry, is how do we get people when they are working in the section to the section waiting place to the underground rescue bays. I think this is the biggest challenge that we face in South Africa, and one of the critical things we started looking at is what is the current technology, base technology, available, but also how do humans respond to an emergency situation? In the past, a lot of technology has been used, but what would you or I do if faced with that situation?

Clear guidelines on basic practice need to be established, especially for rescue bases. Also, early warning systems need to be looked at critically, and evaluation of basic practices after an incident. When we have incidents in South Africa, if it is a success story, yes, we got them out, newspaper headlines, but there is no formal way of going back and establishing why we were successful or why weren't we successful.

I think that's also an area we need to start looking at. Near misses are not recorded. The successful use of self-contained self-rescuers is not widely reported. There is no official system in place. When self-contained self-rescues are done, was it necessary, was it not necessary, and what were the surrounding circumstances? So it's important to have a formal system in place to learn from this.

That's my presentation for this morning. Thank you, ladies and gentlemen.

(Applause.)

MR. KRAVITZ: Well, we set out for our first panel to set a research agenda to set the tone for this workshop, and I think they have accomplished that.

Mike started out talking about leadership skills, group theory, group work, evacuation through smoke, different types of training.

Mike Kalich and John Radomsky related several examples of mine evacuations and mine emergencies in coal and metal/nonmetal.

Kobus, I think you did an excellent job stating the training needs and the research needs that are going to be discussed further in this workshop.

So I think we're off to a good start. Please return promptly at ten-fifteen for the second panel session. Thank you.

(Whereupon, a short recess was taken.)

MR. GURTUNCA: Good morning, ladies and gentlemen. Welcome to the second session of the morning. The second session is about escape technologies. We have five speakers. The first presentation will be given by Dr. Jeffery Kravitz, MSHA, and Mr. John Kovac, NIOSH. Their presentation is about self-rescue devices.

Dr. Jeffery Kravitz is the chief, mine emergency operations and special projects for MSHA technical support. He is responsible for coordination and supervision of the MSHA mine emergency operations program. This includes operation and maintenance of MSHA's mine emergency operations equipment and resources. He is also the manager of MSHA's mine emergency unit.

Dr. Kravitz is responsible for all MSHA respirator approvals as part of the joint NIOSH-MSHA approval program for all emergency breathing devices used in mining. He is also responsible for the MSHA portion of NIOSH-MSHA investigations of problems involving self-contained breathing devices and filter rescue devices.

Mr. John Kovac is acting program manager for mining and construction at the National Personal Protective Technology Laboratory. For nearly 25 years, he has been responsible for research and development of SCSRs.

MR. KOVAC: Good morning. Both Jeff and I will be giving this presentation mostly because the relationship that earlier the Bureau of Mines and later NIOSH and NPPTL has had with MSHA has been a very long-lived one, and it's been a productive and constructive relationship.

Secondly, I look out, and I see a lot of old friends, and I will remark, we have been through a lot together, but much work remains to be done. With that in mind, I'll begin.

In the aftermath of a mine disaster, miners are taught to don their self-contained self-rescuers and make an escape from the mine. So what we're going to talk about today is some history of these devices, the long-term field evaluation, the kinds of training that's been developed, ongoing investigations of SCSRs recovered from Sago and Alma, and future actions that we will take in order to advance the technology.

In terms of history, prior to 1981, miners relied on filter self-rescuers. In 1981, the first generation of self-contained self-rescuers were deployed underground. Those devices, because of their mining application, have a joint MSHA-NIOSH approval, MSHA acting under the authority of 30 C.F.R. • 7517.14 and NIOSH under the authority of 42 C.F.R. • 84. Because of questions regarding the longevity of these devices, their reliability in a mine environment after long deployment, in 1983, both agencies began a long-term field evaluation which amounted to collecting about 50 self-contained self-rescuers on a yearly basis from underground coal mines around the country, testing these devices on a breathing metabolic simulator, and seeing how well they would hold up.

Because of the size of the devices, and what the photograph illustrates, we have a first-generation, FSR, and the second generation, the government underwrote the development of smaller, lighter-weight units which could, indeed, be worn, and that happened in 1989. By the year 2000, SCSR reliability, because of the size of the deployment -- there are roughly 50,000 units deployed out there -- MSHA begins looking at durability of the units, and the long-term field evaluation expands from 50 units a year to nearly 200 units a year, and we include 100 FSRs also.

And, lastly, in 2005, the National Technology Transfer Center at Wheeling Jesuit University, in conjunction with NIOSH and MSHA, sponsored an SCSR workshop.

Meetings were held twice in 2005 to identify technological options for future advancement.

The units that we have today -- the Ocenco EPA 6.5, a first-generation SCSR; the Draeger Oxy K Plus, second generation; CSCSR-100, second generation; the Ocenco M-20, a 10-minute device; the MSA Lifesaver 60, 60-minute-duration apparatus -- the MSA Lifesaver is no longer being produced, so the deployment in the industry today consists of the three, one-hour-rated devices -- the Ocenco, Draeger, CSC -- and some mines choose to deploy, in addition to one-hour units, cached underground, the M-20s, a 10-minute SCSR.

What the devices look like as deployed as they are about to be used; they all share common features. There will be a breathing hose with a mouthpiece, nose clips so that your lungs essentially isolated and depend only on the breathing gas mix being produced by the apparatus, goggles to wear a breathing bag, and oxygen storage. There are two kinds of SCSRs, and they differ in the way that oxygen is stored and released. They are chemical-oxygen units. Some people understand these as "chem-ox units," and they depend on a solid chemical, potassium superoxide. Potassium superoxide stores oxygen and releases it in a chemical reaction that depends upon the water vapor and XL carbon dioxide in your breath.

On the other hand, we have compressed oxygen devices, and their oxygen is stored as a gas under high pressure. There is a separate CO_2 scrubber, and that material is lithium hydroxide, a solid chemical.

A number of lessons have been learned over the 25-year history of SCSR deployment. Let me begin, first: Escape is the primary survival strategy. An escape means taking the miner, on foot and under apparatus, from the deepest point of penetration in the mine to safety. In some cases, more than one SCSR provider is needed for escape, but a one-hour SCSR does not mean one hour for every miner under every circumstance.

The actual duration of the units depends upon the miner, body weight, his age, physical fitness, the difficulty of the escape, how far the escape is, other escapeway factors in terms of broken terrain, whether he has to walk upright or has to crawl, and, lastly, but not of least importance, the miner's confidence in his ability to make that escape under apparatus.

A miner's confidence depends on three factors: quality, the fact that the units at the point of manufacture will perform as stipulated; reliability, that his unit will work when called upon; training, that a miner knows how to inspect and maintain the unit in his possession, and just as important, that a miner has expectations training, what to expect while wearing the unit, how it's going to provide him effective life support.

We know that sometimes escape is impossible, and miners, as a last resort, must emergency shelter and wait for rescue.

None of the SCSR deployment over the last 25 years would have been possible without partnership from our various stakeholders. We work closely with these individuals, with these groups. There has often been controversy, but reasonable people can always resolve these debates in a reasonable fashion. Without their support, though, this wouldn't have been possible, and they include BCOA, the NMA, Mineworkers, Steelworkers, all of the SCSR manufacturers, and, lastly, again, but not least, MSHA being the co-approver in this activity.

So where we stand is this: If there is any objective in deploying SCSRs in this country or, for that matter, any country around this planet, no miner should be forced to rely upon an SCSR that might be unsafe for an escape. Just as important, a miner must have confidence that his SCSR will work in an emergency and have the hands-on knowledge of how to use it. Escape means taking a miner on foot and under oxygen from the workplace to a point of safety.

Jeff now will speak on the long-term field evaluation and the ongoing investigation of units recovered from Sago and Alma. Jeff?

MR. KRAVITZ: Thanks, John. I'll put on a different hat here and be a speaker for a while. I volunteered to take the lesser of the parts here.

The protocol for the long-term field evaluation, which was started in the early 1980s -- 1981 when SCSRs were first put into mines -- we definitely wanted to track the reliability and the quality of the SCSRs, as John mentioned. We started doing this with the first-generation units and have continued that ever since. That program is about a 25-year-old program.

Basically, we sample units from all of the districts. Coal Mine Safety and Health Districts all cooperate with us to help select the mines. We replace the SCSRs using NIOSH funds for replacement units and make sure that all of the units that are collected pass inspection. Basically, it's the manufacturer's inspection. At first, people were getting the idea that they could get rid of their really beat-up SCSRs, and the first batches we used to get in and brand-new ones in return. That's not what we wanted. We wanted something that actually passed the visual inspection.

So we worked that out now, and we have someone who is very well trained to inspect all of the units to make sure that we get good units for the field, although sometimes things do slip through the cracks. Then we end up going to the lab and cleaning units up, and we find that really shouldn't have collected that unit in the first place, which is a finding in and of itself.

We measure the life-support capability using NIOSH simulator and man test to compare them to new SCSRs, and reports are published after that.

Basically, the collection is such that we try to collect from the majority of SCSRs in the field. According to the market share, CSE has a slight advantage. Sometimes we get more CSEs than anything else. In 2004 and 2005, we had 92 CSEs, 22 Draegers collected, 20 MSAs, 49 Ocenco, and 15 M20s, which are very hard to get if you have M20s in your mine. We have a very hard time getting them because one of the problems is it's hard to get replacement units for them, from the government's standpoint.

This is what the testing looks like. Basically, we have the metabolic simulator. NIOSH basically has refined that over the years. The device has shown good reliability, and NIOSH is now looking at incorporating that into new testing standards. Maybe John will say something about that later.

Also, we have your man test. A few units are tested on the man testing to basically utilize the devices on live people. People from our mine emergency unit, when they sign on, they also sign on to be volunteers for this type of work, and they have cooperated very well, although over the last couple of years, we've been so busy responding to mine emergencies, we have not been able to do as much as we would like to do.

Examples of the SCSRs we have actually seen in the field have sometimes come as a result of different investigations that we actually have seen. Basically, a hose was torn. We have a unit here, an Ocenco, that was collected. In the early stages, it actually had a seal that was split. Lifesaver 60; we found some KO2 in the breathing bag. It turned out to have faulty filtering material.

The EBA 6.5; we would find these with slight cracks and sometimes with big dents in the lithium-hydroxide canisters here. Those obviously should have been removed from service, but they weren't. And the M20; obviously, this one here has quite a few cracks. That was before we instituted the program to only collect units that actually pass inspection. We've improved that considerably.

There have also been some problems since '92. Basically, quality control was about 44 percent, and I'm happy to say that, based on our efforts and our increase in audits at our SCSR manufacturing plants -- we were doing them not on an annual basis -- we started doing it on an annual basis, and that has improved tremendously as far as what we're seeing that the manufacturers are doing. I think that the relationship between the manufacturers and the government has also improved somewhat because of our close relationship with respect to finding problems before they actually become big problems.

Reliability was a problem 38 percent of the time, and that's improved quite a bit. Training had also been a major problem. We have units as far back as Wilburke, where training was a major issue, and I think we're still seeing some training issues. With Willow Creek, we saw training issues that were related. When I went out there to do some interviews with miners who had actually utilized their SCSRs, we found instances in other places where they have actually had problems with training. Again, training is a major type of a topic that we're all interested in in this conference.

We started some new training types of modules. Basically, we want to distribute and evaluate new training which will ensure that the mine knows how to inspect his SCSR and how to use it in the event of an emergency. These modules are the direct result of an interagency agreement between MSHA and NIOSH. We have all of the units that John pointed out involved in these training modules. We've just about finished all but the MSA. The Draeger module should be up shortly. It's going through final review. We started out with CSE and Ocenco because they have the majority of the market and then we went to the Draeger and then the MSA, we saved for last because it has the smallest portion of the market.

Each module consists of a brand-new training video. The video goes through all of the donning sequences. It gives some expectations. David Dye was talking about expectations training. We try to get that in as much as possible. That was an issue that was identified quite a while ago, and I still think that we have a ways to go with expectations training.

Some of the new things: We're going to have to now come up with a revision to all of those videos because of the need of the extra SCSRs in the field, different caches that are out in different types of mines. We're going to have to develop standard procedures for actually donning an SCSR when you're actually wearing an SCSR or transferring from one SCSR to the next. It can be a major issue.

Mike Brnich is working on that with Charlie Voigt. I was talking with Mike today, and Mike says that they are getting close to a solution to that. As soon as they do, we'll do different types of field testing with that, make sure it works, and then we'll incorporate it into our new training videos and then into our computer-based training modules.

Computer-based training modules are on the MSHA Web site under "interactive training," and I encourage you all to visit that site. We also distribute the videos and all of the CBT, computer-based training, from our academy. Each CBT has an instructor's guide on it. It has various scenarios from the videos on them, too, and I think we're doing quite a bit of good work with those modules.

I've also been talking with Jeff Duncan. Jeff has an idea of incorporating that into professional mine certification, so when the next revision comes out, we'll be able to printout of the certificate. We'll actually have people who have trained on that type of CBT have a certificate that shows that goes towards the professional monitoring. So that might encourage people to participate in this type of training, as well as the traditional training that's required by our regulations.

Also, we have screen savers and stickers for those who are interested in computer toys like that.

MSHA distributes these to the different mines, and as I mentioned, the certification for the professional miner, I think, will add quite a new facet to this.

Accomplishments: So far, as I mentioned, CSE is completed, Ocenco is completed, Draeger is almost completed, and the MSA is getting close to being completed. The video is just in the final revision, and the CBT is about 75 percent.

As John mentioned, we were tasked by the investigation team at Sago to basically take a look at all of the SCSRs that were utilized. We have formed a team. We have established a protocol, and to do that, we have looked at all of the SCSRs already. Those who are interested have been invited to all of the different types of testing we've done with the Sago SCSRs, and we're at the point now where we're almost prepared to write up our report. That will be incorporated into the accident investigation report from the Sago.

The protocol consisted of a visual inspection assessing the breathing condition. All but one of the SCSRs was actually used. The one that was used was put on a breathing metabolic simulator, and that did go for one hour. At least, I can tell you that.

Life support was assessed using the simulator for that one unit, plus we opened up each unit, looked at the chemical bags, and tried to gauge how much oxygen was actually used from the chemicals inside that particular SCSR. And as I mentioned, we will be doing a report for that. John, the future.

MR. KOVAC: Can the situation be improved? Can SCSRs be improved? The answer is yes. It's not a matter so much of technology but the will to pursue that improvement.

We would like to see the units be made more rugged, reliable, be tested on the simulator, have ways of self-reporting to make inspections simpler and more direct. We would also like to see some sort of registration so we know where the units are deployed at throughout the mining industry in the event of a recall or some other corrective action. Rather than go into a crisis mode, we would simply react by dealing with those units which were damaged and seeing that they were replaced in good order.

We could simplify things. We believe that manufacturers, by just stipulating performance requirements, things would work better, users will have the best SCSRs available, and the government will have the means for effective and early discovery problems.

Meetings were held with our stakeholders at the National Technology Transfer Center under their auspices in June and December of last year, and two concepts were evolved. One was that of a hybrid self-rescuer. That would be a combination of a closed circuit device which either transforms or switches over to an air-purified respirator, the idea there being that sometimes in the aftermath of a disaster, the atmosphere inside the mine has sufficient oxygen for life support but needs to be scrubbed of carbon monoxide or other byproducts of combustion. Prototypes of the unit were, in fact, discussed. Some bench work, in terms of experimental design, has been done.

The other concept that was evolved was for a dockable or piggyback SCSR/DSCSR, and here, because of the requirement for deploying multiple units along escapeways, the idea would be, rather than making a transfer from one unit to another, in effect, removing the mouthpiece from the one that the mine is wearing, they will go over to a completely new unit. You would simply swap out life support capacity in an orderly fashion, keeping the respiratory system, the way that you're breathing, isolated from the mine air.

I need to remark that type of unit is already allowed under the current regulations, which permit a deployment of a so-called "1060 SCSR."

My intention is to pursue these, working in partnership with any or all of the manufacturers that would step forward with the appropriate prototype technology to see it forward for development.

And that, I think, is all that we have to say on all of this, so if there's any questions.

MR. KRAVITZ: We're going to be doing questions at the end, so if you have any questions, we'll be circulating the cards, and then at the end of the day, we'll be having a whole panel devoted to questions. If you guys can start -- index cards, write down your questions.

(Applause.)

MR. GURTUNCA: Thank you. In the second part of the session, the presentations will be about life lines and escapeways. We have two speakers, Dr. Charles Lazzara and Ken Sproul.

The first presentation will be given by Dr. Lazzara. He is a physical scientist with the Disaster Prevention and Response Branch, Pittsburgh Research Laboratory, NIOSH. He received a Ph.D. degree in physical chemistry from the University of Chicago and was a post-doctoral fellow at the Institute of Gas Technology in the area of combustion kinetics. He joined the Bureau of Mines, now NIOSH, in 1971 and has been involved in fire and emergency response research since 1979. He currently leads a team investigating procedures and technologies to enhance the safety and operational effectiveness of mine emergency responders, including rescue teams, fire brigades, and evacuating mines. Charles.

MR. LAZZARA: Thank you. I would like to highlight today some of the research work being conducted by NIOSH under its Emergency Response and Rescue Program. The goal of this program is to enhance the safety and effectiveness of mine emergency responders. Now, when we classify emergency responders, we're looking at our first responders, which are the miners themselves. The underground miners will most likely be the first affected or discover an emergency, and they are going to have to make some key decisions, such as communicating that information to others and whether they can deal with that emergency themselves with the resources they have in hand, for example, fighting a small fire with a hand-held portable fire extinguisher, or whether they need to evacuate.

We look at the second responders to be fire brigades. Several mines do have fire brigade members available, and they have special training in the use of breathing apparatuses and also advanced fire-fighting skills and equipment. So while other miners might be evacuating a mine in a fire, these teams or brigades would organize, get their equipment, go towards the fire site to try to get that fire in its early stages. They may use hand-held extinguishers, water lines, high-expansion foam generators, et cetera, to try to put out that fire.

In terms of sustained responders, we rely on our mine rescue teams. They have the capability, of course, of being under air for longer periods of time, and they have extensive training in mine exploration, mapping, rescuing, and also in fire fighting, too, if there need be.

I would like to focus now, at least, on some of our research objectives for those first responders. We have conducted and evaluated smoke evacuation exercises at operating mines, and this is to enhance the evacuation preparedness of the miners and mine management and safety officials, as well as improve the competence level of miners who might have to evacuate through smoke-filled entries. We are also developing, identifying, and evaluating technology to assist evacuating miners in smoke-filled entries, and, of course, this can improve their chances of a safe evacuation.

In terms of the smoke evacuation exercises, we do this in partnership, of course, with operating mines, and, in general, we'll have a group of 20 to 30 miners which we'll gather together and brief them on what they are about to experience. We'll show them some of the technology we would like them to evaluate during that particular exercise, and then we'll send them through several hundred feet of mine entry where the smoke visibility ranges from about five to 10 feet, and in that first section we'll just have their normal mine escapeway markers that they have in their mine, which are generally reflective materials or signs.

Then we'll give them some additional technology, and we'll send them through an area of around 700 to 1,000 feet long where the visibility ranges from one to three feet, and they get experience of how they can maneuver and manage to travel through a really dense, smoke-filled entry.

Now, this is a white theatrical smoke, nontoxic, of course, and in an actual situation the smoke, of course, would be very black due to a burning conveyor belt, coal, diesel fuel, tires, and that kind of thing, and also they would be wearing their self-contained self-rescuers in addition. In some of these exercises in some mines, we generally have at least one individual in the group that would don an SCSR and travel through the smoke so he could relate his experiences to the other miners that are involved in the exercise.

Since 2000, over 1,900 mine workers have participated in smoke evacuation exercises at nine mines. As one positive output of this work, one major mining company has recently purchased a number of smoke-generating machines so they can conduct these exercises with their miners on a regular basis.

The type of technology we evaluated included directional life lines. The one we used is shown here at the bottom for our work. Essentially, it's a quarter-inch, yellow, polypropylene rope. It is flame retardant. It does pass the modified motor vehicle safety standard 302 test. It has about a 900-pound breaking strength. We have on it these plastic directional cones, and these are the guides that make it directional.

Now, there has been some confusion out there about how they should be installed. The tips of the cones do not point the way out. The line is designed so that once you grab onto it, your hand glides over the cone, so you don't have to remove your hand from the life line as you make your way out. If you happen to be going in the wrong direction, which has occurred, your hand would be blocked by the cone, so you need to turn around and go the other way.

More recently, they have put out another type of life line which is replacing this rope with essentially an airline cable, and this is a steel cable which is covered with plastic. Along the life line, at 25-foot intervals or so, they also have reflective tape. These cones can be positioned at various distances. Generally, in our work, they are positioned at 100 feet along the life line, and we found it valuable that if you're approaching an obstacle, such as a man door, or, let's say, making a right-hand turn, you may want to put a couple of these cones close together, within three or four feet of each other, to make people aware that they are approaching an obstacle.

This is some of the other technology that was evaluated during these exercises: various types of reflective objects and materials, different colors; chemical light sticks of various colors; strobe lights -- that's a xenon type of strobe light and light-emitting diode type of strobe lights; and these hand-held lasers like the one I'm using here. This is a Class 3A laser, five milliwatts. Well, 532 nanometers is the wavelength. You can see you can go a long distance with this, several hundred meters. We've found this very useful in terms of cutting through the smoke, and when you hit a rib or an obstacle in front of you, you'll see the point. You almost would use it like a light walking stick.

Here you see one of the participants exiting the smoke-filled entry, and he has the aid of a life line, which he has one hand on, and you see the laser beam cutting through the smoke. He is also wearing a reflective vest.

So what do we learn from some of these exercises? What I have here is data we got from one exercise in a western coal mine where there were 219 participants or miners that went through this exercise with these various technologies. These are some of the questionnaires we give them in evaluating the exercise. This is the number of miners who responded that they strongly agreed to that statement, the ones that agreed, disagreed, or strongly disagreed. You always get one or two of these guys. I think he misunderstood the numbering system.

I learned something new from this exercise. You see the vast majority of the 219 agreed to that. Some of these, of course, were experienced miners that have been in the mine a long time. Others were brand-new miners that were just there for less than a year and have never experienced anything like this before.

After this exercise, I feel better prepared to travel through smoke. The vast majority, again, agreed to that statement.

Here we get into the evaluation of the technology and what they thought about it. The directional life line was useful for escape in smoking entries. You can see, based on the number of agreements, that this was the best advice in terms of getting them through a smoking entry where visibility was limited to one to three feet.

The laser was helpful for escape in smoking entries. Once again, we got a pretty positive result on that, and we found, of course, this green laser was superior over, let's say, a red laser in terms of color.

The strobe lights were useful in smoking entries. Once again, a fairly positive response in aiding them to get through a smoke-filled environment or leading the way through the smoke-filled entry.

Then we started going down in terms of popularity. Chemical light sticks; a fairly good response, but a number of disagrees. And then reflecting material; that generally ended up at the end of the list.

Some of the comments we received from these exercises: "Good exercise on what smoke-filled entries would be like." "A very helpful exercise." It was surprising that we had a number of those, and the fact that they should have had this exercise a long time ago in terms of walking through their escapeways because generally when they walk through their escapeways now, it's in clear air. "Green was the more visible of all of the devices." "The escape rope was the most useful." "The lasers helped the most to find the ribs. I don't think that the life line would last long, but it definitely helps a lot."

Travel time slows considerably a smoke, a good fact to consider when assigning -- space SCSRs. At least one mine we went to took that into account in terms of where they had their caches of SCSRs placed along their escapeway and realized the fact that if you did have to travel through a contaminated escapeway, you would have to put those caches a lot closer than they are now.

And we get some good ideas, too, from the miners, like placing strobe lights on the escape rope for better effectiveness in actual situations.

We are starting to look into the possibility of lighted life lines based on a couple of different technologies, such as electric chemaluscent wire. So you can picture that as a life line put inside a rope, for example, that could be lit during evacuation either by somebody evacuating or by a signal from the surface or various other types of LEDs or even bulbs encased in plastic.

In conclusion, the underground smoke evacuation exercises better prepared miners for escape through smoke-contaminated entries. Directional life lines were selected by miners as the optimum escapeway aid, and laser pointers and strobe lights were also found to be very beneficial.

We have an interesting report that we put out just recently the summarizes this work, as well as the work that we do with mine rescue teams and fire brigades also. That can be found at our NIOSH Web site, or if anybody would like to be sent a copy, just give me their card, et cetera. Thank you.

(Applause.)

MR. GURTUNCA: Thank you. The next two speakers are -- interesting. They have something to do with Navy. Their experience -- I guess, working underground has got some similarities to working under the water. We'll see what we can learn.

The first one is Ken Sproul. He is the chief, Quality Assurance and Material Testing Division at MSHA Approval and Certification Center in Tridelphia. Ken received a bachelor of science in electrical engineering from the University of Pittsburgh in 1971. He also completed graduate studies in electrical engineering at the University of Maryland under a fellowship program sponsored by the Navy Department. In 1980, Ken joined MSHA, Administrations Approval and Certification Center as an electrical engineer in the electrical power systems branch. In 1981, he was promoted to the position of chief, intrinsic safety and instrumentation branch. In 1992, he became chief, quality assurance division. He later served as chief, electrical safety division, before assuming his present duties as chief, quality assurance and materials testing division.

Ken has served as an expert witness in cases involving intrinsic safety. He has authored several publications and presented papers at a number of conferences and meetings related to electrical equipment in underground coal mines. Ken.

MR. SPROUL: Thank you very much and good morning. It's my privilege to speak to you for a few minutes about the evolution of MSHA's requirements for the use of directional life lines in underground coal mines, and I think it's totally appropriate that I was preceded to the podium by Dr. Lazzara because he has very well made the case from the research perspective of the effectiveness of life lines as an escape tool for coal miners.

