TECHNICAL SESSION IV

PANEL DISCUSSION—ILLUMINATION

Moderator: Mr. Robert Vines, Vice President - Health & Safety, Bituminous Coal Operators' Association, Washington, D. C.

Panel Members: Mr. Kenneth P. Klouse, Chief Electrical Illuminating Engineering Group, Technical Support, MESA, Beckley, West Virginia.

Mr. George R. Bockosh, Mining and Electrical Engineer, Industrial Hazards and Communications, Pittsburgh Mining and Safety Research Center, Bureau of Mines, Pittsburgh, Pennsylvania.

Mr. Randy E. Slone, Staff Electrical Engineer, Westmoreland Coal Company, Big Stone Gap, Virginia

Mr. George Evans, Westinghouse, Chairman, "Committee for Lighting of Coal Mines," Illuminating Engineering Society of North America, Bloomfield, New Jersey

Mr. Glen Beckett, Chief Electrical Inspector, International Safety Division, United Mine Workers of America, Charleston, West Virginia

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Mr. Vines: Illumination is of particular interest to me, and it is an honor and a pleasure for me to serve as moderator. I have been highly interested in underground mine illumination over the past couple of years. I have been active, on behalf of the BCOA, in working with MESA and with the Joint-Industry Health and Safety Committee, established under a labor agreement to consult with MESA on problems of coal mine health and safety. In connection with that work, I shall mention just very briefly that it is very encouraging that this has been one issue, if you can call it an issue, on which there has been a considerable amount of concurrence between the mine operators and union on the problems that we have in connection with trying to get the mines lit in a way that would meet the standards without creating related problems for the coal miners. We have jointly investigated a number of mines and problems that have been reported to the mine operators and the union organization. We

think we have, pretty much, a common opinion as to what the problems are and what the ideal solutions are. We're not exactly sure how to accomplish those solutions.

We're fortunate to have with us today a very knowledgeable panel of experts in illumination—particularly in mine illumination—if there is such a thing as an expert in this field. These gentlemen are certainly students of the matter, and I think they would most likely be the first to tell you that we have an awful lot to learn before we can illuminate the working places in coal mines in a satisfactory manner.

The first panelist on the program this morning is a representative of MESA, Mr. Kenneth Klouse. Ken has an electrical engineering background with a B. S. in Electrical Engineering from Newark College of Engineering. He is currently in the Technical Support Division of MESA based at the Beckley facility where, among other things, he is in charge of the testing and evaluation program for machine-mounted systems to determine whether or not they comply with the Standards. His position is Chief of the Illumination Communications Group. Ken also serves on a number of rather prestigious committees. He is a member of the Illumination Engineering Society—the Committee of Mine Lighting—established by that society and also on an international committee which is, I suppose, the composite of the various professional illumination societies in a number of countries. It is not really listed here in Ken's biographical sketch, but he also is quite a renowned expert on telephone communications. Ken may not confess to that himself, but other members of the committee will vouch for that. That may be kind of an inside joke, but without any further introduction, Ken, I would like to call on you to share some of your knowledge with us.

Mr. Klouse: The Congress of the United States recognized the establishment of minimum illumination standards for coal mining under Section 101 of the Coal Mine Health and Safety Act of 1969. Congress based its decision on many experiments conducted in underground coal mine lighting from about 1885 until that time. Most illumination experiments conducted up until 1950 involved the perfection of the miners' electric cap lamp. Between 1950 and the present, most of the experiments involved area lighting and machine-mounted lighting. After evaluation of underground illumination tests, accident reports, research contracts, and comments from industry, United Mine Workers, and operators, standards were published on minimum illumination required in underground coal mines. Specific areas of high accident rates, such as a coal mine face while operating mining equipment, and the minimum levels of illumination based on test studies of light levels required to perform specific jobs, and minimum reflector values for paints based on visibility studies, are points covered by the regulations.

Other countries have had illumination laws for many years for underground coal mining. Great Britain has the Coal Mine Lighting Regulations of 1947. It requires certain parts of underground coal mines be supplied with sufficient general lighting. The U. S. S. R. has states' standards specifications in U963. This led to the development of the fluorescent lamps. Some of the other countries that have had underground illumination standards are Italy, Germany, Czechoslovakia, and Belgium. These were all well into the early 60's. Since 1938 numerous papers have been printed on illumination in underground coal mines in the United States. At the 1950 meeting of the Coal Mine Lighting Clinic, which included representatives of industry, the United Mine Workers, and state and federal agencies, one of the conclusions reached was that improving seeing conditions at the face was the most crucial problem. The Mining Development Committee of the Bituminous Coal Research Incorporated has been conducting tests since 1953 in underground illumination.

Technical data is also available from some European countries where underground lighting has been compulsory since 1940. In a paper published in 1954 by Dave Roberts, a lecturer in mining at the University of Nottingham, the correlation between accidents, visibility and lighting is discussed. The accident investigation covered a twelve-year span during which lighting became mandatory in certain areas of underground mines midway through that period. The death rate and serious injury rate significantly declined in the second half of that sample period in areas requiring lighting. In other words, the second six-year period showed a 27 percent lower death rate than the first six-year period, and correspondingly, 11 percent lower serious injury rate. Serious accidents because of haulage runways showed a decrease of approximately 40 percent between the two six-year periods. These numbers show a definite relationship between underground safety and underground lighting. Mr. Roberts stated that, while it is not possible to reduce any simple relationship between such accidents and the lighting environment, there is evidence that in certain types of accidents where visibility is obviously an important factor, the effects of improved lighting are reflected in falling accident trends. More difficult is the correlation between production and illumination. Installations in the United States tend to show an increase in production in some forms of mining—specifically longwall. However, the increase is not statistically significant. When more illumination systems are introduced underground and operational time is extended, definite trends in the industry will become more apparent. Here, we need a larger data base before we can make any premise on it.

Mr. Vines: Ken, thank you very much. I didn't mention earlier about our format. I think it would be more orderly if we held our questions until after each of the speakers has had an opportunity to make a few

introductory remarks. We're probably ahead of schedule because of not having the movie that was on the program. It may turn out that our questions and answers may fall properly in line after we have had our coffee break.

Our next speaker on the program is George R. Bockosh. George is also with the Federal government—with the United States Bureau of Mines. In that capacity he has had a special responsibility in the Bureau's Illumination Research Program which he will be discussing with us this morning. George's background is in electrical engineering with a B. S. Degree in Electrical Engineering from the University of Pittsburgh. He followed that with a M. S. Degree in Mining Engineering. George is presently serving as the project leader of the Bureau's Mine Illumination Research Program. He is a member of the same two prestigious committees on which Ken Klouse serves—the Illumination Engineering Society's Committee of Mine Illumination and also the International Illumination Engineering Society's Committee of Mine Illumination. Without any further ado—George.

Mr. Bockosh: I would like to say that it certainly is a pleasure to be back here for the Eighth Annual meeting. The people who are responsible for the planning of it certainly deserve a well-earned vote of thanks. I think they have done, as usual, a terrific job.

Federal illumination standards for underground coal mines were promulgated on October 1, 1976, as parts 75.1719 and 75.1719-1 through 75.1719-4, Title 30, Code of Federal Regulations. The Bureau of Mines research efforts have been directed toward providing appropriate hardware and insuring that the industry is aware of the existence of the hardware and possesses the expertise needed to efficiently apply it. These objectives are manifest in continuing projects designed to demonstrate the feasibility and benefits of supplying additional illumination in even the most demanding mining environments. The means by which this is to be accomplished will be described through a discussion of a selected few of the Bureau's ongoing activities in this area.

The required introduction of additional illumination in the coal mines has found much of the industry lacking the expertise necessary to implement effective programs, thus forcing the operators to rely entirely on externally designed illumination systems that do not always fulfill the specific needs of their mines.

This endeavor, which has been continuing since the conception of the mine illumination program, has taken on increased importance and activity because of renewed interest within the industry sparked by the recent promulgation of regulations. In reaction to the industry's need,

the Bureau has initiated a two-part program designed to inform the industry.

