PANEL DISCUSSION:

OVERALL ASSESSMENT OF CRITERIA DEVELOPMENT

Panel Members: Robert T. Hughes
John Hagopian
R. Scott Stricoff
William L. Dyson
James C. Barrett
James Lim

CHAIRMAN HUGHES: Our panel discussion will give you the opportunity to ask questions and make comments, even on points that may not have been specifically addressed thus far.

MR. BRUCE MENKEL (Bruce Menkel Consulting Engineers, Dayton Ohio): I have a question for the Arthur D. Little people in regard to modeling. I would like for them to explain a little bit more what they went into and if there is any correlation with actual installations.

MR. JOHN HAGOPIAN (A. D. Little Co., Cambridge, Massachusetts): The validation studies NIOSH is supporting will involve field studies to see how these models work when applied. As far as my giving you more details on the models, that is verbally rather difficult. Basically, the two equations I presented for the concentrations before the air cleaner and for the return air are supplemented by a set of equations which are for flow balances within the plant area. Also used are the breathing zone equations, and then a cost function. Most of the parameters in these equations are concentrations or flow volumes, some of which existed before recirculation was implemented. Some are left to the whim of the designer using the equations. These latter variable parameters are adjusted until you get an optimum cost for a system configuration which is acceptable in terms of safety and health considerations. Of course, the efficiency of the air cleaning section is also included in this procedure.

CHAIRMAN HUGHES: There is a program ongoing to validate these criteria guidelines with respect to actual installations. This is being done by contract. Arthur D. Little is involved, and so is Envirex in Milwaukee. As I mentioned before, Mr. Bullock from Envirex will be speaking to us in the morning regarding the validation method, but the areas that are currently to be included are: lead operations, woodworking, cleanup room, rubber tire manufacturing, home plating operations, and some metal grinding operations. These are ongoing and total effort will be done in about another 11 to 12 months.

MR. WILLIAM HUELSEN (American Foundrymen's Society, Des Plaines, Illinois): There are many of us here who are interested in how you translate what is

contained in the report, which is to a great extent quite theoretical, into a practical ventilation system. How would you approach it, Jim, and how would you monitor it so that we would have acceptable air quality in the workplace, and what limitations might you place upon the system?

MR. JAMES BARRETT (Department of Health, Lansing, Michigan): Let me take the second part of your question first. I've not seen the report, so I cannot be specific to its contents, but I would say that in my opinion there are some limitations in modeling, because there are many different ways of putting together ventilation equipment out in the real world. It depends on the size of the plant, the type of operation, and so forth. So, until I knew better, I would look at the equations as depicting the variables which have to be considered, and their relationships. I certainly would not ascribe any precision to them at this moment, because I simply haven't seen them, for one thing. Remember that the Threshold Limit Values, the OSHA permissible exposure levels, and these guidelines and legal requirements are also rather imprecise. As you go back to the preamble of the ACGIH Threshold Limit Values, you see that they are intended to be guidelines and they are not defined specifications as to what condition may or may not be healthful; they are supposed to be used with some judgment. On that basis alone I can say that the guideline equations would have to be used with considered judgment.

Once the system is designed, depending upon the nature of the system, the contaminants we are concerned about, and the consequences of failure, you can determine the initial amount of surveillance to set up as the study program is developed to determine whether or not the approach is feasible.

Following that, when the system is installed, I think the type of surveillance depends again on the system, and other ventilation systems in the space. There are general ventilation systems and makeup air systems, natural ventilation systems, as well as a particular local exhaust system under consideration for being recirculated. The actual surveillance might be simply pressure drop surveillance over the operation of the system or it might be area monitoring, as we talked about the last time this group met a couple of years ago. Don't forget that there are some OSHA standards coming down the road--when, I can't say--that will require some personal monitoring for different contaminants. These are all additional variables that have to go into the design as to how you're going to evaluate the system overall.

CHAIRMAN HUGHES: We've had some discussion earlier this morning about the difference between workplace, personal, and duct monitoring in regard to the recirculation system itself. Do you have any comment, Jim? I'm speaking of a method by which you assure yourself of a healthy recirculation system.