Now, I have to confess to you, though, that as recently as four months ago, this was a subject that I knew very little about, but I've read in the program that I'm now considered an expert, and I guess that tells us that we shouldn't always believe everything we read.

But the good thing is that the subject is not really that complex. It's certainly not rocket science, it's not high tech, and there is not a need for a mastery of high-level mathematics to understand life lines. After all, we're talking about a relatively simple device. It's just a rope, but when it's used effectively, it just might have the potential to save lives, and that's what it's all about.

But even the simplest things can get messy if we don't focus on some simple principles, and so I'm going to do my best this morning to keep us from getting tangled up on the subject, and I'll try not to interject any more puns either.

Let me talk now about the evolution of the requirements for the use of life lines. First of all, I should point out that several states, and these are the only ones actually that I'm aware of, have mandated the use of life lines under varying conditions for a number of years now.

In West Virginia and Kentucky, life lines have been required in alternate escapeways when those escapeways are in return air courses. I'm sure the theory is that in most emergency scenarios, the event is going to be more likely to occur in by, and so if you're escaping through a return, it's more likely to be filled with smoke, and so it's more important to have life lines there.

You can see, though, that Virginia took the opposite approach, and they require life lines in all primary intake escapeways, and I'm sure their theory had to do with something like this, that you're more likely to select the primary escapeway as your first route of escape. So there's two different philosophies there.

Now, let's talk about what we've done on the federal level with MSHA. Prior to June of 2004, there really were no requirements in MSHA's regulations that mandated the use of directional life lines. At that time, though, the belt air rule became effective, and it brought with it the requirement that life lines be used in any air courses that are designated as alternate escapeways when they are ventilated by return air, not only for belt air mines but for all mines.

Then, as David Dye told us this morning, in the wake of the tragic accidents in West Virginia in January of this year, the agency has issued an emergency temporary standard under its authority in the Mine Act, and this is a relatively extraordinary measure, only the third time we've done such a thing. I'm not going to go through all of the provisions. Mr. Dye has already done that. But I want to focus on the life line provision.

This became effective on March 9 of this year, when it was published in the Federal Register. The requirements for life lines are contained in the ventilation section where the requirements for escapeways are defined. Here you see 75.380 defines the requirements for escapeways in bituminous and lignite mines, and there is a parallel requirement, which I won't show you, for anthracite mines as well.

But essentially, the requirements for life lines are these, and you'll see that they are primarily performance oriented. There is not a great deal of detail, but let's break it down and look at it one by one.

First of all, each escapeway is to be provided with life lines, and that means that MSHA's approach is to mandate the use of life lines in both the primary intake escapeway and the alternate escapeway, and certainly I think you can appreciate the theory here, that by having life lines in both escapeways, it does increase the opportunity for a successful escape, depending on the accident scenario that the mines are confronted with.

The directional life lines or equivalent devices are to be provided. Most likely it's going to be a rope, and Chuck has already shown you the polypropylene version of the directional life line, and here is the aircraft cable type, and you're welcome to see me later and look at these in detail, if you would like.

We did leave open the possible that there might be other equally effective means for achieving the same end, and in some mines in the more permanent construction of the out by areas, in the mains, for example, there might be a handrail that would be installed that could serve as a life line, so we didn't want to mandate that it be a rope. Some mines have asked if they could use leaky feeder cables or water lines or something of that effect. As long as it meets all of these requirements that we've established for life lines, we've said, at least to date, that that would be acceptable.

Now, they are to be installed and maintained, and I put an emphasis on "maintain" because if they are installed and forgotten about, they may or may not be available when they are most critically needed, namely, during an escape scenario. They are to be installed and maintained throughout the entire length of the escapeway, and, of course, the escapeway is actually defined in this same section in paragraph (b)(1), and you can read it there, that escapeways are provided from the working section all the way to the surface escape drift or to the escape shaft or slope facilities to the surface. So it's a continuous device that needs to be there for the entire length of the escapeway.

Here is an example of what I mean by a

performance-oriented specification. It's to be made of durable material, and we haven't specified what the material is or what properties it should exhibit, but clearly it needs to be strong enough to survive normal mining conditions, for example, the degradation that may occur due to humidity or heat. It should be available in an emergency when miners need them the most, and they should be, obviously, sturdy enough to withstand any intense physical use that they are put to during the actual evacuation.

They are going to be marked with a reflective material at least every 25 feet so that in those situations where there is adequate visibility, the miners' cap lamps can help them locate the life line quickly.

It should also be located in such a manner for mines to use effectively during an escape. The proper positioning, of course, of the life line regarding its height and accessibility become key in the mines being able to locate and use it. We would recommend that the life line be installed at waist height so that the mines can stay below the level of the densest smoke. There are tradeoffs, of course. It's easier to make the installation along the roof line, and some mines are electing to install that life line along the roof but on breakaway hangars so that if it were needed in an emergency, it could be pulled down to where if the mines either needed to stoop over or even crawl, they could do so.

Incidentally, a number of questions have been raised regarding this requirement and others that I've discussed already. We have developed a compliance guide that's posted on our Web site in the format of a question-and-answer format, and I would direct you there if you would like to see what some of the key questions are that people have been asking.

The directional indicators signifying the route of escape, such as the cones that have been demonstrated to you already, are to be placed in intervals not exceeding 100 feet. The purpose, of course, is to provide some tactile feedback to the miners who may not be able to see because of a dark, smoke-filled environment.

Now, there is nothing sacred about 100 feet. We could have just as easily selected another number, and there has been some debate about how critical this is. Obviously, it's not a precision number, and we have been advising our inspectors not to issue citations if the cone spacing is 101 feet or something of that nature because it's not that critical.

What's even more critical perhaps is to adopt something along the lines of what Chuck Lazzara suggested, that at intersections or places where there may be obstacles, overcasts, or whatever, there could be additional cones or some other device placed that would give some feedback concerning the situation.

Life lines are also to be securely attached to and marked to show the location of supplemental storage of SCSRs along the escapeways. If the miners need additional SCSRs to make the escape, they need to be able to locate them, and that's what this requirement is all about.

So here it is. It's a rope. At least, the prefabricated ones that are available commercially are, for the most part, these yellow, polypropylene ropes with the reflective cones, and here is the aircraft cable version of it. I know that at least one major mining company has reportedly elected to use the aircraft cable type in their out by areas because they believe it will be more durable and less likely to be damaged with mobile equipment, and I'm sure that's true. It is a little more costly. I think it's roughly twice as expensive as the polypropylene rope.

Here again is the direction-of-travel indicator, and it may seem to be counterintuitive, but that was the design, and we're recommending that people install it and use it that way. Theoretically, you could use it in precisely the opposite direction, if you chose to, provided the miners were trained, but because of movement of miners from one mine to another or even visitors and others that may come to the property, a uniform and consistent approach across the nation would be much better.

Here is just a page from one of the vendors' brochures. I chose to put this up here just so that you could see what it looks like when a life line is actually draped through a mine entry. Here is another vendor and some information from their Web site. There's actually at least three that I'm aware of now, and because of the newly created market, there may be others that will be coming along, but Cambria County Association for the Blind in Evansburgh, Pennsylvania, has been a major supplier of prefabricated life lines for a number of years, Boone Supply in Boone County, West Virginia; and then the newest one that I've learned about, in Logan, West Virginia: Mine Life Line.

Well, have you reached the end of your rope yet? If you're trying to escape through dense smoke in adverse conditions, reaching the end of your rope is a good thing because that means you've reached safety, and that's what it's all about, saving lives. So thank you for your attention.

(Applause.)

MR. GURTUNCA: Our last speaker before lunch is Mr. Ryan Webb, who will talk about emergency recreation hyperbaric stretcher. Ryan is a registered professional engineer, and he has a bachelor of science degree in civil engineering. He got this in 1993. He has got 10 years of experience with the design, construction, installation, test, and deployment of ocean systems. He is a U.S. Navy second-class diver, July-November 1994. Very good.

Ryan works for PCCI, and he is manager for acquisition and certification of the U.S. Navy's standard Navy double-lock recompression chamber system. He also manages the creation of a technical manual, including operating emergency and maintenance procedures; acquisition manager for the U.S. Navy's emergency hyperbaric stretcher. He provided technical expertise, project management, and liaison for acquisition and certification. He was a project engineer for the modification to a U.S. Navy underwater fibroscope, designed modifications to the underwater housing, light source, and camera. He also managed the subcontractors involved in fabrication of new equipment and parts.

MR. WEBB: Good morning. My name is Ryan Webb, as he said, and I work for PCCI, located just across the river in Alexandria, Virginia. We are the U.S. distributor for the SOS Hyperlight, which is called the emergency evacuation hyperbaric stretcher, or EEHS, by the U.S. military, which currently owns the largest number of these systems.

The EEHS, shown here, is a portable, monoplace, folding, hyperbaric stretcher used to provide hyperbaric oxygen therapy to injured personnel at remote sites. The contact information for both PCCI and SOS is shown here. If you would like more information on either the company or the equipment, please see me after the session or call Mr. Alan Becker at PCCI, and we would be happy to help you.

The EEHS allows first responders to an accident site to provide an on-site, hyperbaric oxygen therapy to injured personnel. This is important because in most cases where HBOT is to be used, the sooner a treatment is started, the better the results tend to be. There is now no need to wait two to three days to get a highly effective treatment for CO poisoning after an accident. The system is easy to assemble and simple to use. In an emergency, the patient is slid into the stretcher, the windows are installed, and a few hoses are attached by way of quick disconnects. These are sized to prevent an incorrect setup.

Once the patient is ready, the stretcher can be pressurized, and the treatment can begin. Once the treatment is started, the patient can be transported to a full-sized, hospital facility recompression chamber.

Because of the light weight and small size of the system, it is man portable and can be easily stored at a mine site or transported to an accident location quickly.

The Undersea and Hyperbaric Medical Society currently recognizes 13 indications for the use of hyperbaric oxygen therapy. Obviously, not all of them are applicable to the mining industry, but three of these indications certainly are. These are carbon monoxide poisoning, crush injuries, and thermal burns.

Carbon monoxide is a colorless, odorless gas that is produced as a byproduct of combustion. The CO binds to hemoglobin in red blood cells at the sites usually utilized to carry oxygen to the tissues. Hyperbaric oxygen accelerates the clearance of CO from the body, thereby restoring oxygen delivery to sensitive tissues, such as the heart and brain.

The Undersea and Hyperbaric Medical Society currently recommends HBOT for individuals with serious CO poisoning as manifest by transient or prolonged unconsciousness, abnormal neurologic signs, cardiovascular dysfunction, or severe acidosis.

For severe crush injuries, the rate of complication, such as infection, nonhealing of fractures, and amputations range up to 50 percent. When used with orthopedic surgery and antibiotics, hyperbaric oxygen therapy shows promise as a way to decrease complication from severe crush injuries. HBOT increases oxygen delivery to the injured tissues, reduces swelling, and provides an improved environment for healing.

HBOT should be started as soon after an injury as possible. A number of related conditions, including compartment syndrome and thermal burns, are also benefitted by hyperbaric therapy. Thermal burns, if not fatal, can cause disastrous long-term physical and emotional disability to the survivor. Especially in enclosed-space fires, thermal and smoke damage to lungs can occur.

Adjunctive, hyperbaric oxygen therapy has been shown to limit the progression of the burn injury, reduce swelling, reduce the need for surgery, diminish lung damage, and shorten the hospitalization time for the patient. These benefits are more apparent if therapy is initiated within six to 24 hours of the burn injury. Ideally, the patient should have three sessions within the first 24 hours and then continue treatment as directed by a burn therapy expert.

Indications for HBOT typically include deep, second- or third-degree burns that involve greater than 20 percent of the total body surface area and less extensive burns that involve the hands, face, or groin area.

Here is the Hyperlight. It is a foldable, portable pressure vessel which uses light-weight, composite materials to provide a safe treatment environment. The Hyperlight is rigid when inflated but when not in use can be folded up into two compact travel cases. The gas supply for the system -- this is not shown in this photograph -- can be provided by PCCI as an optional item or by the end user to their own specifications.

The system is rated at 30.5 PSI, which allows a full United States Navy Treatment Table 6 to be performed even in an unpressurized aircraft at up to 10,000 feet. It's 88 and a half inches long and 23 and a half inches in diameter. The weights shown here can vary, as there are some optional extras, which we'll come to shortly. This slide also gives you the case sizes.

This is a United States Navy team transporting a patient in the Hyperlight. The photo also shows the gas supply system. You can kind of make it out in the back. This is what the U.S. Navy uses. It has two bottles in it, one oxygen, one air, and they have probably already exhausted one full air cylinder in order to pressurize the system.

Here is a photograph of the two cases that the system comes in, and this is the control box. It contains inputs for both air and oxygen, and on the output side there are connections for a built-in breathing system, or BIBS, the main stretcher air supply, the main vent, and a pneumofathometer connection to allow the chamber pressure to be read at the control box.

This shows the stretcher folded into its storage container with the control box in its storage location on top. To prepare the stretcher tube for assembly, all you need to do is turn the storage container on its side and pull out the tube.

These are the contents of the smaller case. This includes the two windows, all of the hoses, and the regulators that would go on the gas bottles.

Standard items that come with the stretcher include BIBS, communications, regulators, handling straps, a timer, and storage containers.

These systems can be built to a number of standards if used internationally, but for use in the U.S. they should be built to the American Society of Mechanical Engineers safety standard for pressure vessels and human occupancy, or ASME PVHO-1.

These next couple of slides show the components that come standard with the system. This is another photograph of the control box, the two cases stacked, and then the components packed into the cases.

This shows a full system setup on the left-hand side, the penetration window in the middle, which is where all of your hoses from the control box attach to, and the unfolding of the tube.

Here are some optional items that can be purchased with the EEHS: The medical log, which is used to send material into or out of the stretcher during treatments.

Dome hinge protection rings should not be on this photograph. They are required by the PVHO standard, but if you're buying an international tube that's done to Lloyd's, they may have different rings around the outsides of the windows.

Gas cylinders and a gas cart are an optional item. The amount of gas varies depending on the treatment, and different users may want a different gas supply system. PCCI can supply a standardized gas supply package or can customize one to your requirements.

Some other options are oxygen and carbon dioxide analyzers, connectors for electrocardiograms, ventilators, or other monitoring equipment, lifting slings, and a second pressure gauge, which would be located inside the stretcher. This acts as a backup to the main gauge in the control box, and during air transport in an unpressurized aircraft, it will allow direct readings of the actual pressure inside the chamber.

The next couple of slides show this optional equipment and women, and then some other items that I haven't mentioned yet.

The drag mattress shown here, it's useful. It makes the treatment much more comfortable for the patient, and it makes entry and egress for the patient much easier, as well, especially for an unconscious occupant.

The internal gauge is shown here, and the window with the medical lock, which is at the other end from the penetration window.

The hyperlight emergency evacuation hyperbaric stretcher is a safe and effective way to treat carbon monoxide poisoning, crush injuries, and burns by using a small, lightweight, and highly portable piece of equipment.

Before I end today I'd like to read a short article from the Journal of Emergency Medicine regarding a treatment that took place recently in Afghanistan by U.S. military forces. I quote: "We report the first case of suspected carbon monoxide poisoning treated by a hyperbaric oxygen therapy by using a portable hyperbaric stretcher. A 40-year-old British man in Kabul, Afghanistan was found unresponsive in his apartment. Initial treatment consisted of oxygen by mask at a combat support hospital for several hours, with minimal improvement. Operational security and risk prevented his immediate evacuation to the nearest fixed hyperbaric facility.

"He was subsequently treated twice using emergency evacuation hyperbaric stretchers. According to the U.S. Navy Diving Manual Treatment Table Nine, the patient showed marked neurologic improvement after the first treatment, and experienced near-complete recovery before his eventual evacuation."

This case illustrates the practical use of portable chambers for the treatment of suspected cases of carbon monoxide poisoning in an austere environment.

Thank you for your time today. If there are any questions, please see me afterwards or fill out a card with the gentleman in the back. Thank you.

(Applause.)

MR. FINFINGER: I'd like to thank all the presenters for their excellent presentations. Now we would like to break for lunch, and we'll come back at 12:30 to hear the third session.

Thank you very much.

(Whereupon, at 11:30 a.m., the hearing was recessed, to reconvene at 12:30 p.m. this same day, Tuesday, April 18, 2006.)

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A F T E R N O O N   S E S S I O N

(12:30 p.m.)

MR. KRAVITZ: Welcome back this afternoon. We have been leading up to the rescue shelters portion of this workshop.

I've already mentioned some design considerations, touched on it briefly. This afternoon we'll get into it a lot more deeply, with the manufacturers and some other types of discussions on emergency shelters.

To kick it off this afternoon we have Dr. Jan Oberholzer. He's an alumnus of the University of Pretoria, the Wichestrand and Wineza. I know I'm murdering that, but you can correct that if you want. He has been involved with coal and other types of mining for over 30 years with production, technical services, management, and research.

For 15 years he worked for the Chamber of Mines of South Africa, a research organization. When he left South Africa, he was the Senior Coal Mining Consultant for CSIR, a Division of Mining Technology.

He is presently the Manager of Mining Research and Development at SIMTARS in Australia. He is published widely in his field, which ranges from mine productivity issues, safety and health, as well as the environmental side of mining.

He is a Fellow of the South African Institute for

Mining and Metallurgy, the Mine Ventilation Society, a member of the SME, and a life member of the American Society for Mine Rehabilitation and Reclamation.

Of importance to this meeting is that he was the Chief of Field Investigations of the coal mining of the Chamber of Mine Research Organization when he was a post-lobane incident work was done. We heard about that earlier from Kobus. And led to the introduction of self-contained self-rescuers and other rescue methods in South African coal mines.

So again, another wealth of experience. And please welcome Mr. Oberholzer.

(Applause.)

MR. OBERHOLZER: Ladies and gentlemen, I would like to discuss a few aspects of the design and installation of refuge chambers. I would like to do it at the end of basically some history we'd all like to go back to. And then secondly, considering that I've had the experience of doing it in South Africa and in Queensland, I would like to give you some of my experiences there.

When one talks about matters like this, one always harks back to the history. And I think one of the most important historical facts is the Coriaz mine disaster of 1906, which actually, for the first time, accepted that coal dust plays a significant role.

In a similar way, I think Slebon in 1993 pointed out to the use of self-contained self-rescuers in coal mines.

In 1987 a rather nasty accident where 177 people were killed due to a fire of insulation material in a gold mine almost mandated the use of self-contained self-rescuers in gold mines. In 1993, at precisely the point when the South African industry felt that they really almost knew it all, the Middlebult disaster happened, which led to the Leon Commission.

In 1995, six months after the Leon Commission's findings were accepted by all, Fowl Reefs managed to drop a locomotive down the shaft. It killed 137 people, which really made the Leon Commission's implementation mandatory in South Africa. It changed the whole scene of mining in South Africa, possibly the same way as Sago might change the scene of mining in America.

In Australia, in the Moura Number Four disaster, 1986, it only killed 12 people, but it was significant in that, at that time they still used filter self-rescuers. But at that point they found that the normal flame safety lamp wasn't suitable any more.

Moura Number Two in 1994 only had 11 people dead. They had filter self-rescuers, but this warden's inquiry led to the development of new safety standards.

It is a rather nasty little fact between Moura Number Two and Korea's 1906, something that very few people know. In 1906, 25 days after the whole mine was destroyed by a coal dust explosion, 12 people came out of the mine. Three days later, another person came out, and closed the mine four days after the explosion.

What I'd like to discuss with you today is how do things happen in South Africa. Why do we choose a refuge base? What was expected from them? And how Queensland, which has based some of their thoughts on refuge bays and on South Africa, and on some of the experience we have had, and on the present feelings?

I think we must understand how the coal mining environment looked in South Africa, 1983/84. The sections were long; they were distributed geographically about three to four kilometers. The sections themselves were about six, seven rows wide, and over a kilometer in length. It was mostly board-and-pillar mining, and there was up to six sections per shaft. We had to get coal out to feed the power stations.

The interesting thing was there were 30 people per section, on average. In other words, in the event of an explosion or an incident, you would have these people streaming to the shaft, trying to escape. I would like you to consider 180 people arriving at various caches of self-rescuers at different times, at different places.

If one looks at crowd behavior, very seldom are people killed in an indoor place like this when there is a fire. They get killed due to trampling or to other issues. And this is one of the issues why we decided to install refuge bays. And this was based in those days when we did this work, we did various scenarios. In those days it wasn't called scenario planning, it was called what-if.

We actually could not find an alternative solution to the identified problems. How are we going to divvy up extended breathing apparatuses to people arriving at different times at these places? I do not even believe that we could do it today.

So what we came up with was the best horse for the course at that time. We drew up certain general specifications, and we left it up to the mines to develop the details, for the very same reason as it was a horse for the course.

We came up with some generic issues, design issues. The first one was that it had to withstand an over-pressure event of 20 psi. If one goes into work that was done in the U.S. Bureau of Mines, work done by the people that did the atomic explosions, work that was done by a crowd called the McCracken Investigation in Australia, they found that at an over-pressure of 20 psi, you will have a

50-percent chance for survival.

That means that at 20 psi, you will have people that you can rescue. If you have a coal dust explosion where you start running into very, very high pressures, the chance of anybody having anybody to rescue was very small.

The other issue is that the first place that a person needs to go to, and this will be a refuge bay or whatever, needs to be within 600 meters. And this was due to the matters of disorientation that was found by gentlemen like Dr. Kilbloc (ph) or Mr. Funensberg (ph), because they found that even though you can get there within the 15-minute self-contained self-rescuer, possibly you wouldn't be able to make it due to disorientation.

Another issue is that your refuge bay needs to have a positive pressure inside the bay. And this is due to the way that you would have pollution into that bay from the sea air on the outside. Therefore, the doors had to create a kind of seal.

The other issue is that this refuge bay has to be well-signed or identified. We, even in those initial days, considered fencing your roadways off so you would have to lead your workers into that bay.

Communications to surface seemed to be very important, and has actually been proven afterwards to be even imperative. Provision of food, water, and sanitation facilities was seen to be important.

There needs to be air supply, because basically the problem that you're dealing with is a poisonous, toxic, asphyxiating atmosphere. So we need to have a supply of breathing air. We also have to have a positive pressure in that chamber, and we have to have a cooling of the environment.

Now, South Africa has a problem, and Queensland, for instance, not. There is no compressed air in the coal mines of South Africa. And I have an idea that there is not much compressed air in the coal mines of America. It's a kind of electric type of operation.

That's why, in South Africa, with its fairly shallow mines -- 150 meters -- it was actually very much easier just to drill a hole down and put a fan on top. Where this was impossible, oxygen generators or bottles was used. Unfortunately, when you use that, you do not have pressure in your refuge bay.

The other issue is the issue of communication. This is not only based on what we thought, but what I have seen subsequently in Queensland exercises. There is an immense need for leadership in the first-occurrence trauma. People need to have somebody to look at. The only problem is, I don't know how many of you have ever put on a self-contained self-rescuer. Anybody in this place that actually? You would know how well you can speak to your fellow human being when you've got that thing in your mouth. Communication comes to a grinding, sudden halt when you use self-contained self-rescuer.

In Queensland we use a thing called a compressed air breathing apparatus. This is where you've got a full face mask. Even at best, it's almost impossible. There's problems with one-way communication, and this is even if you phone or you get a message, the people up top do not know what you want to say, and sometimes disregard you.

And there's also a very strong need for a consolidation of acts. Once that initial panic and problems are sorted out, people need to just sit back and say how best do we carry on from here.

Now, there's some historic proof refuge bays have worked well in South Africa and have saved lives; elsewhere, as well. In Gloria Mine, after a fire, after four days, that got people out alive. At Emaswati Colliery, they had a major fall in the intakes. They had people captured behind it, and they got them out, very much similar to the Quecreek incident. Canada and Tasmania had one, with Tasmania seemingly, the Australians, anything they were really concerned about is they would have liked more finger biscuits.

(Laughter.)

However, we must realize one thing. And this is, if you look at the news and that, the fact that you've got a refuge bay does not mean you're going to save all the people. You're still going to kill people, because they might not just reach it.

In comparison to what I've just told you, I'd like to just share with you some aspects of the Queensland Mine environment. We have got a very, very low number of workers. Concentrated mining, high seams, on the order of four, four and a half meters, long walls, one development section, one long wall per mine. We have immensely high air speeds, which means that if you have a fire, you will pollute your mine in some cases under a half an hour.

We also work with a very much less prescriptive regulation. We work with a regulation which is based and supports risk assessment and risk management, which I think Professor Joy will tell us significantly more about this afternoon. It is a high emphasis on the management of risks and the use of safety management plans.

If we look at what came out of the changeover in the communication stations with relevance to this, and now this could be a refuge bay, it could be a halfway station, you can call it whatever you want. And this was made by the Task Group Four following them out of disaster. That the intervals at which these stations were should be based on the person traveling on foot. It should be ready, locateable, and accessible. It should resist low-intensity explosions, similar like in South Africa. It should be provided with restorable air, provided with robust communications, a method to determine toxicity and oxygen content of the air. And it should be sized capable for demand.

Now, in Queensland we have what we would call the level-one exercise, and it's held every year. And this is a very, very close simulation to a real disaster or catastrophe. The mines know who they are, they just don't know when it happens. And the way it is done is that it really, we come up with a scenario, we put it to them. We simulate everything. We ask them to do this.

But there has been some significant experiences out of this. And I've synthesized this into a few points. The first thing is that communications is a massive problem.

The second one is that the changeover to EBAs is a serious problem. For example, the very first exercise we had, which was the Southern Colliery, half of the people lost their lives due to the fact they couldn't open an Ocenco EBA with wet hands. Beautifully ergonomically designed, soft, smooth system. But the moment you take it with wet hands, you cannot open it.

In Australia, we have mateship. It is a sad fact of life that the self-escape and the self-rescuer means precisely what it says: you only have enough air to make yourself escape and to rescue yourself.   When you start looking after mates, it becomes very difficult to take somebody out of a mine.

