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Linda Zeiler, Designated Federal Officer

Dr. Jan M. Mutmansky, Chair

TECHNICAL STUDY PANEL

ON THE UTILIZATION OF BELT AIR
AND THE COMPOSITION AND FIRE RETARDANT
PROPERTIES OF BELT MATERIALS
IN UNDERGROUND COAL MINING

Technical Study Panel:
Dr. Jan M. Mutmansky, chair
Dr. Jurgen F. Brune
Dr. Felipe Calizaya
Dr. Jerry C. Tien
Thomas P. Mucho
Dr. James L. Weeks

Designated Federal Officer: Linda F. Zeiler

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122 West South temple
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Reporter: Diana Kent, CSR, RPR, CRR
Notary Public in and for the State of Utah

P R O C E E D I N G S

MS. ZEILER: Good morning.

I'd like to remind everyone if you haven't signed in, please do, as these gentlemen there are demonstrating.

This morning we are very pleased to have Gary Skaggs from Agapito & Associates here to give a technical presentation for the Technical Study Panel on two-entry yield pillar gateroad systems in the Western U.S. longwall mines. Mr. Skaggs.

MR. SKAGGS: Thank you. And on behalf of Agapito & Associates, Incorporated --

MS. ZEILER: Hold on one second. We need to adjust the mic.

MR. SKAGGS: I'll start over. On behalf of Agapito & Associates, Incorporated, we appreciate the opportunity to make this presentation to the Technical Study Committee. Dr. Hardy, Dr. Agapito, and Leo Gilbride send their regrets that they could not be here today. They are principals in the company and they have primary geotechnical experience and the history behind this. However, they had other commitments so I'm standing in as presenter.

I will answer what questions I can. I've only been with the company a few months. If you have questions I can't answer, we will get answers to the panel.

A little bit about Agapito & Associates, Incorporated. We are a mining geological engineering firm founded by Dr. Agapito in 1978. We have offices in Grand Junction, Denver, and Chicago. The firm specializes in geomechanics and mine design in general. And these are some of our Western U.S. longwall coal clients, both past and present.

This slide shows a map of the Central Utah coal fields with the Book Cliffs on the right and the Wasatch Plateau mines over on the left, Price located there in the center.

Some introductory points. The two-entry yield pillar system is unique to Western U.S. longwall coal mining. This diagram, if you are not familiar with it, that would be the longwall face, and the block is retreating in that direction, and you have the yield pillars, the gob from the previous panel, the gob in the present panel, and the panel yet to be mined.

The system has evolved over time, beginning with the Sunnyside Mine to the present. It's been analyzed extensively. It's proved superior over the course of 40 years to other gateroad systems for ground control and the conditions in the West; it's a system tailored to the burst-prone conditions in the West; and it's a system that's only used out of necessity.

So what's different about Western U.S. ground conditions? Very deep cover, currently reaching 3000 feet, and there are a number of coal deposits greater than 3000 feet. Highly variable topography. Frequently we have multi-seam mines, have a very high stress environment, and we have bump-prone geology.

This is a slide of the Book Cliffs near the West Ridge Mine, showing you the extreme topographic relief. Very steep-sided canyons. This is an area near Seed Canyon showing the massive sandstones that are predominant in this area.

Another view nearby, again showing the example of the sandstone cliffs, and there's a mine located at that location. Bump-prone geology; it means thick and competent overburden strata. It causes bridging that leads to high abutment pressures. Here's an example of the Castlegate sandstone. There's also other massive competent sandstones; the Aberdeen, Kenilworth, Sunnyside, the

Star Point. Uncleated or weakly cleated coal, strong coal leads to storage of strain energy and sometimes violent releases.

The highly competent roof and floor strata that confines the coal and resists breakage, essentially with the massive sandstone, creates what we call a bounce sandwich. And we have sand channels present, which also lead to stress concentrations. Massive overburden, it resists caving and increases loads on the pillars and the longwall face.

Some comparison of typical conditions, and I stress "typical" because there's always exceptions. But these are predominant differences between the East and West. Cover exceeding 3000 feet in the West. Typically of shallower cover in the East. Very rugged topographic relief, and Eastern mines tend to have more limited relief. Strong coal, 3000 psi plus, in many cases. Coal strength in the East is variable. It tends to be much weaker. Strong and stiff roof versus a more typical weak and soft roof. And strong and stiff floors versus, again more typically in the East, weak and soft floors. Massive strata in the overburden versus generally a highly laminated strata overburden. Very high burst proneness versus moderately to low burst proneness in the East.

A little bit of history on the evolution of the two-entry system and yield pillars in the West. Two-entry mining was actually the predominant method in room and pillar mining going back to the Sunnyside mine, which was operated continuously over 95 years, beginning in 1897 until it closed. It's the most used historical room and pillar method in the West. It was established well before the '69 Coal Mine Health and Safety Act.

Sunnyside experienced severe bumps and bump-related roof falls at depths greater than about 800 feet. Their solution in the room and pillar days was to limit the width of the entry in the pillar/entry system. And the two-entry system significantly reduced bumping in the room and pillar development.

This slide is a little bit of conceptual illustration of Sunnyside's room and pillar methodology prelongwall, where they would develop the two-entry development entries with yield pillars. They limited their room extractions. You will notice their main slopes didn't have more than two entries. They had a lot of roof falls, they had a lot of bumps, a lot of fatalities due to bumps. I've been in all three Sunnyside mines several times before they closed the main two onward, and they had literally miles of steel arches installed to keep the main entries open.

Bumps continued to occur on the room and pillar retreat. Narrow yielding pillars were tested to control bumping in those panels, and they settled on a 25 to 30 foot wide pillar which virtually eliminated bumping. Fifty-foot wide pillars were tried, but it proved dangerously bump prone.

This is what we call a critical pillar concept. Essentially a yielding pillar system, increasing pillar width, and eventually you end up with a critical area. You either have to be narrower than that area or much wider than that area.

Yield pillars proved successful in eliminating bumps, but resulted in lower pillar recovery because in the pillaring rooms they still had a lot of roof falls. So Sunnyside sought a higher recovery system, and longwall mining was introduced in '61 in Sunnyside by John Peperakis and others, and that was based on John's experience in Germany. He was in the army and put in charge of rehabilitating the German coal mines after World War II. Longwall improved the safety of resource recovery and productivity.

Gateroad development proved analogous to room and pillar development. Bumping was still a problem at greater than 800 foot depths. The two-entry system that was used for room and pillar development was then adopted as a solution for controlling bumps in the longwall development.

They conducted numerous trials to find the right gateroad geometry, one that yielded nonviolently but yet provided an adequate tail gate stability. They even tried three-entry yield pillar systems and the result was they had a lot of roof falls, floor heave, unstable conditions in the head gate and tail gate. And they then went to the two-entry yield pillar system as their basis. It significantly improved the pillar stability and roof and floor conditions. They even tried experimenting with single entry that would provide the best overall ground control but there were other issues that made it impractical; ventilation, water, and supply access. Although we know a single entry development has been used in Nova Scotia, it's been used in other countries around the world.

Key conclusions from 33 years of longwall mining at Sunnyside, mined with single seam and multiple seams and they were mined approaching 3000 feet: Minimizing the overall span of the gateroad is a key principle, as necessary to control the bump proneness in the roof and floor conditions. And there the yield pillars were optimal. At Sunnyside, 25 to 35 foot yield pillars worked. Obviously yield pillar dimensions are going to be site specific. They tried multiple yield pillar gateroads; more than two entries, they still had significant increases in floor heave and roof falls.

Since Sunnyside introduced and developed the two-entry yield pillar concept, it has become the de facto standard for deep longwall mining in the West. And today, 30 foot wide yield pillars are typical.

On the engineering side, significant research has been conducted over the years to evaluate two-entry yield pillars and alternate systems. There have been decades of application and observation, laboratory measurements to get rock properties for engineering analysis, stress and convergence measurements, numerical modeling. And there's many published papers regarding two-entry longwall mining in the West.

This is just an example of an engineering study location. This was the Cottonwood Mine. It's a little hard to see. The panel will have a copy of this presentation in digital form. But in this illustration, you have a legend where the circles are face positions and the corresponding squares are bursts at those face positions, with predominantly bursts occurring in areas of multiple entries.

Another example is at Deer Creek. In this particular instance the longwall face was in this area. There's some instrumentation and they were having coal bursts in these three entry gateroads. And this is just an illustration of some of the instrumentation arrangements.

This is a project Agapito is currently involved with at SUFCO. These are roof sag meters, fiber optics to a data recorder. And the reason SUFCO is doing this is they have been in, relatively speaking, shallow coverage. Their future operations are going to be in cover over two thousand feet.

DR. TIEN: How deep does it go?

MR. SKAGGS: I can't tell you. But multiple levels. Probably 15 to 20 feet or higher. But there are multiple instruments. These are fiber optic borehole pressure cells to collect engineering data. You can see the data logger that is hooked to the personal computer. This is just an example of a measured stress profile across a yield pillar.

This is the pillar width. You are at 30 feet. And the vertical stress. An example of a modelled stress profile here at Deer Creek. There we had three-entry gateroads and two-entry gateroads. You can see the pillar stress was significantly less in the pillar in the two-entry gateroad.

An example of some of the numerical modeling. This is a displacement discontinuity model. It models vertical stress only. These are two-entry panels with the longwall panel side by side. And then this is the barrier panel concept which we will talk a little bit more about later. The longwall gob. And these are the stress levels so you can see the stresses around the pillars and the gob.

This is an example of a finite difference model. Here it is modeling in the vertical versus the plan view. And this illustrates when the pressure arch is still intact over the longwall gob versus when it is not. These areas don't look that different, they are significantly different on impact. And this is a 3D finite difference model. This will model in three dimensions. We can also model sandstone channels, and this is an area that's pretty much an entire mine area. And these are some of the examples of tools that we use for evaluation. An example of a distinct element model. This is used to calculate shield loading and this is a model -- it models discontinuities. In other words, it will model one block moving relative to another.

So why yield pillar instead of rigid pillars? This is an illustration of a rigid pillar that had a coal outburst, a violent outburst. The area of the coal was released and turned out into the entry very violently. This is an example of a yield pillar. It slowly crushes as it yields. No violent release. If you would have visited this mine with the two-entry system, you would have looked at their conditions and said, "Why do they need two entries? These are good conditions." The reason they are good conditions is because of the two-entry yield pillar system that they were using.

This is an illustration simulating pillar loading where you have a rigid pillar, stress in the vertical direction, strain in the horizontal direction. It gives your initial loading and you get your critical loading, and it reaches a point where you have dynamic pillar failure, bumps, bump-related roof falls, dynamic floor heave.

The yield pillar behaves in a different fashion. You reach a peak strength typically in the 4000 to 5000 psi in areas we have worked in. And then you have controlled yielding and a residual strength that is reached, typically less than 1000 psi.

Another example of a rigid bump overload. This wedge, the size of the pillar was ejected. This is another area where you had a bump at the base of a rigid pillar. You can see the cans and the gate entry have been shifted. Dynamic floor heave with the rigid pillars. An illustration of a rigid pillar bump and dynamic floor heave. You can see the can support is buckled severely. And this is a photo of a longwall face outburst. This is an older photo, but it illustrates how severe these can be. This is the shield canopy roof and this is essentially through the pan line clear up and into the shield. And of course anyone in the area when this happens is going to suffer fatal injuries.

Simulated stages of pillar loading from solid on both sides to gob, and longwall area. The second panel, this is again some of our numerical modeling techniques to evaluate the pillar conditions. This is an example of a rigid gateroad pillar in a three-entry system at 1000 feet. These are the vertical stresses. You can see the pillar stresses in this area.

At this point at 1000 feet in this particular line, these were stable pillars. However, at 1500 feet, you can see that the pillars are increasingly loaded and these pillars become burst-prone. There it is at 2000 feet. And now we also have burst-prone pillar on the headgate side.

Yield abutment, which some mines use. Again in the western seams particularly in this area, 2000 feet you still have your yielded yield pillars, your burst-prone pillars are still present, and you can have dynamic loading on the longwall face, and face outbursts.

This is an example of two-entry yield pillar gateroad at 2000 feet. With the yield pillar you still get heavy loading on the tailgated corner but you don't have the burst-prone pillars back in between the gobs because the yield pillars gradually crush out.

So why two versus three? Typical difference, of course, there's a third fewer intersections, a third fewer entries, no four-way intersections, although we can try staggering the crosscuts for three-way intersections. On a two-entry gateroad you have a very narrow pillar entry span, which is the point I made earlier. It's a key point. So your load sheds to the -- your load sheds off the gate pillar and you don't get the burst-proneness in that pillar. You also reduce the weighting on the tailgate corner.

Three entry yield pillar at depth, you still have the heavy loading on the tailgate corner. At the wider gateroad span with three entries generally results in heavier load on the tailgate corner of the face, as well as roof falls and floor heaves in the tailgate entries.

Essentially in these mines, our experience has been that the three-entry yield pillar is problematic. It makes all these conditions worse. It becomes virtually impossible to keep the entries open.

So what does the future hold for Western longwall mine design? One of the alternative designs that's being adopted now as we get into increasing depths of coverage is the alternate panel-barrier gateroad system. In this case it uses a very wide interpanel barrier. Still have the two-entry yield pillars for development. Advantages: It does allow safer mining under extremely bump-prone conditions; it has flexibility to isolate individual panels with squeeze stoppings; and it does improve ventilation by having an entry next to a solid panel. Disadvantages: Takes twice as much gateroad development; increases mains and bleeder development; sterilizes a very large amount of reserves; and it complicates multiseam mining because now you have a stress pillar above or below for future mining.

Now, one mine even looked at this checkerboard system where it had a ridge of deep cover over this part of their panels. And what they were actually looking at was moving the longwall around this part where the overburden was deepest. They would mine this panel through, just as if these were wide barriers, and then move around the next panel.

The industry has worked very hard in trying to solve the problem that we have in the West with the bump-proneness and the conditions. There's been a lot of ideas. It's been brainstormed and evaluated. The interpanel barrier sizing is important. This illustrates a 600-foot wide interpanel barrier, and essentially the barrier then is keeping the loads reduced on the tailgates. This illustrates what happens at 200-foot wide. You can see that the stress levels are very high in that narrow of a barrier pillar. So essentially a wide interbarrier pillar can lower the stress levels by about 1000 psi. Modeling to date and experience to date with actual operations and analysis indicates that a 400 to 600 foot wide barrier pillar can maintain tailgate stresses at historically safe levels as we are approaching the greater depths. But they are still dependent on the two-entry development to work.

So is there a silver bullet for the future? No gateroad system is going to be optimal. The two-entry yield pillar system is demonstrated by science and experience to be the best tradeoff for deep Western longwall mining. It's used out of necessity to control the ground in a high bump-prone environment, and it significantly reduced the risk of pillar bursting, bump-prone related roof falls and floor heave. It has made safe longwall mining possible at depths more than 2500 feet.

Three-entry field pillar systems are not a good replacement. They normally result in problematic roof and floor conditions. Experience has shown that the added advantage of having a third entry in the tailgate is normally lost because of excessive roof and floor instability.

Rigid pillar systems risk pillar bumping in both the tailgate and headgate at depth. And pillar bumping, even when the pillars are in the gob, can be hazardous in the gateroads and on the longwall face. Bumping cannot necessarily be prevented by making a rigid pillar even larger. Developing very large rigid pillars is operationally difficult. When rigid pillars become very large, interpanel barriers such as we saw at Aberdeen Mine become an option. Interconnecting crosscuts in large interpanel barriers are not practical and they increase the geotechnical and ventilation risk.

The future is that even two-entry yield pillar systems may not be able to protect a longwall face from severe abutment loads at depths greater than 3000 feet. Obviously in mines that are using the barrier and panel arrangement now, even the two-entry yield pillar by itself is not sufficient. We have had to go into the overdesign. It's currently being used in three Utah mines at the present.

A couple of nongeotechnical issues, I just wanted to touch on for the panel's benefit. Cyprus Shoshone Mine, formerly Carbon County Coal Company in Hanna, Wyoming used a two-entry pillar system to manage their spontaneous combustion problem. They had severe spontaneous combustion, a number of fires in the gob. And Cyprus, I believe it was early 1988, filed a report with MSHA justifying the continued use of the two-entry system. So that should be in the MSHA archives if the panel would wish to review that.

Another point, Sunnyside Mine was very successful in using squeeze stoppings with their two-entry longwall gates to isolate their individual longwall gobs as a way to control both methane and their spontaneous combustion problems at Sunnyside.

Thank you. Rather fast, but if you want me to go back through anything, I'll be glad to.

DR. MUTMANSKY: We are just going to have to ask you a lot of questions, that's all. Gary, you readily admit that this is to some extent new territory for you. You worked mostly in the East.

MR. SKAGGS: Well, my first experience in the West was 1982. I moved to Colorado and was working on a property in Utah in the Book Cliffs. Part of that property is now being mined as Dugout Canyon. I did extensive personal research and mine tours to learn about the unique situations in Utah. And since then I have spent a lot of time in the West as a consultant, even before moving here again. So I've been in most of the mines in Utah and Colorado.

DR. MUTMANSKY: Okay. Your summary that you presented here pretty much concludes that the two-entry system is the only way to go. And I'd just like to know basically how you came to that conclusion over the years.

MR. SKAGGS: Well, the conclusion is not just my opinion but certainly Dr. Agapito's and others that have worked on this problem. I didn't do research for this presentation on the number of fatalities in mines before two-entries was adopted. But it's -- there's a considerable history and I believe others have compiled the history of Sunnyside.

During the hearings on two-entries in the '80s after the Wilberg fire, there were quite a bit of comments for the record about the experience at Sunnyside and Deer Creek as far as the accidents and mining conditions, the bumps and fatalities that occurred because of that. I know that Sunnyside in one other condition, bumps, they actually had a loading machine get flipped upside down. It was that severe. They had another one that registered over three on the Richter scale. I think it was around 3.6 or 3.7. Somewhere in that range.

So these are -- there's quite a history, a legacy. And they found that it seems to reduce the problem. Nobody will say it has totally eliminated it, but it certainly has reduced it. The record shows mines that have used two-entry development in the West have certainly improved their entry conditions and reduced the number of bursts or falls and the number of injuries as a result of that.

DR. WEEKS: First of all, thank you. This was very educational. I notice your phone number is on your card, so I'll call you.

MR. SKAGGS: Yes. And by all means, any of the panel members are welcome to call. Like I said in the beginning, Dr. Agapito and Dr. Hardy, Mr. Gilbride could not be here and they are the ones that have the real hands-on geotechnical experience over the years.

DR. WEEKS: I want to make certain I understand you as far as the rock mechanics are concerned. This is really not my field and yet it's becoming more and more apparent that I need to learn, I need to become familiar with it. I wouldn't pretend to develop any extensive expertise in that area.

If I could, I'd like to maybe draw an analogy in automobile safety. Believe me it will connect, I hope. And that is, when the change was made from a chassis frame construction for cars to a unit body construction, the theory behind it was that if the unit body of the car absorbs the energy of a crash more slowly rather than that energy being transmitted to the occupants, it would make it safer. People would be -- there would be fewer injuries.

Now, if I understand the yield pillar concept, it's basically a means of absorbing the energy imparted by pressure, absorbing that energy more slowly rather than violently like through the room and pillar. Is that --

MR. SKAGGS: The yield pillar releases the energy more slowly. The energy is going to be stored until you reach the capacity of the pillar, and then the pillar begins to fail. But it fails at a slow rate, what we would call a controlled failure, versus continuing to store that energy like a stiff pillar does and then releasing it instantaneously, extremely violently.

DR. WEEKS: Okay. Then I feel more

confident in understanding what you are talking about. Now, the question that Jan raised, and to which you responded, I think is critical at least as far as I'm concerned. And that is that there have been -- there are records of fatalities and bumps and roof falls and so on associated with three-entry versus two-entry system. In my looking over the whole discussion of use of belt entries for ventilation, which seems to be a natural consequence of using or having to go to two-entry mining, that record has not been presented. I mean, I just don't think that the case has been made that it's safer. I don't think the case has been made in a way that is convincing, at least not convincing to me. But I think the case can be made. And the way to make it, again, I think, as far as I'm concerned, is to get that data on fatality rates, on bumps, on roof falls, on whatever it shows, whatever it takes to show that the two-entry system of mining is safer.

We have to have some measures of safety, and the measures are the fatality rates and so on, as I mentioned. And as you said, I have no reason to believe that it's not there because you and others have made the same point over and over. You have made the same conclusion, and like Jan, how did you get there? So whatever you've got in the way of data, historical record on those measures. I mean, the rock mechanics and the theoretical discussions are interesting and to me challenging. But the proof of the pudding is does it really pay off in a safer mine? Now, you and others are going to say yes. Okay. And I have no reason to doubt that other than I would be more convinced if I saw the data that made the case. So whatever you've got, get it to us, please.

MR. SKAGGS: Well, we were asked to do the presentation on the geomechanics and that's what we concentrated on. I know during the two-entry hearings in the '80s, I attended the one that was held in Denver and there was testimony given about those issues. I don't have copies of it, but certainly perhaps some of the operators would be more -- would have those records available more than we would.

DR. WEEKS: I made that request to operators. The way that we come into it is almost through the back door. Our concern is with belt entry ventilation, not with roof or ground control. And I think your presentation in rock mechanics is totally appropriate. I don't question it. But it leads me to ask the question of where is the data. Now, it's there. Everyone says it's there. I haven't seen it. I want to see it.

DR. MUTMANSKY: Gary, did you say you would give Linda your -- did you say you would give Linda your slides?

MR. SKAGGS: Yes.

DR. MUTMANSKY: That would be very helpful to the committee. I thought the way you presented the rock mechanics information is certainly helpful and I'm certain we may want to use that for study later.