A program has begun to formulate a one-day seminar which will present the history of mine illumination, an explanation of the new regulations and photometry, design procedures for laying out an illumination system to meet the requirements of the regulations, and other pertinent data. The program is to be taken into the mine fields and presented throughout the country during approximately 40 seminars. The seminars are directed toward the people at the mine level who will be "living" with the lights and, as such, are designed to minimize the time such personnel would need to spend away from the job. A second meeting or workshop will be considered if interest warrants.

In addition, the Mining Enforcement and Safety Administration (MESA) has initiated a means by which mine operators and equipment manufacturers can obtain a Statement of Test and Evaluation (STE) for any given mine illumination system. The STE is issued by MESA and enables the operator to forego any in-mine measurement of luminous intensities by local MESA inspectors while the illumination system is in adequate repair and the machine is being operated within the specifications stated in the STE. Although anyone can apply for an STE, the majority of applications are presently being submitted by manufacturers of mine lighting equipment and each manufacturer is presently completing a set of STE's. These files are not cross-referenced, making it very difficult for a mine operator to find existing STE's that apply to his particular mining conditions. The time expended in these endeavors could seriously affect the speed by which the mining sections will be illuminated. The Bureau has initiated the formation of an STE "library" through which an interested party could obtain a list of all tested illumination systems for a given machine.

The realization of this program will enable the industry to quickly determine what systems are available and to efficiently evaluate their applicability to specific conditions.

The method of test and evaluation of illumination systems that is presently being used by MESA's Technical Support Electrical Testing Project located at Beckley, West Virginia, utilizes a simulated mine entry and requires the construction or alteration of a "mock-up" mining machine for each type of equipment to be evaluated. Due to the multitude of machine and luminaire types and combinations, this present technique becomes a time-consuming process affecting industry as well as Government.

The Bureau of Mines is developing a computerized system by which mining machines and luminaires can be mathematically modeled and

displayed on a TV-type monitor. The computer evaluation of illumination systems would enable personnel to determine quickly, inexpensively, and accuractely the luminous intensity levels associated with any hardware configuration. Thus, in addition to reducing evaluation costs, the computer simulation will drastically reduce system design time.

The Bureau has also been engaged in a program to develop hardware and implementation techniques capable of providing general illumination in the working place.

In demonstrating the feasibility and benefits of providing additional illumination in the working places of underground coal mines, the Bureau of Mines has illuminated 38 machines and 4 longwall faces in a total of 22 mines. These installations provided guidelines by which most of the machines utilized by the industry could be illuminated.

The continuing evaluation of mine illumination systems has shown that the major cause of illumination system downtime is physical damage due to machine collisions with coal surface or other machines. The protection of this additional hardware requires the good utilization of machine architecture, for only the massive machine main frames can withstand these extraordinarily large contact forces. Although existing machines have been successfully modified on the section or during a major overhaul, the most efficient time to build in an illumination system is during the early design of the machine, at the factory.

Present Bureau efforts have resulted in the integration of illumination systems into a Galis 300 roof bolter and a Long-Airdox coal drill. These machines have been redesigned to accept an illumination system, and the manufacturers plan to offer the illumination system as an option in the near future. Work has also begun to modify a Marietta drum miner.

The availability of new, illuminated mining machines will provide the industry with excellently protected illumination systems, which will drastically reduce the maintenance costs associated with this additional hardware.

A vast majority of machine-mounted illumination systems have utilized, as a minimum, two Mercury vapor headlights. While these units perform the difficult task of illuminating the face area, production delays could be expected whenever power sags or momentary interruptions occur.

The Bureau has developed, through Westinghouse Inc., a device that is capable of maintaining up to eight Hg vapor lamps for a maximum period of three minutes. The device, known as a "Keep Alive System,"

energizes the lamps at approximately 10 percent of rated power while utilizing a Nickel-Cadmium battery as a power source. The Keep Alive System will eliminate all delays that are now attributed to poor power regulation.

The Federal Coal Mine Health and Safety Act of 1969 provided for the formulation of illumination standards for underground coal mines. The Bureau's program of research on mine illumination, which has evolved data for standards and the technology necessary for their implementation, is presently pursuing an overall major objective of demonstrating cost effective and reliable means to provide the illumination required by the newly promulgated underground standards and to provide technological means by which these standards can be expeditiously implemented.

Mr. Vines: Thank you, George. Gentlemen, our next speaker on the panel is Randy Slone. Randy has already appeared on the program during this conference. I suppose he needs no introduction. But, to kind of recap, Randy has been very much involved in coal mine illumination for about seven years. For the last two and a half years he has been with the Westmoreland Coal Company, which operates mines principally in Virginia and West Virginia, as a staff electrical engineer. Randy also serves on a number of mine illumination committees—national and international—and comes to us very well versed on this subject. Randy.

Mr. Slone: Thank you, Bob. As Bob said, I have already talked on mine illumination, but I would like to add a few comments to what I have already stated—some of the problems that we feel are facing us with mine illumination.

One of the major problems we have right now is that of glare. We have tried various designs and ways of reducing the glare experienced by an operator. One of the most difficult problem areas we've had so far of glare has been on the roof bolter. The reason for this is obvious. The two men who operate around this machine are operating in one of the most hazardous parts of mining. We have tried various methods, such as defusers, filters, and cut-off angles for reducing the glare. In every case, it seems that we reduce the glare somewhat, but were no longer in compliance with the Regulations. When using filters, we have really cut the glare from the lights. In some cases, however, we've had to double the lights on the machine. It is practically the same problem using defusers. You end up setting up cut-off angles that require additional luminaires. Again, when you install luminaires, you have created more problems of glare you have to overcome. This problem of glare has been one of the most difficult items we have had to overcome for desirable lighting systems.

One of the other problems we feel is going to give us all a lot of trouble is the low coal machine. As the height of a seam comes down, a piece of equipment is still required to do the same job—that of extracting the coal. The machines are heavy, and as the coal seam becomes much lower in height, all the components seem to be drawn closer together on the machine. This doesn't leave any room to mount the lights within the frame of the machine so that they are well protected. At present we've tried to recess the lights into the machines so that they will stay on. The problem is that when you recess a light into the frame of a machine you have to have additional lights. Low coal mine machine operators are closer to the directed light of all those lights. They have even more glare to overcome. The problems of glare connected with underground machinery, in particular low seam machines, are the major problems we have to face at Westmoreland.

Another problem is the indication that maintenance costs are going to be very high on most machines. As George indicated, most of it is because the lights are being torn off due to roof falls, ribbing, and running into other machines. These problems, we feel, are going to be very difficult to overcome. At Westmoreland, we feel that it's going to end up with the coal operator being the one who is going to have to solve it. If you're not doing any research or work in mine illumination, we strongly suggest that you begin. The time for compliance is drawing very close and, at this point, the coal industry needs all the help it can get on innovative designs for mining equipment.

Mr. Vines: Thank you, Randy. Like the fellows who appeared here before him, George Evans is also an electrical engineer. He has a B. S. from Penn State and has done graduate work at the University of Pittsburgh and Stephens Institute of Technology. He's been with Westinghouse Electric Corporation for a short period of time—about 41 years—in the Lamp Division. I would expect that George knows whereof he speaks on this subject. His major professional interest is the development and application of light sources, usually for very specialized fields such as aerospace and coal mines, and unique problems of that type. George is a Fellow of the Illumination Engineering Society of North America and a holder of 23 patents. He is the chairman of the Electrical Engineering Society's Committee of Mine Illumination and also serves on the International Committee. George has a lot of pertinent information. I'm not going to steal any of his thunder. George, without further ado, I'll turn things over to you.

Mr. Evans: Thank you, Bob. Ladies and Gentlemen: I'm pleased to be participating in this Eighth Annual Institute on Coal Mining Health, Safety, and Research, not only because of the honor of being with the other

distinguished members of this panel, but also because coal mining has been my family's way of life. I've worked underground for a short period of time with a United Mine Workers' card. And even though I drew my last miner's pay over 40 years ago, I've never lost my affinity for this industry.

I am participating as Chairman of the Illuminating Society's Committee for Lighting of Coal Mines. You may remember that last year in a keynote address discussing mine illumination, Mr. Robert Barrett, Administrator of MESA, said the following:

> "We had to wait until the technology for practical mine illumination and reliable light measuring equipment was available. We also realize the scarcity of illumination engineering expertise in the coal mining industry and in the mining and illumination equipment manufacturing industries."