There is also the decision-making in the aftermath. You do not have time, and that is precisely when you need time. Traveling in escape routes can be beyond the capability of rescue crews. In other words, to get down and help somebody is too far for any rescue crew to actually get to.

The other one is, whether we like it or not, not all men are equal. They are neither physically equal or mentally equal. Sometimes the people that you would believe are the most suitable to rescue themselves are the most unsuitable. And even if it is a simulated exercise, things are not that easy. I have personally seen how people give up hope, and they actually stand there and realize that if this was the real thing, they would have actually died. It is an amazing thing to see that realization in a fellow human being's face.

The historical reality in Queensland is the following. That even though we have had exercises every year since 1998, we have identified issues, we made alterations, there are lists of issues that have come up, I believe that our industry is as highly committed as any industry could be. But we have unfortunately have had many successes, and even more failures, that shows where things aren't really well.

The unfortunate part, or very fortunate part, is that we have had no real emergencies against which we can test our present system.

Just some concluding thoughts. Refuge bays, emergency shelters, safe havens, changeover stations are basically all the same concept; some way for a person to go if he's going to run out of air. They are not easy to install, and they are not easy to maintain. There are, however, quite a few alternatives out there that the mine can use.

But I would like to point out that in my experience in both of these countries, that the refuge bay or these havens is not the solution. It is only part of a system of a very, very big system to get your people safe. These places must suit and fit in with a system at the mine.

To give you an example. The distance to your refuge bay in a mine that is two meters high will be significantly different to a mine where you've got four meters' height.

The bottom line is that a refuge bay costs money, it costs effort, and it costs other resources. The only reality of life is that if you do not spend that money, the alternative is that you will be held to task, say, if this person did not have enough air to breathe.

Gentlemen, I thank you.

(Applause.)

MR. KRAVITZ: Now we'll move you a little bit north, and we'll talk about Canada. Canadian experiences, Alex Gryska, graduated from Ellieburry School of Mines as a Mining Engineer Technologist in 1974, as an adult educator from St. Francis Xavier University in 1992.

He's a certified occupational health and safety technologist with the American Board of Industrial Hygiene, and the Board of Certified Safety Professionals.

Alex gained his industrial experience working at the Kerr-Edison Mine in Virginiatown and at the McKassa Mine in Kirkland Lake. He was responsible for ventilation and health matters while at the McKassa Mine.

He was more than 20 years at the Ministry of Labor. Alex worked in various positions, ranging from inspector, special investigations officer, trainer, mediator, advisor, regional program advisor, and ending his career at the Ministry as Manager of the Sault Ste. Marie District.

Alex has been associated with Imperial Mine Rescue in various capacities since 1975, and has been the Manager of Ontario Mine Rescue with the Mines and Aggregates Safety and Health Association, MASHA, since 2001.

And, Alex. Please welcome.

(Applause.)

MR. GRYSKA: Thank you, and good afternoon.

Refuge stations are an essential component of the emergency preparedness infrastructure at Canadian mines, regardless of what part of the country you may be in. Without doubt, they have resulted in saving countless lives.

Although most of our mines have refuge stations, there is no strict legislative requirement to establish them. Mine operators have found them to be an invaluable component of the safety infrastructure, and therefore integrated them voluntarily.

Ontario does not have any active coal mines; therefore, the hazards associated with our mining are somewhat different than what you folks encounter here in the coal mining industry. We do have some open-cut coal mines in the west coast, and I believe we have one underground coal mine operating on the east coast.

Our mines are generally quite large. They can extend for several miles laterally, and we will be mining as deep as 10,000 feet. We're not quite as deep as the South Africans; however, they are very deep mines.

Most of our mines are multi-leveled operations, where travel time from surface to the active workplace can be very significant. In some circumstances, it can take as long as an hour to get from surface to the active workplace.

These realities pose significant challenges to being able to ensure the safety of our miners, particularly in the event of an emergency. Mine emergency plans are developed by mine operators, and each plan is unique to their particular application.

In the event of an emergency, it's the intention to get workers out of harm's way effectively and efficiently. Although it's preferable to get them to surface immediately, it's not always possible, particularly when you take into consideration the vastness of a mine and their travel times.

In these circumstances, underground workers go to strategically-located refuge stations, and remain there until first responders are able to arrive.

Although we continue to focus on prevention, every year we encounter situations that require the services of our mine rescue crews. We have incidents where workers seek safety in refuge stations, and remain there until rescue teams are able to get them out from underground safely.

The recent incident at Esterhage Saskatchewan earlier this year is an example of how these refuge stations can work effectively. As you probably know, 72 miners sought refuge in underground stations, and remained there for some 30 hours, while rescue teams extinguished an underground mine fire and cleared the mine of toxic gases. Events similar to this, but perhaps not quite as substantial, have occurred, and have gone with minimal notice from the media or anybody else at our Ontario operations.

Our legislation requires that we have mandatory inquests into every event that results in the death of a miner. These hearings have resulted in numerous recommendations which have, in turn, resulted in legislative changes that have improved the quality of working life for our miners.

In 1928 we had a major underground mine fire at one of our gold mines, which our mine rescue teams were unable to handle the situation. Because of our limited resources, we requested the assistance of the United States Bureau of Mines Mine Rescue Teams, who responded and finally got the fire under control.

Thirty-nine miners lost their lives as a result of that fire. An inquiry was held to investigate the circumstances relating to this event, and it changed the approach that we took towards mine rescue. Numerous recommendations were made by the coroner's jury. Many of these have been transformed into legislation, which remain the framework that we have currently in place today.

Although not specifically referenced in a recommendation, refuge stations were first introduced at Ontario mines as a result of this tragic event. Mine operators recognized the value of providing temporary refuge for workers, and their existence continues not only in Ontario mines, but mines right across Canada. Pretty much in any province that you go to you'll find that there are refuge stations.

Our legislation does not require refuge stations to be established at all mines. However, it does state that they must meet a specified criteria where they are addressed by a mine's emergency plan. This approach allows for flexibility for mine operators to conduct a risk assessment and establish procedures which are appropriate for their particular situation. In all circumstances, it's the intent that the workers seek temporary refuge in those situations where they cannot get safely to surface.

And again, I have an excerpt from the legislation in Ontario where it specifies where a procedure, in case of a fire at an underground mine, provides for the use of refuge stations for workers, the station shall "be constructed with materials having at least a one-hour fire-resistance rating; be of sufficient size to accommodate the workers to be assembled therein" -- and the risk assessment as conducted by the employer would determine the maximum number of employees that might need to gather in that particular situation -- "be capable of being sealed to prevent the entry of gases; have a means of voice communication with surface" -- and that's normally done by telephone or leaky feeder systems -- "and be equipped with the means for the supply of compressed air and potable water."

We have developed a refuge station guideline in which we determined some of the good practices that need to be integrated into the system. For example, things such as obviously an air line, a supply of air.

Although until most recently, all of our mines, pretty much all of our mines had compressed air lines because we used pneumatic equipment for the purpose of operating drills and other pneumatic equipment. Therefore, air lines were present pretty much throughout the entire mine.

As far as potable water is concerned, it would be supplied to the refuge station.

Fire or sealing clay. Again, you can't get a perfect seal; therefore, it made sense to have available at each refuge station fire sealing clay.

As mentioned, a communication system. And I have some digital images of some of these set up that we will be looking at. So we will take a look at what we have as far as telephone system.

A system of lighting, seating, and emergency equipment, including stretchers, blankets, first aid kits, fire extinguishers, and miscellaneous supplies, which includes a copy of the emergency procedure, level maps, pens and pencils.

As far as the types of refuge stations that we have in our Ontario mines, we have permanent stations that come equipped with compressed air lines, we have permanent stations with the RANA system, Rimer Alco North American System, so they are the manufacturer. And basically, those are in those situations where we don't have compressed air line. For example, some of our deeper operations, they do not have compressed air lines. Therefore, what we need is to provide a self-sustaining environment. And portable stations with cascade air cylinders.

Now, we have an idealized sketch of a refuge station. You'll note in this case here there is just a single door. Basically, you have a drain in the floor with a P-trap in order to prevent gases from entering. Similarly, you'll notice on the sink, the same thing, we have a P-trap in there. Air and water lines. And as you can see, this would have been excavated out of rock.

You have seating that's provided for workers, copies of procedures, first aid kit, et cetera. Fire extinguishers, telephones, et cetera. And we have some refuge stations with a double door, so basically with an air lock. You have a door here, and a door there.

Now, as was mentioned by previous speakers, the issue of the air moving from the fresh-air side of the refuge station to the exterior, by having that air lock, a rescue team would be able to go through their pass properly. And the other things would have been pretty much the same.

Now, I've got a sequence of refuge stations photographs. Here's an underground refuge station outside entrance. You can see the way that they're marked up. You notice, well, you can't see the P-trap, but it would be under the floor. And you can see the door. Under most circumstances they come with a sill, so then the door will seal properly.

So this would be looking at the inside of the refuge station. You'll notice that we have a hot water tank, and there would be a sink in this particular one.

Again, as far as the refuge stations are concerned, under most circumstances, what we do is we use refuge stations as lunchrooms. It serves a dual purpose. So it gives the individuals a location to congregate. The other thing is it allows them to become familiar and be familiar with the installation. So in this case here, you'll notice there's a microwave oven, there's a stove, and there's a heating oven, along with a water fountain, et cetera.

As mentioned, fire procedures are posted in there. The workers, when they get an opportunity to familiarize themselves with the proper procedures, along with level plans for the operations, know where to go in the event of an emergency.

As mentioned, there's a stretcher, stretcher box, an eyewash station, an emergency list of occupants. So that's a list of individuals that would be working in that area. Again, it's necessary for somebody to take control in the event of an emergency; you can always cross-check against that list.

And again, we have, in this case here, we have a telephone system, along with telephone numbers that an individual would be able to call to inform them that there is an emergency that's ongoing.

As mentioned to you, fire clay. Fire clay is maintained in a bucket at each refuge station door, and it would be used to seal the door.

So we have air and water lines plugged in. And again, we put a silencer on there. We keep the air line cracked at all times in order to keep it under positive pressure, but at any given time that air line would be on.

The other thing is, what we do is we use ethyl mercaptan as a stench warning gas if workers were in the refuge station. This way here, with the air line being cracked continually, they would know if there is an emergency that's ongoing.

As mentioned, you can see that under most circumstances, our stations are going to be screened and bolted properly. We'll shock-treat the walls, and whitewash them so they're easy to maintain and clean. Also, they're all cement floors, in order to make sure that they can be kept clean. And as I mentioned to you, the refuge stations are used as lunch areas.

As I mentioned, some of our refuge stations are located in areas where there are no air lines that are available. We have one of our operations that is using this refuge one system. So basically what it does is, either you'll have oxygen that's supplied with cylinders, or it will be oxygen candles. You'll have a carbon dioxide cover; the air is passed through there via a fan, therefore giving sustainability to the inhabitants in a refuge station.

As far as refuge station procedures are concerned, we have procedures that require investigation of incidents where mine rescue teams are used. They can be real emergencies, drills, or simulations. Regardless, we gather information, assess it, and make procedural changes in order to make improvements where necessary. Over the years we've collected our learnings and developed a refuge station guideline, which is a compilation of information regarding good practice, and we make it available to our customer group.

When an emergency requires that a refuge station be used, a knowledgeable person needs to take control within the refuge station. Being sealed in a refuge station can and will cause enormous psychological implications on its inhabitants.

The person in charge needs to reassure workers, have them stay calm, and continually assure them that mine rescue teams will come to their aid.

Depending on the type of arrangement, they may need to use air sparingly. And that's why we keep the air header cracked slightly. If we're using bottled air, again, the sustainability will be dictated by the amount of compressed air cylinders that you would have there.

The individual needs to contact surface and inform them of the situation, assuming it's a mine emergency, and provide them with key pieces of information: the number of men that are in the refuge station, whether compressed air is available, whether workers have any injuries, and indicate that they are prepared to stay there if they, in fact, are.

Our mines are required to prepare an effective emergency plan that will protect the safety and health of our underground mine workers. The establishment of refuge stations does not replace the need for preparing an effective emergency plan, but rather is one small component of that plan.

Training is also a vital component of the plan. All workers must be trained in what to do in the event of an emergency. Training must address where workers are to go, and what tasks they need to perform. Mine emergency plans often identify refuge stations as temporary safe havens, and that's what they are is temporary.

The training should prepare individuals to take control, ensure the safety of refuge station inhabitants, and make appropriate telephone calls. Our organization provides standardized emergency preparedness training to supervisors, control groups, and employers, and helps them prepare for both fire and non-fire incidents.

Evaluating the emergency preparedness system and procedures needs to be done on a regular basis. We require that fire drills be conducted at each operating mine once per shift, per year.

Furthermore, we conduct audits of the system. We have developed a point-in-time evaluation tool which helps to assess the effectiveness of the emergency preparedness system. This tool looks at response times of first responders, and provides guidance as to the availability and adequacy of first responders.

Continuous improvement is critical to the emergency planning process. As mining advances, the adequacy of mine emergency plans must be evaluated. Are refuge stations still strategically accessible to mine workers, or do new refuge stations need to be established? These are questions that need to be answered on an ongoing basis.

Although we focus on prevention, and we continue to have fire and non-fire incidents at our mines, some of these have potential serious consequences. All the more reason that we need to learn from them, and make improvements as needed.

In conclusion, refuge stations are common at Canadian mines, and they have proven their worth time and time again. We need to remain vigilant and ensure that we do not strictly rely on refuge stations as being our emergency plan. They are, after all, only one component of that plan, and their use kicks in only after prevention has failed.

Are refuge stations an option to the safety and structure in coal mines? I don't think it's an easy question to answer. There obviously are some significant differences between our mines, which are metal mines, and non-coal. And that poses challenges to applying the technology.

Refuge stations have been invaluable to us in Canada, where we are primarily, as mentioned, hard-rock mines. I do believe, however, that by sharing our knowledge and experience, we may be able to distill and apply principles and approaches that may make mining that much safer for all of our workers.

Thank you.

(Applause.)

MR. KRAVITZ: Okay. The next speaker has quite a bit of experience, and I know him quite well. We used to work together for many years. I was working on the Mine Emergency Project, and he was with Foster-Miller, working on various remote-sealing projects and various robotics projects.

Randy Berry has been associated with Foster-Miller for 36 years doing contract research and development for private industry, government agencies, including the Bureau of Mines, MSHA, DOE, Navy and Air Force. He has two patents for underground mine equipment, and received MSHA permits for both intrinsic safety and explosion-proof instruments.

Different projects he's worked on over the last 35 years include robotics systems for the maintenance of commercial nuclear power plants, development of the mine rescue TV cameras and instruments to insert in bore holes, including a remote viewing system that was one of the predecessors of one of the newer types that are on the market today; health and safety studies for the U.S. Bureau of Mines and MSHA with a special emphasis on ventilation in mine emergency systems.

Randy was one of the co-authors on the 1983 published report on guidelines for rescue chambers, and that's what he's here to talk to you about today, among other things. And I think Randy's going to give you some good information.

So without further ado, Randy Berry.

(Applause.)

MR. BERRY: Thank you, Jeff. I'm delighted, having been preceded by several other speakers that have talked quite a bit about rescue chambers, to find that I don't think they're going to be able to call me a liar or vice-versa, so that's a little bit reassuring.

Before I get started, let me just give you a little bit more background about who Foster-Miller is, and why we are here today. What do I press here, anything? Like the arrow key? Will that do it? Enter, okay. All right. So far, so good.

Foster-Miller. We are a consulting engineering company. We are 50 years old this year. And we do contract research, as Jeff has already said, both for private industry and government agencies. And in recent years, we've done a great deal of work in robotics and in other automated systems.

For example, we, just in the past year or two, we have deployed, gosh, I don't know how many dozens, maybe 100 of these little robots here to aid our soldiers in Afghanistan and Iraq. The number one thing they get used for is for bomb detection and disposal, since it's obviously a whole lot better idea to have one of these things handling it than putting our men and women at risk.

These particular robots also come in other configurations. They can be equipped with all kinds of instrumentation. They have been used in hazardous material applications, where they have both sensors and then the arm that can pick things up and put it in a safe place.

But the real reason I'm here today is because back in the seventies and eighties, Foster-Miller did an enormous amount of contract research for the Bureau of Mines for MSHA. Jeff and I and John Kovac hung out a lot together in those days, when the Bureau had a lot of contract research dollars available.

And I won't go through all this, but I just want to give you an idea. Ventilation studies, a lot of different kind of emergency work, escape hoists, guidelines for metal and non-metal mines, how to use oxygen self-rescuers -- that was back in the day when they were still called oxygen self-rescuers. And they were too big to go on the belt, and we developed a whole set of policies, procedures, and suggestions on where they should be stored.

And finally, we did this report that I'm going to talk about today, guidelines for rescue chambers. It was published in 1983. And not to put Jeff on the spot, but I think both MSHA and NIOSH have PFD copies of it. It's a two-volume report. If you want some good bedtime reading, it runs over 100 pages each, and I'm going to try to distill that down to 20 minutes.

So as I say, my presentation is going to be a quick 20-minute summary of that report. And these are the various areas that I'm going to talk about. And again, there's no real point in going down the list. You can see it for yourself.

Before I get started, I just want to make one kind of motherhood-and-apple-pie statement. The United States is a little bit different than our colleagues in South Africa and Canada and Australia in that we don't have an official policy yea or nay for rescue chambers. And I think that's one of the good things about this today is we get some good dialogue going back and forth.

So what I'm going to talk about really is if you're seriously thinking about implementing one or more rescue chambers, here are the things that you should be thinking about. And the first thing, of course, is it is American policy now, and I think it always will be, that the first option is to get out, okay. And rescue chambers need to be part of an overall plan when getting out, for whatever reason, is impossible.

Before I get into some real details on the considerations for a rescue chamber, here is a list of the general major sort of general considerations. First of all, we found in our work that it is always mine-specific. And I think you're going to hear me use that term several more times. There is no one size fits all, literally in terms of the size of it, but also in terms of where it's located, how it's equipped. It really is a case-by-case situation.

The other thing is that for purposes of our study, we assume going in that the rescue chamber should be capable of being moved, not every week, but really for economics more than anything else. As a mine advances it's a dynamic thing, and we want to be able to reuse most of the components.

Finally, and I'll talk about this more later -- well, two more things -- explosion resistance is absolutely key. In fact, our design criteria were quite similar to what our Australian colleague mentioned earlier. That's essential. And we believe a positive air supply is essential. And again, I'll talk about that a little bit more later.

Our particular design will look somewhat similar to what you've already seen, a plan view of a room-and-pillar block-mining coal mine here. Kind of two ways to do it. Take a crosscut, and either put in two bulkheads, explosion-proof bulkheads, the advantage there being then that's accessible from basically two different entryways. Or, if you want to be a little more economical, you could actually either, you know, drill and shoot, or continuous mine or excavate a little bit just a dead-end chamber. And then you could just use a single bulkhead.

This project really came in two parts. I'm going to be reporting primarily on the second project. The first one that we had before we developed these guidelines was actually to design, build, and explosion-test an explosion-proof bulkhead. In fact, as I'll show you in a minute, because of different mine conditions, we actually designed, built and tested three different types of bulkhead. And once we proved that they worked, that they would survive an explosion, then we developed a whole set of guidelines on how to use them, how to implement them.

The explosion-proof bulkhead really sort of has four parts. One is just the structural piece itself, but that's just the beginning of the problem. Then you still have to have a means of securing it to the surrounding strata, the ribs, roof, and floor. You need a man-door that also has to be explosion-proof. And then finally just securing it there to keep it from getting blown out. That takes care of it structurally, but then you also need to be able to seal it to prevent noxious gases and maintain a good atmosphere inside.

And then the rib there, with just a note to myself to be sure to mention, the emphasis on all of our designs was to use off-the-shelf materials wherever possible. So there was really -- well, you'll see, there was very little that was custom-designed. It's standard structural shapes.

Here's that word mine-specific again that I said I'd mention again. The design that you pick, and in our case we did three different ones, was really a function of these two things. Okay, the size of the crosscut that you're barricading, and how competent the strata is.

Here is the first design. This probably would be the most generic of the three designs. The structural elements are 12-inch-wide channels, essentially. They are 12 inches wide, five inches deep, and they just bolt side to side to side. They are held in position -- this is for a mine that has competent roof and floor, okay. They are held in the floor by a trench in which you place these so-called footing boxes, and grouted them in place. The reason you have footing boxes is because when you get ready to relocate this bulkhead somewhere else, those footing boxes are grouted in, and they're going to stay. But the structural element you can lift right out and move.

Same thing on the roof. There's a header that's roof-bolted in. That in itself is not strong enough to withstand the forces, so you also have turnbuckles attached to roof-bolts.

And I have to apologize for the quality of the picture; it's almost 30 years old, or 25 anyway. But this is an actual picture of the assembly. All three of these were tested at the Bruceton Experimental Mine, as I mentioned, and actually explosions were set off. That's a picture of an in-place there. That man-door is a standard 24-inch pressure door again, so there's really nothing in this that's not off-the-shelf stuff, modular and reusable to the greatest extent possible.

Sometimes you've got a spalling roof, or for whatever reason the roof is not real secure. So this design depends only on the floor, by essentially using two footing boxes, okay, and then angled trusses going back there to support the top half of it.

And in this case, these are four-by-eight box beams every 27 inches. They support a couple of rails that go across, and then the final element are the corrugated steel panels. Now, these panels can overlap so that you've got some width adjustability. And they can also overlap this way, so that you've got some height adjustability.

Again, you've got the footings, but all the structural elements can be taken down. Everything is sized that it can be handled by two miners.

The final design is when neither the roof nor the floor is very good, and this is supported entirely by the ribs. This is an arch design, and this is all standard components from the tunnel lining industry. This is all tunnel liner plate.

The disadvantage to this design is, first of all, you have to do some fairly serious rib-sculpting in order to get enough support in there for that. And also, there's much less adjustability in terms of width and height. It comes in bigger modules.

So those are the three designs, and they all worked, okay. Now, what else does it take, besides an explosion-proof bulkhead?

First of all, and I was thrilled to hear almost unanimous agreement on this, is air supply. Our gold standard is a bore hole. And I don't think I need to spend a lot of time on that, because the other speakers have covered it very eloquently.

I will just say that not only does a bore hole give you an air supply totally isolated from the mine, but the next three items all become relatively less important in terms of storage requirements in your refuge chamber if you've got a bore hole, because you can get communications down, you can get water down, you can get limited first aid down. So to us, that's just the cat's pajamas.

Our second choice would be compressed air, and in fact, two independent compressed air sources. Probably something to think about for hard-rock mines, as speakers have already said, where it's available. Not going to see a lot of that in coal mines.

And finally, the third choices, as alluded to, would be bottled air sources.

I'm not going to spend a lot of time on the next couple of items, because again, the other speakers have talked about that. I will just say that some odd little things come up that need to be considered. And a good example of that would be, we've got this sealed-off thing in our case, where you have exposed coal on at least two sides of this. So issues of methane exuding, or other stuff becomes an issue, and you need to remember to keep the thing ventilated. I noticed our Canadian colleague mentioned that they keep their compressed air line cracked all the time for that kind of reason.

So that brings me to the last consideration, which is location methodology. If I had to do this slide over again, I would have put the last item first.

The number one criteria, I think, when you start thinking about where, if you're going to use refuge chambers, where you're going to put them, is it's got to be coordinated with the overall escape and rescue plan. And again, several other speakers have commented on that very eloquently. So I would move that to the top of the list.

And as part of that plan, you have to think in terms of storage of other self-rescuers. There has been talk today about training in terms of changing out from one SCSR to another. Okay, that becomes way less troublesome, obviously, if that can be done in a safe and secure environment.

So now I will jump up to the top, and I think this is the final time I'm going to mention mine-specific, but it is. It really is, once again, a case-by-case basis. There are some other small considerations, but they become important. You really don't want to put a refuge chamber in a low place in a mine where, when your pumps lose power, that that part of the mine is going to flood.

Surface access is real important, especially for us, because of the bore hole issue. I would suggest it's important even if you don't have a bore hole to start with. You really probably ought to think about having a rescue chamber underneath someplace that you will be able to get to should an emergency arise and you want to be able to reach miners that are taking refuge.

And finally, we say within one hour of the face. It should be located on the way out. We don't want to encourage folks to go the wrong way. And the one hour. We did a whole separate study, which time wouldn't allow me to mention here, but it's also available in the literature. We did some really comprehensive escape time studies with miners, without using any apparatus, using SCSRs, and also using a gadget that was about the size of an SCSR that was, basically it was a breathing monitor. It measured respiration rate, oxygen uptake, carbon dioxide generation.

And based on those studies, we developed recommendations for what we thought one-hour travel time was, depending on the scene, which again one of our other speakers has already eloquently mentioned. So that needs to be taken into consideration in converting one hour to a distance.

Conclusions. I noticed everybody had a conclusions page.

We feel like rescue chambers do have a place in an overall mine escape plan. It's not to say that you have to have them, but I think it's another tool that we've got in the arsenal to look at. And again, it has to be done in the context of the overall mine escape plan.

The other thing that I mentioned is that our report is 1983 dated. It would be great to kind of update and reevaluate that. And I feel like we're going a long way on that today, especially with the international speakers, and hearing about what other people are doing from around the world.

The other thing I'd say in that respect is that even in something as mundane as rescue chambers that are all structural steel and explosion-proof door, there are technologies that obviously do have a major impact on them. Communications, power supplies have changed a lot in the 20 years since we did this report. Positioning technology, being able to locate people is so much better. And drilling technology has gotten a lot better, which impacts being able to get in and rescue them.

And finally, just for the mechanics of the system itself, I think we've got improved materials, whether it's lighter-weight alloys or composites, and improved sealants and adhesives to seal off the perimeter of the bulkhead.

So I thank you for the attention. It's been a pleasure to be here today.

(Applause.)