MR. SKAGGS: And these were just examples. The detail national advertise is much more extensive and much more involved. Running the flat 3D analysis takes about two weeks of computer time. It's very extensive and we constantly calibrate models with measurements in the mines.

DR. WEEKS: You know, when the theory and the experience coincide, then everything gets strengthened by that. I've said enough.

MR. SKAGGS: We all know mine design is a balance. You have to ventilate a mine but you also have to keep the entries open in order to ventilate it.

DR. BRUNE: Gary, following up on Jim's question, I think rightfully so he focuses on a comparison or on an account that is based on injury or perhaps even fatality statistics. But maybe you can give us the other side, also, from an operator's perspective of technical feasibility. I think your presentation went more towards technical feasibility. Maybe you can expand on that a little bit, two-entry versus three-entry.

MR. SKAGGS: Well, our experience at Agapito, and I think this is probably supported by others that have worked in this field, has been that even without injuries or fatalities, keeping the entries open with three or more entries and gateroads has been very problematic, very difficult. And so from the analysis, the engineering analysis does support what has been witnessed and experienced in actual operations. I don't know if that is answering your question, but I think there's going to be several operators speaking this afternoon that can certainly relate to their experience in that regard.

DR. MUTMANSKY: The reserves that remain in Utah other than Kaparowitz, which are now locked up, what are the typical depths of remaining reserves and -- well, answer that question first and then I will give you the second question.

MR. SKAGGS: Let me hold this microphone. My voice doesn't carry well so I apologize for those that couldn't hear. But as far as the reserves, of course Utah was getting very limited on easily-minable reserves. In fact, a lot of people would say what we are mining today is, with one or two exceptions, not very easily minable. Certainly not compared to 15, 20, 30 years ago. But the reserves, including some of the federal tracts are going to experience the same problems that Deer Creek, Trail Mountain, the Book Cliff mines have all experienced. Walnut Canyon is a mine project that's in the permitting stage. It is south of where Sunnyside was. Columbia and Geneva mines are in between. But it's still the same, bump-prone geology, the massive sandstones and the deep cover.

So essentially, once you get away from Kaparowitz, which you said is locked up, just about all the reserves it's foreseeable that it's going to have these conditions and worse. All the Book Cliffs mines dip to the east so they get increasing cover, between 500 to over 3000 feet. Part of the resource behind the Columbia Mine actually has some 4000 feet cover over it. And of course the economics of the day make it very difficult to mine something like that. And it is certainly going to take a lot of analysis before somebody can successfully go down 4000 feet. It may be a single-entry development is the only way to do it, similar to some of what the European and Eastern European countries do at those kinds of depths.

DR. MUTMANSKY: You led perfectly into my next question which was if a company came to you tomorrow and Mr. Agapito said, "Gary, you are to take on this project. Would you try to write a justification for a single-entry Utah coal mine," what would be your arguments?

MR. SKAGGS: Well, we certainly would have to get the data and do the analysis. We actually advised a client late last year who wanted to mine in the Book Cliffs area behind some old works that essentially they thought they could go in with the typical Eastern super section approach to it, and I said, "It isn't going to work. All of our experience, all of our analysis basically said it's not going to be successful." And so they essentially walked away from the project.

So if somebody wanted to say, "We really want to do this," it's going to take a lot of research before we could really say what would have to be done. But certainly a single-entry approach might be something to be looked at. Obviously the regulatory restrictions of this country would make that a very time-consuming and detailed process and may not be successful.

But I was in the Falin (phonetic) Mine in the mid '90s under the Atlantic Ocean and they were using single-entry development. And a number, as I mentioned, of other countries permit single-entry development in very deep, very tough ground conditions. But I think that's a long way from where we are today.

DR. CALIZAYA: My question deals with pillar size and leakage. When we reduce the pillar size we are increasing the number of stoppings and I'm sure the stoppings at one point are also suffering. And the result of that, the leakage will increase and probably we need also to think about that. Any comments about that?

MR. SKAGGS: Yes. Although the pillar width has been reduced, a lot of these pillars the length has not been reduced. In fact, the length between crosscuts has been increased. Variances have been applied for and granted in a number of cases to reduce the number of or the distance between crosscuts. So 150 feet and sometimes longer is not totally unheard of to minimize the crosscuts and the leakage. And the other thing that has been used in the past has been a squeeze stopping type of capture, so if the pillar yields you minimize the leakage.

DR. WEEKS: You know, mines in South Africa are much deeper even than 3000 feet. And I don't believe -- I think they are diamond mines. Is that what they are?

MR. SKAGGS: Yes. There's no coal mines in South Africa anywhere near 3000 feet deep.

DR. WEEKS: Right. But I'm wondering if you have any experience with any deep mines like that and if it is at all pertinent to coal mining here.

MR. SKAGGS: The mining techniques are totally different, just as hard rock mining techniques in this country are totally different. For ventilation, ground control, everything is totally unique requirements. The regulations, of course, as I'm sure you're aware, are vastly different between coal and metal/nonmetal. But I would not see where there would be a direct application. Certainly the rock mechanics principles are going to be similar, but the application is entirely different.

DR. MUTMANSKY: Gary, thank you for your presentation. Linda and I now have to discuss the possibility of using the second half of the morning. Dr. Maleki, would you like to present after a coffee break?

DR. MALEKI: I need a few minutes to set up, but yes.

DR. MUTMANSKY: We can give you all the time you want. Thank you very much.

MS. ZEILER: Thank you. We will take our coffee break. Thank you, Mr. Skaggs.

(A break was taken.)

MS. ZEILER: I wanted to mention two things before we start again. One, if you intend to speak during public input after noon today, please be sure you have signed up on the sheet. We have a block of names already but I don't want to exclude anyone if you're not on the block we have. And secondly, Bill Knepp wanted to mention something in response to Dr. Weeks's comment this morning about needing data to justify the use of two-entry, and let me let him speak to that.

MR. KNEPP: Gary mentioned in his report the 1988 Cyprus report. We will attempt to track that down for you. I can't guarantee that, but it's a high probability we can find that. The other thing is the two-entry task force had recommendations in a report, and we will provide that for you, also. I just want to put that on the record. We will track it down.

MS. ZEILER: Thank you.

We are very happy to have Dr. Maleki here this morning and thank you again for agreeing to speak this morning. Dr. Hamid Maleki is the president of Maleki Technologies, Incorporated, and he will speak to us on overview of two- and three-entry yielding gate pillar system in Utah mines. Thank you, Dr. Maleki.

DR. MALEKI: My name is Hamid, as everyone knows me.

DR. MUTMANSKY: Can you use the microphone?

DR. MALEKI: I'm going to move around and it may make it worse. Can you hear me in the back. No?

DR. WEEKS: It's wireless. You can move around.

DR. MALEKI: I guess we have to use it.

Can you hear me now? Okay. I would like

to thank Utah Mining Association for the opportunity to be here and present my views regarding observations and geotechnical measurements within the last 30 years. I also would like to acknowledge the permission by Canyon Fuel Company, Arch Coal in letting us use some of the data that we have been collecting in the property. Also, I'd like to thank Interwest Mining Corporation for allowing us to use some of the data that we have been collecting at the Mill Fork tract.

The last time I gave a presentation similar to this one was about 22 years ago. I gave that presentation with Joe in front of the MSHA panel of 30 ground control specialists and the USBM ground control specialist in Glenwood Springs, Colorado. MSHA completed their investigations and there is a report out for the two-entry versus three-entry issues in the deep Western United States conditions.

And here, after that also the USBM got significant funding to look at some of these issues, and they completed a lot of the studies over a period of 15 years. So in my presentation, I am going to try to kind of give you an update from where we were 22 years ago to where we are right now. Bringing also some of the independent evaluations completed by USBM researchers.

My presentation outline is shown here. After some introductory material I'm going to go over the geology and rock mechanic setting of Utah operations. Then I will talk about the historical data, rock mechanic data and monitoring data that we have from three Utah mines, most of it collected by the U.S. Bureau of Mines, and some of the data collected by MTI and mining companies.

Then I'm going to really go more site specific and look at the geotechnical program at the Mill Fork tract of Energy West operations. And then within the very short time we have, actually because we are using a two-entry system, we are going to show you a side-by-side comparison of the two- and three-entry system by modifying one of the gateroads so you can see that in terms of computer simulation. And then I'll go over the conclusions.

I am just sharing with you a very preliminary guideline that I put together in order to try and summarize the experience in Utah mines and why we are doing what we are doing, and what is the relationship between the different design parameters. Very preliminary, but it is something I hope would be informative.

Historic justifications that has been used in two-entry partitions are shown here. Ground exposure increases when you go from two to three entries, and when you have a big roof or rip which can be outburst prone, then you have more ground exposure to deal with. The three-entry system would have a wider total development width compared to the two-entry system, so you need to look at that and the load transfer mechanics. And you can combine all of that in a stress analysis or some monitoring if you have underground, and talk about total system response during the entire mining cycle. Depth of cover is an important issue but is not the only deciding factors, and I will go over that.

I will really focus on the yielding gate pillars. The previous presentation kind of also discussed the issues with that, the critical size pillars. I touch on it, but really I focus on the yield pillar systems extensively used in the West because they limit accumulation of the strained energy as well as they reduce multiple-seam interaction for future mining.

Here I'm showing in terms, of ground exposure, I'm showing a comparison of the two-entry and three-entry systems side by side, so you can see that when you go to three-entry system you open a lot more ground. That means more sag. But at the same time, I'm showing below along this cross section the capacity of the yield pillar to take the overburden load. And then if you have twice that here, there would be additional, because the development width is wider, you are going to have additional load transferred to the sides after the yielding process.

I go to this thing, this is just a schematic. I go more through it with the stress analysis when we get to it. I will get back to this point again. The two-entry and three-entry system, when you go to three-entry you create the potential of having four-way intersections. And in terms of the ground exposure, I have really tried to summarize the information here. And as you can see, your total development width is increased from 66 feet to 114 feet for typical application, a 73 percent increase in exposure. Your roof and rib exposure is going to increase at least by 50 percent, quite a significant increase. The number of intersections is going to increase about the same. And NIOSH data suggests that roof failure is eight times more likely at intersections than in the rooms. And three-entry system certainly creates more intersections, and four-way intersections in particular.

When I talk about ground exposure, I want to really acknowledge that the roof falls are a reality of coal mining, as many of you know. The geology in coal mines varies over a hundred feet distance. You go from one crosscut to another one. If you have done your technical geological work, it's not the civil engineering project. We go over very rapid changes in the geology. And thus, you not necessarily can magically adjust your support. So the more you expose the roof, the higher potential for failure.

The same thing applies to pillars. When you increase your exposure, you are going to create more pillar ribs. And this is a condition at the Book Cliff Mine, and this is a typical 30 foot or 29 foot wide yield pillar. Notice the amount of support we have got here against the ribs to protect the labor against rib movement. So the ribs and behavior of even a yield pillar is not necessarily that all the problems are over. A considerable amount of effort should go into, depending on the conditions that you are dealing with, into supporting the ribs.

Here I'm showing some data from the Book

Cliff site, prior 1985 geotechnical investigations. And the pillar in this blind canyon seam, this is also a yield pillar. And you expect a yield pillar to yield very uniformly, and sometimes it doesn't work like that, depending on your condition. The horizontal and vertical stress meters within the pillar showed the pillar was resisting a lot to yield, and it was going through cycles of loading and unloading before it goes and yields to a residual strength of about 700 psi in this property. So the yield pillars have been great in reducing the strain energy, but still rib control is a concern. A considerable effort goes into supporting the --

DR. TIEN: The negative number is into the gobs?

DR. MALEKI: Yes. That is the head, and that's when the face goes behind.

DR. TIEN: Thank you.

DR. MALEKI: Here I'm trying to really summarize the experience in Utah mines, every mine historically and more recently. With the use of the yield pillars and semi-yield pillar systems, and due to some surveying errors like Sunnyside in some areas went to a 45 foot to 50 foot wide pillars, more recently, in the '80s and '90s.

And what I'm showing you here is as you increase the size of your pillar, the width of the pillar, you basically increase the potential for strained energy to accumulate in that pillar. So the more you go in that direction, the higher would be the potential for seismicity and rib movements, creating potential for problems.

As you move in this direction, you reduce the size of the pillar, the width of the pillar, then you are increasing the convergence. So in reality, other variable topographic conditions, you are supposed to make a balance between the two, depending on your site-specific knowledge of the property, and decide where you go. As you can see, this zone is the zone that has worked pretty well. As you go in this direction, it becomes quite active. And as you go too far in this direction, you may increase too much roof/floor convergence.

The majority of the coal mines in Utah are using a 30-foot wide pillar width. There are a few with 35 and some I have -- we have tested some with the idea of going to 25 feet or less. But this is the idea of the bigger the pillar, the higher the strained energy accumulation in that pillar, the higher the strength, and thus higher potential for seismicity when it starts to fail, which happens usually during the longwall retreat.

Here I am kind of summarizing the geotechnical setting or some of the parameters of some of the Utah mines. We have got two sites that I will use data on this presentation; on the Book Cliff site, and then I have some here on the Wasatch Plateau. I have also shown the horizontal stress ellipsoids for selected properties in Utah. And as you can see, horizontal stresses and in general even the vertical stresses are quite a bit higher on the Book Cliff side than in the other side.

Also, I am showing here regional jointed measurements at different mines. As you can see, the jointing is more or less stress oriented on the Book Cliff. On the Wasatch Plateau site, we have a series of grabbers coming in, and so the fracturing is more in this direction, north/south. And in my opinion, the cave conditions, because of this additional feature, is in general a bit better here. And the mines here, Book Cliff, generally speaking, although you need to look at every property one by one, they have got worse cave conditions.

Here I'm showing what I mean by jointing, not being very consistent. When you go on the surface and look, you see fractures that go -- they are not very consistent over long distances. You go ten, twenty feet and the fracture dies on you. So you do not have this regular set of joint that would help you create a good cave. And that becomes a problem down the road.

Here is a geology, a generalized stratigraphic setting for Utah mines. Majority of the coal mines belong to the Black Hawk formation overlaid by the sandstone and Price River formation. There are numerous quite strong and stiff sandstones within the Black Hawk formation, sand reaching the coal seams that we are mining.

On top of that we also have the Castlegate sandstone, which is quite thick and persistent over the majority of the mines. However, it is not as strong or as stiff. Over the couple of Book Cliff Mines, the Castlegate sandstone reached 500 feet thick. It became a lot thicker. In general it is 200 to 300 feet. Sometimes less thick in terms of the thickness.

Here I'm showing just for your information some of the mechanical properties for the four sites that I showed in my previous slides. And as you can see in here, most of the features in the roof and floor are quite strong and stiff material. You look at the stiffness or the (E) Young's modulous for some of the mines go from four to five to six to seven million psi. These are quite stiff material.

Also you can see the Young's compressive strengths here. Again, the sites on the Book Cliffs site are among the stiffest and hardest rocks we have, followed by really the mines near the Huntington area. Pretty stiff rocks here, and strong material.

The coal seams are quite strong. When they are strong, they are capable of absorbing a lot of strained energy and then when they want to unload they do not necessarily yield peacefully. So that energy is a concern.

This is a sample of a Book Cliff coal tested in the lab. And as you can see, this sample took about 5000 psi, which is very high in compared to the East U.S. coal fields, for instance. And after the failure, it just exploded. And you can see it kicked the top platen off. So these coals are, some of them, are quite strong and have the ability to absorb energy.

This is a sample of Castlegate sandstone. In the lab again. The Castlegate is not as strong.

5000 to 10,000 psi. And not as stiff. However, because of its thickness and persistence, it is one of the factors influencing a long load transfer distance in Utah mines.

Some of the emerging trends in Utah mines are shown here. We are running out of longwall reserves in Utah. We have to deal with very high stress environment. We talk about variable topographies. Utah mines were known to have good immediate roof, and that's still true in some of the mines. But the roof is becoming weaker. We are chasing -- now we have mined the main basins and now we are going around the margins of the area that we are dealing with sand channels coming in and out. And thus the roof condition also is becoming a lot more sensitive. Multiple-seam interaction, competent overburden strata, lagging cave conditions, long load-transfer distances and seismicity are some of the issues.

And in the next two slides I'm going to run some simulations to just show what I mean by lagging cave conditions. When your longwall -- when you mine, you are supposed to mine and the caving is supposed to go all the way to the surface. If that doesn't happen you are going to have a lot of load transfer to your face. And the measurements in Utah mines indicate that the caving is not as we hoped it to be. And in reality, only the immediate stuff caves and the rest of the material transfers the load to the face or to the side abutment. And that is a thing that we have to deal with.

Here I'm looking at the -- next I'm going to look at the caving of the Black Hawk formation. Here, again this is not all the way to the surface. I'm just showing the Black Hawk formation. As I mine the coal longwall here, you see you don't get an immediate caving. You get fractures forming and as the fractures interconnect you'll hear seismicity, sheering of the asparities (phonetic), and then eventually at the background of the seismic noise, you start to get a big event and that's how the caving is in these mines. And this is why we have such unique conditions here in the Western United States.

Now I'm going to go and give you a summary of the USBM investigations regarding particularly two-entry and three-entry systems, and then I'll also show you some of the studies that we have been completing more recently. I understand that someone from the BLM hearing gave testimony regarding his experience at Plateau Mining Company Site 2. This is the first longwall block at Plateau Mining Company. And it's several longwall panels. As shown here, we started mining from here and going that way. Cover is about 1500, 1400 feet here. Not too much variable. And initial three gateroads used three-entry system with 50-foot wide pillars. And then eventually we switched to a two-entry system with a 30-foot wide pillar. USBM had funding to study, and spent a significant amount of time in this property. This is some of the measurements that they completed in three-entry and two-entry systems.

DR. TIEN: What are the units that we are looking at?

DR. MALEKI: Well, this is a slide I had. This is the subsidence after mining two panels. Just please ignore it. In the short time I had, I couldn't remove that and bring it. It really doesn't have much significance to what I'm presenting here.

What I want you to focus on is this gateroad used the three-entry system and they put a lot of BPC into the pillar and kind of measure it. And then on this gateroad, 5th and 4th and 3rd, a switch was made to a two-entry. So there is an opportunity to compare them side by side. And that's where the usefulness of this diagram is. Okay.

The conclusions from USBM study are shown here. You can read it. Marked improvement in gateroad stability with minor floor heave and reduced rib sloughage. A reduction in roof falls on development and retreat. A reduction in gate support requirement particularly at the tailgate. Reduction on load transfer toward underlying lower seam workings, resulting in improved ground conditions in mining these seams. This comes from USBM.

I am moving rapidly to the next site and showing some of the measurements that we have been completing at the Canyon Fuel Company, and the work is summarized here. I just will mention to you the mining layout for the Rock Canyon seam is shown here. This mine is located on the Book Cliff sites. And the cover was only a few hundred feet here and increased to about 1900 feet back here, to the north-east. Initially they started a three-entry system with two yield pillars, 29 feet wide. And as we got the permission, we switched and these last two gateroads were a two-entry system.

Canyon Fuel Company, with our help, implemented a geotechnical program. We had five measurement locations here. On top of that, we had the opportunity to monitor ground conditions during the extraction of this block. As you can see in here, based on the computer analysis, very early on in 2001 we were expecting difficulties at the high cover areas. And these are the eventual barriers that were left. Some of these could not be completed because of the seismicity conditions that we had. There's three dimensional modeling for estimating sizes, and a series of publications describing some of the work that we have done there.

Very briefly here, I'm not going to go through the process, but having five geotechnical instrumentation sites we monitored the pillar behavior here and here, and we plotted it here. We compared it with the computer model at two to three different face positions. So as you have many different face positions and four technical instruments, you can compare and see how do they match. And this is one of the few properties in my entire professional life that we came up with a very good agreement between the stress measurements, pillar behavior, and also the roof floor convergence as I have shown here. There's technical publications that I can provide.

I don't want to take too much time here

regarding the background. All I am saying is that there was some effort to create models that we had some confidence on. When we had that model, then we used the model in order to predict conditions ahead. And this gateroad, for instance, was a three-entry system and it performed quite poorly. Very difficult conditions. The cantilevers forming in here formed a cutter in this entry. Very difficult condition. You can see we could not finish the panel as expected. And the condition in this three-entry tailgate was extremely difficult and we had to stop mining basically in here, leaving the barrier here.

The two-entry system overall did better, although we can't make a side-by-side comparison because of the changes that we went through. But this also gave us the first opportunity to mine beyond the barrier pillar, and could see quite some improvement in ground condition when mining here next to an unmined block. This experience and geotechnical measurements became the key factor for the next block in the Gilson seam. We used a model for sizing the interpanel barriers for this property, as you can see here, which is under a lot higher cover than the first block that we have.

Okay. Moving to the USBM Sunnyside

interview conclusions. You know, the controversy over two-entry and three-entry system has been going on for a long time. But one of the things that the USBM in Denver's Research Center eventually came to do was that they put one of their ground control engineers and he interviewed 30 long-term employees, miners, section foremen, and the people who worked in the Sunnyside Mine for over a period of 30 years. And they created, at the end, about a thousand pages of field notes. And some of the information that you are looking at may reside there. But they also went ahead and kind of summarized the information regarding the experience at the Sunnyside Mine, and these are the conclusions.

Cantilevering roof near the face results in severe instabilities such as bumps and roof falls. Severity of bumps is proportional to cantilever length. Large coal pillars can be safely mined under deep cover. However, substantial evidence suggests that large, stiff pillars become highly bump-prone when subjected to abutment loads.

When a yielding gate pillar is used, limiting the overall width of the gateroad is considered very important for roof stability. The present two-entry yield pillar system - at the time it was 30 feet wide - had virtually eliminated severe tailgate pillar bumps and contributed to reducing face bumps near the tailgate corner. Almost without exception, miners expressed comfort in working in the current two-entry system developed over 30 years.

