

Critical Issues Conference On In-Facepiece Sampling

PART 3

International Society For Respiratory Protection and National Institute For Occupational Safety and Health

- PROCEEDINGS -

Parts 1 and 2 of the Critical Issues Conference have appeared in previous issues of the JISRP.

Mr. Wilmes: Welcome to the session. There is, for sure, one Panel member missing yet but if I could start out having the first Panel come to the front? It is our second day of the conference. To start with, we had a lot of questions concerning the proceedings of the conference. They will be available in between two and three months from now in publication. Everyone attending will be notified as to when and the ordering procedure for the publication. The cost will be determined later because our production cost is based on a per page basis and it depends upon how verbose we are.

With a group this large, it is very difficult to hold a meaningful discussion on topics such as this. So I chose to address this problem by selecting a Panel of people familiar with this area that had, hopefully, divergent views on what this all means.

We will begin by asking each of the Panel members to give a brief statement of their opinion as to what this all means and what we need to do now and then open it up for

discussion. Hopefully, the discussion will take place between the audience and the Panel members, rather than between each other during coffee break where the rest of us can't get the benefit of your thoughts and insights.

I would like to introduce the Panel. First of all, next to me is Lynette Hendricks, from the Nuclear Regulatory Commission; Nancy Bollinger, from NIOSH; Frank Lotito, who I believe is representing ISEA today, Industrial Safety Equipment Association; Alan Hack, from Los Alamos National Laboratories; Ed Baier, director of Technical Support at OSHA; Bob Bentley, who we heard from yesterday, from the Health and Safety Executive in the U.K., and Tom Nelson, from Dupont.

Let's see, for the Panel's benefit we have two microphones there. The microphone laying in the center is a PA system; the other ones go to the recorder. So I suggest -- there will be another microphone, I understand, coming later. They somehow didn't deliver it this morning. But likewise with yesterday's presentations, when we get to the discussion part with the participants, you must use the floor mike near the center of the room.

Okay, I would like to start out then with Lynette Hendricks, from the Nuclear Regulatory Commission.

Ms. Hendricks: I would like to begin by commending NIOSH and Warren and Mr. Bentley and his group for addressing this problem that has been worrisome to a lot of people for quite a while, which is the reproducibility, lack thereof, and experience in performing fit tests on people, sometimes three or four in the same day and getting widely different results, and also sort of a worrisome lack of agreement between qualitative and quantitative fit testing results.

While what has been done is certainly not the final answer to the question of sampling bias with quantitative fit testing, I think what we have come up with is a very clever, workable approach that will eventually allow us to quantitate this sampling bias. And once that is done, or concurrently, we can work towards eliminating it or somehow correcting it.

I think these should be embraced as an ability to perfect quantitative fit testing and not as an excuse for resorting to qualitative fit testing. Qualitative fit testing has its own set of problems due to the subjectivity of the response. They are not going to be resolved. So using this as an excuse to go to that I think is very bad and should be something that we are all on the lookout for.

Quantitative fit testing is our only research tool, and a strong regulatory tool for quantitatively saying what the ability of a given brand or type of

respirators to fit even a test group of people is. That is very important in view of the current political system to increase the use of respirators and for additional applications with our current set of knowledge or lack thereof -- I mean the ability of the respirators to protect people in the workplace.

Finally, we should remember too that quantitative fit testing is the only way for the field industrial hygienist to actually select the best fitting respirator of a given class for a worker. And given the limitations and hassles of wearing a respirator, I think we owe to the worker, to select the best fitting respirator. So that is it.

Mr. Wilmes: Thank you very much. The next person will be Nancy Bollinger, Chief of Testing and Certification Laboratory.

Ms. Bollinger: Okay, I guess the first question that we were to address is what does all this mean? Well, basically it means that we have had quantitative fit testing in this country for 25 years without really characterizing the sample error. It also means that we are now finally doing that. I think if we got anything from the talks yesterday, it should be that we need to continue the research to both characterize the sample bias for various types of respirators, and to find ways to minimize sample error.

To get a good overview of how this affects the respirator community we need to look at how in-facepiece sampling has been used in the past. Yesterday Jim Johnson mentioned a few of the ways it has been used. Basically, quantitative fit data was used by Los Alamos when they were doing some studies in the early '70's to derive protection factors for various classes of respirators.

NIOSH and OSHA had a joint work-ing committee, a standards

comple-tions program, that then used those protection factors to establish a res-pirator decision logic. That decision logic has been used by NIOSH and most of their recommendations, their criteria documents and their guide-lines on chemical hazards, and it has been used by OSHA in a lot of their standards. Either protection factors or the analogous maximum use concentration have been put into federal law.

In 1980 the ANSI Z88.2 Committee used fit factor that were to be measured using quantitative fit methods to recommend that maximum use concentrations could be raised for respirators.

Employers have used fit factors from quantitative fit tests to go to OSHA and ask for variances so that respirators could be used at higher than the normal maximum use concentrations.

Finally, we have been using workplace protection factors to both evaluate how respirators have been protecting employees, and to evaluate how well respirators are performing.

So our present concern has to be what is the sampling bias? And we have a lot of options based on what we heard yesterday. The first option is to panic. Most of us have lot of experience with that and we are pretty good at it; I know I am-

The second option is to do nothing. And again we have all had experience with that. Another option might be to do nothing until there is further research. And this research could be to look at more adequate sampling techniques or to characterize the bias. That sounds more attractive but that also says that we are going to acknowledge we have a problem until the problem is solved.

So I think the best thing that we could do at this point is to continue research but while that research is

being done, try to minimize the effects of the sampling error, or potential effects of any sampling error that might exist.

Personally, I think one of the things we could do would be to recommend that a practice of allowing maximum use concentrations to be increased based on fit factors be eliminated completely. Since we do not know the sample bias and because our field studies have shown, and other field studies have shown, that there is no correlation between the quantitative fit factors and workplace protection factors, I think this would be a reasonable thing to do at this time.

A second thing we could do in the interim, while research is being performed, is try to minimize any sample error to the extent possible.

Warren analyzed his data on the half mask and found that there are worst and best cases. The worst case was a probe depth flush to the respirator and one liter per minute sample rate. That gave him over 400 percent error. There was also a best case. That was with a probe depth a half inch and two liters a minute sample rate. Now, we all know we can't control all variables, such as the leak site or the breathing rate of the individual, but we could control probe depth and sample rate.

So I would like to suggest that we look at all of the data from all of the researchers that is available today to look at ways to minimize the sample error.

There are other types of interim approaches we could take. We may want to talk about them later. One of them would be to use a safety factor whenever we are analyzing data from quantitative fit tests. This is done quite commonly in the field, today, where there are certain companies that if they want to use a respirator in

an atmosphere where it is ten times the permissible exposure level, they will screen their employees, say, for fit factors of 200 or above. So that may be one reasonable approach we could take. Or perhaps we could even combine that with other means of minimizing error.

Of course, there are other options. They may not be economically feasible. For example, you could do 18 to 25 fittings per individual for a mask and then look at the fifth percentile level. That should help eliminate error. But the economic burden on the employer might be too great. But we could at least look at that.

There are other things that we could explore. I know that the English have some experience with looking at exhalation sampling and that may be one way that in-facepiece sampling could be done until we solve the problem with mixing or until we better characterize the data.

I think that my basic recommendations would be, of course, to eliminate the maximum use concentration and then to minimize error by looking at probe location, probe depth and sampling rate. That is something that we could do today. Thank you.