MR. BARRETT: Well, we are back to what I said a few minutes ago. Some of the personal monitoring may be laid upon all of us, if you will, as the OSHA Standards Completion Project comes around, which contains some specific provisions for personal monitoring. Trying to deal with it objectively, the choice of monitoring would depend on, first of all the toxicity of the material, which determines the consequence of error, or failure, and also the expected rise time in the concentration. This, of course, is a

function of the recirculated air volume with respect to the volume of air in the space and other ventilation systems. If the material is highly toxic, and if it were expected to have a rapid rise time in concentration with serious health effects, then I would think that duct monitoring may be required. That is subject, of course, to the availability and the limitations of the equipment. We have a pretty good idea where we stand on that. It is very spotty, to my knowledge. Area sampling is one method of monitoring in industrial hygiene. We used to take not only personal samples or breathing zone samples for the workers' exposure, but also general area samples, as we call them, to get an appraisal of the miscellaneous sources of contaminant which may be outside the control area of a particular system. Then personal sampling may be a legal requirement with some standards. Those are the things that I would consider in trying to select between personal, area, and duct sampling.

MR. TOM BLOOM (NIOSH, Cincinnati, Ohio): Mr. Lim, I have a question for you. Are there situations which you've uncovered in California where the presence of exterior pollutants, and I'm referring specifically to the Los Angeles area where they have air quality problems, can affect the function or efficiency of a recirculation exhaust system?

MR. JAMES LIM (State Department of Health, Berkeley, California): As you all probably know, the air can get pretty bad sometimes in Los Angeles. I'm not aware of any situation involving recirculation where the outside air is a problem. But I can see where it can be, because along the L.A. freeways, the CO concentration frequently will get up to peak well over 50 ppm.

MR. BLOOM: Since the air quality does vary around the country, is ambient air quality a factor to be considered in the feasibility of recirculation exhaust systems?

MR. LIM: I would certainly think so.

MR. BLOOM: Did Arthur D. Little consider this factor?

MR. HAGOPIAN: Yes, we did. In the equations I presented and in all of the figures which I had on slides, one of the parameters of interest is the concentration of contaminant in the makeup air. If you're worried about CO levels in the workplace, or if you're generating CO, you can look at what the CO level is in incoming fresh air and take it into account.

MR. BARRETT: I would like to add that it would have potentially more effect on the typical once-through type of ventilation system, where you might be contaminating the fresh air intake. If you were in a very highly contaminated area you would then perhaps have the option of putting a very high quality air cleaner on the air intake. In one plant in Michigan a number of years ago, the outside air quality was so poor around their office that they had a pulse jet industrial dust collector to clean the fresh air supply to the office. That is one example I know of. So if you're in that type of a situation you can conceive of a hermetically sealed plant with whatever is necessary for recirculation

systems, and then high quality air cleaning for a little bit of fresh air pressurized into the building, but that would be an extreme case.

MR. LAWRENCE BULLOCK (Envirex, Milwaukee, Wisconsin): Since I haven't had an opportunity to look at your report in more detail, I would like to ask if you could talk a little bit about some of the assumptions you need when developing your model. In particular, when you attempt to measure the baseline level of contaminants you say that you like to look where your worst case, area, or employee is on which to base your decision to recirculate. In terms of fluctuating levels in all mechanical plants, did you state how the stated assumption might be an interim when you assume these conditions?

Secondly, you made some other assumptions that before you can attempt to recirculate, all air mechanically abstracted from the plant should be mechanically made up. You're assuming perfect air balance in the plant when you start. I have yet to see a plant that does this. Could you address some of the assumptions you made to some realistic situations?

MR. HAGOPIAN: We discuss fluctuating processes and realize they cause a problem. If the fluctuations are not over a large range, we indicate that time-averaged values may be used. If they are wide, we make the point that the system should be designed for the worst case, let's say during some time period when the majority of the processes are in operation, again using averages. This is for initial design purposes only.

The report further indicates that when you do have such fluctuations, and if your contaminants have ceiling limits, you have to spot check breathing zone concentrations, using the model, to assure that you don't violate ceiling limits. This would be done by using the model with peak concentrations experienced. The model can also be applied on a real-time basis, if need be. If you have a process emission profile, you can plug the data into the model point by point and obtain corresponding breathing zone concentrations.

In regard to the perfect air balance assumption, we comment that a balanced air system is preferred practice. If the plant does not have a balanced air supply before recirculation, this can be accounted for in equations. But while recirculation is being implemented, we strongly suggest that a balance be obtained.