You know, with all of the things I'm saying regarding the yielding pillars, still there was some concern about having a pillar at your head-gate or tailgate. So some of the investigation, U.S. Bureau of Mines even spent more money to look at the ways of actually going to a single-entry system so you can completely eliminate that pillar, so you don't have to deal with the ribs, the intersections, the crosscuts and things like that. And here I am showing some of the work that was done. On the key here, one single entry 26-feet wide was driven and was partitioned into two sides, supported and fire material sprayed. This is one of the compartments.

USBM considered this experiment a success in terms of the ground control, but it was more expensive. They even carried on and completed the same kind of evaluation in a coal mine using a tunnel boring machine. Here trying to divide it into two decks, upper and lower deck as I have shown here.

Okay. I'm moving into kind of the last

part of my presentation, going into the specific data gathering program and computer modeling that has been going on in the last three years at the Energy West Mill Fork reserve. Other studies have been going on since 1985 in this property.

The first mining district in the Mill Fork tract consists of four to five longwall panels and other freeform has been added. Here's 12 West, 14, 15, and 16 West. Here I'm showing the position of four geotechnical sites that were installed, so that the conditions and the stresses can be monitored here. And also in here, you can notice that the maximum cover is about 2600 feet. Less here, but increasing a lot toward the center of this block.

Although district 1 is single seam, the next district up here is two-seam mining. So a lot of effort is going on in order to optimize mining layouts in this area of two-seam mining situation. Typical instrumentation layout is shown here. And two BPCs in the pillar and three on the solid block side.

On here I want to show that the 11th West and 12th West gateroads were the headgate and endgate of the first longwall panel. The instruments were set at approximately the same depth. This one was a bit deeper. And as you can see in here, the blues are the yield pillars. For the first site the pillar took the load and then gradually unloaded the head of the face. On the second site, which was a bit deeper at 2200 feet of cover, if you can see, the blues never took a lot of load. And what this data showed us was that the pillar, the yield pillar was very close at the edge of its peak strength. It was yielding a little bit on the development. And this has some significance. And as I carry on I'll show the results. Some of the results have been summarized here. Despite what I said in previous slides, we also measured long load transfer distances and also studied the residual strength of the pillar, about 3850 to 700 psi.

Considerable effort was put in order to calibrate the model just like the Canyon Fuel Company. Three face positions was modelled and compared with the measurements. We also did a parametric study of 16 altering elastic properties, peak pillar strength, and cave conditions. The cave condition is quite an important factor and we are trying to see if we can use the geotechnical measurements to see what actual cave condition and how much load transfer we are getting. And then as we mined the second panel, 14 West, we got additional data and we used that to enhance our model.

Here is the vertical stresses on the development for the first four panels I'm showing here. These are the three analyzed face positions, and the location of the first two sites are shown here. If you notice, you see this is the high cover areas. And you see there are some areas that the color pattern is changing here. And the color is so much that the pillar is reaching kind of the yield point and it is downloading, actually, coming down during the development stage in this area. And I will talk about that a bit later.

However, with the two-entry system, still the system is very stable and the pillar is maintaining good portion of its strength in here. The three face positions are shown there. And again, this is the process that we go through, model different face positions, make a cross-section at the deep cover area location. A is here. Compare them to different cave conditions, look at the load transfer, and then compare load transfer to the sites and decide whether you have a good cave or lagging cave condition, a lot of other factors. And this is the process that we went through.

As we mined the second panel, we got additional data. And although we were missing some, and it started to bleed, we got additional data here and improved on the longwall.

The calibrated model, which work was done about a year ago. When this meeting and testimony came up, in a really great rush I tried to do some analysis, and this should be considered preliminary so we can really compare to the side-by-side the two-entry and three-entry system using the same model. So what I'm using is on the 14 West headgate, rather than using a two-entry, I'm switching it to a three-entry system with the same pillar sizes. Everything the same. No other changes. Same thing. And then I compare the conditions during the development; and then we go to retreat the 14 West to the high cover area of location A, look at the headgate loading; and then retreat to location A the 15 West panel, so we look at the tailgate load. Those are the three loading conditions that most people look at. And the results are compared here.

In the next slide, the top is two-entry and the bottom is three-entry. As you can see, the pillar was very close to unload, was in the process of unloading up here. When you go to a three-entry system, the pillar has fully yielded. If we had used that, it would have fully yielded on development. Fully yielding means that you have, over a very large section of the gateroad, you would experience a lot more convergence. I will get back to that point again.

If I compare the stresses during the development for the two- and three-entry system, the two-entry system is shown by blue and the three-entry system is shown by the other color. You can see that the pillar is taking about 3000 psi, below the peak strength of 4000 or 3850, while the three-entry system the pillar has yielded and transferred the load to the sides. So it goes to the sides and deteriorated the rib conditions here on the sides.

Here I'm comparing the roof floor convergence here. And as you can see, the two-entry system has moderate amount of convergence. When you go to three-entry system, suddenly you go from 6 inches to about 8 inches or 9 inches. Quite a significant increase in convergence because you have two pillars that are yielding.

I am comparing here the two-entry and three-entry system at headgate loading condition when I'm putting the second panel to the high cover area.

And then I'm comparing the same thing at the tailgate loading condition, two-entry versus three-entry system. And these are stress cross sections at the headgate and tailgate. And again, what you see is at the headgate the pillars have yielded, transferring the loads to the sides, and the load transfer is higher. This is the face area. It is higher for the three-entry system versus the two-entry system. At the tailgate really there isn't too much difference in terms of the stresses. The stresses are only slightly higher for the three-entry system.

Here I'm comparing the convergence. And this is your gateroads. This is headgate loading conditions. And then this is the face. Less convergence here compared to a lot more convergence here. And you can also look at the tailgate loading condition.

I have summarized the results so you don't have to look at all of those slides that we don't have right now the time to do it. So if you compared the two-entry system and the roof floor convergence, calculate it, you get 5 to 5.8 inches at the entries. For three-entry system you go to 7 to 9.5. It's a 40 to 63 percent increase in the convergence for these conditions that we are analyzing here.

At the headgate loading condition you still get increased convergence, and it goes 10 to 26 percent of an increase. It is still -- 10 to 26 percent is a significant increase.

At the tailgate, there is not too much problem. However, if you compare the outside entry, the tailgate entry to the middle entry, the middle entry on a three-entry system goes to 29 inches, or there would be a 36 percent increase, the outside entry compared to the middle entry. So the point is that the middle entry in a three-entry system really may not be available anymore because of excessive convergence.

Again, when we are doing all of this, we need to remember that the caving is a lagging cave condition in these properties and seismicity is an issue. And here I have plotted the University of Utah data, or actually we are monitoring this but this data was given to us by Energy West. And it shows the University of Utah plot of information during their retreat of the 15 West, the third longwall panel. And you can see that there is quite a number of seismicity here, some exceeding 200. And then you have a three-entry system tailgate as I was showing. Even if the stresses aren't too much different in the tailgate condition and you superimpose that with a lot of loading, dynamic load, with the long cantilevers, the tailgate stability can become quite critical.

The conclusions from this study is shown here. And really from a geotechnical point of view, a two-entry system is better than the three-entry system; an assertion which is supported by four decades of experience in Utah operations, in many Utah operations. Depending on site-specific conditions, one needs to make a decision on the necessity of the two-entry system to ensure stability. The decisive factors are geology, and by that I include or I mean the strength and thickness of the material, presence of the load-carrying members, and the depth of cover and cave conditions. The poorest cave conditions in my opinion exist in the Book Cliff mines.

Besides obvious benefits of reducing ground exposure, site-specific simulations at Mill Fork shows significant reduction on convergence in both extent and duration. And thus a two-entry system is judged to be better for the deep conditions and lagging cave conditions of this property.

Certain geologic and stress conditions

require the use of barrier pillars located at strategic locations and/or between panels to moderate stress and ensure stability, even when you are using the two-entry system.

So my very last slides, really I'm trying -- this is a very preliminary thing I put together. And it is based on some calculation but has to be refined. I'm trying here to show side-by-side extraction and how the stresses build up in the tailgate, average stresses here. And I'm plotting that here, versus the depth of cover. If you are at a thousand feet of cover, you can see that the stresses at that area or at the face are quite low. As you increase and go to 2000 feet of cover, you can see that the stresses are increasing a lot. And if you go to 3000 feet of cover, you can see how the stress is probably reaching 25,000 psi. Very high stresses you are dealing with.

And the other factor I have tried to emphasize here is not just the cover load. It is also what cave conditions you have. And the cave conditions in my opinion plays a very big factor. And here you can see if you have a good cave, you are down here. And if you have a poor cave you are up there. So you can be in a Colorado mine with a favorable cave and you can go to 3000 feet of cover, and mine without any big issues. But if you try to do that at the Book Cliff, some of the Book Cliff mines with very poor cave conditions, you could get into a very critical situation.

On the top here I'm trying also to summarize the experience in Utah with the two-entry system. From really very low cover all the way to 3000 feet has been used with a three-entry system which mostly has been used in this area with concerns. And also, these are preliminary guidelines. Also I am showing in here again, depending on geology and cave conditions, I am showing the zone that even a two-entry system by itself will not resolve your conditions at the tailgate corner, and under some conditions you need to start to think about yielding pillars at strategic locations in order to moderate the stresses and be able to provide stable conditions. That's all. I know I tried to fly over a lot of material but I did want to give you some of the USBM studies as well as show you some of the site-specific factors involved.

DR. MUTMANSKY: Thank you for your presentation. Panel, do you have questions?

DR. WEEKS: Thank you very much. This was exceptionally informative and I appreciate it very much. But I have the same problem I had before. And I would like you to go back to -- you put up a table looking at convergence measurements comparing two- and three-entry. This is important data because it -- that's it right there. This is important data because this gives us real outcome measurement of the consequences of using one system or another.

Let me tell you what I'd like to see in this data to make it more convincing to me. And I hope this is not mere nitpicking. Here is what I'd like to see in each cell that would make it more convincing. One is the number of measurements that were made. And I'd like to know the conditions of measurement so that I would know that one measurement is, in fact, comparable to another. By conditions of measurement I mean roughly the same place, the same conditions, and so on.

But the number of measurements, it would be useful to have some measure of central tendency like an average. That's assuming it is normally distributed, the measurements are, and it might not be because a lot of phenomena like this are not. So a geometric mean might be a more appropriate measurement of central tendency. And some measure of distribution.

When you have a range there, it's entirely conceivable that a range measurement, you know, most of your measures could be for example 5.0 inches and there's one outlier at 5.8. That's an accurate description of the range. But a measure of central tendency I think would be more pertinent because that's what we are interested in is on average what's going to happen whether you use two-entry or three-entry type of development. And if you do that for each cell and the measurements are, in fact, comparable then I would confidently say yeah, under two-entry versus three-entry system there is a difference. But when it is presented like this, and I believe you probably would come out with the same answer, but the question is one of -- you have only given two measurements in each cell, the top and the bottom. And you have lost a lot of information that's very useful and very important.

DR. MALEKI: Those are good comments. I appreciate your comments. And really I think I have flown over a lot of material when I drafted. I just want to make sure I understand your question. The numbers that I have here are not measurements. They are calculations coming out of a computer model which has kept everything the same except changing one thing, which is going from a two-entry to three-entry system.

The reason I have a range in there is that this is actually a fine model, although we are looking at a very large area. The measurements are about twenty feet elements. So in a twenty foot entry, I have got two elements so I can go and get the one at the rib of an entry, which because it is next to the rib it is less, or if I go out at an intersection the number goes higher. So the range that I have here, and I apologize for not clarifying it, one of them is for the kind of rib side or the minimal, and the other one is the maximum for the intersection for the two- and three-entry system.

Now, I also have even --

DR. WEEKS: Let me just respond. I don't know, you might have said that and I missed it when you went over it. I apologize if I assumed something that wasn't there. But just the fact that it's a computer model is quite useful because I realize the limitations of making actual measurements in the mine. You are not going to drive two-entries, take a bunch of measurements and then drive three-entries and see what happens. That is not going to happen.

I mean, as an experimental protocol. A mine is not a place to experiment. It's a place to mine coal, which I recognize.

I had this curious experience as you were saying, "Well, I don't want to go into that." I thought, "But wait a minute, I do want you to go into that," at an earlier graph. But if there were measurements like this that were comparable and so on and so forth, of actual occurrences in mines, it would be better. Now, maybe computer simulation is the best we can do. If that's the case, that's what we deal with. But I'd just like to see more. But thank you. It really was very informative.

DR. MALEKI: I appreciate it. You brought this question before and really I tried to give you what I see as a problem in the direction you are going. The problem is when you can go to MSHA and get pretty good range of statistics from different coal mines, you can try to go -- and it has been done in the old days, to try and say, "These are the two-entry and these are the three-entry system. How many roof falls do you have here versus that?" The biggest problem you always get into is am I comparing apple to apple? This was here, the other one was here. They are pretty close, but that's about 700 feet distance. And geology changes, so you really are going to become -- it becomes very, very difficult. Support could vary. There are so many other factors involved. So coming to that answer as a one-to-one would become kind of difficult.

There are some records like that, like at the Cyprus Shoshone, and you have a copy of that. And there are other mines. But you always will never get away from this fundamental problem: How am I making sure that the conditions were similar; the mining, support, and geometric.

DR. WEEKS: Right. I think that's a very important problem, and I recognize that. I don't quite know.

DR. MALEKI: So really, the approach I tried to use here was let's not just grab a computer model and run with it. Let's use a model, and I know there are limitations of computer models. I'm very well aware of them. But also there's advantages that they have. And you can get more sophisticated as you go from one to another.

But for a typical coal mining, this element of computer models are perfect because they let you do a lot of things. But the advantage you gain if you accept the limitations is that then you can keep everything the same. And if you had had some measurements that you have been able to say, "Hey, the model is kind of predicting what we see underground so my parameters are not too wide open," then you can kind of say, "Okay, now, this is two-entry and at the same place I'm going to do a three-entry. What's the difference?" And then you can make a side-by-side comparison.

Now, I don't know what I said that confused, I apologize for confusing you. But when I said, "I don't want to go into it," sometimes I mean I don't want to make this presentation to become too long. There is some additional information I may be able to give to you or some of the modeling and stuff has been published and you can take a look at it. And that's what I meant. I didn't -- I just didn't want to take too much of the Panel's time.

DR. CALIZAYA: I have two questions. One question deals with the panel dimensions, length and width of the panel. It seems that with the two-entry system you can go farther, and with the three-entry system you reach the limits in some cases. Could you explain a little bit about that?

DR. MALEKI: I am not sure I exactly understand what you mean by "reaching the limit."

Are you -- in terms of ground control problems or in terms of geometry or what?

DR. CALIZAYA: I'm just trying to interpret the results of your drawings. And in one case in the two-entry system we saw the dimensions of stress distribution, convergence and so on. They were quite different from three-entry systems. And it seems that your panels were about the same length.

DR. MALEKI: The same. I haven't changed the panels. Everything is the same. The only thing that is changed is comparing the two-entry, I have another entry added. So the total development width instead of being 66 feet if you use the two-entry, it is extended. When you increase that, then the model and the calculations or observations or measurements, if available, they can tell you what the differences are.

DR. CALIZAYA: Okay. That was one question.

DR. MALEKI: Okay.

DR. CALIZAYA: The second question deals with ventilation system. Do you think that this bleederless system would be a better alternative for some cases?

DR. MALEKI: I think for every property,

depending on what your roof is, what the floor is, you've got to look at site-specific conditions. And if you have concerns regarding bleeder designs that may not be the best for what you are doing, then you have to use a sleeper design. Bleederless designs also have been used quite often. And there is a trend in the West, this is a trend in terms of ventilation, can show that it can be done. From a stability point of view it would be very good to make improvements in those areas. And BLM would be one of the agencies that would be very interested to maximize your source recovery by what you are suggesting.

DR. CALIZAYA: Thank you.

DR. BRUNE: I have one question for you. In one of your earlier slides, I believe you showed something about the miners feeling more comfortable with the two-entry design. Can you tell us where or what that statement is based on? Is that some formal questioning or interview process that was done?

DR. MALEKI: Yes. I have quoted to you USBM publications, I have quoted exactly, although maybe not very clear in some places. But I have quoted you exactly what the report said and I will provide you that so you can see that.

DR. BRUNE: Thank you.

DR. TIEN: That was quite good. Very impressive. A general question on this one. The input are based on actual measurements?

DR. MALEKI: Yes.

DR. TIEN: Are they site-specific? I guess what I'm getting at, do you have another set of this comparison table for different formations? Do they come out in the same range of the increase or decrease?

DR. MALEKI: See, the critical parameter in this modeling, besides the material properties, are easy to test. There is a procedure that we go from lab to field. Those are more established. The area which is very subjective is how do you model the cave and how much load goes through the cave versus how much goes to the sides. That's an area that I spent almost all of my professional life in order to study it. And we actually have got Doug Johnson and I have spent a lot of time at one of the sites to try to make some very unique measurements to find out what is going on in the gob.

So if you can't make the measurements in the gob, which are very hard, then what you do alternatively is you come like what I presented here:

You make measurements on the gateroads. And if you have sufficient measurements and you look at it carefully, then you try to backtrack with what is the gob condition.

So in one mine, yes, based on these measurements in one mine you could indicate that yeah, I had pretty good cave conditions and these are what I'm going to use for that. In another mine, you can use a completely different setting.

DR. TIEN: I understand. What I'm getting at is would it be right for me to make a statement between the two-entry and three-entry development entries I would expect a 40 to 63 percent increase in Utah area?

DR. MALEKI: No. I would never say that. That is only true for the conditions at 2500 feet of depth that we have analyzed.

DR. TIEN: I'm looking for the qualifiers.

DR. MALEKI: And for the geology of this reserve that I'm talking about, the reason for that last diagram was actually a specific that some mines in Utah have used different configurations.

DR. TIEN: I understand.

DR. MALEKI: So you've got to -- really, I think my point is that we don't have a general rule to apply to everything. You want to build a house, you have to study the foundation and the whole nine yards. And for every mine you have to look at those conditions very carefully. And based on the site-specific condition, you decide whether you need to have a two-entry system or three. How far can I go in terms of depths of cover? Where do I need to consider to stop mining and where do I need to incorporate other features?

DR. TIEN: Sure. I understand. Thank you.

DR. MUTMANSKY: You made some -- you discussed some things that haven't been discussed before in our exposure so far. And one of those was you showed some slides where there was a large increase in topography directly over the panel itself, and where that was interpreted to mean that maybe you wouldn't mine through a whole panel and you would have to adjust your panel mining procedures to accommodate that large mountainous feature on the surface of the topography. Do the topography changes greatly affect the rock mechanics of an individual panel in the Utah region? My question is does the change in topography over a panel have a great influence upon the stresses that occur in the underground area?

DR. MALEKI: Yes. In general, the answer to your question, it's a very important factor in Utah. The rate of the change has been cited by many investigators. I can provide you technical papers written by myself and some co-authors from NIOSH that talks about coal bumps, what are the factors contributing to that. And that's one of the factors.

But having said that, I'd like to also say that we have properties in Utah that we have mined up to 2500 feet and have gone under this topographies that change, and Sunnyside Mine is one of them, and I have spent time underground at 2500 feet. And they have been able to do it. The question, again, is what condition are we dealing with? What is acceptable? And how far -- how do you tailor this thing? And because of all of the constraints that we have, really the engineer should look at all of this aspect, including ventilation, rock mechanics, resource recovery that BLM is asking for, and then kind of decide that for this property I can go to 3000 feet. For this property, after 1000 feet it is very troublesome.

DR. MUTMANSKY: Thank you for that answer. Any other question from the panel members?

DR. TIEN: We are going to have copies, right?

DR. MALEKI: Yes.

DR. MUTMANSKY: We will be getting copies. Thank you very much. I appreciate your coming down here today and giving us this presentation. Thank you for coming.

DR. MALEKI: My pleasure.

MS. ZEILER: Yes. Thank you very much. And I suggest we take our lunch break now and we will reconvene at 1:15.

(The lunch break was taken.)

MS. ZEILER: Before we start the public input session this afternoon, I think Jan would want to say a few things about our next meeting of the Technical Study Panel.

DR. MUTMANSKY: The Technical Study Panel will meet in Birmingham, Alabama. The exact place has not been determined as yet. But the dates will be June 20 and 21, and the panel will consider adding a third day if there are enough speakers and enough information that's necessary at that particular time.

The meeting in Birmingham, Alabama will emphasize AMS systems and its relationship to the belt air question. As of the moment, we have scheduled a UMWA panel to discuss their feelings about belt air. We also have lined up Tom McKnighter to speak on some of the Eastern mine issues. There will be a number of other speakers from the AMS community. We will try to line up speakers in the next week or so here so that we can announce the exact speaker identities before the meeting. At this point in time, if you have any questions about that meeting, we'd be happy to answer them as best as we can at this point.

Okay. I think that's all.

MS. ZEILER: Okay. First up this afternoon on our list of speakers will be David Litvin who is the president of the Utah Mining Association.

MR. LITVIN: Mr. Chairman, esteemed members of the Technical Study Panel, on behalf of the Utah coal mining industry, we very much appreciate you being here and we thank you for your efforts to come to Utah to understand the benefits and use of belt air in underground coal mining, and particularly with the two-entry system.

I'm David Litvin, president of the Utah Mining Association. The Utah Mining Association, known in Utah as the UMA, was founded in 1915. It has been the voice of the mining industry in Utah since that time. It is one of the oldest and most prestigious business associations in the state and our purpose is to support and to promote mining and minerals industries, and also all the support industries that are critical to this vital industry.

UMA currently has over 200 member companies that have either mining operations in Utah or provide support to the industry. In fact, in the year 2006, the mining industry in Utah accounted for nearly 50 percent of the state's total exports of $6.8 billion, and the mining industry has been the backbone of this state's economy for 150 years.