"The scarcity of illuminating engineering expertise"—this is where our IES Committee hopes to help, and we have found some measure of acceptance as a means for providing the illuminating engineering expertise.

I'd like to tell you a little about this committee. The IES was founded in 1906 with a very short objective charter: the advancement of the theory and practice of illuminating engineering and the dissemination of knowledge relating thereto. The purpose of our committee is to apply the Society's objective to mine illumination. Our committee should be helpful to the coal industry in several ways. We should be able to help analyze and define illumination problems and find solutions for them. We should provide a forum for objective discussion of the problems, the illumination levels, and how to provide for them. We should be a conduit to the IES headquarters where we have expertise; as we define the problems we can ask for professional help. We hope that eventually we will be able to publish an "International Standard on Recommended Lighting Practices for the Lighting of Coal Mines."

The IES Committee's policy is that we should represent various informed viewpoints regarding the subjects under consideration. We must have a representation that is equally divided between users and producers. I'm a producer, as far as the committee is concerned, because I represent Westinghouse—we make light sources for this purpose. Randy Slone is a good example of a user—a coal producer who is going to have to buy the equipment using our production. To keep a very objective committee I have had, as chairman, the job of keeping a good balance. We currently have 14 committee members in addition to myself. In total we have 15 members—8 users and 7 producers. Users, here at the Institute, are

George Bockosh from whom you heard, John Crawford of Pittston, Ken Klouse representing a regulatory agency, Larry Patts from Consol, and Randy Slone. Other users are Bud Stanley, well known to you from Bethlehem Steel, Ken Whitehead from BCR, and W. J. Vicinelly from the Commission of Deep Mine Safety in Pennsylvania. Three of the members represent regulatory agencies. We are then, as we are currently set up, representative. The members have been objective in our discussions; they are knowledgeable in their own fields. We think the committee probably is of adequate size. We don't want to become a trade organization. It gets too big to handle. On the other hand, our roster is not closed if we find representatives that will further our objectives. We certainly will invite them to participate.

Our first meeting of the Committee was held in March of this year at the Westmoreland Coal Company in Big Stone Gap, Virginia. We had the opportunity of visiting Westmoreland's Wentz 1D Mine. We observed a section that had lighting systems on a Lee Norris 455 Continuous Miner and a Lee Norris TD2 Roof Drill. We certainly saw the practical examples of the problems that Randy was telling us about. Our discussion focused on the problems encountered in meeting these underground regulations and on the impact and implementation of them. We exchanged information on light sources, circuitry, instrumentation, and practical problems such as fixtures being smashed up. We decided to have a task force on exterior lighting because the regulations for exterior lighting are in the formative stages. We are hoping that we can develop data on illumination required for safety and have some input at a public hearing which will be coming along later.

We formed the task force and met in May in Pittsburgh. We organized the lighting study with the BCR providing funding on a no-strings-attached basis for the IES Research Institute to measure the light required for safety in coal preparation plants. That report was made and the entire committee met in August for its review. We concluded after a very spirited discussion, that at that time the study did not support our opposition to the proposed regulations and we would not be prepared to participate in the public hearing. We found that we needed a lot of additional study of the data. We had to consider the required illumination levels for safety as just one factor involving safety. It has to be considered in combination with housekeeping, direction of illumination, mandatory cap use, in-house education, and many other factors that go into the safety environment. We plan to continue looking over this data at our future meetings.

We are also considering the formation of a task force to identify the problems in underground mining in order to find solutions. This is of interest to all our committee. I think it will turn out that the entire committee

will try to work on the task force to identify the problems in underground mining. Eventually we will broaden our scope to include all mines. We hope that our contribution to solutions to problems facing this vital coal industry will be such that people will solicit our help. Thank you very much.

Mr. Vines: Thank you, George. Gentlemen, the anchor man on our panel is a fellow who is pinch-hitting on very short notice for Ed Gilbert, the Safety Director of the International Union of the United Mine Workers, who was not able to be with us today because of the press of other business. Glen Beckett is the Chief Electrical Inspector in the UMWA's International Safety Division. He has been with the Mine Workers' organization for about a year and a half. He has been in the coal mines and a member of the union for 24 years. Most of Glen's background is in electrical and maintenance work in the coal fields as an instructor. Glen has previously been a vo-tech instructor in mining and mine maintenance — a certified instructor in the state of West Virginia. Glen grew up in the coal fields in Logan County, West Virginia. He was educated there at Chapmansville High School and has taken technical courses from the University of Wisconsin and West Virginia Tech. I think Glen can give us a lot of insight into the problems of illuminating coal mines from the standpoint of the fellows who are intended to be the principal beneficiaries of these standards—the coal miners. Glen.

Mr. Beckett: Thank you, Bob. I would like to apologize for Ed Gilbert, since he couldn't be here. As Chief Electrical Inspector, I inherited the job of taking his place. If somebody could come up with a pneumatic or hydraulic light, I could swap it with another constituent in my safety division!

Most of what I know about illumination has been discussed by the panel members that preceded me. I want to talk about another concept: safety, in general, in the mining industry and the fatality rate. In 1973 our fatality rate came down after a period of years when it was up in the 200 to 300's. Back in 1973 we had 132 fatalities in the nation. In 1974 we had the same number. I don't know why we had these same numbers; no one else seems to know either. In the following year (1975) the rate went up to 155. After this time there were more safety people in the United Mine Workers who worked jointly with MESA, the states, the coal companies, our safety committeemen, and other members of our safety division. We brought the figure down from 155 to 141. In 1977 (up until June) this figure was 94. Let me give you a comparison of 1976 and 1977. The fatality rate figures are almost identical through August 27 of this year. In 1976 we also had that same figure. Since then there have been three more fatalities in the nation. I think the rate is now about 78, until this particular time in August. In West Virginia alone, in 1976, we had 20 fatalities compared to 32 in 1976. When I

talked to Mr. Webber on the phone he said, "Hold it a minute, we had one more yesterday at the Buffalo Mining Company in southern West Virginia." I don't know how the fatality came about. I didn't get the information on it. Maybe some of you know about it.

I have had the unfortunate privilege of investigating three fatalities this year. One was the result of a roof fall. The man just didn't have any face supports set at all. This one happened in Kanawha County, West Virginia. The next one was electrically or mechanically related. We're not sure how it will be recorded. It happened with a battery-operated piece of equipment that had faulty connections—a bad battery and faulty tram contactors. The victim got off the machine to check the battery coupler. The battery supplied power to the machine's tram. To reach the coupler, he had to lean over a wheel. The wheel did not have a cover guard and, when he moved the battery coupler, it engaged. The machine began to tram, rolling him around the wheel to the ground and crushing him. I don't know whether you would call this an electrical fatality or not. The last one that I investigated was in Pennsylvania this past Monday. The victim was helping to install a monitoring device at the substation. They had removed the power from the station, opened the door to the high voltage installations, and removed some lead wires. They had to re-energize the substation to complete some of their work, but they had failed to close the door. They proceeded to work for about an hour or more. The victim later stated it was dinnertime and went to the truck to get their lunches. He sat down in the doorway that enclosed the high voltage. A zig-zag transformer with 7200 volts was installed within about twelve inches of the door. When he sat down in the doorway he came in contact with the 7200 terminals. He managed to get out of it himself but was severely burned. This happened on July 18. He died on August 12. It then became a fatality and MESA reopened the hearing.

As I have said, I know very little about illumination in the mines. I got this panel assignment willed to me. Most of what I know is what I have read, what the other panel members have told me, and what little I've seen around the installations in the mine. You know we have problems right now in the coalfields. I can't get into mines any easier than anybody else. I wish I could do something about it. I don't know of anyone who has any answers, but I'd be glad to listen to those who might have the answers.

We do have some programs where we can see and learn about the problems. I didn't have the privilege of seeing one in low coal in southern West Virginia, but I have worked in these same mines and know their problem. When you get down into 28 or 30 inches of coal, it actually eliminates the top. I don't think you can even see the top! I don't think we'll have as much of a problem in high coal as we do in low coal.