MR. KRAVITZ: Okay, our next speaker isn't here today, he's in Kentucky. And by the goodness of our technology hopefully, we'll see if he's there.

Bud, are you there?

MS. MEYER: Well, actually it's Janet Meyer who's here. Bud has a very sore throat, and I'm going to be talking for him.

MR. KRAVITZ: Okay. Well, Bud couldn't be participating in the conference due to surgery. And now Janet, who I hear is a radio announcer, is going to take over for him. So I think it's a good choice.

Bud Meyer lives in Frankfort, Kentucky with his wife, Janet. He has over 50 years of experience designing rockets for the Air Force, DOD, and NASA. So where Ken Sproul couldn't find a rocket scientist, I found one.

(Laughter.)

MR. KRAVITZ: A real one. During that time he served as Battalion Chief on a northern California volunteer fire department, involved in mountain search and rescue before GPS. And that's interesting.

He is a current member of the International Association of Fire Chiefs, and acts as an advisor to the Volunteer Fire Departments of Kentucky. He founded, as Chairman of the Donald C. Hogate Foundation, to provide and champion outdoor recreation facilities for the physically and mentally challenged.

He could not be here today, as I said, because of surgery. And we will hear his talk, and I will be changing the slides. When you're ready to change slides, just let me know, and I'll do it as you see fit.

Okay, Janet, you're on.

MS. MEYER: Well, thank you. I want to say hello to all the distinguished panel members and guests, and offer you a very good afternoon from here in Frankfort, Kentucky. We really do appreciate this opportunity to be part of this workshop.

Because Bud is not able to speak very well at the moment, I'm going to try to voice some of his words. However, in the interest of time, as well as my hesitations with some of this, we're going to show you the slides that are going to be on MSHA's website, so there won't be a great deal of need to go over much on the slides themselves. You'll be able to access them yourselves later. And if you have any questions at all, you can, of course, call Bud in a day or two. And you can also email him with any questions you might have. He can handle email at any point. So he'll be glad to talk with you electronically.

Slide one. This is simply an introduction to the presentation. Bud has taken an integrated systems approach to the miner safety issue, and he's outlined a pilot project concept that involves technologies that encompass high- and low-tech approaches.

Now, slide two names the project, PPFIT.

Slide three lists the three primary PPFIT missions.

On slide four we introduce the elements of PPFIT. And I hope we did get your attention.

MR. KRAVITZ: Yes, I think you did.

MS. MEYER: Slide five suggests the disciplines to be included on the team effort. Any successful pilot project will call for a balanced mix of intellectual capital, strong leadership, specific marching orders, money, and perhaps some temporary waivers of regulations that may unintentionally set up institutional barriers to new technology.

Slide six shows the only marching order needed.

Slide seven lists potential funding streams. Any technical talent will need sustainable funding.

Slide eight lists the priorities for the team action. And these are the problems for which we're seeking a solution.

Slide nine addresses the first listed priority. Now, early detection of the known hazards can actually provide time to escape those hazards. And we think that Argonne may have the answer with their miniature sensors that can drive an audible and strobe alarm.

Slide 10 suggests that particular leaders arrange to visit the various sites of safe refuge, to study them, see how they work, and report their findings to the team.

Slide 11 names two experts in the field of extended breathing air supplies.

And slides 12, 13, 14, 15, 16, and 17 show where this technology is embedded in government and private sectors. Now, there are viable solutions available, and a working prototype can be designed, built, and installed in a test-bed mine for evaluation in a relatively short period of time.

Slides 18, 19, 20, 21, 22, and 23 touch on Dr. Chuck Jorgensen's work at NASA to develop improved communications through converting thoughts to digital signals. Now, this holds great promise for those who must work underground, and we are asking the panel to contact Dr. Jorgensen to learn more about his exciting new technology.

Slides 24 and 25 introduce potential equipment to allow seeing through smoke. And we're told the chances of successful escape would be greatly improved if it were possible to both see through smoke and breathe for at least an hour.

During the war in Vietnam a new technology was developed and has been improved since that time called FLIR.

That stands for forward-looking infrared. Now, here at ASI we think we can make that small enough to fit inside the face piece, as shown there, with a compass aid in escaping those hazardous situations.

Slide 26 discusses new technologies for locating personnel underground.

Slide 27 suggests that we invoke a non-traditional training method to deliver the all-important training that's associated with the process and safety.

Slide 28, ladies and gentleman, this is a quote 500 years old showing the difficulty involved in invoking enthusiasm for change. "If you try something new, there will be many aginners." But as Larry the table guy says, we need to get her done.

And with slide 29, we thank you very much for allowing us to present this. And as I said, this is a very, very brief overview of these items. And you can access these slides on the MSHA website, and get in touch with Bud either by email or telephone in a couple of days, and he would be glad to talk with you more about these items.

So now we hope we've kept you right back on your schedule. And we thank you for this opportunity.

MR. KRAVITZ: Okay, well, thank you, Janet. And tell Bud that we hope he feels better. And maybe we'll get to see him in person.

MS. MEYER: Thank you. He'd like that.

MR. KRAVITZ: Okay. Thank you very much.

(Applause.)

MR. KRAVITZ: What attracted me about that concept was it really brings together a systems approach. And basically, he's the only one who wrote to us talking about the whole system of actually escape through smoke using new technology. And there's a lot to gain from looking at what he has to offer. So his forte is actually bringing people together to get jobs done.

Okay. The last speaker in this session is Kelvin Wu. Kelvin is known to many of us. He's the Dam Safety Officer for DOL, Acting Chief for the Pittsburgh Safety and Health Technology Center for Mine Safety and Health Administration in Pittsburgh. He received his MS and PhD Degrees in Mining Engineering from the University of Wisconsin. He's a registered professional engineer and land surveyor in Pennsylvania.

Dr. Wu has taught as an adjunct professor in the Mining Engineering Department at the University of Pittsburgh, and he's currently teaching as an adjunct professor at WDU. He has served SME as Chair and member of the board of directors in Pittsburgh section, has been a Coal Division representative on the Book Publishing Committee.

He is currently a member of the Construction Materials Aggregates Committee, a program chair for SME 2007, a member-at-large for the Professional Registration Committee, a member of the Coal and Energy Division Award Committees, Mining Engineering Committee, Program Committee for Surface Mining, and a member of the Health and Safety Committee. A mouthful.

He has worked extensively in both coal and metal/nonmetal in the areas of tailings, dam safety, geotechnical engineering, involving high wall, open-pit stability, mining adjacent to underwater bodies, bulkheads, all roads and structure safety.

Please welcome Kelvin Wu.

(Applause.)

MR. WU: Thank you, Jeff. Good afternoon, ladies and gentlemen. I lost my voice somehow a little bit since last week. Just gradually getting it back, so my voice is broke up.

The last one for this panel is very difficult. Low tech all being finished. High tech we don't understand. So it's a little bit difficult, but I'll try. Take a different approach on the problem.

This particular presentation, what we're trying to brainstorm what we can do, based on the assurance we have through different incidents. And though I have Mr. Mark

Skiles, Director, and Richard Allwes and Terry Taylor in the audience, and they all try to get our thoughts together to put this presentation, so the comments are conceptual.

Now, we say, as all the previous speakers pointed out, if there's incidents happen underground, no matter it's coal or metal, if you can get out the best way, the safest way is just exit, get out safely. That's the first thing you do. Don't even think about stay down there.

Now, so this morning's presentation on the communication, training, and escape plans, all those things, lifelines, all most important. Get the people out of the mine. If there's a fire, you try to fight the fire. If out of control, get out. If you're going to have explosion, you didn't get hurt bad enough you can get out, get out. And there's flooding, like Quecreek's incident, actually 1980 the Jefferson Island incidents -- how many in audience remember Jefferson Island? Still a lot of people. Jeff, you were there, you didn't raise your hand.

Now, all those incidents, the Jefferson Island and the Quecreek, only the problem is when people -- Jefferson Island incidents, everybody exited safely, 57 miners. Quecreek unfortunately trapped, but fortunately enough, they all safe.

Now, the training is so important. And when I talk to the students, I say, well, regulations. Regulations apply both on coal and metal on escape routes. People walk out of emergency escape, that's the most try thing to do, perhaps most important thing to do. To familiarize yourself how to get out. So all I try to emphasize is, if anything happens underground, we get out.

This panel, we're talking about refuge chambers, refuge bay, whatever the term we use; that's a last resort. That's only when you cannot get out, and there's something there for added safety, and give some chances.

So we thought we use 1500 feet, but at a distance it's not really that important. I was trying to last, at a meeting, annual meeting, Professor Andrzej Wala of the University of Kentucky, he present paper to publish as a model study for the fire and the smoke promulgations. And those are the research work he done, can be utilized for this type of work, for future development.

We said in here that the distance based on the low-zero visibilities, the 50-percent supply, that's only for the 60 minutes, that's CSR, as other speakers stated, entry heights, all the other things, he's going to have a problem with the people walking out. Now, the distance they travel under the high stress. If he's in a coal mine, the coal seam is lower than five feet, you're going to reduce more, as far as travel concern.

So we set up with those things, and we said, well, provide a minimum, you know, thoughts, 72 hours supplies, if you get trapped. Once you get trapped, it's 72 hours. Well, like this morning's presentation by John Radomsky on the Mexico incidents, that's another couple months. And the things, we thought it was 72 hours, it probably is something a minimum, based on the other incidents.

Now, when we think about this thing here, we are not only talking about it only by explosion, we're also thinking about water, the inundation problems. And the accident cuts through. This is happening. It's the same, getting more and more. The things like Quecreek, hope that's the last one, most likely it probably won't be.

So if you're doing this refuge chamber thing, we'll also want to design, thinking about taking that into consideration, can hold it for high water pressures.

So we look on three different type, the possible refuge chambers, permanent, temporary, and portable. When we talk about permanent ones, I was very glad, many speaker by now on the panels, I personally had no contact before, and so we didn't collaborate or anything. The talk, the thought was along the same line.

This is just based on the research in talking about under different conditions, and how the individual can travel. And that SCSR, how much they can supply.

Now, permanent chamber. We suggest the permanent chamber. And Randy, you put in first. So I'll beat you on that one. You're installing the main travelway and escapeways. Permanent bore hole would be provided. We're talking about that's another thing. If it's a permanent one with one bore hole in the chamber.

There's two reasons, a couple reasons. Pressure is number one. Most speakers were talking about, based on experience they were talking about some of the cases. And there's other important things, if we can keep it in the positive pressures. We know we build bulkhead, no matter how we build it, it's not going to be able to seal. You've got high pressure, high positive pressure. We can keep the toxic gas out from the bulkheads. So keep that area safe and continual fresh air. That is probably most important ones.

Now we can continue to supply air supply and communications. Natural air is going to be a problem for the companies. If you're going to drill the holes, we know that. You've got to get surface rights, state regulation requirements. You know, you can keep the hole open or not. There's a lot of other things that we're not discussing here. What you're talking about is a conceptual thing we're thinking about, how to deal with this problem.

Now, there's one more thing is more important on the survey portion. Survey portion. Now, I'm going to go for the next one, the temporary chamber. The temporary chamber is going to put it close to the working area, with our thought is in active mining areas. But that will be no bore holes. You only provide oxygen tank, whatever needed in there. Now you can put air lines in, all those things. But we thought well, if there is an incident, explosion, chances are that air lines, water line, all those are going to get cut off. And we got to have independent supplies. That is our thoughts.

But I say the survey was extremely important for temporary ones. If we put temporary ones in the mine, that location has to be very accurately surveyed. The reason Quecreek is best example, all the things talking about it is that surveyor used the GPS system, while always contributed the credits to the underground survey crew. They did the best survey, and provided the points, the longitude, the latitude. And so on the surface he used GPS, anybody can locate that points.

So we know if it's temporary, if something happens, people in that refuge chamber, we know, as the other speaker talking about it knew, the drilling equipment, everything is so advanced, we can have high-speed drilling. We can drill into that chamber and provide fresh air. But if the location surveyor was not accurate, we're not going to be able to do it. So that survey becomes an extremely important thing, the accuracy.

The third time we're talking about is the portable chambers; that is, removable. And the most we got some picture later to show on the market, where the most of them are not fire explosion-proof. And, Randy, your test is fire explosion-proof. On the market, most of them found it was not.

So this concept we're talking about it being a room and pillar operation. Say, well, we'll cut right into the pillars, into established chambers. Now, here I want to talk about, he tried to work with, you got the wall and the use of his knowledge on the model study to determine what's the best place to place those temporary chambers and the permanent chambers. And Professor Andrzej Wala was very interested to do this, so maybe more things can be developed in the future to utilize his model.

Light support system in the chamber which are required to be in there, to be furnished. Not much difference was with other speakers. Bore holes is the permanent ones. And the other things we needed.

Now, we're talking about a requirement on the regulation at the present time, and CFR 75.1500 do have coal refuge chambers requirements. And some of those provisions is quite in detail, quite in detail. It's not mandated, but if you do put a refuge chamber, there's a requirement.

Metal/nonmetal, 57.1105(2). Joy, is that correct one? They require the provisions you have to have. Compressor air line issues gives different type of problems. This is two incidents occurred in Ontario, Manitoba. They had problems.

Permanent chamber, we're talking about. That was interesting because, Randy, you're talking about double bulkheads, we're talking about double bulkheads. And, Randy, we never met before, right? We never talked about it.

MR. BERRY: It's all been a set-up.

MR. WU: I thought it was the same thought process. So is the locator large enough to accommodate all the miner in the areas.

Now, we say the designs should resist minimum 80 psi over-pressure. And Mr. Richard Elms joined us recently; he's from Army Corps of Engineers. So they have some other thoughts. So that's adding things to our work.

And last week I saw on the Discovery Channels about hurricanes, and the University of Texas. And they shoot these air guns, shoot these two-by-four stud in the hurricane. Anybody saw that segments? On the brick walls, they shoot right through it.

What we're talking about is, the projectors, when you have an explosion, in the abandoned area you have a lot of debris. When those things being through at a high velocities, there's a lot of other things could happen.

Inundation hazards. Now we said well, this bulkhead has the design it can hold minimum 100-foot water. And that won't be a surprise, because we have so many mines right now being abandoned, and those was flooded. Most of those mines are flooded.

Now, when mining adjacent mines, adjacent properties, that that risk always exists.

Now, we say this bulkhead has to be able to survive initial and secondary explosions. God forbid you never have a secondary explosion. But we know experience tells us it happens.

The concrete design for explosion as a certain requirement, different type of concrete for water invasion to coal. Foundation investigations. I was glad to hear Randy talking about prepared foundations. That is extremely important elements.

How to anchor into the stratus. Whether we need a grout curtain or not. Those are things that's in the thinking process, do we need them for the bulkhead design. That we have them evolving mining industry, doing a lot on bulkhead designs, to separate mines.

We're going to do this to try to reduce permeabilities. We say on both sides the bulkheads should be supported, supplement support, to reduce chances for the convergence on the bulkhead. So reduce the bulkhead subject to the high stress. Other supplementary roof support should be provided.

Under the doors. It has to be airtight doors, explosion-proof. So we're looking through what is available on the market. Fire rate, that has to be looked at. Rock anchor, that has to be taken care of.

We need a construction plan and specifications. We need a design first, then we need a construction plan and specifications, material specifications. This seems so serious, you better make sure, we better make sure the material is what your design plan calls for.

And the most important we thought, those things has to be certified, that type of structure has to be certified. All the material testing during the construction has to be applicable to ASTM standards. Inspection by the contractors, all MSHA personnel whenever it's available, when it's very doubtful they can do that. It should be the mining industry's responsibility in this part, because that's a daily operation, so it should be checked so frequently, particularly during the construction period, for quality control.

You can spend a lot of money to design, and by the end of the construction did not build a quality design plan, and everything is of no use basically.

Now, this is just talking about all the different designs in our mine, what we thought, and it can be done. You have this bulkhead with tight door, with bore hole predrilled, predrilled. As you can see, the bulkhead, and this is three-foot doors, this is the temporary ones, temporary ones without bore holes. But as I mentioned, we needed the survey of this location extremely careful, be accurate. So if incidents happens, the people is in here. Whatever method we're going to have to find the people is in this chamber. We know the location, and we can do the high-speed drilling, we can reach them in very short time.

This is not just different ways we're thinking of steel layout, how we're going to construct this bulkhead. This is on the market. This is the ones they're using on the offshore drilling platform, or shipping industry use for the high-pressure doors. And those doors are reusable. So they use this, you know, when the area section is abandoned, those should be retreated, and for the next location it's for reuse. Those are quite expensive. Those can hold for high water pressure.

The following just all different picture which show what the person time in the mine, you know, has been done. Has been done in contact grouting. This is the ones in Canada. As you can see, because it is potash mine, at a fire where there's no explosion, the fire is far away. It cannot be close. If it close, all those corridors would not going to be closed.

Now, for their purpose, it didn't serve adequately. Portable ones. We thought the portables would be mentioned because in underground conditions, if I have isolated area for certain construction crews and doing work in separate main areas, maybe portable ones would be suitable for them in case for any unforeseeable events.

Through a search on the market, find a different type portable chambers. But would you believe all those is not fire explosion-proof. But they have all the specification capacities and all the detail in their brochure, so I just very quickly went through those. Those are available on the market today, even the portable ones.

So that's basically quickly the brief, gives the thoughts, what we're thinking about, the concepts. Things can be done. There's a lot of work still need to be done. And hopefully that can serve the purpose of what we're talking about today, to save lives.

Thanks.

(Applause.)

MR. KRAVITZ: Okay, let's take a 15-minute break. We'll be back about 2:25.

(Whereupon, a short recess was taken.)

MR. FINFINGER: Okay, I'd like to start the presentation forward. We'll be getting presentation from various manufacturers, and they'll be talking about what is currently available in the market in terms of this topic we're covering today.

The first presentation will be given by Ed Roscioli from ChemBio Shelter. Ed is the CEO of ChemBio Shelter of Allentown, PA. Over the last three years he designed and produced emergency shelters for use by the U.S. military to protect troops from chemical and biological warfare agents. In designing chemical bio-shelter, Roscioli applied principles learned during 30 years of work at nuclear power plants.

The shelter generates pure oxygen from a solid chemical, and scrubs carbon dioxide and carbon monoxide from the atmosphere.

Yes, Ed, are you here? And by the way, these presentations are 10 minutes each. Please try to stick to that time.

MR. ROSCIOLI: Thank you, Gunnar.

As Gunnar mentioned, I was in the nuclear power industry for about 30 years, and I worked at a lot of the different power plants in the United States. That just means that I lived in some godawful places.

It turns out one of them, I remember distinctly, was Edwin I. Hatch Plant near Vidalia, Georgia. And I was going down there for the first time, I'd never been there before. And I asked one of my colleagues, because he had been there for a couple years at a previous assignment. I said, what's it like down there in southern Georgia?

And he says, well, let me put it to you this way. If my doctor told me I had six months to live, I'd go live in Vidalia, Georgia. I said whoa, it must be really nice there. He said, well, I don't known if I'd call it nice, but that six months would seem like 20 years.

(Laughter.)

MR. ROSCIOLI: The tragedies and Sago and Alma in January of this year jolted us, and awakened us to the dangers that miners face every day. We share the grief the families of the victims have, and we extend our sympathies to them.

Now let's share our collective wisdom, and extend the solution to all the miners that take these risks to provide these resources to us.

I've worked, for the past three and a half years, on a ChemBio Shelter. Really it was designed in concert with the U.S. military to protect the war fighter from chemical and biological warfare agents. And this particular shelter, you can actually keep someone hermetically sealed in it for extended periods of time: four days, seven days, 10 days, if you have enough of the chemicals.

If we had anticipated the usefulness of this shelter prior to January 2, we're confident that we could have prevented these tragedies. We could have given them air, food, water for 96 hours or more. And that was enough time for them to be rescued.

That's why we're working diligently and continuously to provide the most reliable, economic, and technologically advanced way of providing a safe haven for these trapped miners.

An essential part of our overall strategy was to partner with an experienced, well-respected emergency shelter manufacturer. Zumro is that manufacturer. They've been supplying shelters to emergency service personnel for more than 18 years now, and they stand out in the industry for rugged durability, design flexibility. And they use a low-pressure air beam construction, and that allows it to be rapidly deployed. And you'll see a little later in the slide show, we have an actual video embedded in there of one of our shelters being deployed.

We take pride in having been selected by the Department of Defense to take part in an $8 million testing program. And this was to find viable methods and systems for protecting the military from chemical, biological, and radiological warfare agents. This testing was done by the

Joint Program Executive Office for Chemical and Biological Defense just this past December.

There was a five-day extensive test, and during that test they actually subjected our shelter to a chemical warfare agent simulant. And our shelter did not allow any of that simulant to go through its wall. And they had absorbent tubes inside to monitor it for the entire duration of the test, and they had no detectable indication of any chemical inside the shelter.

As part of the testing program, they also checked out our decontamination unit and the air lock and mortar lock for providing transition between the decontamination unit and our toxic-free area, which is the hermetically-sealed shelter.

On February 8 of this year, we had the opportunity to demonstrate the shelter to a group of industry regulators and mining executives at the experimental coal mine in Bruceton, Pennsylvania. We got strong praise from that, and we also received some insightful comments. We took these comments seriously, and we made some engineering changes that have made the system even more suitable for the mining industry.

Today we feel confident that we have the best solution for giving trapped miners a safe haven where they can survive until help arrives.

As we can see from the comments and discussions this morning, a mine rescue shelter meets a critical need. It provides a safe haven for miners that cannot escape. It assures that they have a safe haven with a life-sustaining supply of air when, where, and for how long they need it.

In the event of an emergency situation -- for example, an explosion, fire, flaps, poisonous gas -- the first line of defense is always to exit the mine. And there needs to be a concise escape decision-making process. The last thing we want or need is to have miners staying in the mine that could have safely escaped.

But we also do not want miners making panicked attempts to escape that lead to disastrous results when it is not safe, or impossible to exit the mine, these attempts that could be prompted by the belief that barricading will lead to certain death. The availability of a viable safe haven, a rescue shelter, gives them another reasonable option. It removes that sense of panic, and helps give them presence of mind to make the right decision.

It can also do a few other things. It can give them a place to rest, collect their thoughts, treat their injuries, and then move to evacuate or wait for help. Also, it gives them a known location, a place where the rescue teams can focus their efforts.

As I mentioned, there's a rapid deployment due to the air beams. We're going to see the video now. It's about a 43-second video of our shelter that's being deployed at the MSHA Academy in Beckley, West Virginia just four weeks ago today.

(Video played.)

MR. ROSCIOLI: Okay. Notice when that shelter was deploying, no one had to touch it. You just open an air valve, and it automatically sets itself up.

This is part of our ease of operation. To deploy the unit, you just open the panel, and pull the door release. You open the first valve, and that deploys and fills the shelter with fresh, clean air. Then you open the second valve, and that lifts the shelter to the available height of the mine seam automatically. The door release and the valves are clearly marked, they are color-coded, and they are ordered from right to left, just like we read.

Once deployed, the miners simply enter the shelter through the air lock. Then once inside, they start the air-processing system, which maintains the breathable air supply by generating oxygen, removing carbon dioxide, carbon monoxide, and other pollutants from the air.

The durability of this system, it's a rugged and durable shelter material, and it's built to withstand the mine environment. It can withstand dust, falling debris, humidity, and it also can withstand multiple deployment, redeployment within the mine to ensure that it is ready and available when needed.

As previously mentioned, the ChemBio Shelter was designed and developed to meet the demanding military standards for protecting combat troops from the life-threatening effects of chemical and biological warfare agents. It has undergone extensive testing by the U.S. Department of Defense.

This revolutionary and ruggedly-constructed shelter provides an impermeable barrier from the life-threatening atmosphere created by high concentrations of carbon monoxide and other toxic gases. It is flame-retardant. It meets UL 94-V0, which is the highest level of flame retardancy that Underwriters Lab has. It is puncture- and tear-resistant. I have some samples of the material. If you see me afterwards, you can try to rip it. And unless you're extremely strong, I don't think you're going to be able to.

And unlike some of the other concepts on the market, our shelter is available now. We have production capacity that we can quickly gear up to meet the need. We have plants in place, and we have equipment and inventory in store right now.

This is a quick, just a diagram of the shelter itself. It's attached directly to the heavy-duty cart that it comes in. Again, the duration and the other issues such as power, we don't need power to run this system. Absolutely totally power-free. The only power in the whole system are little lithium batteries in the detectors that last two years, and they are intrinsically safe. There is absolutely no other power to run this whole system.

The shelf life you see is in terms of years. It's air being deployed. These are the detectors. We have one for carbon monoxide, carbon dioxide, and oxygen, and they can measure the air both inside the shelter and outside the shelter while the people are still inside.

So in summary, the long-term air supply we can provide, 96 hours or even longer. It's mobile, because it's on a skid-mounted cart, so they can move it along. And the cart is only 20 inches high, for those low coal mines. It can be rapidly deployed, and it has absolutely no power requirements. And it's available now.

Thank you.

(Applause.)

MR. FINFINGER: Okay. I think reading CVs are included in the 10 minutes. Somebody gave me a CV three pages long. That person needs to make a choice. Either I read the whole CV, or --

(Laughter.)

MR. FINFINGER: -- the whole presentation.

Okay, the next speaker is Mr. David Baines from the O.C. Lugo Company.

VOICE: Excuse me. I asked Mr. Kravitz for time. I wanted to address a comment that was made in the last panel.

MR. KRAVITZ: We're going to get at the end --

VOICE: Jeff, this is very important. It casts very bad light on our company, and some people here are on very thin ice by making statements that they have made.

MR. KRAVITZ: Well, you'll get a chance to correct it at the end, after the last panel.

VOICE: All of these people, this is a science academy, Jeff. We come here for truth. We come here because we want to hear the facts of material that is being presented.

Whenever somebody makes a statement that over 100 people died because they couldn't get our chambers opened, that is not true. It never happened. And what we want to know is the source of the information, what mine it happened, and when.