For coal, Utah ranked 12th in the nation in total production, and in 2006 produced over 26 million tons. Utah is very unique as compared to other Western coal mining states in that all of our coal comes from underground coal operations; some of which, of course as you've heard, are some of the deepest in the nation.

For the period from 1990 to 2004, Utah's coal injuries decreased 75 percent, as shown in the attached table to my testimony. As an aside, over the same time period nationally in the coal industry, the industry reduced about 55 percent. We believe that the safety statistics clearly show that the belt air two-entry system in Utah's underground coal mines is a demonstrated safe technology.

For today's meetings before this panel, we have arranged for several Utah coal operators and technical experts to appear before the panel to discuss all aspects of the belt air two-entry system usage in our underground coal operations; the safety benefits for both the workers and equipment, ground control measures, mine monitoring safety features, and the need in Utah for belt air two-entry system because of the deep mining that occurs here and the surrounding geology.

In conclusion, we thank the MSHA Technical Study Panel for their visits to see firsthand belt air usage two-entry system in Utah's deep underground coal mines and also for the meetings here in Salt Lake City. The testimony that you have heard and will continue to hear this afternoon and the visits that you have taken to the Utah coal mines clearly demonstrate that the belt air two-entry system is a safe and essential technology for Utah's deep underground coal operations. It's necessary to properly ventilate our coal mines, and for effective ground coal in a manner where safety is enhanced, not compromised.

It is important for the panel to appreciate the overall safety benefits for both mine workers and the equipment derived from belt air ventilation two-entry system. History has proven this belt air two-entry system technology is both the safest and the most effective for Utah's deep underground coal mines. Thank you very much.

MS. ZEILER: Thank you, David. Our next speaker will be Laine Adair, who is the general manager of Utah American Energy.

MR. ADAIR: As she said, I'm Laine Adair. I'm the general manager of UEI, UtahAmerican Engineering operations in Utah. We presently run two longwall mines and one -- we had a third longwall mine that we pretty much mined the reserve out, and now we have a continuous miner in there using mobile lift supports pulling the mains in the barriers.

So anyway, first thing I was going to do was talk a little bit -- and I apologize to the members of the committee that have been to our mine. I'm going to repeat pretty much what we said but we wanted to have the other committee members hear this, as well.

So first thing I was going to do was point out some of the geology that set up the coal reserves here in Utah. You can see this is the cretaceous area so our coal seams are in the top area of the cretaceous. And this is the map of Utah, right here. About 90 million years ago the Gulf of Mexico came up through the Great Plains, up past Utah, up into Wyoming, and formed the coal beds up in the Powder River Basin, plus our reserves here in Utah. So what was happening is the ocean would come up, and it would progress to the west. And then it would retreat to the east. And we see examples of that in the outcrop data throughout our reserves. And then the land would sink, and the ocean would rise and the ocean would come in again. Typically it would not go as far west as it did the last time, then it would retreat to the east again. This went over and over and over again.

You will see what was happening was as the big oceans would retreat, it would have a white beach sand and the top of the beach sands are bleached white from the sun and the waves rolling through the sand. As it would retreat from the west to the east, typically on top of these beach sands you will find the major coal seams that we mine. And they would just lay down the peat and the swamp behind the ocean as it retreated.

And then typically you would have big mountain formations to the west. And as they eroded, they would have sandstones and water and additional little small swamps and things that would come in behind. So typically you will have major beach sand and then you'll have a big major coal seam on top of the sand, and then silt stones and sandstones and shales. A lot of channel sandstones where these rivers ran through there and cut out the sandstones and silt stones. In many cases they even cut out the coal seams. And then you will have another beach sand on top of that. And you'll also have different little coal seams.

Most of our coal seams are very lenticular, small areas. A major coal seam in our area where you go in, it might be three or four miles one direction and typically the mining to the down-dip would peter out before that because of mining conditions. It's not like back East where you go through many states in the same coal seam. They are very lenticular and it is hard to lay out your mine plan with any real long-range plans to get past where you run into all these outside edges, the marginal ends of the reserves. So as you mine out to the perimeter of your mine, you are typically running into the depositional margin of the coal seam and it makes the mining conditions a lot tougher in those areas.

Some of the major characteristics and how they relate to coal mining. This mountainous terrain that we've talked about has steep incised canyons. This is extremely important. We see this in the mine. You can have a set of gateroads for the longwall panels and longwalls straight just as an arrow. You might have a thousand foot of difference in cover in one gateroad. If you are trying to design a stiff pillar or a medium-size pillar that is going to stand and yield and do certain things, it's going to have to be designed under 1000 foot of cover and maybe 2000 foot of cover, and that's turned out to be just about impossible. And that's another reason for the two-entry yield pillar is because they have proven they will perform about the same at 1000 foot the same as they will at about 3000 foot. There's differences in them, definite differences in them, but you can best handle those differences in terrain.

You'll also see that these big mountains -- as the longwall is approaching a big ledge, it might have 400 foot vertical escarpment. As you approach that ledge, you will definitely see very much increased activity of bouncing as you come into that ledge. You see the same kind of thing as you retreat away from ledges, as you get point goals coming down onto the coal seams.

We also have these massive sandstones that form the big ledges and silt stone cliff members. And they are not very well jointed. We talked about the joints, Dr. Maleki showed us the diagram that showed all the cleavage plains, the joint formations, and they are not very well jointed. The joints are spaced far apart and they don't cave real well, therefore they hang up over the gob and it puts cantilevered pressure out over the perimeter of your gob. The perimeter of your gob gets highly loaded and highly stressed.

There's several coal seams that sit directly on these massive sandstone. The floor doesn't want to heave. It's not going to move. It makes good roadways, but it can be real strong and hard on your pillars so that they want to bounce.

You've got low negative angles of draw. Because of these spaces in the poorly spaced joints and stuff, it doesn't cave real well. So you will get negative 15 degree angles of draw. Typically, in an Eastern mine, when the longwall pulls a block of coal out of the coal, it will slope over like you'd see a hope in a sandpile. And it might be 45 degrees that that will slope back. Well, in some of our mines in the Book Cliffs, we have actually seen negative 15 degrees. So that just means that big rock is hanging out over that panel pressuring down on that perimeter. And 25 degrees is some of the average angles of draws in the Wasatch and some of the Book Cliff places, and that again is still very low compared to what you see in the Eastern mines.

These major sandstone channels that we see in the mine, they came down across after the peat, after the swamp was laid in there, and they would come rolling out across there and they'd cut out the silt stone and sandstones, and like I say sometimes they would even cut out the coal seam or cut out several feet of coal seam. You can be mining along in a ten-foot coal seam and have a stream channel come through and take out five foot of coal, and now you have five foot of sandstone in there. And your roof conditions and your point loads on your pillars and pillar designs are affected by these.

We have these major rolls and we showed

the gentlemen that toured the Aberdeen Mine some minor rolls, some routine rolls where you are standing along the longwall face and it rolls up. You have an overall 10, 12 percent grade. You get rolls in there and you can't see more than about 20 shields at a time. I have seen major rolls that have kicked over as much as 22, 25 percent grade in the mine. A lot of times for the sheer where your longwall trimmers get through there, it won't even bend enough. It has to trim off the roof and then trim off the floor as it goes through because it just rolls too hard for your equipment to get through.

And then we talked a lot about the deep cover, up to 3000 foot. A lot of our longwall panels, our West Ridge Mine went in from the outcrop and laid out a panel to the right. The second panel to the right was under 2000 foot of cover. So the coal seams are going down and the mountain is going up and the cover picks up real quick.

We see a lot of faulting in all of the area. Everybody knows there's a lot of geotechnical things happening around a fault. And you'll see highly stressed areas. You'll see distressed areas. But they definitely play into your pillars and your gateroads and your face.

And then the coal is very brittle. It's strong, as has been pointed out by the technical people here today. And then there's a lot of multiple seam mining. The coal seams in the Wasatch Plateau, as the ocean would come in to the west, the earliest depositions were in Wasatch Plateau. They are also the lowest in the section. The ocean would retreat to the east, come back to the west, typically not quite as far. Then back to the east and back to the west not quite as far. So in the Wasatch Plateau, you have what I call from the Aberdeen sandstone on down into the lower seams.

When you get into the Castlegate area you've got as many as ten coal seams that have been mined in the one section. There's places there in Castlegate where up to six coal seams have been mined one on top of each other.

As you work out to the Dugout operation to the west side with the West Ridge Mine over there, you are way up high in the section. You are up getting close to the Castlegate sandstone, and the bottom seams don't even exist in that area.

This is just typical, and this is quite typical in almost any canyon you go up in the Wasatch or Book Cliff coal field. This is the geological section of the coals at Deadman Canyon where Aberdeen Mine is located. The Aberdeen Mine sits right on top of one of these white beach sands, and then the Aberdeen seam. And then we've got silt stone, sandstones, and little rider seams that sit on top of that, and all those big channel sands. And then you've got the Kenilworth sandstone which is another big, massive beach sand that sits on top of there.

Now several years ago I started calling this a "bounce sandwich." You've got massive sandstone, you've got strong coal, strong silt stones and coal seams, and then you've got another massive sandstone on top of that. This situation occurs in the Aberdeen seam right where we are mining in the Deadman Canyon. You also have, further to the west, you have the same thing with the Sub 3 seam and the Aberdeen seam. There's quite a few situations where you see this.

The big, massive Kenilworth seam sits on top of that sandstone. It was quite a famous coal seam, mined from 1908 through 1972, 25-foot thick coal. Then we've got the Pinnacle Mine, the Gilson seam, the Centennial seam and other massive white beach sand, and then the lower Sunnyside sandstones. This is the coal seam we are mining in at West Ridge, and these coal seams are gone by the time you get clear over to the West Ridge.

This is an example. This is the road cut by the power plant there in Castlegate. The gentlemen that went on the mine tour drove right through this. The Aberdeen sandstone is from right here to right there, and you can see that white cap on top of that Aberdeen sandstone. Then you've got these interbedded silt stones and sandstones. You can see them on the outcrop here. This highway cut was made in the early 1960s, so it's been standing there all that time. See how rigid? You can still see the drill hole marks where they did their pre-split and their blast on it.

Now this is the top of the Star Point sandstone right here, and it's the same size as this Aberdeen sandstone and it sits right on top of here. So when we were mining this in the Cascade number 3 Mine, where a Sub 3 seam was sitting right on top of this sandstone, and then we had this big Aberdeen sandstone above us. Now, it's about a mile from where this road cut back to the ledge. This is the Castlegate sandstone back there.

Now, this is a closer up view of that Castlegate sandstone. This is in Willow Creek. This is the old facilities for the Willow Creek Mine. We had the Bureau of Land Management in here yesterday and they talked about some of the seismic events that they had in this mine. And they showed the 4.2 on the Richter scale. And that was a result of this big Cascade sandstone. This is where it is most dominant, near the town of Castlegate, about 400 or 500 foot thick. And when they were trying to crack that to get to their longwall panels, as they tried to break that sandstone, it was breaking them.

So this is the Castlegate sandstone from here to here, and above that is the Price River formation. It's nothing to mess with. Look at those massive sandstones in the Price River formation.

Now, this is a picture of the West Ridge Mine up in Seed Canyon up by East Carbon. Here are these different beach sequences where the ocean came in, it retreated. It came back in, retreated. It came back in, retreated. It came back in, retreated. And this is the lower Sunnyside sandstone. The lower Sunnyside seam that we mine at West Ridge sits right on top of this sandstone. If this picture went a little further, it goes up here like this and then there's the Castlegate sandstone right there. So these are massive sandstones. They are strong, they are not jointed, and they are not conducive to caving.

Now, this is just a picture of a very small channel sandstone, and this is just an old stream that ran through here. You can see kind of a wedge shape there. The rest of it goes out to a little wedge and comes back in. But if you are mining along -- if you have any kind of roof control books or studies, they talk a lot about these channel sandstones, and you are trying to control that roof. Well, you get this depositional area where it's been cut out. This is going to fall in on you. Now, this silt stone that's been left here between the top of the coal and the bottom of that sandstone there, it's not going to stay up. It wants to fall in on you.

And then if you've designed a pillar to be doing just perfect under this nice laminated material and you are driving out there, it's like Dr. Maleki was talking about where all the sudden you drive underneath this massive sandstone for the next 100 feet and then it's gone again. So you have all these variables going on in the mine almost constantly.

And the thing we have found is trying to design just a perfect width, we found the best thing to do is to be with a yield pillar. And they will load the energy to a certain point, and then they start to yield off. A stiffer pillar is going to load to higher and higher pressures. And then there's another big thing that's been discussed a little bit here today, but it's how the pillar yields, how the coal seam yields. You might do some studies on a couple different coals and find that once they load up around 5000 psi they yield. But one coal will crumble and fall in a pile, the other coal wants to blow a foot off, or two or even five foot of rib. So there's differences in how a coal seam yields, as well.

Now, my experience in the Book Cliffs and the Wasatch Plateau is that the mines from the Dugout Mine over through the top of Price Canyon in that area, the coals have a lot more tendency, when they do yield, they yield in a more violent fashion. Even with very, very small size pillars.

Now, you have all seen this map. I think I will jump past it.

This is the Book Cliffs coal field down through here. And, excuse me, the Wasatch coal field here, Book Cliffs over here. All of these geologic features I have talked about exist in both of these fields. The Castlegate sandstone is a little bit bigger and more dominant here and kind of thins as it goes east and west. But basically these coals over here lie flatter. They are about zero to 10 percent grade and these over here are steeper. They are more in the 10, 15, 18 percent type grades. These coals in the Wasatch are nongassy and these in the Book Cliffs are very gassy.

Now, basically the outcrop goes right around these coal properties, right around and down the other side. And what has happened in the past is the coal companies have come in and they started mining around 1880 and they would come in. Pretty much it was the big railroads when they came to town that got the mines going. But if you look at this property right here, this is about 14 miles across there. There's 24 coal mines in that area right there. And what they would do is start on the outcrop and they would mine down in the mountain and usually get into about 1000 feet of cover or 1500 feet of cover and then the mining would stop because of the conditions. They couldn't keep the entries open, couldn't pull pillars which was more productive, economic for them, and they couldn't control the ventilation. Basically, if you study those mine maps you see they drive the mains down the hill, they'd set one set of rooms off to one side or another and they'd pull pillars back somewhat successfully. The next time they went out they might pull back halfway and have to abandon them. The third time they pull out, pull pillars back just a little bit and give up. And the rest of the mine would just be first mining, and they have abandoned second mining all together. And that's pretty much a rule.

So what we see right here, we went into longwall mining and two-entry mining. Now, two-entry operations, you've got the West Ridge mine here, a longwall mine, two-entry; you've got the Dugout Mine right here, longwall mine, two-entry; the Aberdeen Mine, longwall mine, two-entry; the Skyline Mine, longwall, two-entry; and the Deer Creek is longwall, two-entry. The other operators in the area are the CW Mining. They've operated a continuous miner operation here and they are planning a longwall here in the future. You've got the SUFCO operation, a major longwall operation. They use three-entry systems and have been very successful to date on that. I don't know what their future holds for them. You have the Emery Mining Corporation. They are down in the Emery coal field, a couple thousand foot lower in this coal section than what these are up here. And then you have the Horizon Mine which is a one-unit operation. And they are a continuous miner room and pillar operation.

The major thing -- you have heard us all talk about the Sunnyside Mine. There were major mines, major railroad mines here, the plateau at Hiawatha Country, the Sunnyside operation. We have all talked about Sunnyside because that's where longwall mining started in the Western United States here.

So pretty much what I told you about how mining started, the depths we got down to, as all that was done we found out that narrow entries, minimum number of entries, large stiff pillars in the mains and small yield pillars in the panels. So that's what we pretty much learned.

Well, come the '50s and the '60s, all the mines have pretty much mines in the easy coal down to 1500 foot of cover and the technology wasn't letting them go any deeper. And pretty much the coal field was being said it was mined out. They couldn't mine any different. But John Peperakis, we have heard about him, he went to England during the war and Germany after the wall and he brought the longwall idea back into the United States. We started the second longwall mine in the United States in 1961 or 1962, I've heard a couple different dates today, and Peperakis brought that in. They started with a two-entry yield pillar gateroads because of all their experience with the continuous miners and the pillars they had pulled over the years.

They also had some extreme disasters. There's a lot of technical papers on all the problems they had with mains and barriers and bursts and yieldable arches. But they were allowed to start, and they used it just through their roof control and their ventilation plans with MSHA. They were allowed to drive two-entry gateroads. They experimented with other things. Gary Skaggs mentioned how they tried with Bureau of Mines some single-entry gateroads where they put a barrier down the center, they built stoppings for thousands of feet down the center. They couldn't control the 25-foot width of the entry that required to have a belt and a return on one side of the stopping and in-takes on the other side. But it was very successful as far as not having any pillars in there. But with this design they mined 41 panels from 1962 to 1992 to a depth of 2900 feet of cover. They were a very successful operation.

The other mines, the small family-owned mines, were being bought up by big utilities and oil companies, and they were getting ready to start big production. The 1970s, the oil embargo, buying low sulfur coal from the West, burn it in your plant in the East, you don't have to build a scrubber on your power plant. So you had big companies like American Electric Power came out and opened up the Braztah Mine. That was the second longwall mine out here. It started in April of 1976, followed by the Deer Creek and the Plateau mines.

But as these mines started up, the biggest question and concern was how are we going to control the ground? That was the biggest concern because of the history and experience out here. So they had the Bureau of Mines and Charles Holland and Arthur Wilson and British National Coal Board, and a lot of other consultants got into this and tried to get the technical expertise in there to be able to mine these reserves.

Now, the point was none of the regulatory agencies took the two-entry development lightly. And you had to demonstrate, and you are still being asked to do that these days, to demonstrate that you actually need a two-entry system.

Now, this is a map of the Braztah number 3 mine. This longwall started here in April of 1976. And so as part of their requirement to demonstrate a need for a two-entry system -- they wanted to start with a two-entry system, based on all the experience at the Sunnyside mine. But this was a 50-foot wide pillar, a three-entry, 50-foot wide pillar. That didn't yield. The next gate was a 40-foot wide. So you can see the first panel was started almost as a test. A 50-foot wide and a 40-foot wide pillar, and then they went to 30-foot wide three-entry systems. These were still too stiff. A 30-foot wide angled crosscuts to soften up the pillars a little bit.

And then this panel here, this longwall beat itself to death. That's a month's worth of retreat from right there to right there, my little red dot, and it finally bounced itself to death and stopped here. Now, the Bureau of Land Management, this is federal coal, they wanted this mine. So a new longwall, this one was just abandoned right there. A new set of shields, or chalks, excuse me, was started up here.

This longwall, the BLM wanted this coal mined. They forced us to go in there. I wanted to use a yield pillar so I went to a 20-foot wide. And the reason I'm pointing this out is at this mine, this seam, this 20-foot wide pillar finally yielded without violence. And that was very, very important when we did that. The problem was by the time we mined the top of the hill, this all converts down here and we couldn't get the equipment out of there.

So then when the longwall mine passed here, the air went through there and started on fire so the longwall sealed here and here. After we experimented with these smaller pillars and the technical results showed us that a 20-foot wide, even a 15-foot wide pillar was recommended for that seam, we went to try a two-entry, but big stiff pillars. And the next panel, you can't see them up here, were right up here. The very next panel up here, it had the Castlegate sandstone, and running parallel right down the center of the panel there was almost 1000 foot of cover difference between the tailgate and the headgate on that longwall panel.

This is 800 foot deep right here. This is 1600 foot. The next panel was 2200. We have had some discussion about just how deep it is. An awful lot of this has to do with the rocks that you're dealing with. This is where the subsidence lines was put in by the Bureau of Mines, trying to pick up these angles and draws. This never did -- ten years later it was still a negative 15 degree angle of draw. Never did settle down.

The next two panels up here bounced and banged and eventually the longwall was sealed in the mountain. There's a dead longwall here, one there, there's one about here, and two miles away there's one in Willow Creek sealed in. So there's been some real mishaps trying to figure out how to mine this coal.

Now, you've seen this map several times the last few days. The point I'm trying to make here is companies have come in. This two-entry has never been taken lightly. You have always had to demonstrate a need for it. Plateau operations started out with a three-entry, then they went to a three-entry staggered crosscuts to try to eliminate the four-way intersections. Eventually allowed the use of the two-entry systems, and they mined longwall panels in this area for almost 20 years, very, very successfully once they were allowed to go to the two-entry system. And mined through some major faulting and other complications like that. It's another example of a very successful operation.

But the key point I'm trying to make here is how we have gone time and time again, and it's not just me talking. You talked to -- Dr. Maleki talked about all the pressure cells and closure sections. There's been all sorts of technical data collected and studied and reports written. The best minds we can bring in to figure out how to do this.

Now, this is an ugly green picture of the Aberdeen Mine. Again, this mine was portaled in 1990 and started longwall and some other seams in 1994. We wanted to go to a two-entry yield pillar system. We still were not allowed to do it until we demonstrated that we had to have it. So this is a three-entry yield, three-entry yield, three-entry yield. This has got that bounce sandwich just like I demonstrated in the photo a little while ago, where it sits on top of the Aberdeen sandstone and then it's got the Kenilworth sandstone right above it. This longwall retreated out of here fairly good. This longwall went about 3.2 on the Richter scale here, ripped a sheer in half. We had a fatality. We moved the longwall over to the next panel and went to a panel barrier design from there.

This is a very tough mine. It is -- we have been down here. This is plus 3000 foot, pushing these mains down here. This is the existing longwall

wall we're on right now. We took you on this face the other day at about 2900 foot of cover in the Aberdeen Mine. We have gone to this panel barrier.

Again, you can see these main entries go down here. You get to 1500 foot, the pillars get bigger. You get to 2000 foot, they get better. We are driving bleeders out here that are stiff pillars and we use the yield pillar in between on the gates.