MR. GORDON ROUSH (Dow Chemical, Midland, Michigan): I would like to find out how far ahead NIOSH is, assuming that eventually a standard will be issued, on recirculation of air. I would like to ask a couple of questions to some specific instances and find out if you've given any thought that might allow us to plan ahead.

I work in an office building where the air is recirculated, and I'm wondering if that air would also have to be monitored in case of, for example, smoking. Nonsmokers might very much like to have their air monitored to make sure they are not overly exposed to cigarette smoke, carbon monoxide.

Have you given any thought to whether certain areas would be exempted? But if as long as you have recirculated air does that mean you have to have some sort of monitor?

CHAIRMAN HUGHES: As I indicated earlier, we are not developing this information for the setting and promulgation of standards. I cannot say whether OSHA or the State governments would feel that certain restrictions or regulations might be imposed on recirculation. I would presume that in some cases they may, such as carcinogens. The NIOSH work has assumed that carcinogens should not be recirculated. I think this is carried into the OSHA standards. It was discussed earlier that the OSHA proposed lead standard may prohibit recirculation.

As far as monitoring is concerned, I don't know whether this would be required by OSHA or the State regulatory agencies.

Insofar as office space is concerned, we've not addressed any of our efforts to that in this program, and I'm not foreseeing that in the immediate future we would address the office area and smoking in particular. Our work is oriented toward the industrial workplace, not the office.

MR. BARRETT: I say at the moment we don't have any thoughts on limitations on heating-ventilating systems, which is basically what we're talking about in offices where a certain amount of air is recirculated and a certain amount is brought in from outside. The question you raised about smoking is one that sooner or later all of us will have to address. It has received a lot of attention nationally and in our Michigan legislature. We all know we can't ride on an airplane and smoke wherever we want to. We've had very few problems with office ventilation systems, and the problems we've had are generally due to thoughtless installation. One that comes to mind is the heating system for the offices and showrooms of three or four automobile dealerships where the air intake unfortunately was from the service part of the building, which meant that carbon monoxide released from the automobile service area made its way into the offices. It is this type of problem we've seen, rather than any overall general problem.

MR. LIM: As I said earlier, we in California are open to the question of whether monitoring is required or not, but in a sense we have no choice in this matter because we are in an agreement State. We are required to have regulations which are at least as effective as the Federal regulations. So if OSHA requires monitoring, then we will have to follow suit. We won't have any choice in the matter. But as far as my personal views go, I oppose any unnecessary monitoring, like monitoring of the office atmosphere with respect to cigarette smoking. That is just too unreasonable.

MR. ROUSH: If we were monitoring a plant that had recirculated air, had not seen any buildup, and the employees were not exposed to the contaminant we knew we emitted into the building, in other words, the contaminant level was not apparently building up in the area, we would not need to continue monitoring of the ventilation system or air monitoring, or personal monitoring; is that right?

MR. SCOTT STRICOFF (Arthur D. Little, Inc., Cambridge, Massachusetts): I would pose a question to you in response. If I monitored my plant today and found that there was no buildup, how would I know tomorrow the air was the same?

MR. ROUSH: We monitored perhaps twice a year for several years.

MR. STRICOFF: The fact that the equipment hasn't failed in the last 2 years doesn't mean it won't fail in the next 6 months, and may mean that it is more likely that the equipment will fail.

MR. ROUSH: What I'm referring to is that the plant doesn't have any sort of air cleaner for contaminants. We've not seen any buildup. We do have recirculated air, with a little bit of makeup air added to it. Now I'm assuming in that case that as long as we are not exposed, we needn't have to worry about monitoring the ventilation system.

MR. STRICOFF: Let me make sure I understand you. You have no air cleaner. You are recirculating without an air cleaner?

MR. ROUSH: Yes, other than a particulate filter you might find in any ventilation system.

MR. STRICOFF: Okay, then assuming that you have no toxic dust present, then the situation that you're in would lend itself to a visual air monitoring system and I think it would be perfectly acceptable.

MR. BARRETT: I'll try to give you a legal answer. So long as employees are not exposed to concentrations above the permissible exposure level, the system would be acceptable. Professional judgment should come in here. We look at the NIOSH criteria documents. We look at the ACGIH TLV's, which have been updated considerably since 1968, we look into the NIOSH compilations of toxic substances, and we research the literature.