Mr. Wilmes: Thank you, Nancy. The next speaker is Frank Lotito, representing ISEA.

Mr. Lotito: Well, first of all, my comments may not necessarily represent the consensus view of ISEA or, for that matter of Mine Safety Appliances, my employer.

I believe it was Jim Johnson who started off yesterday by saying that the first service we have to provide is to the individual who wears a respiratory protective device and probably next to the people who are trying to make some assessment as to whether or not a respirator can be used in some sort of respiratory protection program for that working

environment.

We started off yesterday seeing three consecutive reports that very much clouded all the work that has been done in the past. The session ended off yesterday, as you all realize, where for the particular device investigated things may not be all that bad. This definitely points out the need for continued research.

We have right now only looked at two different types of devices, probably the most commonly used devices, the half mask and full face mask, and these devices are generally not used in extremely hazardous environments. We have yet to look at whether or not these phenomena take place in self-contained devices, air supplied hoods and helmets, for that matter, air supplied suits. So there is definitely a lot more work that has to be done.

I think it is kind of dangerous right now to try to make some conclusions as to what did we see and what can we do in the interim, other than attempt to do some basic research.

Now, something else we saw yesterday - we saw four presentations with four almost completely different types of challenges, detector systems - about the only thing common to all of these presentations was that people were using breathing machines and manikin heads.

It certainly would be nice if there were some standardization in the future in regards to the research. I think it is far too soon to try to standardize that.

We have two standards groups that are attempting to put down on a piece of paper procedures for quantitative face fit testing. These groups have not been very successful in the past. These groups are going to be convening in

the next month or two, trying to pick up the pieces and start all over again. God knows what is going to happen at these next reorganization meetings and how they will address these particular topics.

We probably also need recommendations on or investigations on other factors that may affect quantitative facepiece type measurements. We concentrated yesterday on probe location, probe depth, sampling rate. We said next to nothing about detector response. We do know that there are time delays in the system when something happens and you see it some period of time later.

We still have people that are looking at peak penetrations. In order to say something about peak you must know something about the dynamic response of the total system. This includes the transient response of the probe system and the detector and output device.

It is also quite encouraging to see experimenters use challenges other than DOP and sodium chloride. Maybe in the future we could have some sort of standardize procedure, standardized procedure on standardizing the responses and the nature of what we thought at the time were the critical or more important factors of the total QFT system.

I think right now the only thing that could be recommended is that more research has to be done, not just on probing but on the total instrumentation and system package, as necessary, for quantitative facepiece fit testing. We must also include many other types of respiratory protective devices that just have not been looked at in the light of this new information.

Mr. Wilmes: Thank you, Frank. The next speaker will be Alan Hack, from Los Alamos.

Mr. Hack: Well, first of all, Don and I discussed the fact that there have only been a few papers presented here under somewhat of a rush and I guess, in effect, we are calling for papers or further papers on this topic which we might be able to assemble for the meeting in New York. If we have a sufficient number we can have an entire session or a day on it, additional data. So we will continue this process.

I think in trying to discuss what went on here, I certainly have more questions than answers. I have very few answers at this point. But I would like to throw out a few questions.

One is that what is considered to reveal truth changes from time to time - in 1980 a statement was inserted into the Z88.2 which states something to the effect that -- I don't have the exact words -- that NIOSH states that only quantitative fitting can provide adequate protection to the worker and, in fact, this was pasted on the sheet that changed the printed version. And it isn't clear whether they or anyone else perhaps in this room would support that statement today, that only quantitative fit testing can assure the protection of the worker wearing the respirator.

We tried to get a blackboard but we failed - I would just like to list as I remember them, and with some help from the audience, what the different parameters were for the different tests described here. So the minute I state something wrong, whoever presented the paper, please correct me.

NIOSH used a gas, acetone, detected by infrared and also by flame ionization. And NIOSH retained the entire gas during inhalation and returned essentially clean air. Is that right?

(Mr. Myers nods affirmatively.)

3M used a large aerosol, large DOP

particle, several microns, and detected by light scattering. They retained 100 percent of the aerosol, returning clean air to the device.

Livermore used a polyethylene glycol aerosol which they detected by light scattering and they returned all of the exhaled aerosol back into the mask.

Bob Bentley used salt, detected by flame -- did you return all the aerosol to the mask? I don't recall, Bob.

Mr. Bentley: No, we don't return to the mask.

Mr. Hack: You return clean air?

Mr. Bentley: We return clean air, yes.

Mr. Hack: So you see, we have juggled the parameters and it is really hard to draw a conclusion from all of these. Any one of these has to be modified, such that a different sized particle could be used or a different gas could be used or, in cases where the exhaled breath was returned, a smoke essentially can be returned instead. But it is extremely difficult to draw a conclusion from all of this. So I am throwing this out as question more than anything else.

One point I think I would like to make is that to my knowledge the field studies where penetrations into the respirator facepiece were made in the field were done by some sort of in-mask sampling. So any errors that we hold over in-mask sampling done in the laboratory to derive so-called fit factors must also hold for all the numbers generated in the workplace for the workplace protection factors. So I think it is premature to attempt to change any of the regulations because, to put it bluntly, if we don't believe the fit factors, we really can't believe any of the in-mask sampling workplace protection factors because the same errors may well occur there.

I presume we could believe bio-assay, which is a rarely used measurement of the worker's exposure.

I guess perhaps I would support what Peter Raven said, which is that what we have to compare any of these measured respirator performance values to is against what the worker is exposed to or what he absorbs. In most cases, of course, we won't know this is. In laboratory simulations it was the value of the concentration measured on the way to the breathing machine.

I guess, finally, if we are using protection factors assigned to respirators in the range of, like, ten for a half mask and 100 for a full face mask, it is difficult to find any studies today that show any results that poor, meaning that if those values are all that is desired to get from a respirator, it is hard to imagine why quantitative fitting is necessary as a routine procedure for respirator wearers. That is all I have.

Mr. Wilmes: Thank you. The next Panel member just arrived, Rod Wolfred, from Painters Union.

Mr. Wolfred: Well, I, of course, enjoyed the presentations very much yesterday because it added quite a bit of things for me to think about, things that often I don't get the opportunity to be exposed to or to deal with first-hand because as a health and safety professional in the Union a lot of our work is spent in the field with workers, trying to just get respirators implemented in the field, and so on and so forth.

But from that experience that I have had, I think that one of the things that needs to be brought out is that in regard to this issue of quantitative fit there may be other factors which are more important to the actual use of a negative pressure mask. And one thing that shouldn't be forgotten at all is that we really are looking ultimately for the protection or

workers, the assurance of protection for workers. And we can debate the quantitative-qualitative issues or we can find out about probe location and other things, but I believe that there are other mitigating factors, especially in relation-ship to use of negative pressure masks, which would mean that they could not be properly used in the field to assure worker protection, even if these problems were resolved.

These are such things as non-wear, improper cartridge change intervals, incomplete training results, and so on and so forth. And I think that there are enough of these issues to be resolved in regard to that, that in some respects some of this may be splitting hairs in somewhat of a fashion that is not completely beneficial to the worker who ultimately needs the protection. In part it may be keeping researchers out of the field where they really need to be, and in the laboratory where they have always been.