This is the Crandall Canyon Mine. This is in the Wasatch Plateau. Started longwalling in here, and you notice there a three-entry stiff yield pillar here. Another test ran to see what we can do about this. This had pressure cells, stations, rock mechanics, people running all over the place. We went right back to a smaller three-entry type design. We weren't allowed, with the MSHA, we actually had to drive another three-entry yield pillar up here until we got to plus 1500 foot. At that number, the plus 1500 foot, you need two-entry. Minus 1500 you don't. I absolutely disagree with that. With this terrain here you've got 1000 foot of cover.

I recently got a petition for our South Crandall mine from zero to 1500 foot of cover. But with multiple seam mining, we have a petition that allows us to mine two-entry down there. I took Ted

Farmer, the field manager for MSHA, and I said, "You and I are going to walk through this three-entry tailgate several times while we pull this panel. And then we are going to walk through the two-entry panel several times after we pull this panel." The difference is absolutely day and night. We can talk about rock mechanics, experts, and all the technical data. We can do simulations on the computer, but the proof of the pudding is it's been done over and over and over again, three-entry versus two-entry. You get in the mine, like I showed you in the Aberdeen Mine the other day, the calculations from the professionals could tell you that at 2900 foot of cover in the Aberdeen mine, a one-foot adjustment in height to that pillar has the same effect on softening that pillar as reducing that pillar's width by five feet. I can take twenty foot or so off the length of that pillar for the same type of effect.

So we are down to super fine-tuning the pillars. The computer can tell us things like I just told you about, "Where is my finest tuning knob and my stronger knobs?" It's down to the point where we go in there with these rock mechanic experts, and we take our mining people and we do the best fine tuning we can by visual observations in the mine.

When we took you in the Aberdeen mine we were trying to show you how good it looks in there in the two-entry systems. People don't grasp that. They think, "Holy cow, look at this. Pillars are squoze, the ribs are sloughed, they have all the material in there. You had to crawl in to get to the face. We were trying to show you how good it looks, because if that was a three-entry system the mine would be closed and we would not have got you to the face.

This is the Joe's Valley fault. It's a plus 1000 foot displacement right here. These panels right here go from 1000 foot of cover to 2200 foot of cover, back to 1000 foot of cover in the middle. How do you design a stiff pillar to go through that, or even a three-entry system? Dr. Maleki showed some examples where you might pull back to a certain point, move your longwall around it, and go again. This block of coal all through here with 2200 foot of cover running down through the middle of that was one of the most productive per man day mines in the nation. And our safety record at this mine, and in Utah, typically this mine right here was in the top one, two, three, four, or five mines in the nation as far as safety statistics, year after year in this operation right here.

All the Utah mines, David Litvin alluded to it, but our safety records if you look at it, if you look at the nonfatal day lost and if you look at the lost time accidents in the Utah mines, they are the safest in the nation. Typically we are half of what the national average is in those categories. So we are proving that we can absolutely mine safe coal in these coal fields.

This is the West Ridge Mine. This is the Sunnyside Mine we have talked so much about. It goes about seven miles from here on down. When we went into the West Ridge Mine we were allowed to go in and start a two-entry system in there without having to demonstrate the three-entry situation because of all the experience in the Sunnyside right next to us. That's one of the exceptions. We was able to go in and start a mine with two-entry. We have longwalled down here, 2800 foot of cover in this country right here. Major fault running through the reserves right here. We are back over on this left-hand side.

I want to point something out to you right here. This is the 500 foot, 1500, 2000 feet of coverage on the second panel. The same thing going on over here. Here is the outcrop. 500 foot, this is 2000 foot when you get down here. Right there. That's all 2000 foot. So your second panel, you are at 2000 foot of cover. And you have a range from 1000 to 2000 on this existing panel we are on right now. This is like a big point. As we longwall into that point, we will see more activity coming into it and going out of it.

Another example here is a bleeder system. Now, that bleeder was going to go between this longwall and that longwall. So we did all the calculations, had the rock mechanics experts in. We looked at big stiff pillars, we looked at little stiff pillars. We ended up down to a two-entry yield pillar. We were able to use that two-entry yield pillar and it was excellent roadway for the whole life of this block of longwall panels here again. So sometimes we do use the two-entry yield pillar outside of the actual gateroads. We used it in a bleeder in this case because it was sandwiched between longwalls.

After all these mines got in and got going using their two-entry systems, with approval for their ventilation roof control plans, in December 1984 there was the Wilberg Mine fire. It was using a two-entry yield pillar system at the time. There was huge scrutiny and that's the point I'm wanting to make. This came under huge scrutiny and the mines that were still using two-entry systems had to apply for interim relief so we could keep our mines open, keep them from being closed down. We were told in the future we would have to apply for and receive 101(c) petitions.

There was a disaster investigation team and they put together a special two-entry task force and we dealt with this group for a long, long time. A very select group of people, and they studied this real hard. Bill Knepp mentioned today about getting a copy of that report. So my point here is the final result of those reports, the two-entry with additional recommendations was the safest overall design longwalls in the Wasatch and Book Cliff coal fields.

They have had several very, very good recommendations, but the number one recommendation they came up with was this atmospheric monitoring systems, the monitoring we do in the mines now. The Utah longwall mines were all granted petitions over the next couple of years and we continued to use two-entry systems. And all the studies that have come out of these panels and the success we have had here in the West with two-entry systems using belt air on return as we develop the panels and on retreat as the longwalls come out of there was very influential in the rule making, the CFR75.350, 351, and 352. And the technology has been pioneered here in the West.

The benefits of using this belt air. If you could use three-entry, you would have a better ventilation system than you do with a two-entry system. The problem is - and we have proven it over and over again to the point that we are almost tired of talking about it, since 1962 - that when you have three-entry you are going to have bad roof, cave-ins, floor heave, and rib sloughage, and your escapeways are going to be compromised.

A two-entry system, you are not going to have this as bad. Your gateroad systems will be significantly improved, and the ventilation escapeways will be better than if you had a three-entry system. However, it's still a two-entry system and you've got a minimum number of entries. It increases the resistance and requires higher pressure ventilation systems. And belt air provides an additional intake and definitely improves the ability to ventilate these mines.

Now, the Aberdeen Mine, an example again, we mine 7000 tons a day in that mine. That's very low for a longwall mine. We mine about 2 million ton a year and liberate 11 million cubic feet of methane days in a 24-hour period. There's some restricting factors on this mine. The slow rate; we only develop 37 feet a shift in that mine in our gateroad. Now, that's total. That's not in both entries. That's added up, both entries. That's what you mined all day long.

And then what are you going to do with all that methane? It's liberated off the longwall face and out of the gob. We have a vertical borehole plan in place. We take 65 percent of that methane out through the vertical borehole program. About 35 percent of the methane on that longwall panel comes out through the bleeder system.

We just upgraded the system at the mine. We basically shut the mine down. We laid off 114 employees. We put in a shaft and a push fan. We had a big exhaust fan. We put a push fan, we've got a push/pull system now. The shaft and fan cost us $1.5 million. We kept the longwall running one shift a day during that time period because the ground conditions wouldn't allow it to sit. We've now got the miner sections back up in there and we're running again.

Now, Dave Canning, our resident PE ventilation expert did a real quick line diagram to show what belt ventilation means to us in the Aberdeen Mine. So if I've got 140,000 CFM at the intake at the mouth of the section, and I have about 1.6 inches of ventilation pressure, the way we ventilate right now, this is with our fan upgrade, we dump about 50,000 through the point feed into the beltline. Additional air leaks from the intake into the beltline. But when I get down here to the bottom end, I've still got an inch of pressure for ventilation and I've got the entire 140,000 CFM.

Now, if we were required to go back to using the belt as a return, I have the same 141,000 at the mouth of the section with 1.6 inches of water gauge to ventilate. I have a higher resistance because I have all the air in here. I have all these leakage branchs going from the intake to the return. When I get down to this point, I've only got half an inch water gauge pressure.

I turn one thousand CFM out of the belt, just barely perceptible movement of air going out that belt. But out here I've got 43,000, because it leaked through the stoppage to get there. Then I only have 98,000 CFM to ventilate that face. Now, this is just a quick chart to show had we not done the ventilation upgrade that we just did, I would only have 119,000 at the face. And then on the other situation I would have only had clear down to 82,000 if I used belt to go out the other direction.

So this chart here kind of shows that the mine design we've got right now, I've got the use of belt air, I have the new fan upgrade, I've got 140,000 CFM at the longwall face where I need it to dilute methane coming off of that sheer and go on back into the gob and dilute the gob methane coming out the back. And I've got an inch of pressure. If I'm forced to go back to where I cannot use the belt air as an intake, I would only have 98,000. The 140,000 is a 43 percent improvement that I've got better to dilute methane and take dust away from the longwall face and only had a half inch of pressure.

Now, the same calculation would hold true had we not done the ventilation upgrade. I would only have had 119,000 using the belt, 83,000 without it, but the same 43 percent. So in our mind right now the Aberdeen Mine, one of the deepest mines in the nation, that belt air puts 43 percent more air on our face for our work force to keep them safe in that mine.

Now, I've heard discussion lately about stoppings. And I go back to this -- I don't dare go back on the slide. I'll never figure it out again. The stoppings that we use in the Aberdeen Mine, those are yield pillars. How do you tie into the rib? You saw the hourglass ribs in there. We lay crib blocks, eight inch by eight inch by four foot long crib blocks, and we build them solid. We dig back into the solid on the rib. We fill them in solid. They come out about a third of the way on both sides of the entry, build it up solid, and then we build a Kennedy stop here in the middle as that longwall goes by, because that pressure squeezes on to them stoppings. And then we use foam.

On development we use Kennedy stoppings. Kennedy stoppings will yield as that entry converges. That convergence is important. If you use a solid block stopping, they just bust. It just fractures the face of them off and they bust. We've used lots of things but we now use Kennedy stoppings. Kennedy stoppings are a couple times more expensive than a block stopping. We found the Kennedy stoppings give us the best -- they're best for reducing our resistance and leakage into those panels.

At our West Ridge Mine we actually build a wood squeeze seal on every entry, every crosscut as we retreat out of there, and we actually seal each panel with the wood squeeze seals because we had a spontaneous combustion problem in there. So the stopping design is something we have worked hard with, with this yield pillar, and we have used the Kennedy and it gives us very good recovery of the air as far as the air available at the mouth of the section versus what is available at the inby end.

Also on that line, if you are using belt air at the face, the pressure drop across is very small from the intake to the belt and you still end up with all the air to use it. And those resistance factors that we used in here when we don't use the belt air was very typical of what we experienced with the pillars in there.

The benefits of the belt air. It reduces the methane concentration in the belt entry and on the face and in the bleeders. We discussed that. It reduces the respirable dust concentrations on the face because I have 43 percent more air. It provides more usable air at the face. The AMS system improves safety of underground coal mines more than anything else.

Now, we have been using them around here for a long time. They are accurate, dependable, sophisticated, well accepted by the work force, and our work force has confidence in these systems.

The CO detectors are, rather than point type heat sensors, which is all that is required by law, the seal detectors are much better. Escapeway routes are not compromised by belt air. They are improved because of second intake airway.

Now, if I'm in a gateroad and it's a three-entry system, I've got intake coming in one entry; it turns around and goes out the belt, turns around out and goes out the return. If I have a fire in that section, by the time it gets to the face all my tunnels are full of smoke. With the point-feed, which was part of the recommendations of the two-entry belt study, if I've got a fire in the belt or if I've got a fire in the intake, all I have to do is step to the other entry and I have a second intake to step into.

At our Aberdeen Mine with panel barrier, I'm also able to have an intake coming in the tailgate, and I also keep an intake air back to the right hand bleeder all the way down, so a guy can actually go to the gob and get to the air back there.

These escape -- I don't care if you have five entries. If you are taking that air out the belt, there's a single split coming in the intake, coming out the belt, and going out the return. So if you have that point-feed, you can step in the other entry and you have a separate intake all the way off that section. To me the biggest question is how far out can you put that point-feed. That's it. Any questions?

DR. BRUNE: I have a question. When I worked in the Eastern coal fields in West Virginia and Pennsylvania, in the mid '90s we went through the reduction from four-entry development to three-entry development. And that was largely motivated by economics of driving fewer entries and actually saving money and saving time while developing these longwall panels. Can you comment on the comparison between three-entry and two-entry panels regarding economics? Which is faster, or are there any differences between what the development speed or development cost would be?

MR. ADAIR: I think the real bottom-line answer to that is in Utah mines you are just not going to have a gateroad that's going to stay open and so the economics are taken right out. But to get specific to your question, if you are set up to mine in a three-entry system or a two-entry system, your advance rate forward will be pretty much the same in our geologic conditions. Typically it is controlled by how fast you can roof bolt. And so it's not a matter of having that extra face to mine. You have an extra face, you have maybe 40 percent more development to do in a three-entry than a two-entry. But your advance rate -- I mean, I can show it on some of our mine maps where we are advancing in three-entry as fast as we are advancing in two-entry. If you are branching out to four and five, it might become more of a factor. But two-entry to three-entry, it typically comes down to how fast you can roof bolt.

And then the real bottom line, and that's one thing that we really want to get the point across, we are not out here in Utah trying to develop gateroads faster with two-entry systems. I hear that. We hear that a lot because obviously you think you can drive faster with two than three. But it's because of what we just went through.

DR. BRUNE: That's why I asked that question, to have that on the record.

MR. ADAIR: Thank you.

DR. BRUNE: That that's not a motivation.

DR. WEEKS: I wanted to raise a question to Linda. Have we asked for or do we have this two-entry task force?

MS. ZEILER: That was the one thing mentioned by Bill Knepp earlier. We don't have a copy but we will get you a copy.

DR. WEEKS: Laine, thank you. It's more informative -- it's additionally informative the second time around. Basically the same stuff you gave up at Aberdeen. But for the mines you mentioned, if I got them correctly, there's Crandall Canyon and there's the Braztah Number 3, Star Point Number 2, the West Ridge Mine, and then the ugly green mine?

MR. ADAIR: That was the Aberdeen Mine.

DR. WEEKS: That's Aberdeen?

MR. ADAIR: Yes.

DR. WEEKS: What's the time period in which -- for each of those mines that you were --

MR. ADAIR: The first one I put up there was the Braztah Number 3 mine. That started longwalling in April of '76. The second mine was the Star Point Mine, it was just a few years after that.

DR. WEEKS: Like '78. Still in the '70s?
MR. ADAIR: Yes. The Aberdeen Mine I put up next started longwalling in '94, so probably about '96 or so when we went to the Aberdeen seam there.
DR. WEEKS: That's where Aberdeen started operating?
MR. ADAIR: It opened in '95 and started longwalling in '96. And the Crandall Mine, about '95 we started longwalling in there. And the West Ridge Mine started longwalling in 2001.
DR. WEEKS: Did you mention other mines?
MR. ADAIR: Just the list of the mines I just mentioned there. But there was a lot of other mines that opened up, the Deer Creek Mine and several other mines that opened up. SUFCO started longwalling. Typically the back end of the '70s, first part of the '80s.
DR. WEEKS: The Braztah Number 3 and Star Point, are those still operating or not?
MR. ADAIR: No. The Braztah Number 3 mine, they were never economical. The ground conditions and the methane liberations were never economic. The American Electric Power Mines, the UMWA Mines, and the ground conditions --
DR. WEEKS: It wasn't the union's fault.

MR. ADAIR: No. They didn't mean that. But they were great mines and they were well funded, well capitalized. They had a captive market with America Electric Power. They spent $20 million building the wash plant, they bought their own choo-choo trains to haul coal back East.

DR. WEEKS: The Star Point Mine, that's closed?

MR. ADAIR: Yes. But they basically mined the reserve out successfully using the two-entry mines.

DR. WEEKS: Thank you.

DR. TIEN: Jim, the second time was just as interesting as the first time.

MR. ADAIR: Thanks.

DR. TIEN: I am interested in your stoppings. I'm curious, of course, in the two-entry at the panel gateroad. There's no difference. You don't have the stoppings separate? Both intake?

MR. ADAIR: We do have Kennedy stoppings. We developed the gateroads with Kennedy stoppings. As the longwall goes by is when we build that particle squeeze seal Kennedy stopping as we go by to control the gasses. You have to lock into the rib. It's going to yield too much, so you have the four foot block of logs holding that rib intact.

DR. TIEN: I'm just curious, can you provide me a diagram showing how the Kennedy stoppings were built?

MR. ADAIR: Absolutely I will provide that for you.

DR. TIEN: Very interesting to me.

MR. ADAIR: Our Aberdeen Mine, it will be mentioned later, but we have about 8 inches of pressure pushing air in the mine and about 12 or 13 inches sucking air out of the mine. And our stoppings in there along the mains are solid block with palisters in them and then sprayed with, I call it like a bed liner material around the perimeter of the ribs. And every door has to be air locked and it's a very high pressure, high quantity mine.

DR. TIEN: What's your total intake air coming into the mine?

MR. ADAIR: About 600,000 CFM. I was glancing to my expert.

DR. TIEN: Of course.

MR. ADAIR: And he nodded.

DR. TIEN: Under eight and a half inch water gauge?

MR. ADAIR: Hit me with the total.

MR. CANNING: We are running 13 inches negative on the exhaust fan and about 7 inches positive on the blowing fan. So the total differential is twenty-some inches, and that's at 7400 feet. So if you equate that down to 075 density, it's the same as a mine at sea level fan running 22, 23 inches.

DR. TIEN: In your development you have two continuous mining units, or three?

MR. ADAIR: Two continuous miners. One developing the headgate and one developing the tailgate.

DR. TIEN: Maybe I should ask this gentleman, what is the total intake air for the longwall face at the tailgate?

MR. CANNING: 130,000.

DR. TIEN: How much air for each continuous miner unit, roughly?

MR. CANNING: Oh, 40,000.

MR. ADAIR: At the last crosscut.

DR. TIEN: So 40 and 40 is 80. My math is wrong. At 210,000, you have a total of 600,000, so you might have a leakage situation somewhere?

MR. ADAIR: Well, we have a lot of other things that need to be ventilated. Electrical equipment. There's another major split for the bleeder, a hundred and thirty-something thousand goes to the bleeder. So it's a very complex ventilation system.

DR. TIEN: Looking at your mine, it is pretty extensive, distance-wise.

MR. ADAIR: Yes.

DR. TIEN: Do you have a feel for your leakage rate, say so many CFM per thousand feet, or what numbers do you use?

MR. CANNING: Well, unfortunately, in many places our pressure is so high it makes a leakage rate in quantity per thousand feet sort of meaningless. I do have numbers for average resistance lost between the two. And that number, through a Kennedy stopping, is about 1500 practical units per stopping.

DR. TIEN: That's a British unit?

MR. CANNING: No. It is something that Mine Ventilation Associates developed as a resistance unit to make the math easier.

DR. TIEN: Okay. So would that information be available?

MR. ADAIR: I can get something put together. I see what you're after. Our main line entry, we had this ventilation company that comes out of California and they went in the mine and did a bunch of pressure drops and they thought their instruments were wrong because the resistance through the stoppings was so high. So it's actually quite efficient and we have done a lot of work to get the air down. As this shows, this next panel, with the fan cranked up we were over 160,000; 45,000 in the miner section looks pretty good.

DR. TIEN: Keith Wallace's boys.

MR. ADAIR: We will get you some information. Anything else?

DR. MUTMANSKY: Thanks, Laine. We appreciate you doing that twice, and appreciate your invention of the optimum microphone system there.

MS. ZEILER: Could I ask the gentleman in the audience for your name for the record, because the court reporter didn't seem to have trouble picking up what you said.

MR. CANNING: David Canning.

MS. ZIELER: Our next speaker will be George Kenzy, senior mining engineer from Arch Coal.

MR. KENZY: Good afternoon. I appreciate the opportunity to stand before this distinguished panel and comment on the use of belt air. My name is

George Kenzy. I started my underground mining career in the Coeur d'Alene mining district at the Bunker Hill Mine in the early 1960s. And my wife tells me I have not gotten common sense yet, because I'm still in mining.

DR. TIEN: And she is right.

MR. KENZY: I have a Master of Science in mining engineering from Penn State. And since 1980 I have been employed at the Skyline Mine, which is located, for those that may not be aware, in Carbon County, very near Scofield, Utah. For those that are still lost, it's roughly 110 miles south southwest from where we are today. Give or take.

My comments today reflect -- and for the panel I'll paraphrase in places in order to save time, skipping not the important parts. My comments today reflect our twenty year experience with longwall gateroad development from the perspective of safety relating to roof and rib control, ventilation, and AMS systems. Skyline Mine is located in the Wasatch Plateau at an elevation of approximately 8600 feet and can be simply described as a multi-seam coal reserve consisting of four minable seams which vary in thickness from inches to well in excess of twenty feet.

Throughout geologic time, the coal seams have been faulted twice and intensely fractured and faulted. During one of the tectonic events, molten igneous rock was forced up through the pre-existing fractures and faults and gave us large, thick, very difficult-to-mine and quite dangerous igneous dikes. Mother Nature did bless us, some might say, with very low methane liberation rates. She did, however, through my eyes, curse us with extraordinarily large amounts of water. In fact, it is ancient water that flows into our workings from the below-line aquifers through the gouge zones associated with the faults. To put it simply, Skyline is a geologically challenging property which has and shall continue to provide mine design and operational challenges until the day we seal the place. Or places.

In brief, what I'd like to leave you with today is a feel for our history and experience, having mined both two-entry and three-entry gate-roads; our experience with the use of belt air in both mains and ingate roads; and our long-standing experience and confidence in the use of AMS systems.

In 1980, as Mr. Johnson in the audience will remember, we began the design on Skyline, the design and permitting of Skyline with a very, very imperfect and incomplete understanding of what we were to undertake. Especially since at our design rate of 5.5 million tons per year we anticipated from the onset using longwall mining methods.