MR. FINFINGER: Look, I'd like to suggest we handle this issue in the question-and-answer session at the end of the day.

VOICE: That would be fine. I just want all of you to know that it did not happen. If 100 people died, we as the manufacturer would certainly be notified. We have never been notified of 100 deaths because our unit was not able to be opened.

Mr. Oberholzer, I don't know if he is still here, but I would definitely like to know what mine it happened at, and when.

MR. FINFINGER: Okay, we'll continue our discussion right at the end. It's good to have good questions like this, it keeps us awake.

All right, let's continue. The next presentation is from David Baines. He is Sales and Marketing Director of Molecular Products, Ltd. in UK, a supplier of CO2-absorbent materials, chemical oxygen generators, and filter media for confined space and collective protection.

David has over 20 years' experience in sales and marketing of industrial products to the chemical, pharmaceutical, petrochemical, industrial suppliers of instrumentation equipment which are used in safety emissions monitoring, patient protection, and process control.

MR. BAINES: Good afternoon, ladies and gentlemen. Why am I here? Well, this is one of the reasons why I'm here. The company, Molecular Products, provides a number of technologies that are used in confined spaces. And an example of that confined space would, of course, be a military submarine.

The company has three capabilities that I want to talk to you today about, and then apply them to your application within the mine industry. The first of those is it makes gas filtration products, such as CO absorber, H_2S scrubbing materials, and other materials that absorb CO_2 in the military application that I've just talked about. There are, of course, applications in industry and environment, as well, for those filtration products.

The second capability is the production of chemically-generated oxygen. Whether this is used in the confined space of a military submarine, or whether it's in the health care industry in the form of a portable can of oxygen that is provided for emergency patient care. And indeed, in confined spaces we have an instrument that I'm going to talk to you more about as well later.

The company manufactures CO_2 removal devices, many of these being used in breathing circuits in medical applications, but also in military diving sets, and indeed in breathing sets which are used in parts of rescue operations as parts of mining applications.

So those are the three capabilities that I wanted to talk to you about.

The company has identified that the combination of these technologies can be used in mine refuges and safe havens, and indeed in civilian bunkers or safe havens, as well.

Our customers tend to be shelter designers and builders, and indeed, shelter operators. So we are able, then, to combine the chemical oxygen generation with CO2 removal in such environments as you've been discussing this afternoon in those shelters. It is an independent supply of oxygen that we're providing, so it is not relying on compressed air being supplied. It is capable of supplying over-pressure within the confined envelope that is defined. And it also scrubs out the carbon dioxide which is exhaled from the inhabitants of the confined space. And of course, it is the CO2 that gets you first, not the lack of oxygen.

So we've taken these technologies, and put them into a portable atmosphere control unit so it can be used in a confined space, or safe haven. This unit here is going to be able to monitor its environment using electrochemical and infrared sensors. It scrubs the atmosphere for a defined number of people; in this case, the unit has been defined for four people for 24 hours, in a 32-meter-cube environment. But in fact, it can be scaled up to be used in any defined space, it just has to be specified.

The unit that's crawling through behind us is built up of a CO2 absorber unit, which is on the base of the instrument. It is there with its own self-powered unit capable of functioning for 24 hours non-stop, scrubbing out the environment in the defined space that I've used for this example. Indeed, multiple CO_2 scrubbers can be stacked one on top of the other to provide increased capacity for larger defined environments. And the period of 12 hours doesn't limit the instrument, because you can exchange these units. They're consumable units, so you would have a store of them sufficient for the defined period of time you wish to sustain people.

You also, in the unit, then provide a self-contained oxygen-generation unit which sits at the top of the device. The fan system drawing the air from the environment through the CO_2 scrubber then passes by the self-contained oxygen-generation devices, which will produce, according to the oxygen level environment, further oxygen to maintain a 21-percent oxygen environment within the defined space. These are automatically controlled, and can be fired off by the machine themselves to provide that 21-percent oxygen atmosphere. And it also enables you to exchange these units and put in consumable supplies for the defined period that you set out to maintain the people for.

It also has an oxygen readout system, and monitors the CO_2 automatically, and displays that on the unit. And as you can see, it's a fairly compact unit in its own right.

(Applause.)

MR. FINFINGER: He saved us seven minutes. And a short CV. Well done.

Okay. The next presentation will be given by Mr. Ian Houlison from Phoenix First Response. Ian started in mining in 1975. He worked at the various places. He has experience from Australia and United States. He worked at New South Wales Mine Rescue Services, Queensland Mine Rescue Services, Phoenix First Response as a Manager in Glassport. And in 2004 he was appointed as Safety Director.

He's certified as mine rescue instructor and operator, police rescue operator, ambulance officer. As I read this through, I feel myself very safe here.

(Laughter.)

MR. FINFINGER: And Ian has been a presenter for various papers on mine rescue and mine inertization throughout Australia and U.S. Ian.

MR. HOULISON: Thank you for that sterling introduction.

Phoenix First Response and Mine Emergency Shelters and Chambers came as a result of a lot of effort, through a lot of people. Essentially, it was driven predominantly by underground emergencies. And each individual human being has that essence, being the flight-or-fight response, what do I do.

I'm trying to put you in an emergency situation of where you're sitting, where a fire has broken out, an explosion has occurred, or whatever. And your first thought is what do I do. So the non-trained person, his reaction is, who can help me. Who is around who is going to be able to help me?

Previous speakers have identified the fact that we need to have a leader that comes forward. A trained response, timely and rapid intervention, will give us the early resolve, so that people can be retrieved from within the coal mine fairly rapidly.

Egress from the mine are the primary or secondary escape routes. Which one is available to me? Which is the best for me to escape through? Or do I stay underground for rescue or retrieval? What's the best possible protection? And this process becomes involved, because as you go to the next level, then these same questions start to arise.

In emergencies, it generally can be divided into three areas: self-escape, which is predominantly the best way of getting out of the mine, where people don their self-rescuer and escape with little or no injury and exiting the mine with the potential use of SCSRs if it's required.

The aided escape is often overlooked. An aided escape really is about mine workers who are injured or may be assisted by fellow workers exiting the mine, or retreating to a place of safety. Those people who are retreating to that place of safety, or your rescue chamber or rescue bay, or whatever you choose to call it, can then be retrieved from underground by rescue teams.

The mine's rescue philosophy then comes about by the historical involvement of the entry into the affected mine by trained personnel wearing appropriate devices to retrieve injured or trapped mine workers. This may also involve retrieval from that place of safety, as I said earlier. And that place of safety will afford protection to the mine worker.

So we'll go back into this with the fight-or-flight response. It's a danger. It's a human interaction to defend life or to escape danger.

This inherited reaction is involuntary, and as such, requires harnessing in an underground emergency; i.e., training. People have to be trained to overcome that reaction of fight or flight. Trained personnel are taught to SLAM, or to stop, to look, to assess, and to manage their environment.

Underground emergencies demand all trained skills to come together in often hazardous environments. So people in an emergency have this resolve. Step one is to stop. Say not so fast, I can look around and think about what's happening. Think through this emergency. Is this life-threatening? Has the gases present been determined? Do you need SCSRs now, or do you need them later? Can I communicate to the surface? Which is the available best escape route?

The step two is to identify the hazards of each reaction in the emergency, and this step begins before any immediate reactive response occurs. To determine the essential steps to maintain life and property, address the issue of identifying noxious or poisonous gases and identify hazards for SCSRs. Check all communication links to the surface, and identify any escape routes that exist under the present condition.

Step three, analyzation or determine if you have the knowledge, training, and tools required for the job to identify key people within your group. Experience helps to identify potential hazards, obviously. Assessment should continue throughout this active response to the incident. Share the identified hazards with others in your group. And remember, two heads are better than one when you go to this situation.

Step four is to manage or to remove or to control these hazards, and the use of appropriate equipment. Utilize established control methods. Eliminate or remove the hazard completely. In other words, if you can't get out of the coal mine, and you have a place of safety to go to, go to that place of safety.

Substitute. Reventilate from a fresh air source.

Engineer. Enter an established refuge chamber and wait it out. Sit it out if you have to. Administrative, follow the written response instructions on the personal protective equipment such as SCSRs.

The training side of it, mine officials receive training in their years of study, but they never need to use the knowledge. The fall-back then becomes the SLAM philosophy. If you haven't used the knowledge, then you need to have this fall-back. Mines rescue personnel receive training and practice in emergency response, and utilize this knowledge on a regular basis to instill this skill indelibly. People that are trained this way will take the lead, and will often lead people to safety.

Mine workers rarely receive practice in emergency response, but will have the knowledge base through the annual refresher training obligations under MSHA. This will give them at least a little base, at least somewhere to come from, and the mines rescue people will tend to lead from that point onwards.

So the response situation is the basic mines rescue principle is to provide timely, rapid intervention to emergency events that impact the United States mining industry. The fundamental principle has its roots in history, where this concept of rescue chambers began. This took the form of teaching the concept of barricading to mine workers awaiting rescue in small mines. This is very dissimilar to the larger mines of today.

Simply put, mines rescue relies on the physical strength of the trained man to effect a rescue and recover individuals from a hostile environment, some of which may need to be carried. The egress from the mine, from a refuge chamber or place of safety, the endangered miner can be either provided with an agreed safe route of egress from the mine with available communication systems.

He can also retrieve additional SCSR escape devices, or replenish deployed self-rescuers nearing the end of their life. They can retrieve stored mine plans to permit an ease of identifying egress routes, either primary or secondary, whichever is the safest travel at that time. Be supplied with information from the surface to aid the escape from a hostile environment, and/or remain in relative safety.

The Phoenix Chamber then. Mines with those established refuge chambers afford greater protection for all people underground. Mines can now also utilize this place of safety as a major communication link to the surface, and give their mine worker a safe haven to sit it out if this is the required course of action. Mines, in an emergency response mode, now have time to plan the rescue and recovery effort that is not time-critical, as those mines don't have rescue chambers. It gives us time. It gives us time that we can look at how we're going to retrieve these people underground.

So we come to the essential criterias of the refuge chamber. And the Phoenix refuge chamber basically comes to the forefront here. We're thinking of entering the rescue chamber so that we have, I guess, an air lock that goes between the people when they're in a safe haven to entry where rescue teams can come in, or extra people can enter that refuge chamber.

We looked at the fact that they also need to have some facilities in there, such as toiletry facilities and the like. Air supply will give us a means of maintaining life. This chamber that's identified here basically is probably the one that's going to be closest to the face area that's a portable unit.

And if we have this portable unit in place, it will afford us some protection that will give us some time for people to either retreat to a place of safety, or be rescued from that place of safety.

You can also see that we've got the storage areas for the blankets, the pillows, the first aid equipment. All of that sort of things are all accommodated within the chamber.

The Phoenix Chamber, the out-by door will open out to resist an over-pressure. The in-by door will also open out to give an air-lock arrangement. All corners braced for over-pressure resistance, according to RPE that endorses this. The bench seat is to be designed as a storage area for additional supplies, like SCSRs. Blankets, first aid supplies, EMT kits, or for definitive care of patient, oxygen therapy units, et cetera.

Internal wall is filled with foam for insulation and comfort, and the interlock entry door is to guarantee this air lock arrangement.

That's about all I have to give. I thank you for the time that you've given me here. And I believe strongly that this mining industry does need these sort of places to afford protection for our mine workers. It's critical to afford this protection to these people. Thank you.

(Applause.)

MR. FINFINGER: Okay, we're making good progress. Our next speaker is Mr. Rohan Fernando. Rohan's position, he's the Manager for Breathing Gas Systems. He works for Draeger Safety Systems. He gives me a description of what they do, but I'm sure we'll hear about that during his presentation. Rohan.

MR. FERNANDO: Good afternoon. Thank you very much for inviting me to give this presentation here.

I'd like to give you an overview of Draeger's shelters that have been designed and delivered to various countries mainly in Europe.

Draeger's experience in designing shelters and shelter systems is drawn through delivering these systems and solutions to the industry and to the government. Some of these systems are used in off-shore platforms, rescue trains or railway vehicles, and also for mining and tunneling.

These are some examples of custom shelters. For example, these in a tunnel. And that particular design was a solution to actually conform to the shape of it. You can see here gas supply cylinder banks, and access to this shelter was from the front here. Or from a tunnel viewpoint it's from the side.

These are the shelters. And again you can see some of the dimensions tailored to fit into that particular application.

More examples. These are interesting design in that the dual wall is set at an oblique angle in order to take in a stretcher without tilting it too much. Sometimes our shelters are designed based on standardized shipping containers, and modified in order to achieve the protection and the function that you need from these.

The protection principle, we've heard a lot about the life support system that goes into shelters in a lot of the previous presentations. These shelters designed by Draeger are for protection to users by creating a respirable atmosphere inside an enclosed space. This protection is ensured by maintaining the oxygen level in the range 19 to 22 volume-percent, maintaining the carbon dioxide level to less than one volume-percent, and creating an over-pressure atmosphere inside the shelter.

In addition to that, we are also looking to cooling. And a lot of these shelters are made with the air conditioning systems. Here is a graphical impression of that system here. A scrubbing system is used to control the CO2 levels. The air supply from fixed to hypercylinders is used to create an over-pressure, and oxygen from oxygen banks or cylinders is used to feed in the oxygen to make up oxygen that is consumed by the occupants.

In certain cases, we also install the systems outside the shelters. That depends on the customer's preferences. And some of the general features of these shelters are, once again, see the CO2 scrubber in this case in an outside unit, O2 supply, a couple of cylinders over here. The breathing air supply in this case in cascades, cascade banks. Air conditioning, you can see that over there. Alarms and sirens and over-pressure valves basically to control the over-pressure, or to maintain the over-pressure in the shelter.

Gas-tight doors are necessary, as you've heard also in the previous presentations, to maintain the fresh air inside. And, okay, external air supply, delivery of power, battery power, and standard light.

This is an example of a CO2 scrubbing system installed inside the shelter. And it's normally installed underneath the bench. We have dual air conditioned twin blower system. The blowers are housed in this, at the ends of the unit. And it's, of course, designed for battery operation.

The flood line is contained in cartridges, and spare cartridges are stacked so that we could double the calculated time for the scrubber unit.

Now we are off the inside, I would go through every one of these, but the basic control elements are there. The air control, oxygen control, filtration of external air supply, battery control, and electrical switch gear. This also, now that we are off the gas-tight doors from the outside. Sorry, from the inside.

The other equipment of course are necessary, and in this case you can see a toilet, maps of emergency evacuation routes, food and water, first-aid equipment, and additional breathing devices, portable gas monitors can all be stored over here.

I'll go back a slide here to show you that is basically our portable gas monitor. That would measure your O_2 and CO_2 on the inside. Now, of course we can also monitor the gases outside.

So, in summary, shelters can be designed to a required specification, according to site conditions. And these would be smaller shelters for low seam heights, shelters on skids or wheels for transportability, inflatable shelters or assembled shelters, or even stand-alone life support system for built-in shelters.

In this case, these are life-support systems, for example, for 10 persons for 12 hours. And basically, it consists of all the elements. These are the same elements we talk about all the time: the oxygen, the air banks, and the CO_2 scrubber, and also cooling.

Now, modifications necessary to current designs will be driven by MSHA and mining industry recommendations. And we at Draeger basically are here for that purpose, to learn from the authorities, as well as the industry, of what is required from these shelters.

Some of the things that come to mind especially of coal mines would be MSHA-approved components and parts, intrinsically safe electrical equipment, maybe even explosion-proof, fire-resistant material and insulation, training programs, and other modifications.

So with that, I thank you for your attention.

(Applause.)

MR. FINFINGER: I'd like to encourage you to give us your written questions. We have about 15, 20 so far. I noticed that the most serious and difficult questions are for Dr. Jan Oberholzer.

Okay. Our next presenter is Mr. Alan Becker, U.S. Navy. By the way, he's very well represented here today. He is from U.S. Naval Academy, graduated with MS in Ocean Engineering Degree from MIT. After serving in U.S. Navy as a diving engineer officer, he retired to work at PCCI. He has been involved in the design and production of life support systems for the last 20 years.

Mr. Alan Becker.

MR. BECKER: Good afternoon. I literally feel like a fish out of water. I have spent my entire adult life in, around, or under the water. But I did that learning life support systems. And if you think of what we're talking about right now, the mine shelter is a life support system.

I have worked with Cowan Manufacturing of Australia for about 10 years. Cowan has built the U.S. Navy's standard Navy double-lock recompression chamber. Again, not a lot different than a refuge chamber.

This unit that you see right here is in production and in use in Australian mines. I'm going to talk about this unit. At the end we'll discuss some of the modifications that we can do.

I'd also say that from my colleague from Draeger, me, too. Because everything he said is going to apply to the chamber that I'm showing you, so I'm not going to spend a lot of time on this.

Ours is a rigid-construction chamber. And here you see it in the low position. This is to accommodate those places where we have four- and five-foot tunnels that we have to get through. The roof is dropped down to five feet in this one. We have another one that drops down to four feet.

When we get on site, the roof is expanded up to its height of seven-foot-three, and it's about an eight-and-a-half-by-16-foot footprint. What this allows us is to be transported with the common machinery that you find in the mines today.

I'd like to take you on a quick guided tour into this unit. This is a 12-man unit. This is also a double-lock chamber unit. There's two compartments to it. That allows us to bring people in, and not lose the air that's already in there.

You're looking down towards the back end of the unit, and you can see the pistons that raise the roof and one of the CO2 scrubbers.

This presentation was put together by my Australian counterpart, and it's written in Australian. Freezer unit means environmental control unit. That's a heater or chiller unit. And that becomes important when you're on an oxygen candle, and you're generating heat. The oxygen candles are an exothermic reaction, and that compartment will get hot fast. So we have a unit in here which will control the temperature hot or cold.

Air. Air is supplied in three ways, just like all the others. You can either take outside mine air, or you can take compressed air from tanks, or you can recondition the chamber air. Gas is supplied. The air is supplied in the five bottles in the main compartment and two in the entry compartment. Oxygen is supplied in two bottles.

Here we see the filtration system for the outside air. Air from the outside comes in here, and we filter it. The air supply is also used to put a curtain between the entry lock and the main lock. This allows us to keep the pollutants from entering into the main chamber.

The system is under a positive pressure, so we have a relief valve and an external valve to keep the air inside, and not allow it to escape when we don't want it, yet allow it to relieve if we get too hot.

Oxygen supply. Again, this is an oxygen expansion tank. The oxygen comes into the tank from the flask that we have, and then is dispersed in doses to maintain the oxygen content at the 19th at 22 percent.

CO2 scrubbers. We have two of these scrubbers. They have soda lime in there. These happen to change color as they get used up. And when you see the color rise up to the top of that limit, you change out the canister.

Access. Here you can see the inner lock and the entry lock. The entry lock also has a chemical toilet and a wash basin.

The two scrubbers are powered by on-board batteries. They have a 24-hour capacity. That's not the limit. That's what this unit -- this unit is meant for 12 man-days, 12 men for one day, four men for three days, or some other mathematical permutations of that.

The canisters do require periodic change-out, and it's approximately every three hours with 12 men. Again, the system was designed for 240 volts AC, but that's just because of where it exists right now. It does have an internal power outlet where you can have a charger plus a spare. Everything operates on 12 volts DC.

Here you see the batteries. These are standard auto batteries. You can increase the size of the batteries or increase the number of batteries to extend the duration.

This is the part I'd like to really talk to you about, is the current designs. Right now we have a design that will take you to 90 man-days, nine men for 10 days. That number is not hard or fast. Remember, U.S. submarines stay under water until their food runs out. That's measured in months, not weeks or days or hours. So the limit is technically feasible. You have to decide how long you want this unit to endure.

We're evaluating alternative power units. Several things, including human power. And I think human power plays into some psychological issues that we'll talk about later. We need to have something to do.

The other thing is increase the pulse loading. I'm not convinced that these units cannot be explosion-loaded, or have a design for explosion-proof. I can design the chamber so that it withstands the pulse weight. The problem you have is that pulse weight is going to knock the chamber somewhere further down the tunnel. But there are ways of designing the location of that to allow you to absorb or deflect the explosion weight.

So the designs that you see, and you're going to hear some more about the same things again from other portable units, are there. The technology exists. You can buy this unit today. There's nothing magic about it. It uses proven technology. It has not met any MSHA standards, because I don't believe there are any standards as yet. So that's the issue that we're going to face is what standards we have, and what the qualification process is.

That's all I have, and I'll take questions at the end.

(Applause.)

MR. FINFINGER: Our next speaker is Mr. Dwayne Towery from Gamma Services. Dwayne is the Vice President of Gamma Services International, which provides the rescue POD proximity detection system called Tramguard, a miner tracker system, and a gamma detector used on continuous or high-wall miners.

Dwayne is a fourth-generation coal miner, with 12 years of mining experience in maintenance and production support. He also has an 18-year background in emergency medicine, which he currently works as a flight paramedic for an air evac life team.

He has a Bachelor of Science Degree, and he has also completed all the prerequisites for pre-medicine.

MR. TOWERY: Thank you. I'm sure everybody sat there and, here comes another one to the podium. So I'll make it short and sweet, and keep it as small as I can.

I just want to thank you for the opportunity for everybody coming out today. I know a lot of other things were going on.

The first thing I want to start with, why a rescue POD? Well, everybody knows since January that some of our colleagues have fallen. And with that, we have been looking at modern technology, trying to pursue with the mining community to prevent any more losses.

And a lot of people have talked about sealing brattices. And I know that the years and years I've been underground, that's something we always talk about in recurrent training. And that's just kind of a last-ditch effort. I mean, after your fingernails are bleeding where you've tried to climb over rock falls, that's where you go to. And I was underground Friday and Saturday this week, and talking with some people, and they have this same thought pattern on that.

And miners are among the most independent and self-reliant people in the world. You can give us a hammer and a screwdriver and a ball of tape, and we'll make some wizard thing up, and make it run or go somehow. It's just a coal miner. But naturally, miners prefer self-rescuers than to rely on a rescue party to reach them from the surface.

The first thing we've got to do is, everybody's talked about rescue PODs and all this equipment. You've got to build the trust in that miner's mind that it's going to be there when he needs it at the worst possible time.

Some of the key components of our rescue POD, it's a fully-deployed, rugged steel enclosure to help shelter miners from secondary explosions and possible roof falls.

We're going to go by the MSHA canopy standards for our roof on it, and provide a breathable oxygen.

A POD typically stays at the mining unit if you want to put one out by the working sections. But that seems to be where everybody is going to revert back to.

Our standard-size POD right now is, it will hold 16 people for 96 hours. It's 16 feet long. Ours is a short little fellow now; it's only 3.7 feet high, and less than six feet wide. In Kentucky where I'm at, we don't have any of these real tall coal mines, so everybody's bent over. And it's going to be kind of hard to get some components through.

We're also incorporating our through-the-earth battery-powered geosteering tracking system in or near the POD, so that way you can have two-way text communication with the individuals inside of it.

Some more key components. The mine atmosphere with as little as four-percent oxygen can be used as an oxygen source. In a fire situation that if you go and take the oxygen out of the air for the fire, then typically anybody that's been downstream, they've had a bad day. Well, we want to look at that a little bit different. Put a temperature-reduction support system in it, because, as everybody said today, you get enough people in there laying around, you're going to build some heat. So you've got to be able to get rid of that heat.

We're going to use a scrubber system, and our dehumidifier inside the rescue POD to get rid of some of the water and the CO and the CH4 that's outside. Portable self-contained breathing units add to the interior oxygen supply, and interior and exterior monitoring for the methane and the CO levels. And I'll go into that a little bit more in just a minute.

Well, ours is not the Taj Mahal, but at least we're going to put a little bit of water in there, and food and granola bars. We'll get them through for a few days if they didn't bring their lunch bucket inside. We're going to put a canister toilet in there; bodily functions still go on, and these men and women do have to use the restroom.

We're going to use some chemlight sticks, because they're small, and they'll give a little bit of light off. And as I said a minute ago, we're talking a little bit different here about firefighting. We're looking at nitrogen-foaming firefighting as a technique to put, if the people are downstream and you're upstream, and you're fighting the fire, you can actually fight the fire and push the nitrogen foam down to them. And if I've got four-percent oxygen, and I can have a breathable atmosphere inside our rescue POD at least 18 percent.

This is the oxygen transfer. As you can see, this is the size of 192 by 68 by 44 inches tall. It's small. It's 1,000 parts per million of CO and four percent methane and four percent oxygen. I could take that through my oxygen concentrator and give you 18 percent. That will give you some breathable oxygen inside of it.

What we're using is this is a, basically like a self-contained rescuer, that there will be 16 stationed inside of this POD. You will take two of those and plug them into the back, is what will actually give you your inside oxygen.

This, what we show here, you've got two of the personal O2 concentrators are in the back. Here's your CO scrubber and your dehumidifier. Once again, the concentration levels that are outside.

If we do have somebody that's injured on the inside of the POD, what we can do is actually put one of these oxygen concentrators on there and an 18-percent oxygen level. I'll give that approximately a 98-percent oxygen concentration, so I'm giving them almost medical-grade oxygen, without adding any other components inside of the rescue POD. It's just a little different approach.

As I said, there is going to be some heat that's going to be generated, 85 degree through a heat exchanger. We're going to put about 65 degrees back in.

This is pretty crude and rude and elementary, folks. As I said, there's a 36-inch opening. These are your seats. When I sat down in it, the roof almost touches the top of my head. There's some drawers underneath for some nutrition and a little bit of water. We've got to make sure that we do keep them hydrated.

You can see the construction. We're using I-beam construction. It's welded solid inside and out. So when they climb in, they pull the door, seal it, turn the oxygen units on, and start sending us some information and let us know what's going on. We will use our through-the-earth communication, and the same information we use for proximity protection to be able to know who's in the POD by their RFID identification.