In fact, I know we won't. The illumination answers to our problems in the coal industry will hopefully bring the fatality rate down to zero. Thank you.

Mr. Vines: Thank you, Glen. At this time we will entertain some questions from the audience. If you would like to direct a question to any particular panel member, please do so. As an ice breaker on questions, I would like to ask Randy Slone a question.

Question:

You mentioned that glare is one of the biggest problems. Certainly, I think everyone would agree with this. You have probably studied this as much as anyone. Do you have any feel as to what might be done in order to, if not solve the problem, reduce it? Does part of the problem grow out of the Standards themselves, or does it grow out of the physical conditions that we have in the coal mines over which we have no control, or out of the hardware? What are some of the approaches that we might have in solving that problem?

Answer: Mr. Slone

There are several reasons why the glare is more difficult in our industry than in others—it's our environment. Our space is much more limited. The large operating machinery takes up a lot of that space. When you put lights on a machine, an operator, or his helper, is almost eye level with the lighting. This is especially true in the lower coal seams. When you have any type of light source—whether it's a small fluorescent, mercury, or sodium—the object is almost within 4 or 5 feet of your eyes. Your eyes have a tendency to focus on that light. The other problem is with the roof bolter. He is constantly working around the machine. Normally the lights have to be mounted on the machine and, as he reaches over, he is directly over the luminaire. If he is in lower coal, he is almost eye level with the light. Because of that, when you try to reduce that glare, you have to practically cut out 50 percent of the light to get any reduction in the glare. You also begin to lose compliance in that same instance. There are no easy solutions to that problem. I really don't know what to say the answer is to the glare problem. It's one we've talked about to several people. Nobody seems to have a good answer for us. The only thing we can say now is that through the use of diffusion, filters, and cut-off angles we've reduced glare in some cases. Glare becomes a subjective thing. One individual says it doesn't bother him one bit, while another claims that if we don't take the lights off he's going to make sure they come off.

Answer: Mr. Vines

One of the problems with glare is that it is subjective. It's difficult to measure in any kind of objective terms. The problem complaints

from operators and other people on their working sections seem to grow out of the fact that the proximity of the light source makes it a difficult problem to deal with when you consider the coal mine environment.

Question:

Along those same lines, has MESA or the Bureau any plans to further study disability glare? As Randy mentioned in his presentation, this is one of the biggest problems with coal mine illumination. I know we're realizing the same problems, and I'm sure the Union has concern over it.

Answer: Mr. Klouse

When we issue a STE at Beckley, we check the system for glare. However, we are using a mock-up and not a machine. Our evaluation of potential glare from the lighting system is not as good as, say, Randy's. Randy has an actual machine and the exact location of luminaires. He can also bring the operator in to determine whether he likes the system or not. The operator can go into different operating positions that he is going to be in around the machine. When we do it, we do it from a mock-up standpoint and is basically done for the operator of the machine. We make sure that he does not have a glare problem. Also, there are really two types of glare: disability glare and discomfort glare. The disability glare is not really subjective, while discomfort glare is subjective.

Answer: Mr. Bockosh

We are not looking specifically into glare in future research. The glare problem has been considered from the very beginning of the program. Yes, there is glare, and it is very subjective. As Randy said, we've put systems into different sections and it varies from near-identical installations. The reactions to the systems vary from whole-hearted acceptance to rejection by miners. There are two ways that we can avoid or minimize glare. The first way is to raise the ambient light levels. It is a matter of a differential in brightness that causes the glare. If you look at a cap lamp in sunlight, shining directly into your eyes, it will not really bother you. If you take the same cap lamp underground, it will bother you.

Question:

Isn't there another way to do that? Couldn't you lower the intensity of the cap lamp in your example?

Answer: Mr. Bockosh

If you maintain the same ambient level and decrease the fixture brightness, you can decrease the glare. There is less glare if you main tain the point at 0.06 and use twice as many fixtures half as bright.

Question:

George Bockosh, in his presentation, touched upon the fact that the MESA inspection personnel would take underground readings if you had a "Statement of Test and Evaluation" and all the lights were burning on your machine. Will that be a matter of policy rather than just conjecture on the part of enforcement?

Answer: Mr. Klouse

It will be a matter of policy. When the Regulations were first promulgated and we were working on the STE program, the Assistant Administrator for Coal Mine Health and Safety, Jack Crawford, at that time and now Assistant Administrator, Joe Cook, agreed that it would be a directive from policy. It will be a policy that the inspectors will not take readings if the system is being operated within the limits of that STE within the height and width restriction, and if the luminaires are reasonably maintained.

Question:

Could any physiological damage occur to the eyes under high glare conditions?

Answer: Mr. Evans

There is at least temporary impairment of vision, unless the glare problem is prolonged for much longer exposures than you might have in this particular mine illumination. While there's no permanent damage, you are blinded temporarily if the glare is great enough.

I think we should clarify a few things. I've got a small handbook here that has some official definitions in it. It says: "Glare is any brightness that causes discomfort, interferes with vision, or causes eye fatigue." We have all three of those elements in this particular mine problem. The handbook further says: "While it is difficult to evaluate the various elements mathematically, there are certain factors that have been established." One factor is the brightness of the source, which Randy and Larry talked about. Another factor is the size of the source. In fact, if you reduce the intensity of the light source by covering the machine with a whole bunch of fixtures of lower brightness, you may end up causing more problems because of the size of the glare area. Still another factor is time. Time is one of these transient things from eye-limited exposure while looking at equipment underground when men are moving around almost constantly. I think they have a chance to overlook fixtures in some cases, just as they learn to look over their shoulder instead of looking directly into a cap lamp. In some cases it's almost

impossible not to get that swipe of light. Just as you have when you look into the front of a car with headlights, your vision is momentarily impaired. If you were to do this often, your eyes would become tired and, as a result, you would not be working safely. There may be a trade off on total intensity and glare. Somewhere in between might be the best balance.

Question:

I'm reading into what you have said that, under conditions in under ground lighting today, there would be no permanent physiological damage to the eyes; there may be some discomfort, temporary loss of vision, but no physiological damage could occur due to the high brightness sources. I have a spot on my eye that was caused by watching a welder many years ago. Am I right in assuming that there would be no physiological damage like this?

Answer: Mr. Evans

Your damage was from the ultraviolet generated in the arc welder, not from the energy in the visible rays. None of the units that we are talking about for illumination are ultraviolet sources. The light source itself generates ultraviolet, but the enclosure pretty well wipes it out. The polycarbonate enclosures for the fluorescent light system, for instance, have ultraviolet inhibitors to protect the integrity of the polycarbonate. There's practically no emission of ultraviolet from those; there's none generated in high pressure sodium. There is in the Mercury vapor light, but the headlight lens cuts it out. As far as I know, we do not have an ultraviolet problem.

Question:

What is the variation in individual responses to glare? In other words, there are certain individuals who, when presented with a bright light, immediately accommodate to the normal pattern, while others take an extremely long time in order to adjust their eyes to a situation where they can easily see with the average illumination level. Can we test for those individuals who might have problems along this line?

Answer: Mr. Evans

Yes, I think it can be tested. My knowledge is of the general art on these things, but I'm not so sure these tests would be too meaningful. First of all, there is an age factor. I think many of us have wondered why we like to drive less and less at night. It is generally because your eye cannot accommodate to the glare problems—it becomes uncomfortable.

Some people, of the same age, will have different responses to the pupil diameter—the ability to close down or dilate according to the amount of energy entering the eye. This will also vary a great deal with factors such as whether you went to a party the night before, how tired you are, or, to some extent, the food you've eaten. It's a large variable, and I don't know if there would be a practical way of pretesting people and then say that this person could take glare better than others. On a whole, younger people can accommodate glare better than older people. I've heard that the tendency is more towards younger people rather than older people in the mines today.

Question:

In certain cases where people have very poor accommodation and have high glare sources posed to them, could they actually be a danger to themselves and other pople?

Answer: Mr. Evans

Yes, there is very definitely a possibility.

Question:

Are we creating a larger problem by correcting illumination problems? Might our accidents actually increase?

Answer: Mr. Evans

It's been suggested that this could well be so, but we have no good data to be able to make such a judgment at this point. That is something our committee hopes to get into.