Historically we have developed a total of 41 longwall panels. This encompasses all three of the seams that we have mined to date and we still have a fourth seam in the bottom, a lower seam that we have not mined or developed. The first 36 panels were developed using three-entry gateroad design. We had various pillar configurations; that is, two stiff pillars, one stiff/one yield, or two yield pillars. The success of these gateroad designs, through my eyes, I would judge unfavorably, considering first the 54 reportable MSHA roof falls, and tragically one fatality. I should paraphrase or inject here, fatalities are a tragedy. But I find it even sadder, more discouraging, more depressing long term, to witness and experience the life changing injuries, and two of them in particular that have resulted from our experience with three-entry gates, and particularly failure of ribs.

Bear with me. My senior eyes tell me I need my glasses. Forgive me.

Having been a production foreman at

Skyline for quite a while, I had first-hand experience in developing three-entry sections. From that experience I can personally attest that the challenges of adequately and safely supporting the roof and ribs was very, very difficult in spite of many attempts to use different bolt types and designs. And we also had problems immediately in even 10 or 15 feet deep cuts of adequately supporting the roof. In fact, we couldn't even get the miner out of the cut before the roof would come in.

The introduction of cable bolts in three-entry gates considerably improved the long-term stability of the entries and crosscuts, but did nothing to lessen still being subject to the immediate roof or coal in the cut coming in before the miner could get in to support it.

With the change in Skyline's ownership in 1998, there came a rekindled interest in two-entry gateroad development, especially from other mines that had demonstrated the positive benefits of two-entry gates from the improvements and safety and stability during development and retreat mining. Intuitively, with one-third fewer intersections in two-entry gates, the potential for intersection failures was considerably reduced. Similarly, with

Skyline's depths of overburden, highly fractured coal, high horizontal stresses, the potential for rib failures is significantly reduced. Consequently, Skyline applied for and was granted a 101(c) petition, enabling two-entry gateroad development longwall mining in July, 2001.

We began two-entry gateroad development in January, 2002 and have since then mined out -- developed five and mined out four two-entry panels. There was, I should add - and I believe Hal Damus will remember - a sixth two-entry longwall panel that was atypical in that the tailgate was two-entry but the headgate utilized former submain entries, a three-entry development.

Each of these two-entry gateroads that have been developed since 2002 have been no less severe geologic challenges than the preceding 36 longwall panels. In several respects there were perhaps even greater challenges due to large displacement end panel faults with wide gouge zones of incompetent and very difficult to support rock. Also we had igneous, and continue to have igneous dikes and very high water inflow rates.

In spite of the challenge, it is apparent that the narrower gateroad development has provided improved stress distribution and consequently much safer conditions both during development and retreat mining. My statement is based upon the fact that there have been no MSHA reportable roof falls in any of the two-entry developments and very little need, through our eyes, for this very costly and potentially hazardous rehabilitative roof support. Extended cuts of up to 40 feet are minable and safe with infrequent falls of either roof coal or rock except when unusual conditions such as intense fracturing, faulting, igneous dikes, spars or splits are encountered.

Indirect confirmation of my assertion can be had from our outstanding safety record which includes the Sentinels of Safety award and I believe, unless I can be corrected, the best safety record in the state of Utah. In fact, in 2004 and 2005, we had zero reportable injuries and worked well in excess of 652,000 man-hours without an injury.

Turning now to ventilation and the issues of respirable dust exposure when belt air is used at the face, and which has been a subject of some discussion before this panel in prior meetings. Skyline applied for and was granted a 101(c) petition for modification enabling the use of belt air with an injection point in the mains in May 2001, which preceded our two-entry petition by several months. This application of belt air in the face affected six of our main line belts and two operational section belts.

Reviewing the historical database on the MSHA web site, it appears to me that it's safe to say that the use of belt air in the face had no appreciable effect on the worker exposure in the sections or workers in the beltline. As was mentioned in I believe the March meeting, the one operational issue that we did experience was the perceivement of rock dust while belting, or rock dust in the beltlines into the working faces. This was solved operationally by scheduling dusting for the off shift, the idle shifts, and the use of dampened curtains.

Since resuming mine operations in 2005, Skyline has utilized belt air in the face as provided for in our two-entry petition. Although this is admittedly a small database, there have been a total of five Skyline and five MSHA inspector-collected respirable dust samples at the belt DA sampling point, as required by the petition. That is of course the one that is immediately inby the dump point.

The results of these samples have indicated an average of .48 of a milligram per cubic meter for the mine samples, and .39 of a milligram cubic meter for the MSHA samples. Those are the average. None of the individual samples exceeded the one milligram petition standard.

Therefore, if I could conclude, the exposure of workers in the face in sections using belt air does not appear to be a problem. In our case on the longwall, we do use flooded bed scrubbers at the crusher on the stage loader and at the section dump point to pro-actively control potential dust sources at these areas.

The last area that I'd like to touch upon today is that of atmospheric monitoring systems, or AMS, which are required where belt air is used at the face or in two-entry sections. Skyline began using an automated, not an AMS, an automated line monitoring system in the late 1980s when we installed a Mundix, a very primitive but for us effective monitoring system. At the time, I was the mine electrical foreman. The Mundix, of course, did not have AMS sensors or atmospheric monitoring sensors except to protect the mine intake air heaters, and therefore was not a true contemporary analog to an AMS system.

In 1995 we replaced the Mundix with a Conspec Centurion which was approximately six years prior to the entering of either of our belt air systems. The Conspec system allowed us to replace the point-type heat sensors with carbon monoxide sensors in beltlines and to install, or more importantly perhaps, CO sensors in remote locations in installations such as power centers and pump rooms. Our Conspec system has undergone several generations of upgrades in order to improve the mine atmosphere monitoring function and to improve overall system performance.

The current generation of our AMS affords us confidence in our ability to monitor the atmosphere throughout the mine, active and inactive workings, and react quickly to any upset condition at any location underground. The use of sensor packages called diesel discriminators provides us the ability to differentiate between carbon monoxide sources, and by that I mean diesel related, cutting and welding, or - we hope never - fire related. We know the Conspec system works and works well. We depend on it.

We furthermore have sufficient experience with the AMS system to realize that we are a much safer mine because in one case the AMS system detected a transformer heating in an inactive part of the mine and enabled us to respond and control the event before we experienced a serious mine fire.

Another significant benefit that we see through our eyes daily in two-entry section development is the additional fire fighting capability on the intake aircourse, which replicates the fire hydrants and hoses that we have in the belt-line by statute, or would have if we were a non-two-entry section. The intake and beltline fire fighting installations, in combination with the AMS sensors and heat-activated sprinklers and belt drives and transfers make us a much safer mine and able to mitigate any potential risk of having adjacent primary and secondary escapeways. In addition, the special measures required to protect the diesel equipment, to limit the number of diesel equipment in the section, and the prohibition against diesel fuel on the section, in combination make us much safer.

So I'd like to close with several very brief comments and make a request of this committee. First, in my opinion and on the basis of our experience at Skyline, I would like to agree with, and with his permission, which he has already given, by the way, Bill Knepp, who at the January 9 meeting of this panel is on the record as having said in reference to any fixes required to the existing belt air rule, quote, "I think it's a pretty damn good rule and pretty comprehensive," close quote. I would add that it also applies to our two-entry developments. The petition process works, and works well.

Speaking specifically to the matter of two versus three or more entry gateroads, I feel that Skyline's history provides a single but outstanding example of how much safer two-entry gateroad developments are, first from ground control, and secondly from the added safety measures that are required.

Finally, and in closing, finally, I'd like to make a request of this committee. It has to do with discussions that came up in January and March and once again yesterday alluding to the earliest detection in some cases of belt heating events using the human nose. And in fact, in the January meeting, the use of belt air in the face was seen as a distinct advantage because the products of combustion on a fire in either the intake or beltline outby would very quickly be transmitted to the face, and therefore historically or anecdotally have been detected more quickly than they would by even the best of the line monitoring sensors. Therefore, if I could, please consider a recommendation that NIOSH or another research agency or organization dedicate sufficient resources to developing the electronic equivalent to the human nose in terms of selectivity and sensitivity. Thank you.

MS. ZEILER: Thank you. Our next speaker will be Kevin Tuttle --

DR. WEEKS: Can we have questions?

MR. KENZY: I don't get off that easily.

MR. MUCHO: George, in regards to your last comment, I'd like to tell you that NIOSH did put some research into developing a better sensor. Came up with a multi-sensor system that looks not only at CO but smoke and other products of fires and so on. So it does come a lot closer to approaching the human nose. And we might hear a little about that at the next meeting in Alabama.

MR. KENZY: May I volunteer Skyline to be the first to try it? In fact, I will give you a card.

MR. MUCHO: It's been trialed at a couple of mines already, but you can get in line.

MR. KENZY: I very much appreciate it.

DR. WEEKS: Just to second Tom's comment, there are two problems with the nose. One is it is exquisitely sensitive and I don't know that any instrument can do it as well. The other is that it is extremely variable. Everybody's got a different nose, just like everything else. It is different. And I don't think we would want to replicate that.

But I had some other questions, as well. Your comments about respirable dust are certainly consistent with expectations, certainly with my expectations about whether there's much of a difference with or without belt air. And I know a fair amount of time has been devoted to issue, and for my colleagues on the panel I'm most of the way through preparing sort of a background paper on this issue for our consideration and anybody else's that wants to look at it, which comes basically to the same conclusion through a rather different route. But I have a couple questions.

The average results that you pointed to, the .48 for mine programs and the .39, essentially the same, where were those samples taken?

MR. KENZY: Under the petition, we are required to establish a designated area or sampling point, no greater than 50 feet inby the dump point. That is inby from the direction of air flow. In this case from the section that's retreating.

DR. WEEKS: So these are not belt entry concentration measurements. They are actually inby the belt dumping point?

MR. KENZY: Well, yes, they would, Dr. Weeks, represent any fugitive dust generated in the beltline as it heads out. But it would also capture any future dust generated at the dump point from the stage loader onto the mobile tail or at the crusher area within the stage loading. So that single sample captures any fugitive dust from the point feed inby.

DR. WEEKS: The question is where does it come from? Have you looked at that issue and what are the sources of dust? There are two sources in the entry: Transfer points or re-entrained dust on the belt. And I think reentrainment accounts for or is negligible. It is mostly transfer points. Have you looked at that issue?

MR. KENZY: No. I'm sorry. We have not set up pumps at strategic locations along the belt.

DR. WEEKS: Thank you.
DR. TIEN: George, just a simple one. You talk about several special measures taken to protect the diesel equipment, to limit the numbers. Just curious, what are they?
MR. KENZY: Automatic fuel shutoff, number one. Wrapping the exhaust manifold with a material that are high temperature capability to prevent ignitions off of the hot manifold, which is already limited on heavy duty equipment, that is permissible equipment. We have bubblers. We call them bubblers. It's a way of injecting or passing the exhaust through a cooling water shield barrier or pool and thereby lowering the exhaust temperatures.
DR. TIEN: Is DPM an issue in your mind?
MR. KENZY: No. DPMs -- well, I shouldn't say that. We have never had a special initiative sampling that I'm aware of, unless you are.
MS. DAVIS: You are in compliance with the standard.
DR. TIEN: So it's not a problem. Thank you.
DR. MUTMANSKY: Okay.
MS. ZEILER: Thank you, George. Now our next speaker will be Kevin Tuttle, safety manager

from Energy West.

MR. TUTTLE: Chairman and members of the study panel, I express my appreciation for the opportunity to come and speak to this issue about belt air utilization in underground coal mining.

I'm Kevin Tuttle. I have had 30 years in the mining industry. I'm the safety manager at Deer Creek Mine of Energy West. Deer Creek Mine uses belt air at the face through the petition process. We have a petition that allows us to do that.

Underground coal mining is a dynamic industry. It has many challenges, many changing conditions. What method of mining may be effective for one operation may not be effective for another operation. I believe that Congress knew this and they provided a vehicle to address this through the Act of 1977. In section 101(c) the Act states, "Upon petition by the operator of the representative miners, the Secretary may modify the application of any mandatory safety asked to a coal or other mine if the Secretary determines that an alternative method of achieving the result of such standard exists which will at all times guarantee no less than the same measure of protection afforded to the miners of such mine by the standard, or that the application of such standard to such mine will result in a diminution of safety to the miners."

Upon passage of the Act, the Mine Safety and Health Administration, MSHA, established regulations. They are written under part 30 -- 30 CFR part 44. This petition process has been used successfully many times; used successfully by us and I think you have heard through other comments today that we have used this petition process and it has been successful and it has been a safe operation.

When regulation is petitioned to the extent that considerable time is being spent on that petition or resources are being expended to address a recurring type regulation and becomes burdensome, then a set of regulations may be more beneficial if they can provide a specific set of regulations to address that issue being petitioned. I feel this was the case when MSHA wrote the new belt air regulations. The belt air regulations started out with a panel such as this to discuss those. There was many, many discussions. I have talked to some people that's been involved with that. A lot of discussions, a lot of probably arguments, discussing this issue of belt air.

The belt air went through the proper

regulatory procedure with public hearings, with advanced proposed regulations. Went through all that process. They were put out there for public comment and everybody in this room, all the operators and the other representatives, had a chance to comment on these regulations. MSHA looked at the belt air comments and created a final rule for belt air. I feel these regulations address safeguards to provide protections when belt air has been used. This process created a set of regulations that could be used to provide safeguards for the use of belt air without having to go through the petition process.

Doing away with the belt air regulations could put a burden on many mines using belt air either through the previously approved petition processes or the belt air regulations. If there was no need for belt air regulations or petition, it would not have been petitioned.

In addition, belt air regulations do not just give an operator the ability to start point feeding air to any section in the mine. There's still a portion of the regulations which requires MSHA to approve the locations, and these locations are then to be put into the ventilation plan.

75.350 states, "Notwithstanding the

provisions of 75.380, additional intake air may be added to the belt air course to a point-feed regulator. The location and use of point feeds must be approved in the ventilation plan." So we see that MSHA still has a part in this. It's not just up to the operator to say, "I'll start point feeding air anywhere I want in the mine." We still have to go through a process to do that. MSHA still has the ability to approve or disapprove the point feed locations in the mine.

If approved, these locations must meet the requirements of the regulations which deal with many safeguards such as monitoring of the mine atmosphere, closing of point-feed regulators if they see a set level of carbon monoxide, which would automatically isolate the entry being used, and establish the minimum and maximum air current and many more other areas that are addressed in the regulations.

I feel these belt air regulations provide protection when using the point feed system. I would encourage the belt air Technical Study Panel to look at all issues when evaluating this use of belt air, recognize that Congress gave MSHA the ability to petition, to allow them to use a petition process and also the ability to establish regulations, which they have, to address this. Thank you.

MS. ZEILER: Thank you very much.

Our next speaker will be Charles Reynolds, mine manager from CW Mining.

MR. REYNOLDS: On behalf of CW Mining, I would like to thank the panel for the opportunity to provide comments on the use of belt air ventilation to ventilate the working faces. As was mentioned, my name is Charles Reynolds. I'm the president and general manager of CW Mining Company, which owns and operates the Bear Canyon Mine located in the Wasatch Plateau coal field. I have a bachelor of science degree in mining engineering from the University of Utah, and I'm currently a licensed professional mining engineer within the state of Utah.

In the near future, the Bear Canyon Mine will be bringing a longwall unit on line in our number four line. For the Bear Canyon Mine, safety is a significant concern. In fact, we were presented with an award also in the years 2004 and 2005 for zero lost time accidents. Although we have never operated a longwall unit in the past, I have over 15 years of mining experience in retreat mining, using room and pillar mining.

At our adjacent Number 1 and Number 2

mines, those experiences have shown us that with the ground conditions that we have, which Mr. Adair outlined very well for us, we have had a difficult time with bounces and with bumps. Any time we have tried to create an abutment situation, the key has been to, even with our room and pillar panels, to get barriers between those panels to yield and to not try to hold up those sandstone formations that are above us.

Now, extensive geotechnical studies at Utah mines, which have been discussed, have found it necessary to implement two-entry gateroad development systems in order to mitigate the ground control problems that we see within the Wasatch Plateau coal field and the Book Cliffs coal field. It has been shown that fewer entries mined results in more stable ground conditions, providing less potential for floor heaves, rib rolls, rib cutters, roof failures, overrides, and pillar bursts.

With our experience in the retreat mining, you can see that in the Bear Canyon Number 4 Mine a two-entry system will result in a safer mining environment than a three-entry system. Now, because of the petition process and the whole process, we are going to begin with a three-entry system. But as was shown in previous examples, there are very few of the mines that have successfully implemented those three-entry systems. And our conditions are real similar to the conditions that they have encountered. It has been proven that using two-entry development has mitigated many of those conditions that you run into, and using two-entry development requires the use of belt air to meet ventilation requirements at the longwall face.

Our studies and experience through many of the other mines has shown that using belt air will provide the following general safety improvements. First of all, additional air to the working face can increase the total air quantity in the working section and reduces leakage. This can help reduce methane levels, dust, and diesel emissions. Second, the comprehensive atmospheric monitoring system requirements which go along with the petition will be much more effective for us in providing additional protection to the miners at all times. And finally, the use of belt air will provide two escapeways in intake air, rather than escaping through return air.

In addition, in our operations we have also found, as Mr. Kenzy mentioned, that we can greatly minimize the amount of dust particulates that result in the belt entry through the use of water sprays at the feeder, and feel like it is proven that using that air to ventilate the working face does not pose an additional hazard to the miners.

I would again like to thank the panel for the opportunity to speak today. And in closing, I would like to say the two-entry development and belt air has improved the overall safety of miners in many of the Utah mines and we feel it will provide the same for the Bear Canyon Mine. Thank you.

DR. BRUNE: Thank you, Mr. Reynolds. I have one question. You had said that the two-entry development would be safer than a three-entry development but at the same time you are saying that you have to start with a three-entry development. How can -- that puzzles me a bit that you start with an unsafe condition only then to change to a safe condition. Or with a less safe. Let's put it that way. Less safe, only then to switch over to a safer condition.

MR. REYNOLDS: It frustrates me a little bit, too. Currently we are in the petition process and are working toward that, but have not yet received an approved petition from MSHA to allow that two-entry system. So we are in hopes that we can quickly get that approved. For us, the first two panels, the cover is around 1500 feet to where we believe that it will still be safe. But as each panel progresses and it gets deeper and deeper, we do anticipate or we have a tremendous concern. Our choice would definitely be to begin with the two-entry system in the first panel. However, it does require an approved petition which we are in the process of getting, but do not currently have.

DR. BRUNE: Thank you.

MS. ZEILER: Thank you.

Our next speaker will be Wendell Christensen. Electrical manager from UtahAmerican Energy.

MR. CHRISTENSEN: First of all, I will put the glasses on to start so we don't have to stop later. I want to thank you for the opportunity to be able to speak to the panel today. As they said, my name is Wendell Christensen. I'm going to read most of this because I was told not to babble and get sidetracked. And I will. So if I do, someone yell and I will stop.

I'm the electrical maintenance manager for UtahAmerican Energy. I have worked in the mining industry since 1979. It's always been in an electrical or electronic status. I have more than 25 years experience with mine monitoring systems. During that time I have been involved in development, installation, and upgrades of the AMS systems probably in most of the western mines in the area. These would include Beaver Creek, Trail Mountain, West Elk, Skyline, SUFCO, Dugout, and now the Tower and West Ridge and Crandall Mines. So I feel I do have quite of bit of experience in the area.

You have heard from a lot of companies today in the individual mines about how and why they got their petitions. We are going to get off that and talk about electrons for a while instead of rocks.

In the late 1970s and early '80s the mines began to replace heat type sensors used for belt monitoring with the newer systems; AMR, Conspec, Mundix, MSA, Pyott-Boone, and others. We were the first one that started it. They used mainly carbon monoxide monitoring to allow continuous monitoring of the belts. At first, the main monitors we had were carbon monoxide and methane. That's about all that was available when we first started the monitoring systems. These were a major improvement over the existing systems. They were more sensitive and reliable than the old heat point type sensors. They give you the ability to set alarm levels and a particular CO level instead of at a preset temperature, so you could set where your alarms were going to be so you could react sooner.

These sensors, the carbon monoxide sensors, were installed at each belt drive and thousand foot increments along the belts. One little sidenote, and I will get sidetracked, is this is before we were required to do this. The mines in the area, a lot of them, and all over the United States, really, started their own monitoring before we were required to. And I want that point to be stressed. A lot of this is what the mining industry has started before we were mandated. And then the mandates have actually helped us by requiring more stringent and newer technology.

There was a computer on the surface that monitored the CO levels of the air in the beltline and it was set up so it could warn the affected sections of increased CO levels. An ambient CO level was set, and a standard was set at 5 parts per million, was established. And then alarms and warning levels were established. These warning levels were set at 10 parts per million. This is five above the ambient. And the alarm levels were set at 15 parts per million, which was 10 above the ambient.

The systems were DOS based and allowed a limited number of points to be monitored. Typically it was 127 was what the first units would let you monitor. The systems were extremely slow and allowed very little change on the canned program. You got what the manufacturer sent you, and that was it.

Mine-wide monitoring systems have since made large scale improvement. Systems now monitor many conditions, both environmental and operational in the mines. Because of the need to comply with the belt air petitions, and a sophisticated monitoring equipment required, these improvements have progressed much more rapidly than they would have without the petitions requiring them.

The belt air petitions required sensitive carbon monoxide sensors to be installed at prescribed intervals along the belt, depending on the belt air velocity. These sensors could include or be in addition to the existing sensors. So you could have your sensors in there, if your velocity was all right you didn't take the other ones out, you added more to meet the criteria.

These got down to where they were 300 foot intervals that we talked about yesterday instead of the thousand foot. In addition to the sensors installed along the belt, sensors were also installed in the intake entry where the air entered the belt entry, which was the point feed; in the belt entry, just out by the point feed; and inby the point feed. This results in the monitoring of the air entering the belt, the air already in the belt, and then the air after they combine to go down the belt. So you are monitoring all the air that could possibly go into that section down the belt.