It's mounted on a skid surface so it can be pulled along with the units. And it's pretty heavy, because we're using a lot of steel here. So as they drag the thing around and try to stick a scoop stinger through the side of it, then turn around and pull it down to crosscut and rib it out, and then try to slew it around and hit it with a shuttle car to push it into a crosscut, that's just the way life is in the coal mines. So it's got to be rugged to be able to live through all of that.

And in conclusion, utilizing the rescue POD for each mining unit could be a useful method for saving lives during a mine disaster. We could sit up here all day and talk about this, but we don't really know what's going to happen on each individual disaster. And let's hope that we don't ever have to go through those again.

Gamma Services alone, with all its supporting companies, believe our approach is one of the answers to saving lives right now. It's not the only one, but it is one approach.

However, if new ideas or guidance arises in the future, we'll change our direction to expedite the employment for lifesaving devices to the mining community. The last thing we want to see are more fatalities out there. I'm a fourth-generation coal miner, and every time I see one of those fatality bullets go up, it's just another notch that's hard to swallow.

Thank you.

(Applause.)

MR. FINFINGER: Our next speaker is Mr. Bill Kennedy. He's got the long CV, three pages, but I have to make it short.

Bill is from Kennedy Metals. His experience over the last 30 years has included the ventilation of mines and manufacturing of equipment. To do so, having worked on ventilation problems in more than 250 mines in the United States, Canada, Mexico, England, South Africa, and Australia.

He has worked on problems in mines of various minerals, including coal, salt, uranium, gypsum, gold, copper, lead, zinc, falspar, potash, et cetera. Problems he has encountered range from the application of yielding steel stoppings to assisting major engineering companies with insulation layouts for entire new mines.

Mr. Kennedy.

MR. KENNEDY: Thank you very much. Good afternoon. Thank you very much for being here to take a look at this presentation.

I'd like to show you today about the Kennedy chamber. But first a little bit of background. Some of you know me, some may not. My father, Jack Kennedy, started Kennedy Metal Products about 60 years ago. We're a manufacturer of mining ventilation equipment. Many of you would be familiar with the Kennedy stopping, or our overcast man and machine doors, that sort of thing.

We are very used to the nature of underground mine ventilation, and unfortunately, some of the difficulties that have occurred recently.

On the screen you can see the Kennedy chamber. I have two housekeeping statements to make. First, I'd like to advise you that the entire presentation is copyright 2006 Jack Kennedy Metal Products and Buildings, Inc., all rights reserved, with the permission hereby given for MSHA to put this presentation on the website.

The second thing is the presentation shows products that have patents granted or pending U.S. or foreign.

We have heard some things today about the use of chambers. And previous to this meeting, I've heard a number of things about chambers, and people's reluctance to put chambers in the mine because they were afraid people would use them when they shouldn't. And I want to make it really clear that no one at Kennedy is advocating anything of the kind. And this sticker is right by the door handle: Do not use the chamber if you can safely escape the mine.

But if you can't escape, you might want a chamber. This current, the chamber that you're looking at here and most of the chambers we design, is set up for 100 hours' duration, very quick initialization, and basically all you have to do is walk in the door. If the chamber is already contaminated for some reason, the house-type units have purge air, so you can exchange the air that's in the chamber for fresh air. And it contains on-board oxygen supply without chemical seat or ignition sources.

We at Kennedy are concerned that when you have an event in an underground mine, particularly a coal mine, we have to assume that ventilation has been compromised; and therefore, everything in this chamber and what we're talking about here, including the oxygen supply, is designed to have no ignition sources.

The design criteria includes the oxygen rate adjustable according to the number of people that are in the chamber. That's pretty important. CO2 scrubbing, that is just as important. You can't just put in oxygen and ignore the CO2.

The chambers operate under a positive pressure. No power is required. It's a mine-tough unit; it's designed to be used in an underground coal mine, and dragged around from one place to another, and so forth. And it's designed to operate without maintenance for five years.

As I said, the unit is tough. It's designed to be used in an underground mine. The skid design allows repeated movement, with a minimum amount of height. That thing is only 24 inches tall. A special hardened version is available as an option.

The hardened version you can see depicted here, it is the chamber that you saw initially, but with a heavy tubing frame around it to give it considerable structural integrity. This design will stand being blown around in the entry, at least to some extent.

We have an explosion test chamber at the factory, and we will probably test these in explosion conditions as we get a little further along in their development. I'm not sure that's a real valid criteria myself. If the chamber was blown around badly enough to tear it up, I'm not sure there are going to be too many people around to use the chamber.

Life support capacity for a standard unit is 100 hours. If it was used at half capacity, it would be 200 hours. I had a customer call me the other day, and he said well, I like that 100-hour, four-day design, but we really want five days. And I told him that's not a problem at all. We're going with more seats. If it is loaded to capacity, it would be 100 hours. If it was loaded at half capacity, it would be 200 hours. There is enough room in there, honestly, for about double capacity, so you could do that. If you had the people there and no place else for them to go, they would have about 50 hours.

The house-type units, we have three types of units that I'll tell you about. But the house-type units are the most appealing to me. They have an instant set-up time. Most of the time all they have to do is open the door and walk in. If it's contaminated, as I indicated earlier, purge air is available to blow the chamber out. Oxygen flow is started with the turn of a knob, and CO_2 is able to be initiated in minutes.

The operation is simple. Purge the chamber if necessary, start the oxygen flow, deploy the CO_2 scrubbing material.

Inside the chamber are very clear, simple instructions, including in this case even a drawing of where you put the scrubbing material on the ceiling. Everything inside the chamber is similarly documented. You can see here, although I'm sorry it's a little out of focus, what you're supposed to be able to see right there is something that says purge air valve. And by golly, there's the valve.

Everything in the chamber is designed to be very simple. Even if you didn't have training or just got hit in the head and can't remember your training, you could probably still do everything that's necessary to get this chamber in operation.

Purge we want to do very quickly. Discharging a whole lot of air inside a small chamber creates a lot of noise. We provide a purge-air muffler.

If you've got the inside under control, the next thing you'd want to do is start oxygen flow. It must be regulated according to the number of people in the chamber rather accurately. Too little, of course, causes hypoxia. Excess flow wastes chamber time, could cause oxygen toxicity, certainly will if you're in there long enough. And the time you start being concerned about is about 16 hours, and it creates a fire hazard.

There is an oxygen flagon next to the oxygen flow meter, you can see it here. And in this particular chamber, it's right by the window where the flow meter is. In this particular chamber, if you can read some of those numbers, if there were 10 people in this chamber, you would set it at five liters per minute.

The oxygen flow meter is a typical medical device, just like what you would see in a hospital. It's inside the chamber, and you can see the oxygen pressure gauge just to the right of it. The gauge to the left of it, sitting at an angle, is the purge air pressure. Both of these gauges, incidentally, are able to be viewed from the outside.

The third thing that you would do, of course, is to deploy lithium sheet scrubbing material. We happen to have a couple of lithium sheet experts in the audience today. If you have interest in that particular sort of thing, ask me afterward, and I can introduce you to them.

No power is required for a very long period. Hours exist between the time that you have to exchange the scrubbing material.

We provide, inside a sealed box that you see on the left, a mechanical timer. In the picture on the right is the timer box with the door open, you can see the timer in there. It's a 24-hour mechanical timer. It has a bell that rings. You can use that to determine when you're going to change the scrubbing medium.

It has a five-year commission life. Everything in the chamber is designed for a five-year life without maintenance. Routine inspection only requires looking at the outside for damage, checking the air and oxygen gauges, which as I indicated you can do from the outside, and checking the tamper seal to make sure that nobody has been in there.

The picture on the left, there is a good picture of the double oxygen gauge. One of those is facing into the chamber, one of those is facing out. And in the picture on the right, I'm sorry for the glare, but if you look just to the left of the glare you can see a portion of the purge air gauge.

Recommissioning is available at the factory, if you would like that. At their five-year anniversary, the oxygen and air cylinders must be removed and hydrostatically tested. That's not our requirement, that's not MSHA's requirement, that is a pressure vessel requirement. Would the chamber work afterward? Certainly, it probably would. But you wouldn't want to take that risk, and you certainly wouldn't want the liability. The thing to do is at that time, to have the chamber renewed. The provisions would be replaced, the damage would be repaired.

As I indicated, there are three types. This house unit, in my opinion that's the best choice, because it's always ready to go.

We have a folding house unit available that you can see deployed here. And I'll run through these slides relatively quickly, and you can see the chamber coming into existence, so you could get that thing up and going in a few minutes.

Its advantage is that when it's collapsed you could get it around low locations, and erection doesn't take any more height than the erected chamber.

Well, we also have available a skid unit which is the basis for the other two units.

MR. KENNEDY: It has all the provisions that you would expect and need, and it would have a space in it for barricade materials.

There are some pictures here. You can see the inside the cylinder arrangement. It has some energy-absorbing design to it in case of an accident in transporting it, escape windows, permissible telephone, chemical toilet, provisions that you can see here, including $300 permissible flashlights. There is a nice, bright interior with good seats, guest sampling ports. It operates under positive pressure. It has relief valves that continually purge the chamber and the air lock, and it comes with first aid, some repair materials, and is available with some DVD retraining materials and mobil chamber for training purposes.

I have run a little bit over. I am about to be frowned at. Thank you very much for listening to the presentation and coming today.

(Applause.)

MR. FINFINGER: His rescue chamber also got a red light flashing, so we show it to you.

Our next presenter is James Rau. He is qualified as a mining engineer from the University of Queensland in Brisbane, Australia, and he has been with MineARC since 2006.

At MineARC, he has been managing the United States division of the company, and providing metal companies with retimber variations. These assessments involve irradiating down into ground mines, current refuge chamber designs and capacities, escape route systems, ventilation, emergency preparedness and required numbers and locations.

Prior to MineARC, he run two of the of the new Australia operations, and he was responsible for completing refute timber due diligence and restoring MineARC's refuge chambers. James.

MR. RAU: Thank you. I'm going to keep this very short. Another thing, you can turn to my bios, I don't like public presenting, so we will start quickly.

What I wanted to do today was give you some background as to MineARC. MineARC has been involved with designing refuge chambers since 1994. They originally were requested by Western Mining Company to design one of the first refuge chambers. Now, this was a very basic system, had a scrubbing unit and basically a converted sink and turner.

What I want to -- right here is basically, in other words, leading developer and manufacturer of refuge chambers. These are a few of our major customers in Australia. As you can see, Newcrest, Newmont, Baouk, Satwad in Australia is our refuge chambers. There is over 200 refuge chambers in Australia alone.

Other locations around the world include Ireland, Sweden, Turkey, Canada, South America, Papua New Guinea, Indonesia and all of Australia. Of particular interest today is that we have one unit in a coal mine at Huntly, which is solar energy.

What I want to explain today is basically the two units which we have designed. One of them is for licensing insertion, the other is for standard cementry. We are currently manufacturing our standard cementry unit within Australia, a privilege to be sought in Australia and MSHA concurrently. Outstanding within Australia basically require that all equipment that goes in the coal mines is intrinsically safe. That is not the case here in the U.S., so effectively if you have the same height you could use our chambers in the coal mines. What we want to do is put best practice for down and ensure they are intrinsically safe.

We anticipate delivery to the U.S. within four to six months, and this is dependent obviously on the MSHA approval process, and long-term, we would like to manufacture within the U.S.

Now we have already spoken to private enterprises and we're looking to state government and centers and things like that as well, and anyone that would like to do a joint venture.

What you are looking at here is CRM64-inch units that has a standard 64-inch height. Because there is no compressed air in the mines here, it uses an air locking system. I'll go into it in further detail, and that's the one we are currently manufacturing.

This is our CRM24-inch unit. The top left picture you will see there it has in its collapsible state, the lower one is basically once it's been put into place. This unit would be brought into the mine on rollers. Once the area where it was supposed to be placed is found, they would have to mine it out, and that goes up to a height of 72 inches.

The scrubbing systems that we use in all our refuge chambers is the same essentially. We scrub for carbon dioxide and carbon monoxide. Obviously, it's to clean the air. It uses a series of chemicals actually from molecular products we presented earlier.

Now, the purpose is to remove the carbon dioxide and carbon monoxide from the air, reducing the risk of poisoning. Now, some of you might actually be thinking that the carbon monoxide is from external sources.

Do we have any smokers in the crowd? Anyone? Actually the smoke in endogenously-produced carbon monoxide when you feed them oxygen. Now, this was the process that was discovered by Monarch quite accidently, and it's a serious issue which hasn't been picked up by a lot of other manufacturers. Cigarette smoke will produce about 20 parts per million. That's an average cigarette smoker.

So in terms of calculations, what I'm got there in 10 hours the carbon monoxide will reach 2,000 parts per million in a 15-man chamber.

Now, essentially what that is -- that's assuming that you had 15 occupants all medium to heavy smokers. Now, this is a patented system of Monarch.

As mentioned previously, there is no compressed air within coal mines, so the initial source of oxygen supply is fed from medical oxygen cylinders. Following on from that, that's regulated for the number of occupants at half a liter per second -- sorry, half a liter per minute, and following on from that as a secondary source you have an oxygen candle. The oxygen candle is an exodemic reaction. It's sodium chlorite and it basically produced an enormous amount of oxygen in a short period of time. That also oxygen enriches the chambers which produced further carbon monoxide from the occupants.

The electrical systems, basically as I said we want to have them intrinsically safe. In stand-alone situation, they are designed to run on mine power. Once the mine power fails, a UPS battery backup system will automatically run the unit.

Now, our current chambers run for 36 hours. that's for the metalliferous industry. We can go anywhere up to 96 hours. You just need to add more batteries, more oxygen and more chemicals.

Another point that's been missed today which I think is extremely important is air conditioning. If you put paper inside a chamber and you don't tell the occupants, you will end up killing them. Every person gives off between 100 to 200 watts of light and heat. It's an enormous amount of heat. If anyone sat inside one of those older star refuge chambers that they showed this morning, they would be fully aware of it.

Okay, the air locking system, basically it ensures occupants can enter the chamber without contaminating other persons. It's a pneumatic system and it basically has a binary locking. So what would happen is the first person would arrive at the chamber, they would push the button. It would flush both the chamber and the air lock. Then they would move into the pressurized air lock. It would recharge from behind, and then the second door would open, so both doors can't be open at the same time, and it has an override system.

Okay, this is some details of our CRM64. As mentioned, it has a 64-inch overall height. It's essentially very similar to our current metalliferous unit except that it's intrinsically safe. Constructed of quarter-inch steel plate, and four-inch pressed-formed channel reenforcement.

Now, this bundle we normally put with a skid base and towing and lifting points and have wheels as optional. It will have internal and external real-time gas monitoring and also temperature monitoring.

Details of the CRM24. As mentioned, hydraulic, telescoping roof. Now, that 72-inch height is still something that we're questioning. We can bring that lower. It's just dependent on the height restrictions of the mine.

It's constructed of quarter-inch steel plate. The scrubbing system in this unit will be a little bit different because of the height restrictions, so it will be a closed system with everything pre-regulated. Essentially it would just be a push button system. It will be fitted with steel wheels and internal and external gas monitoring.

What you're looking at here is a prototype which Monarch built. It's a fire-rated refuge which will withstand 2,000 degrees Fahrenheit for 120 minutes. I won't go into too much detail. If anyone is really interested in it, they can ask myself or Jeff.

Essentially it has a cutting, it's got a quarter-inch paint and that expands when the flame contacts, stops the structure buckling, and all the scrubbing unit's air conditioning, batteries, everything is internal within the chamber.

Our future developments, we're looking at video camera imaging for internal and external. All this is to tie in with the mine rescue personnel so that they have the best information available to them in an emergency. Also alarms for power disruption. Basically that will allow the information from the chamber to be fed back to the surface. All of this is obviously contingent on the communication systems staying up in an emergency.

Contact detail, they've got brochures basically outside on the information bench if anyone would like to take one, feel free, and if you would like to talk to us when I'm not so nervous, it will be good as well.

Thank you.

(Applause.)

MR. FINFINGER: Our next speaker is Kimberli Tatton. Kimberli has over 10 years business sales and administrative experience. For the last four years, she has been working with mining health and safety solutions, working with one of the most respected mine safety professionals in the mining industry. Kimberli has joined forces with Lynn Sitterud of Modern Mine Safety Supply to design and fabric a refuge chamber for the underground coal mining industry.

Kimberli has a degree in business administration, and she is currently pursuing a degree in occupational health and safety with a concentration in fire science.

Kimberli.

MS. TATTON: Good afternoon. I am going to keep this very short and sweet so we can get back on track here. I have a fairly short presentation for you.

My name is Kimberli Tatton, and I am here representing Modern Mine Safety Supply, which is owned and operated by Lynn Sitterud. Lynn has over 20 years experience in fabricating, repairing and overhauling mining equipment and has done special projects for various mining operations.

Lynn has teamed up with Mining Health and Safety solutions whose president is Randy Tatton. He is a nationally-recognized underground mine safety expert, and they have joined together to design and fabricate what we believe is a unique mine refuge chamber for the underground coal industry.

The outside of the chamber is fabricated from quarter-inch steel with welded joints, and there is a dual-sealed air locking door. The unit is likely to withstand fairly substantial secondary explosions and is designed specifically for the unique needs of the underground cooperation and as completely customed, which means it can be used in any operation given their coal height.

Inside the refuge chamber, we are using the refuge 1 scrubbing unit which was designed and built by Rand Medical in Canada. We are also using medical-grade oxygen cylinders, and have available backup oxygen candles.

The air conditioning unit is there to combat heat and stroke which has been shown to actually impair decision-making, so it is very important that these units do have the air conditioning units in them, and the inside of the unit is bright, it is lit with fluorescent lights which runs off of the battery system. It is continually powered by a 120-volt direct source from the mine, and once power has gone out it is powered by 24-volt battery.

Like I said, it is completely customizable for any operation size or needs, and we are currently in the design process to make it intrinsically safe.

It can be outfitted with any operation's individual communication needs, whether they are using the PED system or any other communication system.

This unit is fully portable. It has wheels that make it easily relocated to support the mining operation as it progresses. Inside the unit is fully equipped with any food and water supplies that are needed as well as a first aid kit with blankets for shock treatment, structures and other necessary first aid implements. There will also be fire extinguishes, alternate light sources like flashlights and batteries or chemical light sticks, cards, pen and papers, which have been shown to relieve stress and tension for the occupants within the chamber; environmental sampling capability, which will be capable inside and outside of the chamber itself; as well a separate sanitary facility within the first chamber like there is sanitary facility for people to get a little bit of privacy while they are in the chamber.

Quickly, we have developed a fully self-contained mobil and modern mine refuge. We think it's unique for the coal mining underground operation. The cutting edge of technology to further enhance emergency response capability, refuge chambers will provide an additional alternative to escape during mine fires or explosions.

If you have any questions or want any details about how we can customize this for you, please look to myself or Lynn Sitterud who is out in the audience. We will be happy to answer any questions for you.

Thank you.

(Applause.)

MR. FINFINGER: Thank you. This is the end of this session. We would like to continue and do the panel discussion 5, the session 5. I would like to thank all the presenters in my session. I think they have done very well. They all kept their time, and I would like to invite Jeff to come and introduce the speakers, the next speakers.

MR. KRAVITZ: Okay, coming down the home stretch here, our first speaker for the next session will be Professor Jim Joy from the University of Queensland. He will be speaking on risk management for the mining industry. Dr. Joy is professor of mining safety and director of Minerals Industry, Safety and Health Center at the University of Queensland.

The center was established in 1998, with the support of major Australian mining companies and the Queensland government. MISHC is a national center active in education, applied research, consulting, and the development of the mineral industry's cooperative initiative, funded by the Minerals Council of Australia.

Jim has worked on many industry risk projects across Australia and overseas. He also presents papers, seminars and courses on risk management and human factors as well as developing resources such as safe mining handbook for the 2003 National Minerals Industry and Risk Assessment Guideline, and the 2006 Risk Management in the Minerals Industry Guideline.

Jim has also been involved in corporate and board-level advisory roles to BPHBilliton, WMC, and currently Extrata as well as been a panel member of the 2005 New South Wales Mining C3U. Dr. Joy.

MR. JOY: Thank you.

(Applause.)

MR. JOY: Thanks for the opportunity to be here and thanks for hanging in for the whole day. I feel like I could go home and design a rescue chamber after this having knowing very little about it before, but it's been terrific.

I'm going to switch gears probably considerably from the last session because my center is a not-for-profit sort of -- it's a center that was set up by the industry. It's been around since 1998, as the introduction said. It's always been 100 percent funded by companies, and those companies, these days we get about a third of our funds through the Mining Council of Australia, which is similar to your own National Mining Association, as well as the research consulting projects for industry as well as education.

I had been honored to do a two-and-a-half-day seminar on risk management in the minerals industry about six weeks ago at Pittsburgh Research Labs for NIOSH and it was great, really enjoyed it, put 40-50 people in the room. I'm going to try and compress some of that down to about 20 minutes of what risk management is about, focusing on, I guess, two things: one is this is what a mine manager gets taught to be able to be a mine manager in underground coal.

There is a five-day course that every underground mine manager in coal and metalliferous have to take in risk management, so I'm going to give you a little slice of what they have to take to get a ticket to manage a mine, which is all about their competency to make decisions about managing major hazards, including the emergency response and rescue aspect, because actually they are the people that will make a lot of the decisions or be involved at least in initial response and decision-making in an emergency situation.

Secondly, I am going to focus the discussion of risk management on one area of it, as the title says in the slide, managing major hazards, and those are by definition in my definition multiple fatality potential hazards in the minerals industry.

As I said, we were set up in 1998, and initially, as the bottom line says, we were set up by companies. Seven companies funded the set up of the center for the first five years because they felt like mining engineers didn't know enough about managing safety and health risks, and they needed to learn more about that while they were still students in the university and before they graduated.

So we started off and developed quite an extensive program. That's our program to date. A lot of courses down the right-hand side of the screen that you can get various levels of paper for, but the thing with the red box on it, risk management with a bracket G3 after it is actually, as I said, a requirement to be able to get a mine manager's ticket. If you have one already, you still have to take the course.

It's a five-day course, and you can imagine a 20-year experienced coal mine manager showing up for a five-day course on a Monday morning. He doesn't like me very much, that's for sure, but by the end of the week normally it's an interesting week because we are really challenging thinking about managing hazards and trying to deal with changing naturally human reactive mind-sets to much more proactive and prevention-focused thinkers in the management of the mines.

The course is run about once or twice a month, and has been for the last three years. We have put more than 300 people through the course, and there are only 50 coal mine managers in eastern Australia.

History of disasters, as Dr. Oberholzer mentioned this morning in some of the disasters that occurred in Australia and elsewhere, has driven the industry in Australia to look at major hazards as a separate problem to be dealt with. The picture on the left is not one of the ones on the right. That, of course, is Freeport, and you would have sen that I'm sure before. The four events listed on the right are ones in order that Dr. Oberholzer mentioned, the Moura explosion this morning, but there are other events, and that's in time order from the oldest at the top to the youngest at the bottom, all during the last 15 years, multiple fatality events, single multiple fatality events in metalliferous mining.

We have a decreasing fatality rate in Australia. Risk management has been a part of an approach to managing risks in Australia over that time period. It probably started in terms of discussion in the early '87-88 period, a similar sort of presentations like I'm making to you were made in that period quite frequently through to, as I'm going to talk about, the use of risk assessment and risk management integrated into the regulatory requirements, later adopted by companies in a way that was much more detailed and much more extensive than the regulations required.

But as you can see, if you do a line through that you wouldn't get a significant, although it does look significant, it doesn't come out to be statistically significant, but it looks like a pretty good trends, and I haven't got the last two years, but they are quite similar.

Note that that's in per million manhours and yours is 200,000 here, I believe.

This slide is meant to sort of illustrate a regulatory approach. It's meant to show a continuum where the left side is prescriptive regulation, that is, prescriptive about the detail of how you manage hazards, and the right end of the continuum is the enabling regulatory approach, and that is one that's purely duty of care.

Do whatever you need to do to make it safe. The government is not going to tell you anything about how to achieve that.

Where we are right now in the Australian minerals industry is in the middle, where the government is prescriptive about process, not so much about the detail of managing hazards, although there is still a fair amount of detail and regulations in various states. Really what you are doing with integrating risk assessment/risk management is saying the government is prescribing how you make decisions. Decision-making is what it's all about, and somebody mentioned it earlier this morning that the way we reduce risks is we make better decisions. So the government sets the approach.

Now, some of the ways that the government sets approach where the regulator then becomes a cogent or an auditor of that approach and the industry basically decides what to do. Some of those manifestations are having generally the principals of risk assessment and risk management in the acts and regulations. In other words, saying that you must understand the hazards.

You must assess the risks. You must put in the appropriate controls. You must think about the hierarchy control, which was mentioned by Ian earlier, the elimination through to personal protective equipment of five or six steps in the hierarchy of control. You must have certain competencies in your workforce related to risk assessment/risk management.

The second aspect is the -- what I will talk about as major, and that should say major or principal hazard management plans. Excuse me, I left out a word there. But say hazard management plans in New Wales and Queensland, and you must have major hazard management plans, or they are called principal in the other states, for certain hazards such as outbursts, such as gas, such as roof falls and those kinds of events.

You must also have a competency in risk management, and one of the ones I mention to you was this risk management for mine managers or other competencies in risk assessment and risk management in Queensland, and in some states there is also a requirement if you want an approval for new equipment to come into an underground mining environment, especially coal, or if you want an exemption for existing regulations, risk assessment is the way that you demonstrate that that approval or exemption should be accepted by the regulator.

So you're looking at a fairly extensive integrated approach to risk assessment and risk management, but I would hasten to say that the regulations are evolving, and there are limitations to risk assessment/risk management that we could talk about if we had a lot more time.

What I wanted to get into specifically this major hazard management approach. What you are looking at on the screen is just a basic model of what you're suggesting should be done with a major hazard or any hazard, but I would say major hazard.