I might add here, our State is like California in that we are an agreement State of OSHA. We have adopted all of OSHA's regulations by reference. That is our legislature's desire. But we did hold over some of our own State standards along with OSHA standards, and in particular on the subject of recirculation, we have a requirement that you have to have a bypass duct outdoors. As a matter of practicality and policy we exclude small unit collectors from that particular requirement. But the reason we require the bypass duct is that, if there is a failure of the collector or some other part of the system, the exhaust would be burdened and the operation could become hazardous to the employees. Without stopping the system, the bypass duct could alleviate a hazardous situation.

One of the things I didn't think received a great deal of attention this morning, and not too many questions, but that I hope will be stressed in the report is the necessary maintenance that will be required, recognizing that many people have ventilation systems or other control systems.

MR. HAGOPIAN: There is an entire chapter devoted to that subject that basically outlines what must be done. Specifically, it describes which items must be periodically checked, inspected, tested, etc., and notes that recordkeeping is necessary, that a maintenance plan must be developed, and that such a plan should be based upon the recommendations of the equipment manufacturers.

CHAIRMAN HUGHES: Any plant that has any kind of process which emits a toxic hazardous material is going to have to have some kind of a monitoring scheme, whether it is recirculated or not. Just good practice will demand that. The monitoring that we are talking about in this report of recirculation does not in any way preclude or change that necessity. We are talking here about monitoring, or some kind of a sampling technique, to determine if there is any problem with that recirculation system that could be harmful to the worker.

MR. LARRY JOHNSON (Chevrolet, Warren, Michigan): Mr. Barrett, based on NIOSH criteria, you can recirculate processed air if your cleaning device removes 90 percent of the contaminant. Do you accept the manufacturer's guaranteed results?

MR. BARRETT: Well, first of all, let me say that that particular requirement was written pre-OSHA. It came down to the question of whether or not the workers were overexposed. By OSHA standards, exposure standards would apply, whether the discharge concentration was 10 percent of the TLV or not. That relates to all of the other variables. As to where we would get that information, as to what discharge concentration might be, we would of course rely heavily on the manufacturer's data taken from similar installations, particularly test data, if that were seen necessary, and then if we had questions we would ask to have a test run to be sure.

MR. JOHNSON: You then wouldn't require a monitoring device on recirculated air?

MR. BARRETT: I think, number one, any type of engineering control system needs some kind of surveillance, even if it's just routine pressure testing of ventilation systems to see if they are up to snuff. In recirculation systems, the monitoring or surveillance requirement might be as simple as a standard pressure tap to be sure the volume is maintained; or a little more complex, e.g., a flow switch that might discharge the air outdoors--static pressure control would do that--if the nature of the contaminant and the expected degree of worker hazards indicate that; or very complex systems for something that might potentially contain concentrations of highly toxic substances.

MR. MENKEL: The two gentlemen from Arthur D. Little this morning indicated it was their feeling, and actually a premise of their's, that an endeavor under any circumstances to recirculate a contaminant, such as a carcinogen, back into the plant should not be allowed. I would like to have the opinion of the other members of the panel on this.

MR. STRICOFF: I just want to clarify that. What we intended to say was that in writing a general guideline for people interested in recirculation, we would write, as that guideline, you should never recirculate carcinogens. There is a distinction between saying that, at least the way I look at it, and saying that one should, for example, write an OSHA regulation saying nobody should ever, under any circumstances, recirculate carcinogens. The difference is that one has to be careful about who makes the evaluation and the decision that, yes, this is sufficiently safe and the

contaminant characteristics are such that the recirculation of the carcinogens is okay. In writing general guidelines, we were not prepared to say, well, you should think about it and make a decision. We are on much firmer ground saying don't do it, but that doesn't preclude the possibility of exceptions.

MR. LIM: In regard to carcinogens being recirculated, even if the air is decontaminated, we in California feel that there is no absolute assurance that the air is completely decontaminated, so we would be very reluctant to accept any system that recirculates carcinogenic, or carcinogen-exposed air.

As I said earlier, recirculation is rarely used in California because the economics do not justify recirculation, and I just don't see the recirculation of carcinogens being practical in California because the system that we would require would just be too costly.