Answer: Mr. Bockosh

I think you're overlooking one thing. You're assuming that the man with a cap lamp can see everything that you're seeing. You're talking about all the possible negative results. The typical man with the cap lamp is operating with tunnel vision. There is no peripheral vision to enable him to see hazards from the sides, such as a rib roll, if he's looking toward the face. The glare situation that you're talking about does exist in some cases and, to a large extent, the cause is that we're trying to minimize the number of luminaires, necessary maintenance, cost of installation, and all that. The best way to do this is with very high intensity sources that are sources of extreme glare when improperly utilized. Some machines require the use of high intensity sources, but you have to be very careful when you do use them. I think that as we go along, however, very few machines will run into extreme difficulties.

Randy Slone's work is a very good example of this. Am I correct in making this statement?

Answer: Mr. Slone

We've run into some bad difficulties with the twin head bolters and the large bolters, but some have worked out fine. We initially ran into problems when we put lights on machines in low coal. We had to take the advice of the operators and the miner who worked on the machine, and move one light and add another light to make up for it, but it worked out fine. We gave the operators a choice of having the lights taken off after two weeks. In the vast majority of cases when we did return after two weeks the response was something like, "You're not really going to take them off are you?" I think the industry as a whole is on a learning curve. That's not to say, however, that we don't have problems.

Answer: Mr. Evans

George's comments did put this into better perspective than my answer, perhaps. I was directly answering your question without considering that perspective. I'm glad he made those remarks.

Question:

This question is in two parts. It has to do with the adaptation of the eye. Years ago, during World War II, those of us who were in air groups were put through the paces to see whether we could go out on night flights. There was a series of things that the human factor engineering people have now. Has any thought been given to working with people who are doing this sort of work for the military—people in submarine warfare, people in the aircraft divison, or those that have to go out on night reconnaisance missions? There is a wealth of literature generated from this. We know, for example, that there are some people who have tunnel vision. For example, a person who is perfectly capable of running a piece of machinery in a lighted area is not the person you put into a situation where you have high glare. If his eyes can't accommodate, he may then increase his risk level. Has your committee been working with any human factor engineering to look at some of these things?

Answer: Mr. Evans

Our committee has just begun its work. We're barely out of the organizational stage at this point. This would be one of the areas that we would certainly have to consider. If you're implying that perhaps

people working on illuminated mine equipment are using rod, instead of cone, vision that the assumption is open to question. There is enough general light levels around that it's essential for a cone daylight-type of thing, and the Bergenzy effect has not taken place. I don't think we're talking about night vision in this sense.

Question:

We've been taking a very close look at some of the studies that have come from the Vietnam War, particularly. Again, if I might put it in terms of risk level, we know that the risk level will go up with stress level. We find that any situation that increases the stress level increases the susceptibility of a person doing something he might not do to place him in a hazardous situation. I would consider a stress level as with glare situation or stress associated with noise. Has any thought been given to this?

Answer: Mr. Evans

There's been a brief discussion, but we haven't had a chance to look at it in any detail. There's a counterthought too. When you have tunnel vision, such as with the cap lamp alone, there's a tremendous contrast in the field of vision between a bright area and the darkness of the mine. The surroundings are rapidly changing as the man turns his head. His vision scans very quickly. When you have high contrast ratios like that on moving targets, you also generate a good deal of stress. The problem is, how do you evaluate whether or not you are creating a good deal of stress? We're hoping to improve conditions with better illumination, as against what is there now.

Questioner's Response:

One way of evaluating that is, of course, after the new lights go in. If the injury rates go up, then maybe there is just too much illumination and maybe too much stress. It might be a little late then!

Answer: Mr. Evans

There may be a quicker way, too. I understand that in some cases, for trial purposes, it was suggested that illumination is going to be taken off the machine and then working at will with lights on the machine. They may have thought of a better way.

Answer: Mr. Vines

I think you hit on a couple of very interesting points here which I would like to comment on very briefly regarding the testing of miners as it might relate to a test on Air Force personnel. There isn't the same relationship with the employee in industry that the government has with Air Force personnel. I think that puts us in a position of having to have an operable system underground that would be designed for a "worst-case basis" with respect to the employee's ability to accommodate. This increases the difficulty of trying to solve the glare problem even though, by coincidence, a lot of our miner operators and machine operators are younger fellows who can accommodate very quickly. We still have to have a system suitable for the older fellow or the fellow who, by some natural trait, cannot accommodate as quickly.

In connection with the matter of stress, I really wonder if perhaps our failure to solve the glare problem in an acceptable manner would pose an even more serious problem than posed by the lack of additional illumination. Certainly that failure would be self-defeating to the purpose of this standard itself. The reason the standard was adopted to start with was its potential for improving safety in the mines. I think one of the biggest potential factors that the standard has for improving safety is really through the manner in which it can improve the comfort of the coal miner. In doing so, he is going to become a safer worker just because he is more comfortable and has less stress—not necessarily because he can see peripheral hazards. That's an opinion of mine. Now, if we fail to accomplish that, in fact, if we put this man under more stress and make him less comfortable, then I think we certainly have a counterproductive situation.

I might comment very briefly, too, on some of the successes that we have mentioned here in illuminating working places. Some of the mines that were visited by the Joint Union-BCOA Committee had some very encouraging successes. One in particular characterized an outstanding success from the standpoint of light. We found another one which was a total failure; it was obviously counterproductive to safety. The men, after having given a fair trial of letting the light stay on for about thirty minutes (I think that was pretty generous on their parts) refused to operate the machine any longer. No one has been able to suggest any modifications to that system at this point that could have eliminated the real safety problems created by that system.

We have a multitude of situations in the coal industry. I think George Bockosh said it well: "A mine is not a mine is not a mine." We've got the full range of problems. After seeing a successful installation, I concluded that there were three key elements to the success of that operation.

First, it was a very reflective coal seam. I think it was about 4.9, permitting the light level standards to be met with a less intense source. Second, there was ample clearance over the machine for mounting the lights. Part of this was artificial, because roof rock was being taken to improve roof control. That leads into the third reason and perhaps the most important factor for success. The installation was made during a scheduled rebuilding of the machine out on the surface. A lot of thought and effort and engineering went into it. Seven of the ten lights that were mounted on the machine were at customized locations that did not exist on the original machine. The lights were mounted on bevelled edges. They were recessed, serving two purposes. One was to protect them mechanically, and the second was to set them in at angles so that the light could be directed at the surfaces where you wanted it to be directed. It struck me that if we're going to be able to have successful, satisfactory, safe installations in the coal mines that it's almost essential (especially more so in lower coal seams) that these installations be made when that machine is out on the surface. I don't know if this practical situation really lends itself to the problem of complying with the law by some fixed date.

The capability of the industry to rebuild its machines and install lights is certainly limited to some fixed date. It is not going to be able to do that by April 1. Would the panel members like to comment further on that?

Answer: Mr. Slone

We've checked into that. We've done about half of our installations underground and the other half in shops. We've discovered several things. The amount of labor for a system installed underground is approximately three times as great as one done in our shops. Also, even though the systems and drawings may be identical and may be put on two identical machines, the lighting systems (once they were installed) were not as good as those done in the shop. I'm thinking in particular of a continuous miner where we had the same lighting system put on two machines: one underground and one in the shop. The lighting system put in underground was very substandard. The wiring was not protected, the fixtures were not mounted properly, and the welding was poor. The ones we did in the shop, of course, were better protected. In fact, there was some slight recessing done, giving more protection around the light and around each individual cabling to the light. There were also less labor costs.

Response: Mr. Vines

You really got a better resultant light and also a safer installation.

Answer: Mr. Slone

We feel we did, but we had the problem of not having enough time in which to do it—not the way the law was written with the 18 month period. We're trying to proceed as best we can, but at this point we are still delayed by the problem of the certification of the lighting, etc.