Additionally, alarms were installed in the working sections that provided both visual and audible alarms to the miners working in the face if these levels exceeded the legal limits. Two-entry petitions actually added more to this, when you go to a two-entry system. Two-entry systems, you put CO discriminating sensors which George alluded to. They are now installed at thousand foot intervals in the intake entry in addition to the belt. So now you are monitoring the air in the belt, every thousand foot, plus the intake air coming in. These additional sensors are required from the conveyor drive all the way to the working face.

Also, the intake air used to ventilate a two-entry system is monitored the last 4000 foot outby. What this means is your main intake air before it hits the injection point or the dump point, we monitor that 4000 foot outby. So we monitor the air coming into the section.

In addition to that, during development when the belt air is used as a return, methane sensors are required; one at the tail of the belt where the air leaves the section and enters into the beltline, and another at the point where the belt air dumps into the return.

Alarm and warning levels for the CO on the belt and two-entry systems have been reevaluated and have been lowered. Depending on the conditions and the samplings done at the mines, ambient levels as low as 2 parts per million are now in use at some mines. This gives you a warning level of 7 parts per million and alarm levels at 12 parts per million.

Systems now interface with environmental monitors, PLC equipment and processors to monitor and control the mine. State-of-the-art graphical interfaces, fiber optic trunk lines, radio and wireless technology allow monitoring of more than 32,000 points in a single mine. And that's increasing with technology. Every time Alan Bradley comes out with a higher point number, you can increase the number. So the technology is increasing all the time. Current systems now include continual self-diagnostic capabilities. The system monitors its own status and reports if there's any problems with it, so you continuously know that.

Sensors have evolved from the first rudimentary CO and methane to discriminating sensors, infrared technology, and many specialized sensors. A couple of them are air velocity, differential pressures, H2S, hydrocarbons, just to name a few. The industry will make just about any type of sensor you want now or that we can come up with.

The mine-wide monitoring system also has the ability to control devices underground such as stopping conveyor belts and removing electrical power from selected areas. This is a safety and operational enhancement that is built off the environmental monitoring platform. If CO is observed moving down a belt, the belt can be shut off and potentially halt a heating or friction problem in a developing stage. In addition, as everyone knows, shutting down the belts is a good way to get them to call outside if you can't communicate with them underground.

The systems are monitored by a trained individual 24 hours a day, 7 days a week. Also, an electrician trained in system operation maintenance is available on all shifts. Not only are the system operators trained to respond to alarms, but also to analyze conditions that may indicate possible problems before they have a chance to escalate into alarm conditions. And they always know where the responsible person on shift is at, and how to contact them.

The system has, on numerous occasions, proven its value by detecting hot belt idlers and hot equipment before a fire has occurred. Further, the system has helped locate and analyze diesel equipment that is not functioning properly. We have installed CO sensors and temperature probes in compressor stations, regardless of the fact that they are already housed in fireproof enclosures. We monitor electrical installations along primary escape routes and other applications that are too numerous to name. These are not required by regulations, but I have found that when a mine installs a good AMS system, the mine personnel come up with all sorts of ways to use it. Everybody is always saying, "Can you do this? Can we monitor this," all the time, so the system is just building.

Through the use of live time graphical representations of the equipment status and environmental monitoring, the system helps us make quick and accurate decisions based on realtime information. With the system's ability to set multiple warning and alarm levels, we can have warnings set below the required limits. From these warnings the operator is alerted to potentially dangerous conditions, thus allowing us to investigate and control situations before they develop into a problem. We use the system to help determine the importance of an alarm, the required response, and the proper personnel to respond to that alarm. And I'm saying alarms, but these aren't alarms yet. We want to respond to them before it's an alarm, so we can cut it off. If there is an alarm, then this would apply. But we set our levels low enough, we want to know before it's a problem.

We believe that the utilization of belt air is safe and that it is, in fact, safer because of the requirement to install an AMS system. By virtue of the use of two-entry gateroads, ground control is improved, air quality is required to be continuously and carefully monitored, responses to the problems are expedited. Without the monitoring system, as required by the use of belt air, our ability to know what is going on in the mine at an instant would be reduced, and the safety of the miners would likewise be reduced.

I want to clear up one thing of confusion. There was a question at the Tower Mine about the ambient levels. Tower Mine is set at 3 parts per million, is the ambient. So the alarm is 8 and the warning is at 13 parts per million. That's on the two-entry system. The numbers that you were given, the 25 and 30, are some monitoring that we do outby. It's not required, but we have our own levels set at. Thank you.

DR. MUTMANSKY: Thank you, Wendell. We are going to spend a lot of time on AMS systems in Birmingham, but I think this is maybe a valid question for you to answer with your experience. Is it possible to set up and automate the doors at the point feed system through the AMS system, and has anybody ever done it that way?

MR. CHRISTENSEN: Yes, it is possible. I don't know of anyone doing it because I'm not sure that the regulations would let you. That would have to be something that we would have to check into. "Possible" is easy. Just some hydraulic jacks and a control.

DR. MUTMANSKY: One of the concerns I have about the point feed system is a fire in the main intake airway. It would seem as though an AMS system would have the ability to detect it in that position, close the doors under those conditions, and then provide a signal to the section crew as to where the location of the reading is and the ability at that point in time to utilize the proper airway to get to that point without compromising the safety of the belt air way.

MR. CHRISTENSEN: It's easily possible. We now close compressor doors, shut doors on compressor rooms if the CO goes up or the temperature goes up. And then as far as locating where the problem is, yes, we could do that. There's multiple -- there's a lot of stuff I never touched on. We have voice alerts that go over the pager system that we can tell it exactly, you know, "Air door on third left is closed. Use the belt." Or, I mean, there's no limits to what we can do.

DR. MUTMANSKY: So you are saying it is possible and MSHA would have to give their approval to such a system and that it would have to be designed in such a way to overcome any altered problems, essentially.

MR. CHRISTENSEN: I don't know what MSHA's regs are on the fire doors. I thought a designated person had to close them. I think that's what the law now says. So MSHA would have to say, "Yes, the system could close them." You'd also have to have some way to get through them because you wouldn't want to trap people in the mine if both entries had smoke in them, or CO. You wouldn't want to lock the people in. But technologically, we can do it. You tell us what you want done, and it can be done.

DR. WEEKS: When we toured the mines we visited the AMS operator in two mines. And we were impressed both with the complexity of the tasks, and the capabilities of the operators. And the question has come up concerning training of operators. And have you had -- what's your experience been with training, selecting and training operators and that sort of thing? Because that's the critical -- that person has to manage huge amounts of information and is a real critical link in the whole process.

MR. CHRISTENSEN: I think I know where you are leading because I was there at one of them.

There's two trains of thought in the operators that we have come up with. One is you take a coal miner that is probably retiring and doesn't want to work anymore and you have that person do the monitoring. He has a lot of knowledge of how the mine works.

DR. WEEKS: Monitoring is work.

MR. CHRISTENSEN: It is. But it's not shoveling belts. I will say "physical labor." That person might know how to mine coal and how the belts run.

The other philosophy, and we have actually looked at, is putting a younger person in that you can take to the mine, explain how it works. But you train them more on the safety and responding to safety for higher levels of CO more than the operation of the mine. Training is essential, though. No matter who you get, the person has to be trained.

DR. WEEKS: What are your thoughts on those two schools of thought?

MR. CHRISTENSEN: I'd like to find a young person that was in the mine that would do it.

DR. WEEKS: You think the mining experience is very important?

MR. CHRISTENSEN: It would be beneficial, yes, to know the system. If not, you've got to do additional training so that that person knows it. At the sites I have been to, the people monitoring there, first they were contract labor and they are hired full-time by the mines. The mines have seen this and they are putting more training into this person, taking them underground if they are not acquainted so that when someone calls and says, "I'm at third left," they know where to look.

DR. WEEKS: Well, neither monitor that we saw had experience as miners.

MR. CHRISTENSEN: No. I only know of one right now that is experienced. But I don't know who is doing it at all the mines.

DR. MUTMANSKY: I'd like to get back to the previous question. Alan Davis is over here to give some information.

MR. DAVIS: I want to comment about the issue of having AMS system capability to close the doors that are provided at the point feed. And that's never really been -- it's not addressed specifically like that in the regulations. And it's a difficult call to make about closing those doors. There's issues about the locations of personnel who might still be in there, in general where people are located and how they would be affected by closing the door.

And then the other concern is the effect on ventilation at the time you change that. Are there methane issues that could be involved and a potential for a fire that's beginning and growing, possibly? So I think while it would be a good benefit to have the capability of remotely closing those doors after people are at a safe location, that would be good. But to have some sort of protocol where somebody saw a rise in the levels and just automatically closed the door, I think could be a dangerous situation.

DR. MUTMANSKY: I'd like to address that question again in Birmingham. Would you be able to do it yourself or would you recommend somebody else?

MR. DAVIS: Well, I could be at Birmingham. But I think we also have some other people down there from MSHA that could also address it there.

MR. MUCHO: Just to stay along that line, the regs right now require that they be able to be closed remotely from some location not affected by products of combustion. So the regs do permit remote closing. It's a question of how remote are you going to get.

MR. DAVIS: Right.

MR. MUCHO: Am I 50 feet away and outside the cross cut entry or am I outside? But I think in any instance, the point you just brought up, Alan, is a good one. Seems to me that the closing of door ought to be made by the responsible person on the shift, with as much of that information as he could possibly have from the operator or whoever. I don't think the guy walking down the entry ought to say, "I see some smoke. I'm going to close the door."

MR. DAVIS: Right. That's true. I think it's a very important and far-reaching decision to reach to close that door. And it needs to have as much technical input as possible. It may be important to try to do that early on in the case of a fire, but you certainly have to look at all the factors and the people that are exposed certainly are probably the number one factor.

DR. TIEN: And along the same line, I guess you already answered part of my question. That is looking ahead, do you foresee from MSHA's point of view that AMS is going to replace some of the human activities in the future? Nintendo mining, sort of?

MR. DAVIS: I don't know. We have seen

more and more application for AMS in our plan approvals system or program that we have. And we are utilizing it where we have issues and concerns about levels of gasses in a bleeder system, for instance. I think we will see additional use of AMS monitoring to enhance the systems we already have in place. But I'm not so sure that I see it displacing kind of the basic human examinations that are going on right now.

DR. TIEN: So it's a complement, to enhance rather replace in the near future.

MR. DAVIS: Right.

DR. TIEN: One question for you. Your system has a capacity for 32,000 points?

MR. CHRISTENSEN: Different ones do. Right now at Tower we are upgrading. It has four times 27 at Tower right now. The one at West Elk, SUFCO, Skyline, I know all three of those have 32,000 points and we are putting the system in Tower right now and we will at the other UtahAmerican coal mines.

DR. TIEN: So you are saying you have 32,000 points, sensors, or capacity?

MR. CHRISTENSEN: Points. Could have.

DR. TIEN: So you don't have 32,000?

MR. CHRISTENSEN: Could have. That's the capability. Actually, 150,000 is the latest upgrade.

It's the potential.

DR. TIEN: Those points are sequential, not parallel? In other words, you have these sensors, these sensors.

MR. CHRISTENSEN: It depends on what back-bone you are using. If you are using fiber optics, it is sequential but you may get 15 of them at a time, depending on the packet of data you are receiving. So it depends on how it is programmed and what backbone you are using.

DR. TIEN: Would one second be adequate?

MR. CHRISTENSEN: Actually, we have had to slow down the system sometimes because of too much data being available for the systems to process. That's just the fastest time -- actually it's in milliseconds now that it sends the data. But not all the systems, the interfaces aren't capable of talking right now that fast.

DR. TIEN: How is this data being physically transmitted to the surface? You have more than a pair of wires. Do you have optical?

MR. CHRISTENSEN: We have fiber optics. We have twisted pair. We have RS 435s. Data highway plus. Actually, we are using some radios at some different locations. So there's a lot of technology that we are starting to use to get the data.

DR. TIEN: They are not able to be interchangeably used?

MR. CHRISTENSEN: Yes, we do. We have systems that have all four of them or three different kinds on them. It's just that what is available now, the new technology right now is going to fiber because of the speed and the data that you can get.

DR. TIEN: Thank you.

MS. ZEILER: I'd like to suggest we take a ten minute break before we get to the last four speakers.

(A break was taken.)

MS. ZEILER: Before we start again with the speakers, I want to make a couple of announcements. One is to say that as in our Pittsburgh meeting in March, the Technical Study Panel extended an invitation to both the UMWA and NMA to speak officially on the record on the agenda on the topics of consideration, and they declined for this meeting. But that invitation will be extended again for the Birmingham meeting.

And secondly, I just want to remind the speakers that if you provided hard copies of your statements to the panel, we need a copy, MSHA does for the record, as well. So thank you.

Our next speaker is Jim Poulsen who is safety manager of UtahAmerican Energy.

MR. POULSEN: Thank you and good afternoon. I'd like to thank this Technical Study Panel, MSHA, my fellow colleagues here for the opportunity to present my comments regarding the belt air. And my comments are going to be concerning safety of the mines who are utilizing the belt air to face.

My name is James Poulsen and for the last 30 years I have worked at Energy West, Valley Camp Coal, Skyline Mines in various management positions. Currently, I'm presently serving as a safety manager for the Andalex, West Ridge, General Resources, who are all subsidies of UtahAmerican Energy's parent Murray Energy Corporation.

I belong to the International Society of Mine Safety Professionals and I'm a registered Certified Mine Safety Professional. UtahAmerican currently operates five underground coal mines. We employ over 500 employees. 400 employees. Excuse me. The three UtahAmerican mines that are currently in production, including the Aberdeen and West Ridge are all presently utilizing belt air at the working face. Crandall and South Crandall Mines have successfully used the belt air in the past but at the present time are not doing so.

We consider the safety of our employees to be a value which we will not compromise. We believe it's our moral and ethical responsibility to protect the health and safety of all our employees, and that's what brings us all here today. I cannot emphasize enough that the elimination of the belt air would be very harmful to the safety of our underground miners. I can personally testify from a safety perspective that the ground control, dust control, dilution of dangerous gasses, and the overall miner safety is improved when belt air can be utilized at the working face.

Now I'd like to turn my remarks towards the ventilation at UtahAmerican Mines. Previous testimony and comments and numerous studies have demonstrated the use of belt air definitely increases the efficiency of the mine-wide ventilation system. This additional air increases the dilution of methane and dust, reducing worker exposures to those hazards.

Some questions have been raised about the increased dust levels with increased ventilating pressures or current. MSHA, NIOSH, other data testing and operator sampling substantiates that the use of the increased beltline ventilation provides an enormous reduction of respirable dust and increased gas dilution. It's a well-known fact that the concentrations of respirable dust are adversely proportional to the air quantity used to dilute them. If you double your air quantity, your dust concentration is cut in half.

In today's Western U.S. mines, 1500 to 3000 feet of cover is common place. Now, to control these adverse roofs, the pillar outburst, bouncing conditions, and enhance worker safety, two-entry systems were developed. At these depths, studies and experience have proven that it's just not good practice to develop more entries than you absolutely need. The less entries you have, the more likely you are to be able to control the ground and the bouncing conditions.

Operators desiring to utilize two-entry systems had to file petitions pursuant to Section 101(c) of the Federal Mine Safety and Health Act, and if granted these petitions obligated the operator to a multitude of additional requirements. Unquestionably, the most rigorous requirement contained in the petitions is the use of the AMS systems. Other common petition requirements for two-entry development were automatic fire suppression systems on diesel equipment; tracking and monitoring of equipment entering and leaving sections; diesel discriminating CO sensors no greater than 1000 feet apart in the intake and beltline, and extending 4000 foot out by the section; two separate and independent means of communication, one in the intake and one would be in the belt, with these phones no greater than a thousand foot apart. Additional SCSRs were stored on the headgates and tailgates. This was prior to the additional requirements of the Miner Act of 2006. Firefighting outlets extending into the escapeway every 300 feet; trained mine monitoring system operators on duty on the surface 24/7. And some mines had other various requirements, all of which improved worker safety.

Now, previous testimony described the functions of the AMS systems, so I'm not going to go into detail about the capabilities. In my 30-plus years of mining, I believe the AMS system is one of the most important devices introduced in the industry to improve overall worker safety. Congress, MSHA, NIOSH, mine operators, labor organization, individual miners and many others had a hand in propagating the current belt air rules. And as far as I know, the current belt air rules have not been shown to be a contributing factor to any of the disasters which tragically occurred in this country in 2006. Not even the Aracoma disaster which involved a beltline fire.

Now, we would encourage this committee to acknowledge the previous experience and endorse the current rule.

DR. MUTMANSKY: Your other two mines, why are they not using belt air at the face?

MR. POULSEN: Currently we are not longwalling in there. There's no longwall activities in there. South Crandall Mine is temporarily idled and we are pillared in the Crandall mine.

I might add, Dr. Weeks, for your information, the data you asked from Mr. Kinsey for sampling on the beltline locations for longwalls, I do have some of that sampling data. I have probably 40 to 50 different samples collected, and I will be submitting them for the record.

DR. WEEKS: Thanks. I'd like to see it.

MS. ZEILER: Thank you very much. Our next speaker is Gary Leaming, who is safety manager for Arch Coal.

MR. LEAMING: On behalf of Canyon Fuel Company and SUFCO Mine, I'd like to thank each of you for the opportunity I have to speak before you today regarding the use of belt air to ventilate working faces in underground coal mines. I've had various work experiences and jobs in underground coal mining at the SUFCO Mine exclusively for more than 32 years, and I'm currently the safety manager at that coal mine.

I've had the opportunity to witness many changes in our industry, including great reductions in the injury incident rates all across the country. One thing that has remained constant at the SUFCO mine during the time I worked there is the use of belt air to ventilate working faces. I guess it ought to be known that SUFCO Mine was coal mined in East Spring Canyon from 1941 until the current time. Obviously back in the early days, not near at the rate that we are mining now. And so there's been coal produced there for a long period of time. Lots of coal has been mined, and as we continue to mine we are now moving under deeper and deeper overburden, which is going to probably cause us to look at some different ways of mining.

SUFCO has safely used belt air in three

entry development sections, mains development, and longwall mining. As has been previously mentioned, the practice increases quantities of air reaching the working face without greatly increasing pressure on the ventilating system. SUFCO Mine has been fortunate in its geologic conditions to have panels of 15,000 feet. We don't have any of those in front of us at this point in time, but we have had those in the past. And being able to have intake air in our beltlines has greatly reduced stress on our ventilating system, especially near the head of the sections.

SUFCO Mine, like many other mines has been attested to, will continue to gather America's coal reserves under this deeper overburden. As we move into heavier and more deep geology, using belt air at the working face will become even more necessary as two-entry systems need to be employed for improved ground control.

Using the belt entry as an intake air source is an important safety factor because it provides a second intake escapeway which is almost always more valuable than a return escapeway in the event of an emergency. I think, as everyone knows in here, prevention is the key. But in case there is a problem that comes up, the more intake avenues that you have to escape from a mine, the better off those people are that need to escape. The better chance they will have of getting out.

I know all the coal mines in Utah, and I think all in the West and everywhere across the country are preaching more and more and more escape, escape, escape. But the more intakes you have, the better off you'll be.

Keeping this intake air theme in mind for beltlines, many mines' firefighting water supply to their working sections comes through the beltline. Having return air in this beltline entry would almost certainly cause more difficulty in firefighting operations than if the belt air was on intake. Hooking up and routing of hoses is much more safe and accomplished much more quickly in a smoke-free atmosphere, which intake air more than likely will provide. Regardless of where the fire is located, intake air is more likely to make firefighting successful.

It's hard to know and impossible to predict where a mine emergency may originate. It would, however, be a shame to look back knowing we took away a valuable early warning system that had the potential to save lives. As good as underground monitoring system and sensors are, there is still no substitute for seasoned miners who know in an instant if something in their environment has changed. For continued safety of underground miners, the advantage of intake belt air and its early warning potential should be maintained. During emergencies, seconds count and may make the difference.

In conclusion, I appreciate the large responsibility that each of you have been given to make determinations regarding belt air and those things that are governed by that. And it's my hope, and I'm confident that each of you will carefully consider and weigh your judgments and direction in order to move coal mining forward in a safe, responsible manner to help protect our industry. And it is all of our industry, not just the people who work it, but the people who regulate it and the people who benefit from it all across the country. I appreciate the opportunity to be able to speak to you, and wish you good judgment as you go forward. Thank you.

DR. CALIZAYA: A general question in terms of methane emissions. Is there any signs? Have you had any spot where it's a concern?

MR. POULSEN: There would be some in the audience today that would say that SUFCO has kind of been a coal yard where you just had to go in and load it out. We have had extremely good, favorable conditions at SUFCO. We have no methane to speak of. There are bottle samples taken at least quarterly at SUFCO where in effect four decimal points behind the zero there is a trace of two out of those four each time. So I can't say that we have never had any methane, but you can't measure it in the face. We just really don't have any methane. We are very fortunate. We are on the very south end of the Wasatch coal field, and the only real circumstance that we have, because we have had three-entry all along. And we are favorable without the methane.

One thing about three-entry that was brought up that may be helpful is that if two-entry systems were put into place simply for faster development and production, we would probably have petitioned for one. We feel like at this point in time, due to our conditions, that we can mine three-entry gateroads as quickly as we can mine two. Unfortunately, we are moving under heavier cover and, in fact, we are looking not too far in the future of having some 2500 feet and plus cover. And we are seriously -- we know that we are going to need two-entry systems with what it has to offer for us to be able to do that.

DR. TIEN: Just a general question again. At your face, what kind of equipment do you have in developing those gateroads? You have a miner. How many cars do you have?