DR. WILLIAM DYSON (Burlington Industries, Greensboro, North Carolina): In further response to your question, there are several classes of carcinogens, and by this I am referring specifically to those for which standards are set up and accepted and those for which there are no standards at present. If we accept the premise that you can recirculate as long as the worker is not exposed to material above the threshold limit value or the OSHA standard, then those carcinogens, such as nickel, which have standards set for them, would be acceptable to recirculate. And in addition to that, you see the possibility of excluding from recirculation any contaminant you don't want recirculated just by requiring monitoring capability--this is particularly true of carcinogens if you require specific monitoring.

MR. HUELSEN: I would like to address my question primarily to Bob Hughes about the carcinogens. We have had published in the Federal Register proposed levels for nickel, and in the bare scrap we buy in the foundry industry, our metallurgists tell us there is about 2 to 3 percent nickel; whether you want it or not, this is what is coming in. You have under contract a study on foundry cleaning rooms and on grinding, buffing, and polishing operations. If we know we are getting this 2 to 3 percent nickel in the bare scrap, whether we want it or not, and we begin grinding, we are going to have airborne dust containing metallic nickel. Now how much of that nickel is going to oxidize, we don't know, but nevertheless, the analytical technique will be to take what is on the filter and look for nickel. Well, here we are talking about a suspected carcinogen. How should we proceed? Should we abandon thoughts of recirculating air in the cleaning room, or should we proceed and perhaps have to take some of these systems out in the future?

CHAIRMAN HUGHES: I think that particular dilemma would apply to more areas than just nickel. We spoke of lead earlier. At this time I don't know how to respond, because we don't know what the regulations will be. For instance, when we first started to work on recirculation with Arthur D. Little, the thought was that we would consider all materials and all chemicals as being potential to recirculation except those which were identified by OSHA as carcinogens, and those are the only ones, of

course, that have restrictions. But as we got into this study and we looked more and more into the quite large list of things which are potential carcinogens, it raised quite a dilemma. I think the only thing that we can look at right now is if the material has carcinogens in it and it can be detected and measured and controlled to that level, then it probably would be suitable for recirculation.

MR. HUELSEN: Could I address the limit question? In the Federal Register it states that the limit is set because this is the level of detectability. Now if someone devises a means of detecting nickel at a lower level, the implication is that the standard will drop to this new lower level. So we are concerned with 15 $\mu g/m^3$ according to present standards. If the limits of detectability later drop to, say, 1 $\mu g/m^3$, then the implication is that the Permissible Exposure Level (PEL) will drop down there, and I think that in light of the Delaney Clause, we have to be concerned.

CHAIRMAN HUGHES: If you want to project into the future, you probably would be precluded from recirculation because if you control today to the detectable limit, and that detectable limit goes down, then you would not be meeting the levels.

UNIDENTIFIED: If the results of the discussions and research into recirculation exhaust systems proceed to development into an efficient system, I think you can anticipate that there might be a rush by employers to install and buy equipment and manufacturers to manufacture the systems. I think naturally this might raise questions as to the integrity and efficiency of these systems, particularly by employee group unions.

Has it been considered a possibility to have "certification programs" for recirculation exhaust systems; if it hasn't, should it be considered?

CHAIRMAN HUGHES: There has been no such thought, and I'm not too sure that there is going to be any thought.

DR. DYSON: From what I see and what I know of industry, I don't believe there should be any worry that there will be an uncontrolled rush to install recirculation systems. There are far too many constraints and there are also means of conserving energy just as applicable, which are not the subject of this symposium.

UNIDENTIFIED: The point I wanted to bring up was that recirculation is an attempt to reduce the contaminant by a cheaper system, not necessarily in quality but in dollars, because of our considerations for energy. I think that going on this, employee groups are extremely reluctant to accept what they consider to be inferior systems, and I think that the more recirculation exhaust systems are available as alternatives, the more we are going to have to sell them to employee groups. I think this is going to raise a few problems with selling the product to the employee.

MR. STRICOFF: I'm not sure that anybody here wants to sell them. Our objective is not to sell recirculation. It is merely to make sure that, if people are going to do it, they are not going to hurt other people in

doing it. The selling aspect is something I would suspect NIOSH would not be particularly anxious to be involved in.