Answer: Mr. Evans

During the break, several people asked me some questions. It made me realize that perhaps we haven't separated the two principal adaptations we're talking about. First of all, the ability of the eye to adapt to a changing illumination situation depends upon the situation from which it is changing; that is, the state of adaptation from which it begins. One, you might say, is a mechanical adaptation and has to do with the pupil size. The mechanical adaptation is relatively fast. If your eye suddenly sees a very bright source, the pupil can shut down fairly quickly. Conversely, if you go into a dark area, the pupil can mechanically open up fairly quickly. The other adaptation has to do with the photochemistry of the retina. This is extremely complex. It has a great deal to do with the body health and whether or not you're on medication and things of this sort. The restoration of the photochemical balance in the retina is a very slow process. If you suddenly go from a bright environment to a relatively dark environment, you are then asking the photochemical adaptation to take place. It could take place fairly rapidly, perhaps in a minute, but you are far from dark adapted. It could take up to thirty minutes or longer, i.e. those people who had the Navy testing to whom Dr. Dabetakis alluded. The main problem in mine lighting occurs under these extreme conditions, the discomfort caused by the pupil opening and closing a lot. The safety aspect has more to do with the photochemical adaptation, that is, from going to a very bright source down to a dark area. We're talking about two things: one fairly fast adaptation, the other fairly slow.

Question:

Randy Slone touched briefly on certification problems with lighting fixtures for underground mining in his presentation. About 2 months ago the operators received a memo telling them that their approvals had either been rescinded, or revoked, or suspended for certain underground lighting fixtures and that they were to de-energize such luminaires. To date, the operators have not received any written confirmation so that this problem could be squared away. I believe that date was to have been July 15. It has held up lighting programs and, in fact, stifled them because operators are, of course, leery of buying hardware and installing it on machines when they don't have an approval for it.

My question is: When is this recertification problem going to be resolved, and when will the operators know about it?

Answer: Mr. Vines

This refers to the memo that went out to all operators advising them that certain light fixtures were being retested and were again being subjected to consideration under permissibility approval. It advised the mine operators that if they were going to continue to use these lights underground that they would have to make certain precautionary exams of every shift, etc. I'm not sure anyone here on the panel has all the facts on that, because the matter of certification is handled by Don Mitchell's office.

Answer: Mr. Klouse

Memos have been sent out on almost all the lights that were rescinded as of now, except one. The memos have gone to the district managers. They would have the memos for the approval and recertification. I don't believe they are going to issue a general memo to the coal operators like they did under rescission. They have notified the districts, and they have notified Washington. If you have a couple of systems, whatever lights they are, I would suggest calling the district manager in that area. He should have that information. There were two lists that came out. One list was certifications that were rescinded, and the other list was certifications suspended. The suspended list has been reinstated, I believe, all except one luminaire. That one might have been reinstated by now. Luminaires on the suspended list are still suspended.

Answer: Mr. Slone

If I remember that memorandum correctly, it stated that the coal operator would be informed and updated on the reinvestigation and retesting of those fixtures. Now you are stating that the coal operators will not be directly informed as to those changes.

Answer: Mr. Klouse

I don't know of Washington's policy on that. The memos have come out of approval and certification. They have been out about a month. Washington might have been waiting until the entire suspended list was either revoked or reinstated so that they could handle all the luminaires in one memo. They might be going to send a memo to the coal operators. I will mention it and see what we can do about it.

Answer: Mr. Slone

This is the point. We were notified to de-energize the fixtures, but we were never informed of the progress or whether they were reinstated.

Question:

Do I understand that at this point the coal operators don't really know what systems can be safely purchased as approved?

Answer: Mr. Klouse

That's correct. I'm sure that memos reinstating the suspended certifications have also gone to the equipment manufacturers; all would have copies of their memo reinstating their certified lights. I believe that Washington is going to handle this when all the lights on the list are dealt with in their entirety. That will probably be coming out in a couple of weeks.

Question:

This question arises because of the delay in acquiring and installing lights as a result of the question about their certification and because of work stoppages experienced in a large number of mines and the fact that we might expect a general work stoppage later on.

Would there be any consideration for the failure to become completely equipped in the mine by April 1?

Answer: Mr. Klouse

Let me read something, and then I'll try to answer your question. "The Secretary shall propose standards under which all working places in a mine shall be illuminated by permissible lighting within eighteen months after the promulgation of such standards." This is in a Congressional law. I don't know if we can legally extend or change the April 1 deadline. We are aware of the problems we have had with certification and the potential problems of the coming contract negotiations. I don't know legally, if there's anything we can do about that. As it stands now, underground equipment, when used in the working face without lights, would be in violation after April 1.

Question:

It has been mentioned that there is some type of time lag when a person goes from a source of intense light to an area of darkness or vice versa. Everything that we have talked about so far has dealth with

stationary-based equipment. I am concerned with the fact that people coming from areas of darkness into areas of light might create some additional hazards or stress on the individual because of adaptability. This could also happen with mobile face equipment where a person is constantly subject to changing from areas of darkness to light and then from an area of light into darkness.

For example, if there is a buggy runner coming up to a continuous miner, is there going to be a period of time in which the operator cannot have visual control over his piece of equipment?

Answer: Mr. Evans

I would say there is a good possibility.

Question.

Will there also be a period of time in which his visibility might be impaired when he leaves from behind the continuous miner to go back to his loading or discharge point?

Answer: Mr. Klouse

In the regulations, 0.06 footlamberts is required. This light level was picked for a number of reasons. The Crane Report was done in Crane, Indiana at the Naval Ammunition Depot and is a low-light study. It was a task analysis performed underground. The light level available from cap lamps at nominal working or walking distances was used. This level came out to be 0.05 fl. Most of the studies showed around 0.05 fl for making a splice, etc. The 0.06 fl level was picked because 0.06 fl is approximately the same light level you would get if you went into and left a lighted working section and used only your cap lamp for walking. You would get approximately 0.06 fl from a distance of about 5 to 10 feet off the coal surface. That's why the 0.06 fl level was picked for the working section. When you leave the working face area, you go from peripheral vision down to tunnel vision. Basically, that would be the only adaptation change.

Question:

Would this cause an additional stress factor on mobile face equipment operators, for example, since the eye must constantly adapt to tunnel vision to peripheral vision and back again?

Answer: Mr. Bockosh

You just lose your peripheral vision. The eye goes through no adaptation. The question I put to you is: How do you measure the stress?

There's the man who returns to the handicap that he's been working with for years; there's no adaptation, either retina or photochemical, when he makes that transition. He just no longer sees a

Question:

This question is about setting up your black box evaluations of a mock-up system in order to make allowances for other things that may happen later. When you get underground, do you actually test that configuration of light against 0.08 footlamberts as the light level that is to be reflected from the most dimly lit surface?

Answer: Mr. Klouse

Right. For a surface evaluation or the STE program we require 0.08 foot lamberts. The pupil in the human eye can adapt or change for a wide variation of illumination levels without getting into a photochemical change. A photochemical change, as George described before, involves high contrast areas, like coming from daylight into a house or very dark interior. These are very bright levels and would not even exist underground.

When these systems are laid out for continuous mining, or other types of equipment, the layout is designed for the operator. The operator has a fixed operating station and should not be able to look into the light source in a good system. You wouldn't have the Mercury vapor headlight glaring at him, for example. This is one of the reasons we have more difficulty with roof bolting equipment and/or some continuous miners like 101 L's or Wilcox where you have jack setters and other people working in front of the machines. We really do not have much of a problem lighting to these levels on continuous miners or any type of equipment where you have a fixed operator position near the rear of the machine. The continuous miner or shuttle car operator coming into that area almost never look at a fixture or sees a fixture lens. The only remote possibility of that happening is when they are turning a break. I don't think that looking into a fixture is any problem in the normal mining cycle for the operators of such equipment. The only ones who are expressing some dissatisfaction are the miners' helpers, especially if they are along the side of the machine. When they have to go up alongside the machine to the face, the machine should not be operating. It's an avoidance type of problem. You can't look into a fixture and maintain the same type of visibility as if you had avoided it. As someone said before, you don't look at the headlights of an approaching car—you look to the side of the road and can still see where you are going.

Answer: Mr. Evans

I thought your comments were very good, Ken. I looked up some brightness values. The clear blue sky has the brightness (in foot lamberts) of around 1, 000. An ordinary 40 watt fluorescent lamp is around 1, 000 footlamberts. The 1500 milliamp fluorescent types being used underground go up to about 6, 000 footlamberts. You have a good chance, if you look directly into some of these fixtures, of exceeding the brightness of a clear blue sky.