Also I think that a couple of things that came to my mind from the work is that it does make qualitative fit test results somewhat questionable in terms of the way they have been derived and the ultimate meaning they may have, and that any recommendation to point to qualitative fit testing might be inappropriate.

I did, however, have one thought in mind regarding the streamlining that does occur that I would like to just bring up for anyone else's consideration. It would seem that if slip streaming does occur inside of a negative pressure mask that, in part, the worker is then receiving a larger concentration of materials directed into the breathing zone, into the mouth, into the lungs. If that is occurring when a qualitative fit test is being performed, then the actual concentration that the person might receive in the mask could be higher

than what the mixed concentration would be in the mask. And the question could be is the mixed concentration of the mask really what the person would be exposed to and, therefore, would this slip stream be an overexposure that, in part, would help to detect the leak? And could that have some bearing on the higher rejection rate of qualitative fit that has been found in many tests? So in part perhaps qualitative fit testing in that way could be pointing to a possible greater detection level in some respects, simply because of the slip streaming that occurs.

One of the other things that came to my mind in that regard was the notion of the smaller cavity size, such as Lawrence Livermore saw with the full face and it appears that the slip streaming would be less as the volume increases. I know that Don brought up the question yesterday about the needle probe placement and, of course, I tend to agree with Don somewhat on that issue because if the needle is further in the mask where the smoke is being injected into the mask, it would seem to me that, much like a window that has air near it, the wider the opening of the window when the air is jetted, the less opportunity there is for slip streaming. If the smoke had been introduced at a point where the difference between the side of the mask and the face were nearer, it would seem that there would be a greater result for slip streaming than when it is introduced further where the actual space around it for creating the venturi effect would be less.

But in that regard then, I think that also might point to some notions for cavity size and perhaps larger cavity sizes would reduce the possibilities of this streaming and

increase the possibilities of better mixing. And in that regard then, I would also think that might call into question some of the more tighter fitting masks, the disposable masks, such as are made by 3M, in regard to the possibility for greater slip streaming because of the closer occurrence of the mask medium to the face.

I also again believe ultimately that's what this really does, or what a lot of this does, with the half masks in particular is to call ever more into question the possibility of them being capable of providing any form of protection at all. Of course, for a long time we have been pushing to move away from half masks and into supplied air and positive pressure respirators. And we think that in some respects that some of this is moving toward unreliability assuring protection with the half mask. Of course, we haven't tested the positive pressure so who knows what that will be like when that is done.

The other issue of this is that if what is true about quantitative fit, quantitative fit does not work and if such under-reporting is possible, I think that in a regulative fashion there are going to be very big problems because if you can't have those assurances and if the regulator in the field can't in some fashion use a quantitative fit to help in determining compliance, I think that there can be problems from a compliance standpoint. I don't know where that will lead in the long run.

One of things that I also noted, I asked Dr. Myers concerning his challenge atmosphere and it was 12000 ppm. And if you take a look at that then in regard to the actual exposures that were detected within the mask, of course, you see that the minimum protection factor afforded in that test situation was a protection

factor could have been as high as 12000 because there was at least one where the sample was less than 1 ppm detected by the probe.

So there certainly is a lot of variability but it does show that there may be a way of assuring that perhaps a negative pressure mask could provide some protection, at least equivalent to what people expect.

I think that bioassay is an essential ingredient of ultimately determining worker protection. Jim Weeks, of the Mine Workers, had a great idea the other day, because we can't do this, he suggested that really what needs to be done is to slit the throat of the worker and insert the probe at the point so you would be sampling directly the contaminants coming down into the lung.

Of course, that was only half way suggested by someone else the other day. But in the long-run sometimes if you can't get good protection for the worker, maybe that would be the test choice, to put them out of their misery early.

But in that regard, I hope that more work can be done to really look at what the worker needs in the field and to really assure that the respirator is going to function. That is about all I have to say.

Mr. Wilmes: Thank you, Rod -- I think.

Our next speaker is Ed Baier, Director of Technical Support at OSHA.

Mr. Baier: Thank you. Yesterday we had some very interesting discussions of research findings from Warren Myers and Bob Bentley and from Jim Johnson, over there.

One of the things I was fascinated to see was the discussion of the streamlining versus the turbulence. And essentially they were using a smooth-faced manikin to make these determinations. And there was no

discussion of the stubble or the five o'clock shadow, the scars or pimples, not to mention beards and several other kinds of things. It kind of reminded me of the old story on the argument of the streamline versus the turbulence, and I am sure many of you are familiar with it, but it seems that a mathematician, an engineer and a lawyer all applied for the same job. The question was, what is two and two? The mathematician, being very precise, said 3.9997. The engineer, kind of always overestimating as an engineer, said 4.13. The lawyer said, what answer do you want?

So it looks like you can get any answer you want with these experiments.

I think one of the problems is that all of us, and especially our clients, so to speak, the people that we are supposed to provide services to, want to reduce everything to a number. We have a TLV, we have a PEL, Germany has MAK's. If you put this number in you don't have to think any more.

With industry, and I guess even in my present job, my fundamental function is to reduce complex issues to analogies -- science in general terms, if you will. If you look back, much great music was composed without knowing the frequency of the middle C or any of the other notes, you know, as far as that goes.

I said a long time ago something similar to this, that just about any of us can sing but very few of us can play the piano. And I think that came out yesterday.

When I met with you in Minnesota I pointed out that if you design a plant, it is engineering; if you design a ventilating system, it is engineering; if you design a process, it is engineering; but if you

design a good respirator program, it is not engineering. I think you are getting there though.

To design a ventilating system -- I am sorry Charlie from Johns Hopkins isn't here because he could go into detail, but remember things like Reynolds number, density of the air, viscosity of the air, the fluid which it goes through - all of those factors go into play in the design of a ventilating system. When you stop and think about a mask, isn't that a microventilating system?

You have a problem here though because it is a push-pull system with a nose and a mouth. And not only is it sucking, it is also blowing. And it is changing your humidity, it is changing the conditions within that mask. You have a random push-pull. You have varying actions. Essentially what you do have is a complex ventilating system. And I think essentially what you are doing here is finally going from art to science. And I think this was a beautiful initial, first blush on that issue.

I think it points up several points, that it is not a simple thing. We have hearings on standards and somebody gets up and makes a great dissertation and someone says, where is your hard data? And they say, well, I say so; that is why. I think finally you are getting to the hard data point and I am sure as this progresses and as everyone on the panel preceded me has said, I am always concerned with when do we know enough? I have yet to hear a scientific paper which does not end with "more research is needed."

I think yesterday pointed up three complicated areas -- lots of holes in it. Nobody is going to argue that, But I think you are getting there. And I wish you God speed.

Mr. Wilmes: Thank you, Ed. I appreciate your comment about numbers. The next speaker will be

Bob Bentley, number seven --

Mr. Bentley: Okay, thank you. the problems we have in the U.K., although fundamentally the same as you have here, are applied in rather different ways. For example, we are not required to do quantitative fit testing on workers, nor are we required to carry out qualitative fit testing. The only testing of the apparatus, the respirator, breathing apparatus, whatever it may be, is during the process of certification and approval. So for that reason the continuation of research in this field is of paramount importance in the U.K. because it is based on the results before approval for the use of respirators is actually given.

Now, there is no suggestion at this stage of either withholding approval or revoking approval of things that have gone before but, nevertheless, the people who sit in the wings with the piles of paper are very anxious that the answers they are given from the test houses do have real meaning.