MR. POULSEN: We are running right now three-entry. We are running three-entry and we always have. But we use electric shuttle cars and continuous miner. Anywhere from, depending on where we are mining, two to three electric shuttle cars, dumping on two sides of the feeder breaker.

DR. WEEKS: It was said earlier that the limiting factor on the rate of advance for your gateroad was - and I forgot who said it - was how fast you can install roof bolts. Has that been your experience also?

MR. POULSEN: Yes. Absolutely. That's what it comes down to. After you get -- once you get your moves down where you can make your moves efficiently, it takes longer to bolt it than it does to mine it. That's our experience.

MS. ZEILER: Thank you very much. Our next speaker is Carl Pollastro, director of technical services for Interwest Mining.

MR. POLLASTRO: I appreciate the opportunity to address and give a few comments. As I said, I am Carl Pollastro, Director of Technical Services and Development for Interwest Mining.

Interwest is a division of PacifiCorp and we operate the subsidiaries of Energy West here in Utah at the Deer Creek operation and also Bridger Coal in the Rock Springs area, which is a combination of surface and recently underground coal mining. And as I sat there, I know that I appreciate most of you on the panel and in the room are very tired. And the reason that I'm tired along with you is just listening to all the comments that are here of the ancient mining in Utah. And the sad part was, I have been there. And so I'm really tired.

As I look across that and I look across the idea of two-entry and geotechnical studies and surveys and experiments throughout the years, I stop and I think as I started my coal mining career at Kaiser Steel in a two-entry development in 1972, with that experience and with what Hamid put up there with that single entry, I was able to work on that and see that. And I watched the early developments of two-entry.

As we look at that development, in my career I've had opportunities to be the manager at some of our operations, at Cottonwood and Trail Mountain and also Deer Creek. As we look at that period of time that Energy West and its predecessors have mined on East Mountain and on Trail Mountain, we always had the opportunity of taking advantage of some of that early history of Kaiser and the success that they had.

And so as we started into the longwall operations in 1979. At that time we started out with two-entry development. And that first plan that was approved there offered us the opportunity of not only actually returning that belt air upon retreat, and that's the way we operated, in that sense.

As we look at what we have done since then, certainly we had Wilberg come along in 1984, and we looked with the two-entry group that studied that, and the stipulations that came out of that at that time resulting from that having mandated that belt air should be a separate intake split.

As we think about some of that history that has gone on, I'll just give you some stats. I think that's important. We have had a few of those today and I think as we talked about and as Laine said, we are maybe tired of something that we think -- no longer think, but we know works. And I guess we will defend it until we go out of the business.

But Energy West and its predecessors, you heard George Kinsey talk about the 41 panels that have been pulled at Skyline. I think it's been presented up here that Kaiser pulled about 41 panels in its 30-year history. As we look at our time at Energy West and its predecessor companies there, in the 28 years now that we are going on, we have actually mined 568,000 feet of two-entry development. That's just two-entries counted together. 108 miles, and that's not going to be much farther than what it takes me to go home at night in the Price area. That's an amazing feat. If we were to combine all of those, it's an amazing history, a rich history that we have of saying this is a successful and a safe way of operating.

There's 122 panels in that 108 miles that we did. 122 panels between the mining operations down there. And that comprises the Wilberg, Cottonwood, Trail Mountain, and Deer Creek Mines. And as we look at that, 185 million tons have resulted from that as far as longwall coal coming from those 120 panels. As we look at the situation and the comparison again, I guess, like we say, we started out with two-entry in 1979. During the time after Wilberg we didn't have the approved two-entry petition for about three years. As we went through similar hearings in trying to defend that, we went ahead with about three panels' worth of three-entry. And three-entry yield system that we put up against that, we could not succeed in that with those three-entry. And as a result, prior to us getting that approval of that two-entry petition, in about 1987 we decided both at Deer Creek and at the Cottonwood at that time that we needed to have the two-entry. We had to find a way to get it even if he didn't have the petition, and we drove about a 5000 foot panel from each side using piggyback and shuttle cars to connect that up. We needed it that bad.

Bottom line, I guess I would say in watching over the time period that I have been able to witness, that it would be very highly suspect that we could successfully and safely mine what we have mined in those statistics I just gave you. As we look at some of the things that we talk about, about why we are here. Have we just said, "It's two-entry," and then we have given up? Do we try and improve? You have seen representatives from Agapito and with Maleki Technologies and you think about what has gone on. This is an evolutionary process. And certainly that initial sizing and the right sizing of pillars and how we deal with those has not stopped in all the time that we have been working at this. It's always a constant refinement.

It's been a great aid and assistance to us to have the computer modeling that's there. But again, it's a blend. It's a blend of these people who can help you in that geotechnical area, combined with operations people who know what's going on, the seat-of-the-pants kind of things that are there, they observe, and they can incorporate that. And that's just what has happened over the years, and I can testify to that.

Over the past 25 to 28 years that we have been doing this, we went at two-entry and we have not ceased to try and perfect that. As we go through it, there's numerous studies that are there that our company has done, as well as many others that are here represented today. But as a combining of what we see and what is modelled and a refinement of that process, as we look at it, it's no fluke that we are where we are at and able to successfully mine in the conditions that we have. The average, as we look at the properties that we have, we have mined with two-entry from 400 foot outcrop areas to 2600 feet. The average is, probably over that 125 million tons, about 1800 feet.

As we look at situations that have lent itself a little bit, more particular to our properties there at East Mountain on the Wasatch Plateau, I just would touch on a couple of those. A lot of these factors have been reiterated over and over again. But our main potential as we look out there is the bounce and burst-prone and outburst conditions that are there. As we look at it, we have some very unique abilities through the design of the gateroads to mitigate, you never eliminate, but to mitigate some of the effects that we talk about that have been placed there by Mother Nature.

Those factors, again, as we talk about are depths of cover. But that's not the only one. Depth of cover, the strength and thickness of the overburden that we have, as well as the strength of the immediate top and bottom as well as coal seams. As we look at layout and orientation, that hasn't maybe been brought out as much, but we are under a rigid standard as far as orientation. You look at that, it's not by a fluke that you see most of the orientation in the Book Cliffs and the Wasatch is an east/west orientation. A lot of this has gone into a lot of study. Those of us that have tried a few other things have some real serious problems with cave conditions, with lagging cave, and an unrelenting bouncing face that we cannot control, and abandonment of equipment as well in some of these areas.

As we looked at the regional setting of things such as joint spacing which is infrequently found, we see a situation that we mined in on East Mountain from the Cottonwood and Wilberg and Deer Creek situation to just across the canyon at Trail Mountain. Very significant differences where you see that joint spacing was. And in a synclinal development we saw severe differences in cave conditions and especially magnitude of bouncing that had changed.

As we look at regional stress fields as far as horizontal stress, the steep topography that we have talked about there. Most of us I think would say without a doubt we would like to have a flat 2500 foot cover area to mine under rather than going in and out of 2500 feet. Significant differences there.

As we look at all these things, we have an ability to maintain a gateroad that is safe and effective for not only development but for retreat. And I know the comment has been made again, and just was again, as far as two- versus three-entry; and again, yes, development goes the way bolting goes. That's the key point. As we look at it, it's not only just could you mine quicker in a two-entry. What could you maintain long term as far as the stability? Entry maintenance has a great play in all of this. You can have two-entries that you can maintain and safely develop and retreat, or you can have three entries that you put a lot more bolting into and you still cannot control. This is simple geometry as we talk about the size of opening that we are talking about here.

The other factor that I just want to bring up and touch base on is that in all this mining that we have, on East Mountain we have had abilities to multi-seam mine. We have the Blind Canyon seam that is located as the top seam. That has, over time, been mined by the Deer Creek operation primarily. The underlying seam, about 85 to 100 foot below us lies the Hiawatha seam, and that has traditionally been mined by Trail Mountain and Cottonwood Mines, and currently we have two seam conditions which allows us to mine both seams out of the Deer Creek Mine.

Multi-seam mining brings a whole new aspect to all those factors that I talked about. Again, the unique interaction of the geometry we talk about as we go under and we mine the top seam first and then come underneath it, we need to ensure one thing: That we have the smallest opening we can to penetrate frontal barriers, to penetrate the gobs that we mine under and develop. Likewise, in the top seam, it's a distinct advantage to have those gate-roads as narrow on the top because, again, as you come under we penetrate in the gob zone, but then also we want those highly stressed areas above us. If they can be minimized by narrowing that entry and that opening size such as two-entry affords you, you can see the stress on the face in a lot narrower area and take care of it that way.

We have had numerous areas as far as design at barriers and, as we said, trying to go under pillared areas above us. In the early days we started multi-seam mining in the Wilberg mine in 1981. We had done a lot of stress relieving, a lot of work with a German industry to try and do stress relieving in those areas because we were mining under mains that had not been planned for longwall mining, pillared sections, and we had a quick education on a lot of these things.

Consistent design of a longwall mine, and if you can incorporate those designs in panel layout, particularly as we look at these in these deep covers, and with the two-entry layout, affords us the best opportunity for success.

Are we finished learning? We never are because Mother Nature teaches us every day as we look at the geotechnical world.

One last area that we have become a little bit more aware of and we have seen in some isolated areas, just wanted to bring up in summary today is those areas that have weaker top. We have talked about the bounce sandwiches and the strong strata and what hat we have. But there's also areas of generally weaker inherent conditions. And some of those mines they have talked about like the Shoshone in those basins, as well, where two-entry has proven a much greater success on development by eliminating number of intersections, being able to narrow up, being able to do additional supporting, and being successful with some of those areas that are naturally weaker. Shoshone, with the two-entry and some of its inherent capabilities there through mining with the two-entry, and success with that in weak conditions. We currently are seeing some of those situation as we open up in the Rock Springs area. And so I think that there's application as we look to continue to see where this technology can be expanded.

As we look in a safe sense of where we go, the question was asked earlier what does the Utah picture look like for reserves. And as we look at that, we know we are limited, but one thing we know we are is deep, and continue to be deep. We see continuing topography just like we have. We see the continuing factors that we have. If we are going to continue to be successful as we have in the past, we definitely need to have the ability to mine safely through, number 1, the geotechnical considerations that are here.

As far as ventilation, and we talked about diminution of safety, I believe that in Utah mining I can safely say that it is not a compromise to go to two-entry or to these other factors. In fact, it is the only way that can be mined in many of these deposits that have been here and will be in the future.

Just one last closing comment. I think we look at it and I know that the rub has always been people saying, again, "You are just doing it for economics." I would tell you with the additional precautions it takes to be an effective, safe, two-entry longwall operation, the economics are in the favor of mining a three-entry, because there's some great stipulations that have been placed over time. There's a lot of safeguards that have to be put in place. And if we were to look at it in that sense, we probably would have made another choice. But I'm telling you now, the two-entry is the only choice in a lot of these situations. Thank you.

MS. ZEILER: Thank you very much. Our final speaker this afternoon will be Doug Johnson, Corporate Services Director for UtahAmerican Energy.

MR. JOHNSON: I appreciate the opportunity to present these comments to this distinguished panel. I will be giving kind of a wrap-up of the comments that have been made by the people before me as put together by the Utah Mining Association. I'd also like to thank the panel for taking the time to come to this area. And also for taking the time to tour the mines that you did earlier this week.

My name is Douglas Johnson and I have worked in various engineering and operations capacities at six of the major underground coal mines in the state of Utah. I have a Bachelor of Science degree from the University of Arizona and I'm a Registered Professional Engineer in Utah. In addition to the state of Utah, I hold valid underground mine foreman papers in Ohio, Illinois, and Wyoming. And I presently serve as the chairman of the Utah Board of Oil, Gas, and Mining.

I began working in Utah as a mining engineer at the SUFCO mine in 1978, after working as an engineer and production foreman at mines in Ohio and Illinois. In 1980 I transferred to the Skyline Mine where I had various engineering and operations positions through the year 2003, including ten years as General Mine Superintendent. At the beginning of 2004, I went to work for Energy West Mining Company with responsibilities at Deer Creek Mine, which included both the engineering and safety departments.

Since early this year, I have worked as Director of Corporate Services for UtahAmerican Energy, which operates the Aberdeen, West Ridge, and Crandall Canyon Mines. Aberdeen and West Ridge both presently operate longwalls utilizing two-entry gateroad development and belt air at the face. The Crandall Canyon Mine did the same until late in 2006, but presently operates only a continuous miner section.

At the present time there are five mines in Utah which operate longwall utilizing two-entry roads and directing belt air to the longwall face. I have worked in management positions at four of those five mines: Skyline, Deer Creek, West Ridge, and Aberdeen. All four of these mines operate much more safely from the ground control standpoint, in my opinion, because of two-entry gateroads. I have not worked at the fifth mine, Dugout Canyon, but based on my experience while working at Dugout's sister mine, Skyline, it operates more safely because of two-entry gateroads.

I'm also very familiar with the work of Dr. Maleki and Agapito Associates and thank them for the comments offered to the panel previously. I agree with them completely that for Aberdeen, West Ridge, Skyline and Deer Creek, the mines with which I'm familiar, mining more than two gateroad entries would result in a diminution of miner safety.

That being said regarding ground control, I would like now to direct my comments to the ventilation aspects of two-entry gateroads and the use of belt air at the face. At all the operations with which I'm familiar, the health and safety of the miners is improved by the use of belt air. Because of the sophistication and reliability of the AMS systems in use at each of those mines, directing air in the belt entry away from the face and dumping it into the return at the belt drive will be a waste of an available resource that is presently used to make the environment safer and healthier for miners. The mines in Utah have shown over the past two decades that use of sophisticated and reliable AMS systems allow the safe use of belt air and significantly improve the atmosphere at the face for the miners by diluting both methane and respirable dust. It's an inverse relationship: Doubling the quantity of air coursing through the area cuts the methane and respirable dust concentrations in half.

Wendell Christensen presented comments regarding today's AMS systems and, given the performance of these systems, it would be imprudent to do anything to discourage their use in our mines. The use of belt air carries with it the requirement to use CO sensors rather than the more common, but far less reliable, point-type heat sensors. I offer to you my opinion that a mine approved to use belt air, along with the accompanying requirements including state-of-the-art AMS systems with CO sensors, provides a safer and healthier environment for workers than a similar mine which does not use belt air but does use point-type sensors.

Mines in Utah have significant requirements placed on them in order to receive approval of their two-entry Petitions for Modification. By now I'm sure that the panel knows the requirements placed on mines in order to use belt air, but I'd like to touch on some of the practical issues involved with these requirements.

All Utah mines use diesel equipment to transport men and materials underground. Before entering the two-entry section, the diesel operator must call the mine manager or dispatcher to get permission to enter. The mine monitor person keeps track of what equipment is operating in the two-entries and knows the quantity of air required for each piece of diesel equipment in the mine.

The monitor also keeps tracks of what equipment has entered the section and then has been parked or been idled. If too many pieces of diesel equipment are operating, the mine monitor will not give you permission to enter the section.

Likewise, if you were at the section and want to leave, you must call to get permission before starting your diesel engine after it has been idled. Many times I have been told to wait until a certain piece of equipment arrives at the section and is idled before I could start my engine to leave.

I'm not complaining about the level of additional requirements in a two-entry system, but just trying to point out to the panel that the petition places many restrictions on two-entries that ultimately make for a safer overall environment.

The visible and audible alarms required where they can alert face personnel, the additional two-way communication system and additional SCSRs required at the longwall headgate and tailgate are among the requirements imposed by two-entry petitions that, in my opinion, make two-entry longwalls using belt air safer overall than face without belt air.

As Laine went through in his presentation, our ventilation engineering at UtahAmerican, a P.E. by the name of David Canning, ran some simple models using VnetPC to illustrate the additional air available at the longwall face by using belt air rather than directing it to the return at the head of the section. I know that Laine has gone through this previously, and in fact Derrick presented very similar figures yesterday representing the Colorado Mining Association. But having increased air available for use at the face is very important to the health and safety of the workers, so I'm going to present it one more time.

Using actual leakage and resistance values measured at West Ridge and Aberdeen, Mr. Canning showed that on a typical 9000 foot longwall panel, with 1.6 inches of water gauge ventilating pressure differential, and with Kennedy stoppings on 120-foot centers, 140,000 cubic foot per minute of area would be available at the longwall face. Using the same parameters, but directing the air out the beltline, starting with 1000 CFM at the last open crosscut moving outby, only 98,000 cubic feet per minute of air would be available to the longwall face. This is an increase of 42,000 CFM, or 43 percent, by using belt air - a significant difference in the air available to dilute and render harmless methane and respirable dust by anyone's standards.

Another important point that Mr. Canning demonstrated with his model is that the diagonal pressure, the differential ventilating pressure from the headgate end to the longwall face to the tap point at the back end of the panel where air leaves the gob to enter the bleeder entry, is increased by using belt air. The available pressure at the head-gate is doubled with belt air. This is a clear-cut factor in improving the performance of the gob and bleeder ventilation system.

It could be said by some that all the mine would need to do to make a safer and healthier environment is to increase the amount of air being directed to the working face. But the fact is that a mine ventilation system is a finite resource; adding air to one portion of the mine must be accomplished by taking air away from a different portion. That's precisely why we prefer using belt air at the face rather than directing it down the beltline into the return.

It could also be said that instead of taking the air from another section, the mine could install a more powerful fan to make it a safer and healthier environment. But increasing the overall ventilating pressure causes other problems such as increased leakage and increased pressure against man doors, which both potentially decrease the safety of the miners underground.

As an example, the total net ventilating pressure at the Aberdeen Mine is approaching 19 inches water gauge. At the mine's elevation of over 7000 feet, this converts to 24 inches of water gauge at sea level, which is near the design limit for vane axial fans.

At mines in the Eastern U.S., a common practice is to decrease mine-wide resistance by driving or boring, holes to the surface on a regular basis. In Western U.S. mines that is often not an option, due to the increased overburden and adverse terrain.

It could also be suggested that additional entries could be driven in the mains in order to decrease the overall mine resistance. At Skyline, we mined at depths up to 2200 feet, and at Deer Creek over 2600 feet. At West Ridge we have mined at more than 2800 feet deep, and Aberdeen has developed mains at over 3000 feet deep. At these kinds of depths, longwall gateroads are not the only entries that pose ground control problems.

At UtahAmerican, because of extensive ground control modeling, verified eye in-mine measurements, we routinely drop from seven-entry mains to five entries, and widen the pillars when the mains go beyond 1500 feet of overburden. When the mains go to 2000 feet of overburden, the pillars need to be widened again.

With the depths at which we mine in Utah, developing too many entries in the mains is likely to cause a squeeze condition in ground control problems. By driving too many entries in the mains, a mine can actually hurt its ventilating ability because of decreased cross-sectional area caused by squeezes, falls that may block off entries, or because of roof support cans or wooden cribs set in an effort to hold the entries open.

At the mines I have worked at in Utah, we have had to cross faults with as much as 45 feet of displacement and cross igneous dikes that were more than 200 feet wide. With the amount of drilling and shooting that is required to get the mains through these features, in many cases it's not practical to develop more than three entries to cross these geologic features. Indeed, at all the mines I have worked at in Utah, drill jumbos have been proud parts of the equipment fleets.

In summary, I would hope the panel leaves Utah with a good understanding of the unique problems that have been faced and overcome by mines in the

West. The following five points I believe summarize what the panel has seen and heard over the past three days.

First, two-entry development has proven itself over more than 50 years as a successful way to mine the deep reserves in Utah.

Second, using belt air is an important component of two-entry mining.

Third, modern AMS systems are reliable, dependable, and comprehensive.

Fourth, the existing belt air rules offer a safe and healthy environment for the workers, if the rules are followed.

And finally, the use of belt air, if systems are properly maintained and operated, offers benefits, not hazards, in the event of a fire.

I appreciate your time and if you have questions for me or anyone else that presented on behalf of the UMA, I think everybody still here would be glad to answer any questions.

DR. MUTMANSKY: I think we are out of questions. I'd like to thank you and all the members of the Utah Mining Group for their participation today. We have heard a lot and before I adjourn I just want to make certain that none of the panel members have any additional questions at this time.

DR. TIEN: I just have one.

DR. MUTMANSKY: Jerry says he has a question.

DR. TIEN: Earlier I think Mr. -- this is addressed to Mr. David Canning.

MR. CANNING: Yes, sir.

DR. TIEN: Earlier you talked about the exhaust and ventilation system. You have a negative pressure of 13 inches water gauge.

MR. CANNING: Correct.

DR. TIEN: And you're blowing in about 7. So you add the two and that's about 20 inch water gauge, roughly.

MR. CANNING: Yes.

DR. TIEN: Earlier, here you talk about -- that's close enough. 19 inches.

MR. CANNING: Yes.

DR. TIEN: Do you have a chance to verify the simulation underground?

MR. CANNING: It's not been verified by MBS.

DR. TIEN: Okay. Thank you.

DR. MUTMANSKY: Any other final questions? Linda, do you have a final announcement or two to make?

MS. ZEILER: No. I think we are at the end of the announcements, as well. So we are ready to adjourn if you concur.

DR. MUTMANSKY: I concur.

MS. ZEILER: Then we stand adjourned. Thank you.

(The meeting concluded at 4:58 p.m.)

REPORTER'S HEARING CERTIFICATE

STATE OF UTAH)
) ss.
COUNTY OF SALT LAKE)

I, Diana Kent, Registered Professional Reporter and Notary Public in and for the State of Utah, do hereby certify:

That prior to being examined, the witnesses were duly sworn to tell the truth, the whole truth, and nothing but the truth;

That said proceeding was taken down by me in stenotype on May 17, 2007, at the place therein named, and was thereafter transcribed, and that a true and correct transcription of said testimony is set forth in the preceding pages;

I further certify that I am not kin or otherwise associated with any of the parties to said cause of action and that I am not interested in the outcome thereof.

WITNESS MY HAND AND OFFICIAL SEAL this 28th day of May, 2007.

____

Diana Kent, RPR, CRR
Notary Public
Residing in Salt Lake County