Question:

I wonder if any consideration might be given to the possibility of altering a standard from a fixed point to a range of levels to allow some control from the operators and people associated with the equipment in the area? It's a matter of individual differences. It appears to me that with the great variability in other human factors that perhaps some allowances could be made. Perhaps the operator should be the best judge of how much light he needs, as opposed to some arbitrary standard that says you need this much. We see such choices in simple things as dashboards in automobiles and lighting in homes. I don't really see why we can't apply this in an industrial setting.

Answer: Mr. Vines

The suggestion made by the UMWA people on the Joint-Industry Safety Committee was that perhaps MESA should consider a system that would permit the mine equipment operator use of a rheostat or something to reduce the level of light to his own liking. We discussed whether the standard might be open to challenge for a change to accommodate that and other suggestions that have been made to MESA. Perhaps MESA people should handle that question.

Answer: Mr. Klouse

Let me give you a little bit of history first. The Health and Safety Act of 1969 gave the Secretary 9 months to produce illumination regulations and 18 months after that for the mines to be in compliance. At the time the proposed regulations were published, the expertise in illumination did not exist in the industry. There had been enough research and so the regulations were suspended at that time. Some research contracts were entered into, such as the Crane Report and the Haldane Report with the National Bureau of Standards. These reports helped set the light levels by the professionals in the field. They have done a lot of work underground measuring jobs that had to be performed by a miner. They also measured levels that were compatible without causing adaptation problems and possible other problems in that area. These reports took (approximately) until

October 1976 before enough data was obtained. Also, enough people in the industry are building and making hardware that can be used to light the equipment underground to implement the lighting regulations. That's why the illumination standards were promulgated on October 1, 1976. I don't believe there's going to be any way they can be modified.

Answer: Mr. Vines

I'd like to comment on that answer. I think there are problems in providing adequate light levels for coal miners in a satisfactory manner so as to contribute to safety that are owing to the manner in which the regulations themselves are drafted. I think that these problems have not come to light. We really didn't recognize the existence of these problems until we had some practical experience underground. I'm not sure that the people who did all this research work for the Bureau of Mines and MESA did it on much more than a theoretical concept anyway. We have had a number of trial installations underground. I think it would be unfortunate if there has been information gained since the time the standards were adopted--information that would indicate that the standard could be re structured to provide for better safety with no opportunity to incorporate those changes into the Standards. I don't think you should stand on some "sacred cow" position that Congress in its infinite wisdom said you have to do something within a certain amount of time. If your initial effort could be improved upon, then certainly Congress or nobody else would criticize you for taking that kind of an action. I don't think it would be contrary to their intent to make an improved standard based on fact.

Answer: Mr. Klouse

If information was received that there is a problem in safety, and if data came in that the regulations could be modified to increase the safety provided by illumination, the regulations would be changed. That data, so far, has not been brought forth in such a way. There is quite a bit of data that was originally generated and worked on to develop the Standards as they are now. Some of the problems we're experiencing now were considered in this. There are some areas where there are going to be problems. It's going to be recognized and will probably be handled on a policy decision because it would be unique or a special case--not a general problem.

Question:

Do I get the picture, Ken, that as we get closer to this ultimate date of compliance that there is a strong possibility that there won't be enough hardware available and enough time to install it? Will there be

many companies (even companies sincerely trying to do so) that will end up having a lot of their equipment not in compliance?

Answer: Mr. Klouse

I made a survey in May. At that time most of the lighting companies were working at less than 25% capacity because of no sales orders or demand. This was prior to the problem with the polycarbonates. This was three or four months ago. They are probably still working at 25%. It takes time for an industry to gear up. If they had enough orders to start working at 100% capacity, it would still take them two or three months before they could gear up to 100% capacity. I don't know what the capabilities of the industry are for April 1. With no orders coming in, they're not gearing up.

Question:

The law pretty well has the area of normal vision for an operator covered as a minimum of about 0.06 footlamberts. I would like to have a few areas clarified. Is the top of a canopy on a continuous miner considered in the normal vision of an operator?

Answer: Mr. Klouse

The area of regulation reads: "By inby end of the shuttle car on continuous mining equipment, all coal, face, rib, floor surfaces, roof surfaces to the face when the machine is within three feet of the face." This would include the area immediately over the canopy. If that canopy is within one foot of the roof, the roof does not have to be lighted. This takes into account many seam conditions where the operator usually can't see the roof anywhere. If the roof is within one foot of the top of the machine, the roof does not have to be illuminated.

Question:

I don't believe I understood the question. Were you asking whether the top surface of the canopy has to be illuminated, or the roof area above the canopy?

Questioner:

Either, or both.

Question:

If you have more than a foot, do you have to illuminate both? Is that the answer?

Answer: Mr. Klouse

No. If you're using the machine-mounted system, readings are not going to be taken on machine surfaces at all. No readings will be taken within one foot of the machine. If, again, the roof is within one foot, it would not have to be illuminated. If the roof over the canopy is more than one foot away from the top of the canopy it would have to be lighted. The canopy roof itself does not have to be lighted.

Question:

Has there been any research done concerning the difficulty in lighting a longwall system? Do you have any idea of a cost indicator for lighting a longwall section?

Answer: Mr. Bockosh

We have illuminated longwalls. We have done four of them now in coal seams ranging from 10 foot to 36-38 inches--both shocks and chills and plow-type coal headings and shear type. The estimated cost right now comes in somewhere between $35,000 and $70,000, depending on what kind of hardware you are using and the mining situation.

Question:

Ken, you mentioned that there were standards in other countries, i.e. United Kingdom and Russia. What is the nature of the standards in England and Russia? Are they mandatory standards that are enforceable by law with failure to comply leading to coal mines being shut down? Do you know the actual status those standards enjoy under the law?

Answer: Mr. Klouse

The illumination law in England empowers the district electrical supervisor to require lighting as he sees fit--it is not a mandatory standard--it's not nationwide. It empowers on a district-by-district basis. It would be the same as if you were to go on a mine-by-mine basis where there would be lighting in one mine and no lighting in another. Usually it runs on a district level. The district electrical engineer or the government's regulatory agency usually has the final say on lighting.

Answer: Mr. Vines

As I understand the situation, the district engineer is actually associated with the mine operator; he is an agent of the operation of the mine. That's quite a dissimilar situation to the one we have here. Our mine operators are not the ones who decide whether or not the mines are to be lit or whether or not the mine is to be shut down in the event it is not in compliance.

Answer: Mr. Klouse

The only reason I mentioned that report is that there have been some safety papers written in England on safety based on lighting in underground mines. Conditions change from section to section and from mine to mine. Even when you try, you're not going to be able to hold your variables constant. The conditions change so much that you're not going to get reliable data on either production or safety with respect to lighting—not at the present time, anyway. When there are so many variables you have to create a larger data base; you need a larger sample. The reason I mentioned the English report was that I think eventually that data will be significant. They did a 12-year study which we do not have the capability of doing. That 12-year study had 6 years prior to lighting certain areas in a mine and six years after. They did show that accident rates fell in some areas where they had illumination.

Answer: Mr. Vines

I think the improvement is true of the industry in this country too, although we have not had a six-year period of illumination to be able to compare with any other six-year period. In the country, when you compare one six-year period with a previous six-year period, you will find an improvement. The British improvement may not be entirely related to the fact that they compared an unlit period with a lit period.

Question:

This is directed to Mr. Klouse. You mentioned lighting of mines in England. I assume this is done for the sake of safety. Is that true?

Answer: Mr. Klouse

Basically, that is true. They were having haulage runway problems.

Question:

Let's use a longwall for an example. I don't know whether you've seen lighting on a longwall or not, but my assumption was that it was done for safety—as far as the face area goes. Is not England's level considerably less than what we are trying to attain?

Answer: Mr. Klouse

Correct. They don't have a fixed level, as such. They usually average about one light per two chocks. We average approximately one light per chock. They have about half the levels we require. Instead of 0.06 footlamberts, they have 0.03 - 0.04.

Question:

I'm wondering whether we could learn something from their safety record versus level of necessary light?