Certainly from the results of the papers I heard yesterday, I was very gratified to find that at least answers appear to agree with some of the work that I have carried out. Whether we are both right or both wrong I am not quite sure. But, nevertheless, this is an ongoing exercise and or area of interest particularly in the conventional half mask respirator and the filtering facepiece of disposable respirator.

The point has been made, of course, that these are devices with relatively low protection factors, say ten, but in the U.K. this covers the very large number of users who are required to wear any sort of respiratory protective equipment.

The real problem for the time being, of course, falls back on the manufacturer, that because the sampling from fit testing is producing such variable results, then the onus is upon

him to over-design his equipment so that whatever he produces will meet the highest standard.

Now, in the U.K. we have filtering facepieces in Classes I, II and III and as the technology now stands, then we cannot assign any one respirator to any one group. Everything has to be done to the highest protection level. So, clearly, there is much need for an improvement of the techniques so that we at last can obtain the realistic answers.

The other point I would just like to make is that again in the U.K. statistic evaluation of the data involved in fit testing is being used, particularly for filtering facepieces. But I am a little bit scared that we are using statistics to put to rights data which essentially is based on unsound foundations. So I think that is all I would like to say for the time being, Mr. Chairman.

Mr. Wilmes: Thank you, Bob. Our next panel speaker will be Tom Nelson, from Dupont.

Mr. Nelson: I would like to make my comments from the perspective of ANSI Z88.2 Committee. I am currently leading a group of individuals who have to deal with this question. In the ANSI standard in-facepiece sampling shows up in two main areas. The first is in fit testing, where it states that you can use quantitative fit testing to apply higher protection factors to a given mask. The other part is using quantitative fit testing to select the best fitting mask.

The other area where in-facepiece sampling shows up is in the assigned protection factors, how we use the respirators, how we use the equipment.

The data used to generate those use limits is based on in-facepiece sampling from quantitative fit testing and in some cases it has been

backed up recently by workplace protection factor studies.

We are starting our work and these are the main issues we will be dealing with. We don't have a consensus viewpoint yet. And from now on I will be talking more from my viewpoint and if I step on any committee member's toes who are here, I apologize for it.

As far as using a quantitative fit testing to assign higher protection factors to a group of respirator wearers, I think the committee is pretty much in agreement that can't go on. I think we were in that agreement before this work came out and that problems like Warren showed up with his studies, and other studies, that showed that there was no correlation between what you got inside measuring workplace protection factors and quantitative fit testing.

I think the one thing I think we need to -- and we are talking and speaking here that I think clarifies a lot of the situation -- I think we are not in a panic situation - we are talking, as has been presented here, not talking in terms of errors inside the sampling. There is a bias, a slight bias. We are talking about variability. I think this is the key point. We see from the measurements that we have made that they are very variable. What that means is that work that has been done and the way we look at respirator performance, that we probably have some very good estimates of the mean performance.

We have increased variability from the sampling but that doesn't really hurt our ability to make a statistical measurement of what the mean performance is. But we do need to go on I think and study this further and try to have some understanding of what the variability is and control the variability. If we could lessen the variability we will have a much better

picture of what is happening inside the respirator. I think I will just stop at this point.

Mr. Wilmes: Thank you. We can open up for any comments or discussion from any participants. Anyone -- go ahead.

Mr. Schneider: Scott Schneider, with the Carpenters Union. I guess my initial reaction is that I am not sure what the fuss is all about in the sense that for years, until the last couple of years, we have been using -- you know, giving fit tests for respirators and then using them in the workplace without ever knowing what the variability was between the fit we gave in the laboratory when we fit them and the actual workplace protection.

We knew there was some discrepancy. And the studies that have come out have shown that in many cases that discrepancy is wide, that there is much less protection in the actual use in the workplace than there is when we fit them in the laboratory. Now, that never stopped us from giving people respirators.

From our perspective all it did was, we knew that there was this variability and we said, well, that makes us more skeptical about respirator use and more intent on trying to minimize the use of respirators wherever possible, and to get people more protective respirator as much as we can. So we knew there was this discrepancy.

Now here we see there may be another discrepancy between the actual fit and what we get on a quantitative fit test. Now, I don't think that should stop us necessarily from, you know, giving quantitative fit tests or -- I am not sure where that leads us but all I am saying is that I don't think that this is a real - I don't know - stumbling block.

From my perspective, the other parts of respiratory protection programs are equally important and

this is only one minor part that we have to worry about. You can get a great quantitative fit test or a great qualitative fit test and if the guy doesn't wear the respirator or if there are leaks or if it deforms as they wear it and the protection factor changes because the strap tension changes or because of sweat -- all those things are affecting the fit. And we have yet to quantify what the actual fit in actual use is.

So you know, my stress is, look, let's let -- you know, where they are necessary let's make sure there is a good program in effect. I mean, in many of these workplaces, sure, there are good programs but in the vast majority there are not. That is my concern.

And also my other perspective is wherever we can avoid respirator use, you know, obviously through the use of engineering controls, let's do it because I don't know anyone that would like to wear respirators if there is a real choice available.

Mr. Wilmes: Thank you very much. Any other comments?

Ms. Watkins: Margo Watkins, Dyna-tech. I just want to make two points. Dynatech wouldn't be in business to-day if the people buying fit test systems were doing it solely for the purpose of applying the maximum use concentrations, applying for variances, and all the other things we have heard reference to. The reason that people are buying quantitative fit test instrumentation today is because of the basic fact that they are concerned about the worker health and safety.

What they are doing in quantitative fit testing is selecting the best respirator for the worker today, and they are allowing that worker to play with that respirator on their face for a period of familiarity

and have confidence in the facepiece.

So in quantitative fit testing we are getting right down to the basics that Peter Raven mentioned yesterday so aptly. We are trying to help protect the worker where the respirators have to be worn.

The second point I want to make is in trying to get any correlations whatsoever between fit factors and workplace protection factors, I think we are really chasing a tiger by the tail. To try to get correlations when the variable you are introducing is the actual human face, I don't understand how anybody can expect correlations - when you work with a fit factor in a fit test chamber, under controlled, at best, work simulated conditions, apply that number you get in any way, shape or form to what that performance of that respirator on that person is in the workplace, I don't feel that we will ever, ever be able to track that one down. Thank you.

Mr. Brennan: Bob Brennan, Scott Aviation. For a day and a quarter now I have listened to this and I have been trying to put it in perspective myself, and it keeps blinking in and out of focus. And I think the comments this morning, Mr. Baier's comments in particular, helped me put it into focus.

We as a group, as an industry, users, regulators, are constantly aware that what we are trying to do is serve the user, the end user. And we attack everything in terms of the big picture. When I look at this carefully, what we are talking about here today is not a big picture. We should be aware of it, yes, but we shouldn't address it, I don't believe, from the big picture standpoint.

What we are talking about here is a very small area of technology. It is saying, how do I make a measurement? And I agree with all the other comments that said, gee, if

a fellow doesn't wear it, what difference does it make? But when you get right down to it, before you can standardize, before you can write a procedure, you have to understand the basics -- how do you make the measurements? Do you use a ruler or do you use a micrometer? That is what we are talking about here.

If you put all these little building blocks together and you know what you are doing, then you can address the variabilities of the human being. But if you try to solve -- if you try to address the purpose of this conference in terms of the big picture, I think you might be missing it.