You've got to identify them. You have got to understand them. If you have got me saying you've got to identify it, understand it, make sure you understanding the levels of methane, where it might exist, why it might exist, and it would be the same for in-rushes or any similar event, identifying the hazards especially when there is a fair amount of uncertainty is a critical step to risk management.

Then analyzing the risk is looking at what can go wrong, how likely it can go wrong, what are the consequences if it does, and from that trying to identify the right level of control. There is no zero risk.

So some hazards you just, and risks you put up with because the risk is acceptable. Sometimes you can't do something because the risk is too high. In the middle you have this aspect of control. Managers are taught to go through the process of thinking, to learn to think this way about hazards, and to put in those controls, monitor the performance of those controls through auditing and performance management, and also to look out for change.

Change is a major factor, of course, in the mining industry, and it's something that often is a contributor to major events. A hazard is changed. The risks changed. We missed it, and we blew up the mine.

The control framework mind-set that you teach mine managers is a four-part approach, and of course we've been talking a lot about emergency response and rescue, which is at the right end of the model, but of course we want the other three parts too. We want the manager to think in a continuum of response to a hazard from prevention and monitoring of conditions and important controls, through to first response, or as they call them in Queensland, TARPs, trigger action response points; points where the CO level goes up to a certain point, and we start to take action. We don't wait for it to get too high or methane to get too high, and that applies for every major hazard.

We look for ways that we can identify early in the development event that we are on the way towards potential major event, and my managers are taught that they should be thinking that way about every hazards: find that trigger, look for the early warning so that you can do something before you start to progress towards a major event.

And of course the last bit is should it all hit the fan be prepared, whether it be with chambers or whatever the technology that's required for that particular hazard.

I would note here that it's pretty easy to see when you do a fair amount of risk assessment, as I've done over the last 20 years, that sometimes the emergency response isn't very well thought out specific to the hazard and you get conflicts in mines like, for example, their emergency egress is great for -- is good for a mine fire but it's lousy for an in-rush.

So why do this major hazard management planning? Well, obviously we want to focus as an industry on the big killers, on the high consequence events, and make sure they are under control. They are low probability/high consequence events, so by human nature people may not think about something that hasn't happened before, but could. The infrequent event is harder to manage than the frequent one.

We want to do that in the most effective and efficient manner. In other words, we want to make sure we are focusing on priorities and spending our dollars where it's most important. Risk assessment will focus you on the most important issues and the most important controls.

Of course, it's to meet regulatory requirements in some cases, but I could give you a list of companies that have gone well beyond that and use the same technologies in a lot of different areas where they have major threats to the success of their business.

So in the Queensland regulations, you end up with a list of specific issues which are considered to be major hazards. This was a decision post-Moura to basically say there are certain major hazards that there must be a risk assessment-based major hazard management plan for, and a process to achieve those plans, although not defined exactly in the regulations is inferred, and the general good process is to, of course, find those hazards, review them, location, risk controls, and then to manage with that information which can often be that we do the analysis but we don't do the management through documentation, action plan, standards, setting accountabilities, certainly putting things in place, and the two last steps are actually extremely important: monitoring and auditing to make sure things are there that are absolutely critical.

Again, remembering that the infrequent, high consequence event is a very easy one to not think about in the day-to-day pressures of managing in a mine, so we have a particularly -- the major hazard management plan establishes a particularly formal documented approach to managing this hazard that says we must have this, and we have got to check it. Even though we don't think it's going to happen, we've got to go out and check it regularly whether it's through monitoring or auditing, and we must have a formal change management process.

If something changes, whether it be the hazard or a control or a competency, we've got to review where we are because this very infrequent high consequence event demands a higher level of management system than we use for the rest of our operations, and that's what drove the whole development of this approach.

The industry recognizing that management systems were not particularly robust in coal mines, and the major hazard management planning approach is much more robust. It is an artificial management system really, and probably in some mines you don't need it anymore in Australia, and perhaps other parts of the world because there are other management systems are more robust.

But where the management system is not robust, and that is that accountabilities are not clear, auditing and monitoring is not a regular part of duties. Change is not managed well, creating this artificial management system greatly increases the likelihood that you will prevent and be prepared for a catastrophic hazard.

Risk assessment is a key part, of course, of developing a major hazard management plan, usually at two levels. Those of you that are familiar with risk assessment, I'm just going to touch on this quite briefly.

The terms "risk assessment" or "risk analysis" are juxtaposed in Australia. Risk assessment refers to a method like HAZMAT or a formal technique that looks for hazards and risks, analyzes the risk, and then decides on controls. So what I mean by this is those kinds of techniques, the high-level broad-brush technique such as preliminary hazard analysis or "what-if" analysis is used initially, and then from that you identify the things that need more detailed analysis in major hazard management planning such as if you had an underground fire potential, an underground metalliferous mine, you would do much more detailed analysis on a fire in that location once you've done the broad-brush analysis that said in this mine the major potential events are these 10. Let's look at those in much more depth, and create either individual plans or one major hazard management plan.

So tools like fault 3 analysis commonly used in many industries developed, I believe, in the U.S. military missile project back in the fifties as a technique to take a significant unwanted event and understand all its contributors, very commonly used for major hazard management planning in mining.

So what this top event might be a fire underground causing multiple fatalities, so what you're doing is a deductive logic technique to try and say what will be all that causes the fire, its propagation, the lack of escape, and you identify all the potential contributors so that you can then look at each one and say do I have controls that are adequate for all of those contributors.

Another common technique, probably less common and simpler is the bow tie analysis technique that was developed by Shell as part of their -- the name slips my -- Tripod, Shell Oil's Tripod Program back in the eighties, a technique to help people look at an event, not the worst-case event, the top event in this would be a fire starts underground where the left side of the bow tie you would use -- it's just a schematic here -- but to and thing of what are all the causes of a fire underground that we could have, and therefore what are all the threats and the controls that we have in place, or need to have in place to make sure we don't get that fire.

The right side of the bow tie is to say should we get a fire, what are we going to do, what are all the consequences and how do we control for all of those.

It's a very simple illustration of the logic and most of the time risk assessment is not about crunching numbers to four or five decimal places, it's really about asking a logical sequence of questions that simply challenges people in terms of their understanding of a hazard and challenges the organization to make sure they are ready.

With all that analysis, we get to the framework that works and put it into the plan.

Just quickly to close off, an additional layer to this sort of major hazard management plan is actually the industry trying to work together to contribute information to each other, so we learn from each other. We share our best practices.

So in Australia, we have the Minerals Industry Cooperation Initiative for the last three years. We're just setting up for the next five. The idea is to improve industry risk management, and this is sponsored by the Minerals Council of Australia, which is similar of course to your National Mining Association; in other words, 29 mining companies belong to this.

What we are trying to do is the hard products of the last three years, which are now available, try to help the individual mine through computer access, access guidelines on risk assessment and risk management so the know how to design a risk assessment and they know how to do risk management.

MIRMgate in the bottom left is a best practice guideline database. You can access online and it has 1,500 publications in it from around the world, including a lot of the American MSHA publications that are available. Professional pathways tells people where to get competency in the sort of thing I'm talking about, and of course, we are trying to work on the bottom right, which is the database of lessons learned, but I have to kill a few hundred lawyers to be able to get that one going, so we're still working on that.

You can access our site at that address. If you want to look at the resources, they are owned by the industry, by the companies, and they are endorsed by the regulators, and we try to work cooperatively with the regulators and the companies to develop these things that are optimal for the industry.

The next thing that will be on there will be a risk management guideline which will help people chart their path to move from vulnerable reactive management approaches through to their fully resilient integrated risk management ideals that are set in some textbooks, and are presented by people like Western from Michigan, and the University of Leiden, a professor there also has a model similar to this which just basically helps a mine or company chart an approach to improving their risk management over time.

So I went through that very quickly. Just a closing slide. I'm pretty proud. I'm not Australian as you noticed. I am Canadian. I have been there for 20 years and I have always been in mining since I've been there. I wasn't in mining when I was in Canada. I was in nuclear power stuff.

But Australia has adopted risk management, not only the regulators, but the regulators did it first, and then the companies came on board with it, and they saw value, and they picked it up. And what you're looking at just briefly is improvements.

The top one on rock fall potential and severity in a WMC mine that went to risk assessment-based ground control standards basically went from a significant problem in actual and potential outcomes to almost nothing, and the bottom one is outbursts in a coal mine where it used to be, in 1986 and '87, somebody got killed by an outburst, people would come on TV and say, well, that's just the way it is in mining. You get killed by outbursts. These days there hasn't been an outburst since 1994-95.

Thank you very much.

(Applause.)

MR. KRAVITZ: Did you think you were taking your life in your hands in that last comment about the lawyers. Half the audience that's left are lawyers. The other half wishes they were lawyers.

(Laughter.)

MR. KRAVITZ: Maybe not.

Okay, our last speaker today is proud to be the clean-up batter. She likes that. Good. Kathy Kowalski-Trakofler is going to speak on psychological and training aspects, specifically she has a strong niche here, I don't think anybody else addresses it the way she does, and she has a fantastic job at doing this type of work.

She has been a research psychologist at the Pittsburgh Research Laboratory since 1991. Received her Ph.D. in counseling from the University of Pittsburgh, her M.S. in counseling and behavioral disabilities, and B.S. in education from the University of Wisconsin-Madison.

Her research interests include human behavior during emergencies, work stress, judgment and decision-making during emergencies, and issues on non-emergency communications.

Dr. Kowalski-Trakofler is the mental health advisor to NIOSH, Office for Emergency Preparedness, and I keep calling her Kathy Kowalski. Fake everybody out. Okay, please welcome Kathy.

(Applause.)

MS. KOWALSKI-TRAKOFLER: Thank you very much. I hope that, I would like to think that you saved the best for last, but I'm a psychologist, it's the end of the day, and I know that I'm the outlier here. We are just about to do 180 degrees in terms of a lot of the information that you have gotten the last many hours.

I would like to acknowledge my colleagues at the Pittsburgh Research Laboratory who have done work in this area in the last 10-15 years, looking at behavioral aspects of miners and escape.

I want to begin by putting this within an historical context. When we are talking about escape behavior, it's not new. Actually reported history, it goes back to approximately 603 B.C.

We're discussing behavior under stress. This falls into the discipline of disaster psychologies. Studies of military experiences, police, emergency and medical personnel have provided most of the data for this particular area.

In the 1960s, research began to be done with the police departments, and also in general human response to disaster. The disaster mental health area was exploded in the 1970s when Dr. Korentelli developed research institute at the University of Delaware.

The Vietnam War brought attention to the psychological issues with a medical diagnosis of post-traumatic stress disorder, and it then became common parlance that there were psychological issues that needed to be dealt with in disaster. After 9/11, the research has exploded expidentially in this area.

What do we mean when we talk about the psychological aspects of escape and sheltering? What we do not mean, and I want to emphasize this, is we are not talking about counseling, we are not talking about psychotherapy, we are talking about individuals, normal individuals who are put into an abnormal situation, and we know what some of those responses are.

Understanding this very natural, normal human response to danger provides escapees, command center personnel leadership, mine rescue team members with an ability to be more resilient in an emergency situation, and that is our goal.

An individual during an escape is experiencing normal symptoms of the fight-or-flight response. One of the earlier speakers referred to this. This is the innate response that prepares us to either fight or to run. There are psychological, physical behavioral and cognitive components to this response.

For example, and I'm not listing them all here, but it's important to think about this with respect to those miners as they are escaping, increase in heart rate, muscle tension and perspiration. In many instances, there is hyperventilation which creates a rapid heartbeat, shortness of breath and in some instances nausea. This is where miners have reported to me that they feel as if they are having a heart attack.

The pupils dilate, again getting ready to run or fight, the mouth gets dry, and there is numbness in the hands and feet. This is usually attributed to the fact that the blood is rushing to the center of the body to protect the major organs.

In addition, there is fatigue, and the fatigue is not just physical fatigue, it's an emotional fatigue. With physical fatigue, many times there is a release. It's like those of you who are runners know that you are fatigued after a run, but there is also a release. Emotional fatigue does not provide that kind of release. There is also confusion and fear.

There are different phases of a disaster that organizations experience. There is the initial impact phase, and this is a phase where you can't quite believe this is happening. This is also the phase that, as again was mentioned earlier, people tend to try to normalize. They initial response to a situation, for example, the belt fire that was mentioned this morning, is to try to normalize it. Oh, that can't really be a problem. It's not that serious. Because of this we lose precious time in response.

The next phase is the heroic phase. This is a phase where people are helping each other. This is where the miners will be working together helping each other to try to escape, to try to get out. In other disasters, this is where the normal citizen passing by will come in and rescue somebody.

Then we move to the honeymoon phase, and this is where there is relief. I made it through, I'm alive, everything is going to be okay.

Then we move into the disillusionment phase, and that's the phase where all the questions come up. That's the phase where we start to ask the questions to find out how did this happen.

Finally, there is a reconstruction phase. It's been suggested that emotionally the major impact is six months later. What this means is when a disaster is over, which many in the mining industry think when it's over, it's over. When we either get the people out or the mine is back in production, it's over. This is not true from a psychological perspective. Actually, sometimes, as I said, six months later this phase is just beginning.

The stages, individual stages that people go through after that initial disbelief, after that initial trying to normalize, there is shock. When the recognition that there is danger, shock and disbelief. Then there is a very strong emotional response. This can take many forms. Sometimes people get angry. Sometimes people will withdraw and become very quiet, but there usually is in some way or another a very strong response internally or acting out.

Following that, there is acceptance. The individual realizes that the incident happened. They are going to have to accept it into their lives. Finally the phase of recovery. These are not linear. They don't happen one after another. People move in and out of these, sometimes over a long period of time. And recovery does not mean that we're back to normal because after a traumatic incident there is no back to normal. What happens is there is a new normal.

Short-term psychological symptoms, symptoms that you can expect from someone after they have had a traumatic incident, and this is usually within immediately afterwards and within the next three months. This applies not only to escapees, but this applies to people in the command center, rescue personnel who have worked many long hours. There is a numbness. There is a denial. A lot of times people simply don't want to talk about it. They will evidence-avoidance behavior not to talk about it.

Some miners who have escaped under duress don't want to drive back down the road towards the mine because they sometimes will get flashbacks.

Again, difficulty concentrating is very normal. This is not a time to make any major decision. Withdrawal of behavior, acting out of behavior, relationship problems, depression, not necessarily clinical depression in the first couple of weeks, but feeling down, feeling depressed is normal, feeling overwhelmed, expressions of anger. Many times there is an increase in alcohol consumption, change in sexual functioning, and many times change in eating habits.

Now, these are short term. They can take effect any time immediately after the incident to up to three months.

Long-term psychological symptoms are much more serious, and this is after three months, usually after six months. We hear so much about post-traumatic stress disorder, but that diagnosis is not relevant until three to six months after an incident when symptoms such as fearfulness, sleep disturbance, consistent flashbacks, feelings of guilt, and that includes survivor guilt for people who survived when their buddies died, generally high anxiety and irritability, and many times an exaggerated startled response. If there is a loud noise, particularly if the incident was an explosion, people will have an exaggerated response.

Post-traumatic stress disorder is a medical psychiatric diagnosis and it's based on some or all of the following: certainly a traumatic event and re-experiencing that traumatic event; numbness and avoidance, which we talked about; hypoarousal symptoms, which is the startle response.

Psychiatric disorders are diagnosed on duration and intensity: how long are the symptoms persistent, and how severe are they? Are they interfering with normal function?

The RAND/NIOSH report after 9/11 looked at responder behavior, and this is very important because I know this is talking about escapee behavior, but human behavior is human behavior, and it's relevant in many different circumstances and situations, and we need to take our mine rescue personnel into consideration when we look at some of these very basic human responses.

Stress affects responders' judgments, and many times they will take high risk. We've heard some people talk about this morning. We found this true in 9/11, some of the recent research that we have done in this past year with interviews. I've heard particularly mine rescue personnel many times say they take additional risk when there are people involved, sometimes to their own detriment.

We send our people in, our people who have been exposed to major events, see many times some horrific events, horrific events and see horrific things. I have had mine people talk to me about seeing body parts, and these are traumatic events.

Of the five senses, smell lasts longest in memory. That's something that you probably didn't know. But because of this, even years afterwards there will be flashbacks with certain smells, particularly a burning type smell. I've had people talk about 20 years later going back to an incident that happened in a mine.

Visual sense is the next sense as you might have guessed, and these also can trigger flashbacks many years later. We recently have completed collecting the data on a study in the last year because we were interested in what happens in those first critical moments, we were particularly interested in initial communications after a disaster or when an emergency is identified as an emergency.

What we did is we went out and we interviewed experts in mine emergency response all over the country, and we also did some focus groups. We talked to people at the mines who had experienced disaster and managed them, and we also talked to mine rescue personnel.

It was very interesting. The data fell into two very distinct categories. One, the mine rescue data, and two, the on-site data. Mine rescuers get there later. They aren't there immediately. So what happens is very different, and their perceptions are very different in terms of issues like communication.

We asked open-ended questions so we ended up getting the story. We looked at first reactions. We wanted to know what their first reactions were, what some of the first decisions were that were made, some of the information that they needed, and finally, what kind of recommendations they would make. We wanted a lessons learned opportunity.

This is an ongoing study, and I'm just going to give you a couple of the highlights. We're really just at the tip of the iceberg here.

One of the key issues that surfaced was the issue of judgment and decision-making. Information must be accurate, and several of the experienced mine managers told us that the first thing that they would recommend is stop. That's unusual in an emergency to stay stop. You're in an emergency. The goal is to move forward, go ahead. But these seasoned mine emergency managers said stop, assess, make sure that you have accurate information because the decisions that you make impact the outcome.

They also talked a lot about the source and how the source affects decision-making. If it's old, seasoned miner Joe who is calling out, and is sounding very panicky and concerned about the belt fire, there may be a different reaction than if there a red hat or a rookie calling out. So the source of information again is something that became very emphasized in the interviews that we did.

They also talked about the fact that stress and fatigue many times led to poor decisions, and that this is something that certainly is evident in the command center with the adrenalin pumping, people are not always relieving each other as they should.

Another issue that came up was trust, and many people, not only in the on-site mine emergency personnel, but the mine rescue people talked about the issue of trust and that in some instances it's more important than protocol; that you are going to call on somebody that you trust to take care of an issue that you must get done even if protocol calls for someone else in that slot.

Trust is built through working together, and training together. Psychologically preparation is the most important activity in which to engage after a disaster. The question becomes what can we do to prevent or mitigate such an event. We're doing that today. This is a very important event.

Information lowers anxiety in planning quiets fears. Training, training, training, we've heard about training a lot today. In the research that we have done recently, we continue to hear about training and the key part training plays. Knowledge is power.

We heard a lot about instinctive behavior. You hear people say, well, I just did it. It was instinctive. It was a natural thing to do. I'm probing that. What we find is that instinctive behavior is the result of training. Adult learning is active and problem-centered, and it's important that in training that we utilize the principles of adult learning. Training together, again, builds trust.

Recommendations: Include community mental health professionals who are trained in disaster mental health, and I hope you note the difference between general mental health and counseling psychotherapy and disaster mental health. Disaster mental health is information. It's information about the normal behavior under duress, normal human behavior under duress.

Develop a curriculum to train mine personnel on the human stress response. We know this. This needs to be part of our training for disaster, for escape, so that people can understand the normal response. If you've never had an SCSR on, and don't understand it gets hot on your chest, if you don't realize that it doesn't inflate, you can panic, you think it doesn't work, and you can take it off.

We also need to do training in judgment decision-making skills, normal group escape behavior and leadership in mine escape. In NIOSH, we have done some work on leadership behavior that is of interest, and that could be part of a curriculum.

We need to study the psychological aspects of sheltering. We really don't know a lot about the psychological aspects of sheltering. We really haven't studied it. We at NIOSH have done some preparation of training materials for a shelter that was built in the mid-nineties out West, but we really haven't studied what happens to people when they are sheltered, when they are in a situation like that.

Finally, I would like to thank you for your attention. I hope that this 180 degrees has raised a consciousness of the importance of looking at human behavior along with the technology as you look at mine escape.

Thank you.

(Applause.)

MR. KRAVITZ: Okay. Now as promised we are going to have five panels with questions. I would invite Kathy and Jim to stay up there because I have a couple questions for you. I'm sure we will have some from the audience.

We're going to try to go through the questions that were asked by the cards first, and then we will take questions from the audience, but as promised, we will handle Jerry's question. I also would like to invite Mr. Van Zyl up for the panel, Mr. Oberholzer, and Alex Gryska, and John Kovac.

Very good, come on up here. Come up here by the panel. Thank you for volunteering.

Before you leave, we have compiled -- Maria has done it, well, we have been having fun out here -- she has been compiling a list of all the attendees, and please get a copy if you want it. John Gibson has them down there so should have enough for everybody. If not, we will make some.

Okay, is Jerry still here from Ocenco? Okay, do you want to come up and we'll ask a question. I want to have some ground rules though. I'm going to give you two minutes to have a retort, and Mr. Oberholzer, can begin. Is that microphone on? I think so. I don't want the debate to last the whole session. You understand that?

MR. STICKER: My name is Gerry Sticker. I am a national sales manager for Ocenco, Mining Division. During the presentation of Mr. Oberholzer -- I'm sorry, I have trouble pronouncing your name -- I heard through your presentation 100 miners died because they had wet hands and could not open the Ocenco SCSR.

MR. OBERHOLZER: Mr. Stickler, I have thought about it rather long, and I do not know at which stage I could have said that. I would like to reiterate what I said: that during one of the exercises, a very well-made designed self-riskier could not be opened by people. This does not, and I reiterate, that this does not reflect badly on your project. It reflects on the ability of people when they are under stress to do things that people would think is normal. They cannot do it. Their hands, they were wet, they were stressed, their eyes were closed, and they couldn't open the self-riskier, whether it's yours or whether it was a cup of coffee. They just couldn't open it.

MR. STICKER: On our unit, it's designed with two opposing nylon straps. You pull the straps apart and the unit opens.

MR. OBERHOLZER: Sir, I have seen them not being able to open a normal self-riskier. It's not an indictment on your product. It's an indictment on the situation when people are trying to save themselves. They have just walked for half an hour, they are walking hard. I think in this case they were about 18 inches deep in mud, and they were wet.

Now, the fact of the matter is the fact that some of those boots got pulled off their feet while they were walking in the mud is not an indictment on the boot, and further than that, sir, I cannot offer any advice.

` MR. FINFINGER: Okay, thank you, good.

We have a question from Mr. Gryska. Could you tell us what was learned from the Westray Coal Mine disaster?

MR. GRYSKA: From the Westray?

MR. FINFINGER: Westray, yes.

MR. GRYSKA: The Westray disaster was the incident that occurred in Nova Scotia. Certainly the findings in that particular incident were failures in the system as a whole. To go into the details of the Westray, frankly, it would take considerable energy.

The findings in that found fault on everybody involved and right from senior manager at the operation, the enforcement agency and everybody else. Whoever is wanting information with regards to it, what I can do is give them a transcript of it and they can read it to themselves. It's a very complex issue. If they would like to contact me, I'll be here for the next few minutes.

MR. FINFINGER: Okay, thank you. Next question.

MR. KRAVITZ: Okay, this is for Mr. Van Zyl. With emphasis placed on refuge chambers, rescue rooms, this could be putting people, miners at risk. I would think that these chambers should at least be the last resort, which I think everyone is emphasizing here, only when egress service is impossible, so if you would like to comment on that.

MR. VAN ZYL: Yes, I think this was mentioned earlier that the goal would be egress. But when this issue was investigated, it was found that the condition for the amount of people underground exits from surface, but at that particular point in time rescue bays were the best and the most effective manner of actually ensuring that the workforce reached the rescue bay and then get retrieved from that.

Again, saying is it -- I think it's time that we revisit the strategy that's been put in place and maybe review its efficiency.

MR. FINFINGER: There is a question here, we think this is for Jim Joy, but if anybody else would like to answer, you're welcome. It's a very general question.

What are we doing as to prevention? Yes, Jim.

MR. JOY: That's a general question, yes.

(Laughter.)

MR. FINFINGER: Do everything possible.

MR. JOY: Does somebody want to be more specific about that question?

MR. VAN ZYL: Maybe I can explain this a little bit.

MR. KRAVITZ: Yes, basically they are asking about flame resistant retardant conveyor belts. You know, as sort of risk analysis goes, more efficient controls, slip switches, more effective electrical controls, effective CO warning system, monitoring systems, you know, that kind. So that gives you a little more information.

MR. JOY: Yes, you can certainly take a model of the four different levels of control from prevent through monitoring through first response and emergency response. We've been talking a lot, I guess, mostly at the emergency response end, and you could list out, and we went through mostly chambers, but we talk about a lot about refuge-base, but we talk about a lot of other things in that context.

You could develop a list for every hazard almost as long in all three of the other areas, and the first response area is the area that is developed a lot in Australia, and that is, monitoring systems, real-time monitoring systems which you have of course which define interiors for various gases. We are looking at real-time monitoring systems even for driver behavior in large trucks, using Caterpillar's Minstar system so we can actually look at triggers for behaviors as well as gas, that tell us the behaviors or being erratic if a person is on a 12-hour shift, or in the seventh week of a 12-hour shift every day thing, some subcontractors in northwestern Australia has got them working.

So it would take a long time, and you could make a list of all the innovations and preventions, I suppose, related to underground fire, as someone mentioned. Monitoring, things that we monitor, not just the gas, but we actually -- the innovation probably isn't monitoring the gas. Innovation is monitoring the controls that are important to keep the gas where it's supposed to be, in the first response area. That's about all I can say.

MR. FINFINGER: Okay, thank you.

MR. VAN ZYL: Maybe I can just add onto that is he just indicated that escape was research quad activity search 15 years ago. Since then major efforts have been to prevent disasters, specifically around explosions. A lot of work has gone in, active barriers, passive barrier systems, fire retardancy, monitoring systems, where do you place these systems, et cetera, et cetera.

So in South Africa, the focus for the last 10 years has been on prevention or eliminating the risk.