Answer: Mr. Slone

I'd like to comment a little bit on the British lighting. I was there last November for three weeks. We visited various longwall faces. In fact, we were on five longwall faces, and not one of them had lighting. Of the collieries we visited (I think it totaled some 26 sections), only one section out of 26 had lighting. In our discussions with the general managers of the collieries we were told that the final decision was up to the general managers as to whether they wanted the lighting or not. Not all their longwall faces are lit.

Answer: Mr. Klouse

That report was based only on sections where lighting was introduced. There was an analysis based on 6 years before lighting and 6 years after with as many things constant as possible.

Answer: Mr. Vines

That brings up a very interesting analysis of the situation. If, in fact, the English have concluded that illuminating their longwalls would improve either their safety, or their productivity, or anything, and the fact that the people who make the decision as to whether or not they want to comply with the standard can do so at no cost to themselves, it makes one wonder whether they really have reached that conclusion inasmuch as they apparently have not availed themselves of it.

Question:

This question refers to Mr. Slone's paper given on Tuesday. What was the basis for the concern over the polycarbon emissions and the resulting slowdown in the work on illumination? What data has recently come to the front to suggest that this is now a problem? You stated that replacement costs on an annual basis represented about 100% of your initial investments. This would seem to me that you are having a lot of breakage problems—ripping off these lights and so forth. What kind of health hazards would result from emissions of Mercury vapor in underground mining?

Answer: Mr. Slone

You asked about how the polycarbonate problem came about. There were several quality control problems with various manufacturers at first. We had several fixtures in our own laboratory. As you know, polycarbonates are supposedly unbreakable, yet we were able to toss them across the room and they shattered into small pieces. This was partly due to a quality control problem which was taken care of immediately by the manufacturers we contacted. The problem started back in November of last year. We came up with the problem in our own lab. Later, MESA sent out a letter (April 23) that they were questioning the problem. Apparently that problem has been resolved with new manufacturing techniques and quality control procedures to insure integrity of the tubes being properly used for their application.

George has already commented on ultraviolet rays in Mercury vapor lamps. The enclosure of the lamps and the glass through which the light is transmitted should stop any ultraviolet radiation.

Maintenance costs of lighting have, so far, been based on five sections of lighting at Westmoreland. We have experienced a lot of lamp failures. Vibrations are not supposed to affect them, but a 45-ton machine that can dance around creates a lot of vibration. We are losing quite a few lamps. You have to take into consideration that you have some sections with bad tops. In those particular situations, we've lost a lot of lights. In a five-week period we lost five lights off machines. We have two headlights on a machine; in a five-week period we replaced a headlight three times. In that same five-week period, we had to replace three fluorescent fixtures that were torn off because of slate fall, ripping of the machine, or whatever. These costs are preliminary figures based on what we have so far. They are not conclusive yet, but we based them on information that we have now. Maintenance and replacement costs could run as high as 100% of our initial installation costs. I can only speak for Westmoreland on that fact, because we know the cost when we put them in and what our original cost estimates were. They are living up to every

one of our original estimates. At present, Westmoreland operates 100 sections which have as many as four pieces of equipment. We have 95 continuous mining sections, normally with two pieces of equipment. This averages out to approximately $20,000 per section over the 100 sections. That figure is just installation costs. We have found that on systems that we do underground that labor sometimes far exceeds what we had originally estimated. The reason we were estimating 25% of the material cost for labor was that in the shops that figure proved to be accurate; on the underground systems it came out to be three times (in some cases) over that done in the shop. So far, our figures have been pretty accurate on what we have done at Westmoreland. That is why we are trying so hard to cut down on the number of fixtures we have to put on the machine in our lab and to cut that cost down.

Question:

I didn't get a chance to hear your paper the other day, Randy. As I understand it, you are saying that your annual maintenance costs will be equal to your original installation costs. In figuring the annual cost, did you use any factor for lost productivity?

Answer: Mr. Slone

No, we did not figure that factor. It is difficult to figure down-time for machinery. All we could take was actual figures for replacement. What does it really cost to put in a lighting system? When I estimate $20,000 per section, that doesn't include some fifteen people involved in four years of research that Westmoreland has done. Those costs can't be recovered. How do you figure those in on the longwall or the down-time you have on the machines underground? Most of the machines we have done underground have been done on the weekend at premium time.

Answer: Mr. Vines

I'd like to point out something that George Evans mentioned briefly—the Standards that are in the rule-making pipeline right now for illumination of surface areas. These were published in proposed form some time ago. There will be a hearing held sometime in the future. George mentioned that he is chairing a committee, made up of professional people, which will be consulting with MESA and give some input to MESA with professional expert advice on the standards for lighting on surface areas. If anyone in the audience wishes, it would be appropriate at this time to offer comments to Mr. Evans, or ask questions which could be helpful to the committee in its activities.

Question(s): (not picked up by original tape)

Answer: Mr. Klouse

The Bureau of Mines (George Bockosh, in particular) laid down a system for a particularly difficult piece of machinery—a 100 L Jeffrey. It has a problem of jacksetters operating in front of the machine. When the Bureau of Mines laid out the system for the machine they laid out a combination system using an area system and machine-mounted system. The system was in compliance with the Federal Regulations. The company and the operators complained because of the cabling. There are two pogo sticks laid out on each side of the machine in the system. This came out to be two cables per side. The pogo sticks with the lights had to be moved up. We tried to eliminate the area system because of the complaints and put the entire system on the machine. The entry was 30 feet wide in very low coal. We had to put some very high light sources on the machine itself. This is the machine that the miner operators would not operate because of the glare problem with that light system on it.

We suggested two possible ways to modify the machine and still give them a machine-mounted system. One alternative was slight modification by building some hangars for the lights in areas behind the operator as an extension for the building of an operator's deck onto the machine. The other alternative was to go back to an area system. We were going to try to improve upon George's first layout by combining the lights on each side onto one pogo stick and one cable, rather than multiple cables.

There was one other area system that was looked at. It was done in one of the two high mines—about 6 - 6 1/2 feet and done at the time the Regulations were not in affect. We put in an area system that was in compliance. It involved six pogo sticks, three on each side of the machine. It was the only light plus the two headlights on the machine. The people mined ahead and left the lights where they were. If the lights and the power supply were moved up, an extra person would probably be required on that section.

There is another area system being looked at right now, I believe it is Peabody in Ohio. They are using a hangar method where they are going to suspend the lights from a guidewire. The only movement would be from the helper moving the lights forward. We have not had very good success with area systems but, on particular machines like 100 L's, an area system is the only way you can light without modifying the machine and have worker acceptance. A combination area and machine system can be done for the 100 L. In fact, George did it at one time and we are trying to narrow down the number of fixtures on each side or only one pogo stick per side, rather than multiples.

Answer: Mr. Vines

I was referring to the post-mounted system tried with a 100 L miner at the Len's Creek Mine. They had discontinued the use of it sometime before the Joint Union-BCOA Committee went to visit them. It was my understanding that both the local union people and local management people had been dissatisfied with it because of the problem of handling and potential safety problems with the cables. With regard to the machine-mounted system, they were not as dissatisfied with the resultant light itself as they were with the glare. We talked to the crew and the safety committee there and asked if they had any suggestions on how to improve that system. They suggested that we put the lights some place else rather than on the pogo sticks.

Answer: Mr. Bockosh

I'm a bit confused. When we put that installation on the 100 L machine, the company came back to us and asked for a second machine to be illuminated because it was well accepted. The only problem they ran into was that they had taped two lights together on either side and ran out of cable when it was moved up. The cabling was intrinsically safe. I don't understand what the hazards were. The movement on the 100 L is not all that fast that you're going to get caught up in the cable.

Answer: Mr. Vines

I suppose that maybe a lot of things are as subjective as glare. A man's problems are what he thinks they are. It's very difficult work in a 36-inch coal setting timbers. Those guys really move around. We watched that crew there for awhile. It's very difficult work. The use of the cables made their work much more difficult and, although there may have been no real hazard in handling and moving the cables, the men perhaps thought there was a hazard. Maybe it was based on the fact that it made difficult work even more difficult for them.

I'd like to thank all the panel members for their participation.

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