This is a small area of technology that will help understand the big picture. I have no problem with the diversity of tests being run at this point. When you are trying to measure something, when you do understand it, it usually doesn't matter whether you measure it from front to back or back to front, you get the same answer. So I have no problem personally with the diversity of test measurements. When diversity of different approaches and different challenges can be shown under controlled conditions to start yielding the same general answer, then you can say, oh yes, I understand how to make that measurement and then you address the big picture.

And the only way I can keep this in focus personally is to address this issue as a technical issue, one that is going to help solve the big picture. But taking this and trying to apply it as a general solution to respiratory protection, I think beclouds the issue.

I do not think we should run out and standardize on the basis of this one conference a new way to do testing. But I do think that when we solve this one we are going to find some other area that is a variable, and another area, and another area, and in

about two or three years, Mr. Baier, I think we will be ready to run a railroad.

Mr. Wilmes: If any panel members have any comments on any information we are hearing, feel free to speak up.

Mr. Weeks: My name is Jim Weeks. I am with the mine workers, I am not really an advocate of slitting workers' throats, as Rod said.

But I would like to make a request. One respirator that is very commonly used in the coal mining industry is the airstream helmet and I realize that most of the research that has been done has been done on the half mask. And I would be interested in knowing about work that has been done, similar work, evaluating the protection factors of airstream helmets and, if people who are doing research for the future, if you would want to consider that, it would be beneficial at least in coal mining because that particular respirator is fairly common in the industry. So I would just like to make the request and if people have any information on that, I would be interested in hearing it.

Mr. Gee: Earl Gee, from Three Mile Island. I would like to expand a little bit on something that Nancy brought up and maybe Al Hack can shed some light on it, and that is the correlation between the protection factor and fit factor for a rated device. Specifically, about a year ago Los Alamos produced a report relative to iodine canisters that said, in effect, if you want to take a protection factor of 50 you have to achieve a protection factor of at least 100 with the test aerosol. And I wonder was there a basis for that conservatism?

Mr. Hack: That paper only concerned the assortment. There was no facepiece activity at all

involved in that.

Mr. Gee: In the last part in the recommendations -

Mr. Wilmes: Please use the mike.

Mr. Gee: In the last part of that new reg. that came out there was recommendations and it said it had to be used with a facepiece that achieved a protection factor of at least 100 of the test aerosol.

Mr. Hack: That is the regulatory end of it but the study didn't involve any facepiece work at all.

Mr. Gee: That was in the Los Alamos report though.

Ms. Hendricks: That is correct, it was in the report. I think it was an attempt, without much basis at all, to acknowledge the fact that between your fit test and your actual use you see, if anything, decrease in protection. It was just merely an attempt to do something about that. There is nothing behind it that I can tell you that a factor of two is magic and comes from somewhere.

Mr. Hack: A factor of two is just as magic as the action level being half of the PEL.

Mr. Kyriazi: My name is Nick Kyriazi. I am with the Bureau of Mines in Pittsburgh, at the Pittsburgh Research Center. In the life support group we deal exclusively with closed circuit breathing apparatus and a lot of this has probably nothing to do with the mouth bit escape apparatus. We do work with rescue apparatus that use facepieces.

We are concerned right now with quantitative leak testing where you test the actual tightness of the circuit in a mouth bit escape unit. And we would need to do some sort of protection factors for that.

I think the concept of protection factors was arrived at with the respirators and it may be a little bit different in considering the work that we have done with close circuit apparatus. Has

anybody given any consideration that it is possible that at a higher work rate you have a higher leakage rate? In addition, the longer the duration, you have some accumulation? So it seems to me that if you specify a protection factor, you would also need to specify at what work rate and at what duration of a work rate. Has anybody given any thought to that?

Mr. Nelson: I can comment on that. I guess I think this is --

Mr. Wilmes: If you speak up, if they can hear you it is okay, you will still be recorded because of the table mikes.

Mr. Nelson: Good. I guess this is why I am very interested in seeing how this work comes out. We have started to do some work, taking a look at powered air purifying respirators under work loads, putting somebody on a treadmill at four miles an hour, putting it up to a work rate that is probably close to work that is going on at some workplaces; it is a moderate level of work. When you do that, you do see changes in the quantitative measurement of the quantitative fit test booth. There is a decrease.

You know, we need to have a better understanding of the variability so we can use this as a research tool and be able to make some heads or tails of what these numbers mean. From a strictly qualitative basis we know that work rate is a problem. It also shows up in positive pressure respirators. Raven - Peter, did you do that work? They were taking people, looking at pressure inside the facepiece. Positive pressure respirators don't stay positive when people work.

So I think it is very important that we try to come up with some answers and find some ways of being able to do this kind of research.

Mr. Lotito: I think we all recognize that the negative pressure type respirator is a relatively simple pas-sive

device and if we are going to examine anything first, it should be that. Also the majority of people that need respiratory protection need nothing more than a half mask or a full face mask. We also know that.

The closed circuit type device presents another problem. There are basically two types of closed circuit devices, as you know, the oxygen generating and the oxygen supplementing. The problems that are experienced are that some of the challenge agents that are available may be composed in an oxygen generating type of device causing problems for the wearer, such as KO-2 types of devices.

We have to be very cautious as to what type of challenge agent would be used. It would automatically exclude certain types of challenge agents.

Another problem in evaluating the closed circuit devices is if you should for a short period of time, in an ingress of challenge, the challenge may not be scrubbed and may continue to circulate in the system, clouding the continued performance of the device. For instance, if you used a noble gas as a challenge agent, if you were to, for a second, have a peak leakage of a tenth of a percent, let's say, once that volume builds up, if the device were to return to a higher protection factor, let's assume just for the sake of discussion, 30,000-plus, you would probably never see it.

Within these large volume devices you have a number of particulates floating around that are related either to the oxygen generating, the CO-2 scrubbing, or the massive amount of elastic type material that is necessary to store a volume of gas, such as the zinc type oxides used for mold release of rubber agents or to keep the rubber

from sticking to itself in storage. These create interferences.

There is also another problem with a closed circuit device. When you extract a sample, unless it is a relatively small sample, you just can't dump it or collect it in some reservoir. You have to return something back or else you are going to offset the chemical stability of this type of device.

In the past the ASTM E3414 standards group had tried to recognize that, indeed, something must be done to look at these devices. We were probably even less successful in addressing those particulars than we were with the simple half mask or quarter mask type of respirator.

But these devices, indeed, do constitute some specific problems. Now, the mouth bit type respirator I think, indeed, we can talk the equivalent of facial seal -- how well a person can keep the mouth bit in his mouth for the duration that he must. And it is probably just as easy to break that seal as it is a quarter mask, half mask, or for that matter, full face mask seal.

Mr. Kyriazi: Well, we aren't even going to try to quantify mouth bit seal, but we are trying to quantify the relationship between duration and protection factor with work rate. So if anybody has any papers that have been published in the past, please contact me. Thank you.

Mr. Wilmes: Anyone else have any comments?

Ms. Iverson: Sandy Iverson, 3M. Yesterday - this question is mainly directed to Rod -- yesterday in Warren's paper and then in Jim's talk we saw presented some differences in opinion, we might say, about what might be occurring in a full facepiece respirator. In Warren's presentation and in his demonstration we saw what definitely appeared to be streaming in a large volume full facepiece respirator. In Jim's presentation we saw what

obviously seemed to be some mixing occurring in a full facepiece respirator. I didn't see anything presented yesterday, and I haven't heard anything yet, that would allow us to assume at this point that a large volume provides any better mixing than a half mask respirator, for instance.