MR. FINFINGER: Thank you, Kobus.

This question is for Cathy Kowalski. Is it possible that the ability of a rescue chamber could negatively effect the miner's willingness to evacuate through small conditions given the uncertainty of it later?

MS. KOWALSKI-TRAKOFLER: I heard part of that. Is it possible that the?

MR. FINFINGER: Is it possible that the availability of a rescue chamber could negatively effect the miner's willingness to evacuate through small conditions given the uncertainty of it later?

MS. KOWALSKI-TRAKOFLER: That's a very interesting question. We do not have a lot of data on sheltering. The normal human response, which comes from data on escape from structural fires, is to egress, get out, and usually there are several parameters on that.

People tend to affiliate and leave with groups, usually the groups they came in with, and the tendency is to leave the same way they came in.

Sheltering and training miners to go into shelters is the -- the training aspect is absolutely key because the natural tendency is to escape.

Did that answer the question?

MR. FINFINGER: Dr. Oberholzer.

MR. OBERHOLZER: Mr. Chairman, I would just like to add something here. In Queensland at the moment, if it is directed so strongly at escaping, that we have now just developed what we would call a mine rescue vehicle, which is a diesel vehicle that's fitted with sensors that will allow a person to get out of the mine without actually seeing the roadway that he is traveling in. It wasn't part of the scope that I was asked to talk about, but this information, if anybody out there would like to know more about it, it's available, and they can contact either contact me here or later and we can discuss the matter further.

MR. FINFINGER: Thanks.

MR. KRAVITZ: That brings up a -- you just ran into this next question I had in my hand, and it's an interesting question. How should we address the handicapped people, physical disabilities, overweight, aging miners when we require walking or crawling escape routes? Should vehicles be developed for these people?

MR. OBERHOLZER: This whole vehicle issue was developed on an exercise at the Castro mine where the exercise actually showed the difficulties that people or brigadesmen would have when you go into the 2 kilometer plus panels, and actually they are not able to reach it with the oxygen that they've got on it, and we came to the conclusion that there must be a better way, a faster way to get people that are incapacitated out of the mine.

If anybody is interested, all this is written up under ACOR project. It's available. You can acquire this, and if anybody would like to write me, I'm sure I can supply them with the latest information.

MR. FINFINGER: Thank you.

MS. KOWALSKI-TRAKOFLER: I would just like to add something to that. I would think there is also a self-selection aspect of that.

Mining is dangerous. Miners know the environment, and if they can't egress, if they can't get out in danger, I would suggest that in many instances they are going to self-select themselves out of the workforce.

MR. FINFINGER: Thank you.

Next question is about self-rescue devices. What work is being done on self-rescues to replace the current goggles, mouth piece, note clip arrangement with a full face piece arrangement?

MR. KOVAC: None. If you have a face piece, you have to be fitted. No, if you have a face piece, you have to be fitted to that face piece. A self-rescuer becomes yours. If you have facial hair, you have to shave it in order that that face piece could be easily fit in an easily accessible package. We've added size, weight, complexity to the program, and as desirable as it might seem, mouth piece, nose clip is a better way to go.

And since you deploy multiple rescuers in mines along the escape ways, those face pieces would have to be yours. Whether you would keep them and interface with the device or not, it would still have to be your face piece.

MR. KRAVITZ: Thank you.

This one is for Mr. Van Zyl. You used computer simulations as a tool for landscape planning, and the second question, and this is do you use some tool for miners training? The first one was computer simulation for mine emergencies, and the second one was tool for miners training.

MR. VAN ZYL: As far as my knowledge goes, we haven't used any computer-based simulation to determine the positioning of self-rescue bays. On the computer-based training, we did start off with virtual reality training for the workforce, but having a workforce that's been dominantly illiterate, we found that your virtual reality training had to be very, very realistic to use abstract forms and colors. If you didn't represent exactly what was underground, the connection was very difficult. They made the connection between reality and the training on the computer-based was not really brought across, so that program ended about five-six years ago, but we have started looking at advancements in computer simulation and obviously the increased power of computers. But currently we're not using it.

MR. FINFINGER: Thank you.

The next question is for Dr. Jon Oberholzer. I would like to know your opinion about additional strategically located bore holes along intake entries which could serve as escape openings equipped with rescue hoist capsules.

MR. OBERHOLZER: The placement of bore holes ultimately would be an economic decision. I'm not sure this is going to answer it rightly. In a country where you have got mines that are 150 meters deep, going down with a bore hole is not expensive. If you are sitting, from what I hear in West Virginia where you can go down a thousand feet to get a seam, it's going to get very expensive. Then it's going to be very difficult to do it.

The other thing that I would like to add is if I look at what is being offered in the form of refuge bays at the moment, one starts wondering why one wants to take the effort to go very deep with a bore hole very deep in a situation where it becomes almost uneconomical.

So I don't know if that answers the question.

MR. KRAVITZ: Is that because of the available oxygen sources that you can actually build into the --

MR. OBERHOLZER: Well, if I just looked at all the products that were offered this afternoon that would supply oxygen, keep people there for 90 hours, 120 hours, one sits and considers why would you try and drill a 1,000-foot bore hole to supply air.

MR. KRAVITZ: Okay. Anyone else want to try that?

MR. FINFINGER: Okay, next question is for Kubos Van Zyl. You spoke of using oxygen candles inside underground shelters. How do you prevent carbon monoxide from entering into the chamber form a contaminated mine atmosphere?

MR. VAN ZYL: Oxygen candles is currently used in both the limited products available in portable units, and also in the fixed chambers. In the portable units, there is CO scrubbers that's installed as part of the unit, and on the fixed units, as far as my knowledge goes, it's actually on positive pressures. You release the oxygen and that's just bled into the environment, and if your environment needs more oxygen, you just light another oxygen candle. So there is a difference between the two, the application of the two.

MR. FINFINGER: Thank you.

MR. KRAVITZ: Okay. This one, if the panel doesn't feel they can address this, we can ask the manufacturers if they are interested in addressing it, but this one, I think the question was written before the manufacturers got up here. With all the safety chambers presented, none of them seem to have significant blast or fire rating. None seem to insulate the occupants from extreme heat.

Would any manufacturer like to address that? Okay, the microphone is up here.

MR. RAU: With the explosive proof, did they mention that? They're interested in explosive or just fire rating?

MR. KRAVITZ: Both.

MR. RAU: With the explosive proof, I don't think anything is going to withstand a 80 psi, which people are throwing around. It's an enormous force, and if we did make them and manufacture them to withstand that, at the end of the day they would be thrown out at the end of the drive.

The way we see it the refuge chambers are basically there to substitute for barricading. Now, we can manufacture them to be explosive proof, fire rated. There is no limit to what we can do. We actually have a refuge chamber in Sweden which is on a locomotive and it drives itself out of the tunnel and it has heat sensoring cameras on it. So there is no limits. It's got 15 beds, the frig., almost the kitchen sink chucked in. So there is just no limit. It's just who is going to pay for it, and what we want to do with it.

Does that answer it?

MR. KRAVITZ: I think so.

Any other manufacturer want to address that?

Okay, I want to do a follow-up question. Is Randy still here? Yes, there he is.

If you build a bulkhead type of shelter into a pillar, how would a fire and explosion affect that?

MR. BERRY: I'm glad you called my name because I want to address a couple of things on that.

First of all, and I have to apologize because it was a long time ago, and there was one document that I wasn't able to lay my hands on, but I have a problem with my friend, was it Kelvin, who mentioned 80 psi. I'm not so sure that's the right number.

That was not the number -- I know that was not the number that we designed to, and as I say, we had three bulkheads and all survived actual underground explosions.

Part of the reason for putting bulkheads in crosscuts, as I outlined, was to get it out of the direct line of fire so to speak. That should largely eliminate the collateral damage that's caused by not just the shockwave, but the debris, locomotives or whatever getting carried down entries.

So you've got a couple of different things going. You've got pressure waves and you've also got debris being carried.

But I wouldn't go to the bank with that 80 psi number. To me, that's high.

MR. RAU: Even 80 psi for portable rescue chambers in --

MR. BERRY: That's what ours was designed to if my memory is right. I think we designed it to, and this is really 30-year-old memory, so I apologize, but I think we designed it for somewhere between a 9 and 15 psi, but that was not a static load. Okay, that's a dynamic load. So to convert that to static you effectively -- let me finish -- you effectively double it.

Okay, so we had somewhere between basically a static 20 and 30 psi. That's consistent, by the way, with a Canadian report, and where else did I see? Something on the order of 14 bar, which I think works out to -- help me, English people -- 20 psi?

MR. BROWN: -- force people inside. It's not a matter of the structure itself, we're saying, it's the blast to minimize the force of the people on the other side. Eight psi would knock somebody out, down, down, that's it, they are done.

MR. BERRY: Yes.

MR. FINFINGER: Next contribution from here maybe.

MR. GRACIOLI: Ken Gracioli with KEM BioShelter. We've been working with the West Virginia task force on the issue of mine safety. One of the questions that they sent us in writing was how did your shelter protect against 26 psi, and they said that above that level there is no sense in protecting because the human body can't withstand it.

MR. BERRY: All right. So once again I' hearing with the exception of the one presentation --

VOICE: I would agree those are the numbers?

MR. BERRY: What's that, John?

VOICE: Those were the numbers, 20-30 psi.

MR. BERRY: Okay, sounds like we are pretty unanimous on that, and you can very definitely build bulkheads in chambers to resist that that I don't think are too overwhelming. I showed you three examples.

Anything else?

VOICE: Have you considered in that study the positive and negative issues when you do an exploding, a blasting situation?

MR. BERRY: Actually, my talk could have gone on for hours. As a matter of fact, in one of the designs, okay, the second design I showed that was supported from the top and the bottom, but down into the floor, okay, so there was very little support at the roof, and in fact we were worried about it upsetting, okay, the other way, and I left that out because it would have just taken too long, but it is pinned into the roof to prevent it from upsetting on the back swing, so to speak. That was a good question.

MR. KRAVITZ: Would you like to respond to that then?

MR. WU: Yes, I would like to respond on that particular.

We were thinking about using what it appears we need, as I stated, we want also to take care of this one not only for the exposure purpose and also the water. Now, that was not being thought in the past. In these last 15-20 years many things have happened. So when people cannot get out, then you get into that areas of want to be able to hold in that water, and that water is combined into one of the things we're talking about for that pressure, aesthetic pressures.

Now, the other things we're talking about is on grouting curvage on the roof, on the coal mesh materials. When you're doing ground curving on those to prevent the passage, those would need more work to be done. That's probably the things we need to strengthen that from footing and rib and roof. There is a lot of other problems that we haven't talked about.

MR. FINFINGER: Okay, thank, Kevin.

We would like to go on to the next question. This is for Joel Kovac. How will we address the storage and transportational self-rescues with the manufacturer's recommendations? For example, exposure to 32 degree Fahrenheit.

MR. KOVAC: You follow the manufacturer's recommendations in order to keep the device within its service life plan and to keep it in approved condition.

The 32 degrees represents storage. Don't store it at that temperature. You monitor that. If you exceed the manufacturer's instructions, remove the device from service, replace it with a new one.

MR. KRAVITZ: Okay. This one to the panel, and if the panel would like to defer to the audience we can do that. Should we encourage mine designers, engineers to design mines with escape shaft entries with shorter routes to the surface? Anyone?

MR. VAN ZYL: It always comes down to cost. For an example, in deep South African --

MR. FINFINGER: Put the microphone up to your --

MR. VAN ZYL: I'll go to the microphone.

I said it's always an issue of cost. For example, in deep South African gold mines the original mining layout was to get to the ore most effectively and safely currently due to heat loads. Mine designers are seriously taking into consideration ventilation requirements when actually doing the mining, the mining layouts.

So again, if it gets to the point where you have multiple fatalities, potentially can be brought into the design criteria. But again, it's open for debate.

MR. GRYSKA: What I would like to do is talk about what we do in Ontario. There is legislative requirements in Ontario to have a second means of egress. So in fact we do have a second escape way and it's mandated by legislation. But mind you again, we don't have coal mines.

MR. FINFINGER: Okay, thank you.

Next question, doesn't having a stove in the refuge station present an explosion hazard? A stove.

MR. VAN ZYL: Depends if the mine is classified as a fire mine or non-firing mine. If it's a firing mine, definitely. I don't know a flame proof or intrinsically safe stove, but again it depends on the -- well, in South Africa it will depend on the classification of the mine.

MR. KRAVITZ: Same thing holds true for electricity like microwaves and refrigerators.

MR. VAN ZYL: Exactly.

MR. KRAVITZ: I think some of the things -- most refuge chambers we saw pictures of that were actually mental/nonmetal mines, and it really didn't apply to the coal situation.

Probably you want to put MREs with the heatable, open it up and heat the other, you know, that's another question about the MREs, would that do anything.

Okay, I don't know if anyone knows the answer to this one. You know, we would have to dig into our databases, but how much caches are there today in all coal mines? Are mines required to report the number of caches?

Anybody want to take off? Is Terry there, Terry Bentley?

I know that coal, you know, has plans for all caches currently, and the cache storage plans, and I'm sure that all those are reported back into the system, but I've never seen a report, and maybe someone from coal, anyone here want to answer that one?

Okay. We will see if we can get an answer for you. If you could come up and identify yourself on this card, we'll definitely get an answer for you, okay?

MR. FINFINGER: Okay. If a sustainable IE nonventing liquid air supply could be developed for rescue chambers, would be beneficial to have an air supply of greater than 5 days. If more than five days, what quantity is desirable?

MR. KRAVITZ: Interesting question. How many days would you actually prepare for? Anyone want to take a stab? One day more than you need, right?

(Laughter.)

MR. KRAVITZ: That seems like it would be a real hypothetical there.

Has any work been done on infrared imaging to penetrate smoke? I think we saw in one example. Bud Meyer was showing a face piece with -- and Chuck was showing the IRs too, I know he's been working on that.

That's all the written questions. I think we have time for some questions from the audience. If anyone wants to ask a question, please come to the microphone, identify yourself, and then if you have someone you want to ask the question of, please do so.

MR. PAPEO: Christopher Papeo from NexTec Materials in Columbus, Ohio.

The question is probably for Dr. Oberholzer or perhaps Mr. Van Zyl. We have the capability in NexTec materials to make oxygen from water by a kind of reverse fuel cell technology, so we don't have to bring any compressed air tanks or oxygen tanks into the coal mines since coal and methane are explosive with air and oxygen.

I'm thinking that this would be a great advantage for perhaps in rescue chambers as a way of bringing in oxygen and air, and you know, if air/oxygen compressed tanks get ruptured from one of these explosions we've just been talking about, 20 psi explosion or so, they could add to the problem in the emergency.

So I'm wondering from your experience, or it could be anybody but I'm just kind of curious what Mr. Oberholzer would say, if that could be a great advantage to be able to generate oxygen that way on demand as opposed to having a storage of oxygen.

MR. OBERHOLZER: I would think that in a portable cell or refuge bay the ability to have oxygen would be very advantageous on one condition. I don't think the generating facility must actually take up too much space.

One thing as I pointed out previously it is quite evident, if we look at all the products in offer and the new technology that is available, that I think the whole original theory of piping a down bay and only using candles, well, that is passe nowadays. I think there is new technology that is going to overtake us and bring a whole new, I would say a new generation of refuge bays that possibly I might even not know about to the fore.

This is a typical type of thing as in my talk I pointed out that there are certain inputs from the environment that create or stimulate the growth of things. Failure is going to create the growth of a new generation of things out there that the mining people can -- for some it's going to be easy, for some it's going to be difficult, but the new products are going to be there.

I hope that answers the question.

MR. PAPEO: That was helpful. Thank you.

MR. MCKENNA: Tom McKenna with Micropore, Inc., a manufacturer of CO2 absorbants, and I guess I had a couple of comments and maybe a question relative to acceptable CO2 levels within some of the shelter scenarios.

I know the U.S. Navy in their submarine has approved our product for use and is able to supply seven days of life support at a 3 percent maximum CO2 level. NATO submarine fleets have also accepted levels at 2.5 percent. I saw a couple of levels that were down around the 1 percent for the mine safety shelters.

I guess, you know, in the diving community and submarine safety community we have seen that you can support life -- life support is acceptable up to exposures of 3 percent for up to 40 days without any physiological effect, and I guess we would recommended that NIOSH and MSHA set a level that's somewhere in that 3 percent range.

I know that with the re-breathers and SCSRs half percent to 1 percent seems to be the accepted level, and that's great for working environments, but with an emergency safety shelter situation, higher levels are probably acceptable.

So I guess the closing question is what is the intent for acceptable CO2 levels within the safety shelters?

MR. KOVAC: If you regard a refuge chamber as a respirator, closed-circuit respirator for a lot of people, there are standards for certifying the same, or stipulated what the performance has to be over a required time period. So you are right to raise those issues. The 2 or 3 percent, I wouldn't see that as a problem. It would make it technically easier to achieve.

But again, there are no standards. And so when people make claims about the performance of those chambers, those are claims that need to be verified, and it's best to do that in as scientifically sound manner as possible. So if we're not talking standards, we're at least talking about somehow making sure that the chambers do what we intend them to do, but that remains to be seen.

We all have to reach some common agreement, what safe life support capacity is, what sedentary oxygen rates/consumption are, are the people in the 1983 report I had done, are people really going to be sedentary, aren't they going to be managing the functions of the chamber. They are going to be moving about. Somebody is going to have to attend to or monitor the oxygen generator. There is going to be other things to be dealt with. So to project a flat three-tenths of a liter uptake per minute of oxygen or half a liter per minute of uptake, that may be wrong. You might have to have fluctuations.

So there are issues like that that have to be dealt with, but primarily what's a safe level, how do you verify it, how do you verify what the claims are for these chambers, or what ought they to be, what performance should we stipulate.

MR. MCKENNA: Thanks.

MR. PINKLEY: Jim Pinkley. I'm the market manager for Hilte Mining, 13-year underground experienced miner, mine manager, degreed engineer.

One of the questions I have is to Alex. It seems that sealing seems to be a big issue with the refuge chambers and use of the chambers in Ontario in practical terms. In regards to that, you know, there is a lot of concern over explosions and what is going to happen with the chambers and so forth, but I'm not seeing an interest in having materials for the miners when they escape to the chamber.

If there is damage to these chambers, if they are going to be able to do anything to be able to fix that. That sealing doesn't seem to be on the radar screen for us here in the U.S. while it's been the top five important issues for Ontario, and I would like for Alex to comment on his practical experience, and then I would like to hear from dr. Rau and some of the other personnel here within the U.S. on where we are at with sealing. Go ahead, Alex.

MR. GRYSKA: Okay. By the sealing, you're referring to the sealing the door closure, is that correct, or --

MR. PINKLEY: Yes, and having materials to seal with.

MR. GRYSKA: Yes, okay.

MR. PINKLEY: I mean, you know, we have seen a lot of the manufacturers put up their information, but I don't see how if there is damage to the -- if there is damage to the facility, how the miners have any recourse here, you know, and you're all talking about, you know, 20 psi, 30 psi, debris waves. You know, in real life let's face reality. Things are going to happen.

MR. GRYSKA: Yes. Okay. During my talk, I did mention to you the hazards that our mines are exposed to are very different than that of the coal mine environment. Certainly the occurrence of methane is very rare in our mines. Secondly, one of the other hazards is we do get sulfide dust explosions.

Our experience has been is when we do have something of that serious nature, knock on wood, it hasn't happened very often. We had in the mid-eighties a situation whereby we had a sulfide dust explosion. There were only three miners underground, and two of them were fatally injured, a third one survived. They didn't even have an opportunity to go to the refuge station.

MR. PINKLEY: I guess my question is more in the fact that when your miner is trying to go to that refuge station, do they not use the sealing materials to seal themselves in?

MR. GRYSKA: Yes. Absolutely. Yes.

MR. PINKLEY: That's exactly what my point is.

MR. GRYSKA: Oh, yes.

MR. PINKLEY: We're not making any preparations to allow the miners here to have that option in case there is any type of damage, and I just think we are overlooking some key issues here.

MR. GRYSKA: One of the things that we do focus a lot on in Ontario is training, training our miner rescue teams, training our miners as far as refuge stations. As mentioned to you, we do have fire drills and we do run simulations, and in some of those circumstances they will go as far as sealing themselves into the refuge station to make sure they are functioning properly.

MR. KOVAC: I would like to make a comment too. One of the reasons that you would evacuate a refuge chamber is that you were incapacitated, you're injured, things are going against you. To make the assumption that everyone in that chamber will be fit, will survive that experience is short-sighted.

When you look at the report we did in '83, one of the requirements was to include body bags. The ability to handle casualties, to handle fatalities, and do it with a manner and decency and everything like that.

Refuge chambers are very hard to deal with. What has to be in them, how you train people to deal with going into them, what you expect those people to do while they are inside, how they will react to tragedies, but you need to begin considering things like body bags, the ability of the miner to repair the miners who are so in shelter to repair that shelter in the event that there is damage, bring it back up to gas-tight condition whenever it's sealed. All those things have to be factored in.

MR. KRAVITZ: Excellent point. Kevin has a comment to make.

MR. WU: I want to answer that question. I was trying to talk before that question could be raised. In all the years we're talking about the barricades --

MR. KRAVITZ: Lower that microphone a little bit for you, sir.

MR. WU: In a mining emergency conditions for a miner to be able to barricades and never could build ones which to serve its purpose. It's very difficult. So the important things, you know, everybody agreed, the aims is you've got to have some kind of refuge chambers for the last choice. So hopefully again design, no damage.

Now, grooves you 100 percent, you needed some materials, whatever that needed to be discussed to finalize what needed to be there be put into use. That should have been no argument. When you say hopefully you're going to design something that would not be damaged the first thing, because when you have an emergency like this if something happens, it's always difficult, always difficult, and all the barricades through the years you can never build it in a short period of time, and to serve its purpose.

MR. KRAVITZ: Okay, we have time for one more question. That's the last one. Fortunate you are.

MR. RAU: Just quickly wanted to make the point the difference between a sealed environment and a leaking environment. Two completely separate systems. In a sealed environment you have to scrub the atmosphere. In a leaking environment you have to ensure that everything that goes into that chamber must come out, so that's a compressed air style system. You cannot use oxygen-generating tools in a leaking environment. It doesn't work. You have to scrub the oxygen, otherwise the carbon dioxide builds up, so there is succinct difference in between the two systems. I think that's just something that's been missed.

MR. KRAVITZ: Kathy, you were about to tackle the microphone, so you better ask a question.

MS. SNYDER: Kathy Snyder, Mine Safety & Health News. Basic question. I think we have heard at least one coal mine, if I remember correctly, make a decision to use refuge chambers. I understand it's a difficult thing in coal mines because you can have different scenarios. You could have a second explosion. You could have an engulfing and overwhelming fire, but then again you might not in a coal mine have those things happen.

And I was wondering if anyone has any information on the decision process that one or mine operators in coal may have gone through deciding to use these chambers or not use these chambers.

MR. KRAVITZ: Anyone?

MS. SNYDER: No baseline.

MR. BROWN: No baseline so there is not --

MS. SNYDER: Right.

MR. BROWN: I'm shocked. Quite frankly, I'm shocked. I'm not in this business. So how do you arrive at what you require if you don't know what needs to be --

MS. SNYDER: Did someone say there was a New Zealand mine in coal that --

MR. RAU: In Australia, all our mines have to be treated with that. Essentially you couldn't put that unit into the coal mine. In New Zealand, same as the U.S.

MS. SNYDER: Do you know how they decided that this was a good thing to do even though it was a coal mine and there were some possible scenarios where it might be worse than -- you might be worse off?

MR. RAU: (Not on microphone.) I guess it's just an area in the mine which I saw that it wouldn't address that successfully. It's one single chamber, it's not the whole mine.

MS. SNYDER: Thanks.

MR. KRAVITZ: And one last, last question.

MR. LONG: Yes, I want to talk about that also. I'm Gary Long from BHPBilliton, New Mexico, San Juan

Underground, and we decided in January that we were going to do the right thing and build some refuge chambers and beings we are an Australian-owned company we had plenty of information of how to build those, what to put in them, doing risk assessments, that type of thing, and we done some testing with rescuers at our mine, it's about a six -- well, not even a 6 percent decline.

We done some testing with the CSE100s, and determined that we were going to put rescue chambers or refuge chambers we call them every five to six thousand feet. On the testing we done, we were able to -- one 6,400-foot walk and another person 7,400-foot, so we just went with the five to six to keep our refuge chambers far enough apart that you could actually walk, get in fresh air, we've got more bore holes to each one, getting fresh air to change rescuers and keep moving. And then if egress is stopped, then we could use those chambers to stay in, and they have everything that we've seen here today. They have everything plus that.

MR. BROWN: Looking at anticipation that distance, so -- (not on microphone.)

MR. LONG: Yes, that's basically it, is that every 5,000 feet, we know we can make it that far. If not, we'll stop, and every panel has two of them. The way things are going we've got 1,250-foot panels, and we're making a lot of assumptions doing this but we thought it was the right thing to do psychologically for the coal miners also. They have another opportunity there if something should happen, so I think psychologically the miners are more of these by having such another instrument, and I think it's the right thing to do.

MR. KRAVITZ: Okay, thank you very much.

I think we have accomplished our mission today, stimulated thought, and we have identified quite a few things for a research agenda, and I would like to thank all of you for coming today, but be sure to pick up the attendance list. Thank you. It's been a pleasure working with you. Thank you, panel.

(Applause.)

(Whereupon, at 5:34 p.m., the workshop was concluded.)

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REPORTER'S CERTIFICATE

DOCKET NO.: None

CASE TITLE: Mine Escape Planning Workshop

HEARING DATE: April 18, 2006

LOCATION: Washington, D.C.

I hereby certify that the proceedings and evidence are contained fully and accurately on the tapes and notes reported by me at the hearing in the above case before the Department of Labor.

Date: April 18, 2006

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