MR. JOSEPH KUKLA (Sentry Insurance, Stevens Point, Wisconsin): I think you brought up a very good point, which we have been touching on. This selling is education. I've seen insurance carriers who were reluctant to insure double risk of exposure. I see a lot of nuisance claims with employees coming out with chest pain, even though they smoke four packs of cigarettes a day, saying, "They recycle that air, I'm exposed." I can see product liability suits where this monitor, or whatever system you're using inside the duct, fails, and you have an employee sue for quite a bit of money from the manufacturer. The monitor on the stack into the park is one thing, and into the workplace is another.

DR. DYSON: Since this is a panel discussion, possibly the panel could make a comment that is not in response to a question. There are probably two or three other areas of the model on recirculation that aren't addressed by the Arthur D. Little report, and I would like to mention those very briefly.

First, the report does not consider the effects of air cleaning on the work environment. Two examples would be where a wet collector is used as a cleaner, and where you are using some type of air cleaner such as a catalytic convertor, or burning process. It increases the temperature and humidity within the work area.

Second, the model does not address the removal of contaminant by internal surfaces within the work environment, such as settling of particulates on the surfaces inside; again lead is an example of this. In general, as the calculations go, using the model would be conservative, which is desirable.

And third, there is in my opinion a problem with input to the model for those sources of contaminants within the working environment which do not have local exhaust systems. As the model is written right now, this is to be taken care of by the initial monitoring for determining C_{BZ}, the breathing zone concentration of the worker. Increased air movement from the recirculation system may increase generation through volatilization of contaminants in the working environment that are not controlled by exhaust systems.

MR. HAGOPIAN: As far as any changes which might be caused to the airstream by the air cleaner, I agree wholeheartedly that this issue must be given consideration. If you want a dry atmosphere, you shouldn't use a wet collector, obviously. I guess if you're having problems with what we said on this subject, we haven't addressed the issue as clearly as it should be.

The next item mentioned was that we don't take into account the settling of particulate matter. That's true. It would be a complicated issue requiring knowledge of settling velocities, exposed room surface areas, and a host of other factors. The model assumes that the same amount that settled before recirculation will settle after recirculation. For uncontrolled sources within the workplace, we assume that the generation rates before and after recirculation will be the same, and that these can be accounted for through accurate determination of breathing zone concentrations before recirculation is implemented.

MR. BARRETT: Someone said this morning that recirculation is rather novel. It is not. We've had recirculating exhaust systems in Michigan for years. One of the advantages of having the bypass duct is to get rid of exhaust heat and humidity when they are undesirable. I know some systems in Michigan that recirculate from cast iron machining through wet collectors, and return the air to the plant in the winter when the heat recovery is important and when the moisture doesn't cause any problems; in the summer bypass ducts are open and the air is discharged outside, eliminating the humidity and heat. Heat can be a problem not only with catalytic types of units. I remember some years ago I responded to a request for help in a woodworking plant. They had a large fabric collector connected to woodworking machines. They were complaining of being hot inside the plant in summer, and the temperature rise through the ventilation system from the hood through the collector and the fan was something in the order of 15 degrees. By installing simple bypass ducts they could exhaust for the summer; they got rid of certainly not a heat stress problem but a comfort factor in this case. So I do stress the use of bypass ducts, not only from the standpoint of equipment failure, but for some of the other reasons that Bill mentioned.

MR. STRICOFF: I go back a little bit to an underlying part of the question the gentleman from Dow raised. I'm sure a lot of people here are concerned, as are we, that OSHA may attempt in the relatively near future to regulate recirculation, and I think it is worth mentioning specifically that the objective of the work that we did was not to develop anything that would be close to promoting standards or writing standards, or a basis for a standard for OSHA. Our objective was to provide guidelines for the target audience of users. It would concern me quite a bit if I felt that OSHA was, in fact, seriously using this information as a basis for a standard, but I don't think they are at the present time.

MR. DAVID J. BURTON (D. B. Associates, Salt Lake City, Utah): I guess they say there is nothing new under the sun, when we know we've had recirculation systems in our APAC building ventilation mechanical systems for years. There presumably are a number of specifications that already exist for recirculation: the ASHRAE specifications, the building codes, NFPA codes, and so forth, and the one that comes to mind is the ASHRAE specification for 15 ft^3/min per person of new air for recirculation. I wondered if your guidelines took into account the existing specifications and regulations.

MR. HAGOPIAN: Am I correct in assuming that when you're talking about existing specifications you are referring to ASHRAE recommendations?

MR. BURTON: Well, I'm referring to ASHRAE and any others that may exist. Did you look into that problem to find out if any others do exist, and to what extent is their effort?