So I think it is wrong at this point to draw any further conclusions saying that full facepiece respirators allow better mixing and, therefore, are more suitable for any kind of fit testing.

Mr. Wolfred: Yes, I was not drawing that conclusion. I was merely stating that it might be a possibility that, as others had discussed, that the size of the cavity may influence the turbulence or the mixing that takes place. And I was speculating based on what Don had mentioned about the placement of the needle, that the needle in the Los Alamos area was placed in an area where the actual surrounding volume of air around it was larger. And from what you could draw to explain that seemed the only logical reason to explain it in terms of the one introduced at this site or the other. But, obviously, it is something that has to be explored.

Ms. Iverson: What I, of course, would take exception to is your taking what seemed to you to be the next logical step and saying that close fitting respirators would --

Mr. Wolfred: Oh, I wasn't saying it; I was hypothesizing. We are allowed to do that, aren't we?

Mr. Iverson: Okay, thank you.

Mr. Matthiessen: Craig Matthiessen, with EPA. I have some comments and a question and it is all kind of mixed up together. Basically, I enjoyed hearing about this. I think I agree that it is a question of variability and I think that it is an issue that we need to attempt to resolve because of the comment that was made that we are trying to assure the safety of

workers. And I think that is the paramount thing that ought to be kept in mind.

I think there is a lot of -- or at least there used to be a lot of black magic associated with assigning a respirator to someone. And knowing what I know now about respirators, that would give me a lot of problems if I were actively in the workplace today assigning someone to a respirator, going to an unknown concentration, not knowing really for sure how much protection that respirator is actually providing.

I think that is the key issue here, that we really don't know what is happening in the workplace and I think that is something that ought to be -- we ought to try and get information about, what actual protection these respirators provide in the workplace. I realize and I know from the comments yesterday that there are a lot of variables that need to be resolved and a lot of problems that need to be overcome to do this.

Of course, the first one is determining the variability in the in-facepiece sampling. Then the second is to go out and try and find what that effectiveness is in the workplace. If, in the meantime, we are able to discover a correlation between quantitative fit and what you actually get in the workplace, then that is even better.

I think we are concerned more about the chronic effects in the workplace, rather than acute. In other words, we know the workers aren't putting the respirators on and going out and dropping over even though they have the respirator on. But we don't know what effects there are ten years down the road of small in-facepiece leaks.

So what I would like to find out is if it is possible, since we know that there is this variability, if we can at

least publish this information, get people to back off on trying to use a lot of black magic to assign respirators, and to be sure that the best possible protection is given in the workplace until we get more understanding of workplace protection factors. And I would appreciate hearing any comments on that.

Mr. Wilmes: We have lots of them. Maybe we will just go down the table.

Ms. Bollinger: Okay, I would like to make the comment that I think the purpose of this meeting was to discuss the results to date and try to stimulate future research in this area. I know that Warren's data was presented last May and at that point did not stimulate a lot of interest in going out and replicating it or doing future research, and it was presented at the AIHC.

One of the things that we hope to accomplish by having a conference is to bring all of the data out in the open and to stimulate that future research. I don't think the purpose of this conference was to do away with a lot of our old policies or say that the old protection factors that were assigned to respirators are totally wrong.

I think what we really are doing here is just trying to better understand the sampling bias and to come up with something in the future. And I know that I have been hearing a lot of people say that it may be too early to try to come up with any standardization or any interim solutions, and that may be true, but it is not too early to start looking at the issues and start looking at the data that is already there, and using that data to, hopefully, mitigate any sampling error or maybe to at least use that data as a stepping point for further research.

Mr. Lotito: Well, I don't think we should lose sight of the fact that the probe placement, probe mechanism,

is not the only problem. That is probably one of the problems that keeps us from characterizing the true, whatever that is, performance of a respirator.

I think we do have some sources of conclusive evidence that respirators do, indeed, work. I think one of the things you can probably even say in general is that most people that have to wear respiratory protective devices are not dropping dead like flies. We know that.

We know from certain industries, probably the more highly regulated industries, that results of bioassays do prove that respiratory protection programs can work. Of course, these probably represent only a very select number or a very small number of the total workplace population.

What is the best device? Should we, in the interim, provide self-contained or air supplied type devices? I don't think so. It certainly is not the best device. These presentations and these discussions certainly point out the need for more research. Probably what is necessary is a commitment for the research.

I think when you look at the developing type technology, when the technology is first developing, it can probably be successfully done or investigated in its infant level in your own basement or garage. And as the technology improves and you start talking about buying infrared analyzers, and what have you, you are talking about a lot of money in equipment, a lot of money in maintenance and a certain degree of expertise, in order to manufacture this equipment.

Where should the research best be done? We haven't touched upon that. Who should be doing it? Who can do it in an unbiased and possibly orderly fashion? And can we have independent research done to prove

that conclusions reached are, indeed, factual, that we just don't go off on a tangent and say based upon the results of one experiment, this is what we are going to do now? That is a very hazardous approach.

In defense of the manufacturers, manufacturing and marketing a respiratory protective device is a very expensive undertaking. As manufacturers, we would certainly love to experiment with things like facepiece volume and contours, and find sources for tiny little tubes and measure airstreams, and what have you. The process of making a mold to mold out of rubber something as a half mask, you are talking about \$100,000 in tooling. And once the tooling is made, if you decide to change a feature, you are talking again about five to 25 percent of the cost to make some minor changes. These are very expensive undertakings.

Some of the type of research that we are taking about may be out of the hands of manufacturers. It may be approaching the megabuck range type of research.

I would like to see some discussion as to how in the future we can start to address these problems in a more orderly and scientific fashion, such that when conclusions are reached, they can be relied upon.

In that regard, I think sometimes it leads to inferior products being introduced and inferior products being accepted, simply because they can't market what necessarily would be the appropriate and best respirator.

Also, just making a group of general comments, I am trying to address some of the things that I heard out here, the hypothesis that all that a worker needs is a half mask respirator for most circumstances I

don't think is really proper to make because, in fact, the half mask respirator may be something that provides really no protection to most people who need protection.

We have -- and this is a very limited kind of an issue - but we have been doing work with neurotoxic symptomatology among painters and this is the area we have been working in primarily, and we have noted with neurotoxic symptoms among painters - we characterize the gallons of paint that are used per year, without looking at specifics, and we try to look at their symptoms, and we find that the only group that has decreased symptom reporting is the air-fed users, and these are also the high application spray painters, whereas, others wearing cartridge respirators in similar circumstances, even as much as 80 or 90 percent of the time, and especially those wearing no respirators, there is not that much difference.

So in regard to this, and again we are now having medical examinations done with groups of workers to try to make these determinations, but the impression we are getting is that even in this area of acute symptomatology we are not really seeing any difference in the groups between non-users and cartridge users, as far as the symptom reporting.

Again I admit these are crude measurements and we are really not willing to do any more than talk about it, but I would at least indicate that perhaps there is really any evidence to support the notion that all anyone needs is the half mask.

I may not be good at making up stories but it sort of reminds me that you take an animal and what you need to do is, you need to get this animal to breathe 12 times into a tube to complete your experiment. Well, first you tie his legs down, then you tie its head down, and pretty soon

you kill the thing and the experiments fails. The thing that you really finally end up with is the fact that you can't get the animal to perform that and that, no matter what kind of device you have, no matter how you design the device, no matter how well you test the parts of it, the device itself is faulty from its very nature and none of the testing, none of the work that you do will ultimately produce the results that you need for that device to be functioning.

In that regard, I personally believe that half masks fall into that category, that they are a device that by their nature will never be effective protection. And in that you can see some of the principles, that you have a negative pressure with all these variabilities that fit into it, and only by overcoming those variabilities with a system design, such as a positive pressure that would be great enough so that an outward force always existed, would you ever be able to overcome all of the design problems. If you think about it, that is really what you are talking about. you need to create an environment inside that mask that overcomes the variability. You can't do it with a negative pressure mask. So all the other stuff ultimately becomes endless games for doing something that finally produces no results.

Mr. Nelson: I guess, Craig, going back to your question and asking about performance, I do think we have some data that establishes levels of performance for certain types of equipment. If you start with the half mask -- I will disagree with you, Rod, a bit -- there have been several studies that have been done taking a look at the workplace protection factors. Warren has done some. 3M has done some. And we have established -- and this is recent work -- we have established types of respirator

programs and what you need to go through. We have established levels of performance.

Now, we do have a problem in that we use the same in-facepiece sampling. But again, going back, it is variability we are talking about. So the mean protection that we are seeing in those I think are probably fairly good estimates, unless there is a real serious bias, which I don't think there is. It also means, and the part that we are making our judgments on, is looking at the lower fifth percentile of the data. And those lower fifth percentiles are going to be very conservative estimates because we do have a large source of variability. You remove that variability and your standard deviation is smaller, which means your fifth percentile is going to be higher.

I think with half mask respirators we do have some studies which have taken a look at biological monitoring. We have the one at the pigment plant and they showed a fairly good level of performance.

I think one of the questions to get into is a fairly good level of performance -- what do you mean by that? And I think with a half mask we have enough data to say if you are using a use factor of ten it is satisfactory.

I think the next piece of equipment we have data on is powered air purifying respirators. There have been three studies that I know of that have taken a look at those. At Chalk River, I have just heard about one that they have finished. And they are all coming out at the lower fifth percentiles, in the range of 20 to 25. Again that is a conservative estimate -- how conservative I don't know.

At least I think I can say if you use it at 20, I feel you are safe. Beyond

that we don't have the data. I don't know of any data on the full face respirator. I know of no data on airline respirators. I don't know of any data on SCBA's that really gives us the ability to say this is a safe use.

One point, to finish up, I mean, I think there are some safe use levels. I mean, airline at ten, I have no problem at all. It is how high you go up.

Mr. Johnson: Jim Johnson, from the Lawrence Livermore Lab. I think the thing that we want to remember is we came here to evaluate in-place sampling error in respirators. Now, one of the things that I think is most important, that I mentioned yesterday, is that it has to be shown, whatever we do, to be reproducible, if it means anything.

And to me the best hope for starting that is to iron out some of the variables where we can control them in the laboratory with the breathing machine and a manikin. And we are still not there yet. There is significant disagreement right now on that. So I see that as a first point and emphasis, that we need to come in and see what we can do in the laboratory.

Now, some of our bird walks, so to speak -- I picked up a new term when I talked to a school teacher - that is a student who asks a question to lead the instructor off on a bird walk until the period ends.

Now, we have had a lot of bird walks and they are important, as long as we keep them in perspective. Now, I am going to take a bird walk now. And we want to talk a little bit about philosophy of respirator use. There is all kinds of variabilities. Certainly, the one biggest thing, as I see it, is worker acceptability. You know, 3M brought out the disposable. And why do the workers trim off the bottom strap or let it hang there? Because they don't like it. It is a pain in the butt to pull over your

head, if you ever did that, but it makes the respirator work. So you see, we have an acceptability problem when we look at respirators from the employee standpoint.

The other thing that I see is we want to give them the best. But go out and watch two factors in the workplace that are very significant -- the best costs a lot of money. So you are fighting the owners there to put the investment in. The best is also very cumbersome. Hang an umbilical cord on somebody and a compressor somewhere and get power for it and find out that you usually need 220 to 480 to run the compressors to get you the air flow, and you look at the cost schemes and all that, and you find out, wow, you have problems. So what do you do when you really look at systems? You find that we might be encumbering the worker and making it unsafe by trying to protect him. That is just a little philosophy that we have to keep in mind.

Truly good use of an air purifying respirator is something that I think will be very valuable in protecting the employee, once we understand a good program. So we don't want to forget all these options. But my emphasis right now is, I think we need to get back to the breathing machine, the subject at hand, which is in-place sampling error, and the fact that we need to get into the business of trying to see what the real problems are there.

Mr. Nelson: I think I agree with you on that quite a bit and want to say something about best. I hear, you know, use the best equipment and I look at it from two viewpoints. The first one, you have a substance and exposure limits of 1 ppm. If I have 2 ppm, I need - what? -- a factor of two to get down to one. Do I need something that gives me a factor of 1000? Not if a half mask will work; I

don't need it. I think you have to look at it from that standpoint.

The second one comes out in the question of quantitative fit testing. You select the best fitting, whatever that means.

I think that if you look statistically, from a pure scientific standpoint, we have some data that says you take a person, you put him in a booth and you measure a fit factor. And you do that a number of times. You will find out a mean value and you will find out the variability, the geometric standard deviation. That runs somewhere between two and four generally. To select the best fitting mask between two masks you want to have 90 percent confidence to detect a 50 percent difference between two mean values, you only have to do 16 tests. I think you are fooling yourself to say you are selecting the best mask. The best mask is the one the guy will wear and that will give him a level of protection over what he needs.

Mr. Wolfred: I think that some of these other questions are important because one of the purposes of discussing some of this research, of course, that we saw yesterday would be to determine the significance of it, what significance the research has in terms of ultimate respiratory protection and other things. And so many of these other topics, I think, are important considerations.

We are supposed to talk later on today, about what will be done in the future. Isn't that correct? Isn't that the aspect of the second one?

Mr. Wolfred: Yes, future research.

Mr. Wolfred: And so, consequently, we can't really go too much beyond what we have already seen and at that point it seems that some of these other

issues become natural to address, especially as it may relate to the significance of the research overall.

So with that in mind I would like to take another little bird walk because I am sure I have been doing a number of those already. It seems to me that the philosophy of respiratory protection itself has been based upon selecting a respirator that provides the minimum protection needed to overcome the problem. For example, if it is only two times the PEL, throw the guy a cartridge respirator.

My personal feeling, and some of the feelings that we are trying to push, is that this is wrong. When you engineer in a workplace, you engineer for the best protection and work your way down. Respirators should be selected in the same fashion -- best protection first, most feasible protection first. That is what OSHA mandates in its regulation, if you read it correctly -- most feasible protection. I think that respirator selection should be made on the same basis.

As soon as a person encounters a problem and exposure exists, they should be offered the option of an air-fed hood as their first option, if that is what is required. And if that is not feasible for some reason, then we should select the next level. And I think that the entire respirator selection process has been stood on its head because people have worked from the bottom up, trying to provide workers with the minimum thing to get them by, rather than with what OSHA law itself should mandate.

In that regard, I, of course, would think that -- I think that is a crucial factor in terms of moving things around. I would rather see more of this work done in the area of air fed hoods and in improving them and making them work.