MR. HAGOPIAN: In regard to the volumes of air handled, I think the right answer would be no, we did not. We assumed that if you're controlling toxic contaminants, the amount of air you're handling is substantially more than that amount necessary for the purposes such specifications address.

MR. BURTON: Not necessarily. On an old exhaust system you might have a small volume problem in controlling the handling.

CHAIRMAN HUGHES: In response to that, the standards you mentioned from ASHRAE are more oriented toward the office building, the home, and things of that nature. We are not addressing this study to that. This is to what we call the industrial workplace, where there are industrial processes of contaminants. I don't think you should give consideration, per se, to the idea of air changes per minute or per hour when you're talking about exhaust systems and certain airflows required to capture and remove contaminant. I think there was an effort to look at State regulations, where State regulations may occur.

MR. STRICOFF: What we are concerned with is principally the State regulations that were oriented toward safety and health rather than ASHRAE.

MR. KEN SCHOULTZ (Enviro Control, Rockville, Maryland): I was curious as to whether you considered for recirculation the fact that you might be altering the nature of the exposure. In other words, whether you will be building up a concentration of fine particles, and actually destroying the criteria for which possibility the TLV was based, that being the normal evolution of particulate for a given industrial process.

MR. HAGOPIAN: Actually, you're asking two questions in one. One of them has to do with whether we consider the fact that recirculation may increase the level of fine particulates. The other asks whether a change in size distribution may affect the validity of any permissible exposure limit.

We give you quite an involved example in the report where we were looking at silica dust. It shows that even if you filter out most of the large particles, you can wind up recirculating more fines and get significantly more fines in the breathing zone. The example assumes, however, that the TLV for silica dust is correct.

MR. STRICOFF: Now we come to the hard part. The answer to the second part of your question is basically no, we did not explicitly concern ourselves with the fact that by changing the particle sizes we might be in fact destroying the basis of the TLV. That is an interesting point, I think a good point, but not one that we specifically address.

MR. WILLIAM CHENEY (United Air Specialists, Cincinnati, Ohio): I haven't heard any mention of the suggested criteria of discharge from air cleaner being limited to one-tenth of the TLV. Is that still the criteria that is mentioned, or are you going to drop that?

CHAIRMAN HUGHES: That criteria was not included in this study. We set the criteria that the end result of the total circulation system will not raise the level of the contaminant above the threshold limit value or some other value which has been selected in the design.

MR. STEVE CHANSKY (GCA Corporation, Bedford, Massachusetts): In regard to the question raised about the changing particle size distribution, in reading over the proceedings of the conference in 1975, I talked to Milt Caplan. I referred to some studies under sponsorship by EPA, which interestingly

show that the particle size distribution downstream of filters was not much different than particle size upstream of filters, and this is primarily because the particles that get through--and I'm simplifying this, of course--are due to faults in the fabric, itself, so that those that do get through retain much the same distribution as before. This is of course limited only to fabric filtration, not the mineral filtration.

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FOREWORD

These proceedings of the symposium on "The Recirculation of Industrial Exhaust Air" are submitted under Contract No. 210-77-0056 to the National Institute for Occupational Safety and Health of the U.S. Department of Health, Education, and Welfare. The symposium was held in Cincinnati, Ohio, on 6-7 October 1977.

The objective of this symposium was to discuss the development of technical criteria for the recirculation of industrial exhaust air. With emphasis on the protection of the worker's health, technical subject matter discussed included: (1) decision logic for determining recirculation feasibility; (2) design and performance guidelines for recirculation systems; (3) availability of air cleaning and monitoring systems; and (4) maintenance guidelines.

Mr. Robert T. Hughes, Chemical Agents Control Section, Control Technology Research Branch, Division of Physical Sciences and Engineering, National Institute for Occupational Safety and Health, Cincinnati, Ohio, was the Symposium General Chairman.

Mr. Alfred A. Amendola, Control Technology Research Branch, Division of Physical Sciences and Engineering, National Institute for Occupational Safety and Health, Cincinnati, Ohio, was the Symposium Vice-Chairman and Project Officer.

Mr. Franklin A. Ayer, Manager, Technology and Resource Management Department, Center for Technology Applications, Research Triangle Institute, Research Triangle Park, North Carolina, was the Symposium Coordinator and Compiler of the proceedings.