I can only speak for the paint trade in terms of some of this obviously. And I know that our workers find the air fed hood to be extremely acceptable because we have people wearing their hoods all day long simply because of the air-conditioning that is produced. And again, if you talk about acceptability, it is there.

But those are all moot points in regard to the issue of what we are here for. But I think one of the important things, and I would just reiterate and pass the mike on, this work today has shown, or the studies we have seen have shown additional variabilities that relate to half masks. That is all we have looked at in this time really, half masks. I think that further brings into question the assurance of the protection that can result from the use of half mask respirators in the workplace.

If we are to be honest about it, we no longer can depend upon the quantitative information that we have seen. So, consequently, what this to me has pointed out is that there is no longer any reason that a person can legitimately say that they can be assured that this half mask respirator is going to provide protection to workers.

Now, that may be changed in the future and maybe probe placement will do it because ultimately we are looking at the concentration that is in the mask that we want to sample. But if the probe placement is variable, who knows about all the work that has been done in regard to what the real concentration in the mask is? No one knows.

Mr. Wilmes: Any other questions or comments?

Mr. Askin: Dan Askin, Akatech. After listening to a day of research and two hours of opinions, the thing I probably would most like to see sometime in the Journal is a study of basically air flow patterns and mixing

patterns inside respirator facepieces, based on some simulation of how a leakage actually occurs on an individual face.

Leaks are primarily, in a full face, the result of hollow temples, which is basically a flat injection airstream; or the facepiece is coming up short of the eye sockets. Hollow temples is the most common leak in eastern Pennsylvania. In northern Illinois the most common leak happens to be square chins, coming around here. There are very few pinhole leaks that seem to be best represented by injection with a syringe. And a lot of leaks are the result of facial creases or scarring and pock marks.

I haven't been able to visualize yet how to represent that visually. But I think perhaps some additional pictures of what visible smoke looks like in mixing patterns, coming into a facepiece around the edge and a variety of orifices, rather than around essentially critical orifices, would help identify what types of probe placements might help.

And I can't remember the second point.

Ms. Bollinger: I think that is a good point. I think Warren pointed out yesterday that some of his future research is going to be looking at leak site geometries the effect of the shape and size of the leak.

Mr. Askin: the second point was — what would happen if you took a pulsed sample that nearly instantaneously evacuated the entire space so that you could get, like in a ten millisecond or a half second, or whatever was feasible, the entire volume of what was inside the mask out for analysis, which would essentially give you a total mixing, which may have some interesting relationships to what is extracted after the passageway down to the breathing machine?

Mr. Hack: I think we are getting too far away from what Peter Raven said - we have to correlate, whatever our sampling technique happens to be, we must correlate that with what the person breathes and is exposed to. What you describe would produce an incredible number of degrees, graduate degree candidates — but I can't see it being related - we have to sample from the person in effect and correlate that with whatever the sampling from the mask happens to be.

Mr. Moran: John Moran, NIOSH. I think it might be useful to look at this from another perspective, if you will. Until we can, with some degree of reliability and accuracy, determine what exposures are occurring in the facepiece, we cannot accomplish two essential objectives. One, we will not be able to determine what workers are really being exposed to and, therefore, would be able to deal with that problem and permit OSHA to deal with that problem.

Second, until we can do that, we cannot expect manufacturers to improve the performance of their products to meet that objective because, based on the data that Warren presented yesterday, for instance, it showed a good deal of difference between three facepieces - what do those manufacturers do with that data? There is really very little that they can do to respond to a potential problem until we get this issue settled.

Mr. Wilmes: Thank you, John. Any other comments?

Mr. Mintz: I am Al Mintz. I would like to go a little further than what John said. I think there is a lot of merit in what was mentioned there but what I see here is that these studies are sort of made in isolation and in labs where people who are concerned from a scientific standpoint and have different instrumentation to conduct

these, are doing it in isolation. And what I would like to see is more disciplines involved in this so that when a study is made, it is made in a way where all considerations are taken - worker perspiration in the work environment, speed of work, different facial contours - so that we can come up with some possible findings which will be something in agreement with people from the working discipline, from the scientific discipline, that they all agree that these are taking all these factors into consideration.

So I would recommend whatever we do in the future in trying to resolve these questions that we take as many disciplines in consideration while working on it.

Mr. Lotito: Well, I think that might be biting off quite a bit more than we can handle right now with the information that is available to us. Many times manufacturers and regulatory agencies are criticized for spending their entire life in the laboratory and not leaving it and going into the real world.

The problems that we are faced with, both yesterday and today, is the fact that in a controlled setting where we attempt to rigorously control everything and vary only one or two features of the experiment, we have found that there are still quite a number of items that are beyond our reach. We may not be recognizing the full significance of what is happening.

I don't think right now there is any justification for going into some grandiose program where we try to factor in a whole bunch of other items that may obscure the end results. We have to be able to understand each individual component of the total system.

I just jotted down a couple of notes as to what might cause errors in a laboratory setting in trying to determine what we are determining. This list is certainly not conclusive and,

obviously, probe design, probe placement and the sampling rate. We have some evidence that these have some -- could have some significant effects on what we measure.

We also saw a paper where the transport system itself did not behave uniformly as the challenge concentration varied. That may only be characteristic of large particle sizes. We don't know that yet. Theory seems to say that it should not be taking place.

The detectors themselves have to have something in the way of accuracy but they really don't need resolution. We don't have to know that the penetration is 0.09137. It is nice to know that the penetration is 0.01, 0.03, 0.05 or 0.1.

The detectors have to operate through a rather large dynamic range. In case of half masks, if we should resolve protection factors of a million, it would certainly be questioned, depending upon the type of challenge agent and protecting system.

But if we look at self-contained breathing devices, we must be prepared to have a device that is very sensitive. It probably will have a large dynamic range. All detectors are subject to some sort of saturation when they are bombarded by an overload. They all have noise and some sort of instability that limits the low end. All detectors have a response time and when you introduce the challenge they don't automatically or instantaneously give you an output.

Worse yet, most detectors are rather large volume. Some have a large cleanup time. Now, in the case of a simple breathing machine where we glue the mask to a face form, we can live with the response time or cleanup time characteristics

of our system. When we try to now go into the field and we know we can't get minute or second to second reproducibility of seals possibly on certain designs or certain faces, this becomes a very important factor.

And then the detector only gives us an output that we have to convert to something we can record, a strip chart recorder, a line printer, or whatever. And then we start to get tracings, or just columns of numbers that are being punched out on some sort of printer. And what do we do with that data? After we get about three yards of strip chart recordings or about 200 numbers, the mind really can't digest what is happening so we attempt to average. Do we really average? You can average if you know the response of the system. But if the response of the system on an increasing signal and a decreasing signal is different you may not be able to average.

So there are an awful lot of basic things that have to be investigated and they must be investigated in a very controlled setting, possibly using nothing more complicated than a manikin with the face seal type devices, quarter mask, half mask, full mask, glued to the face form. And we have to synthesize the leaks, the malfunctions.

Once we start to factor in the real world - there are just so many variables, we will not be able to see the forest through the trees. So in defense of the experimenters, I think we have an awful lot of basic laboratory work that must be done.

Mr. Wilmes: Okay. I think it would be appropriate to take a break. Are there any more questions? After the break we will continue on with the next panel.

More excerpts from the Critical Issues Conference will be published in the ISRP Journal, Volume 6 Issue 2.