

Synthetic Fibers in the Workplace:

Where Less Fiber is Healthier

(Based on AIHce 2000 Roundtable 223)

American Industrial Hygiene Association



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Panelists

Moderator: Ralph Zumwalde—NIOSH, Cincinnati, OH

John M. Dement—Duke University Medical Center

William H. Kojola—American Federation of Labor,
Congress of Industrial Organizations

Dean E. Venturin—Unifrax Corporation

Steve Hacker—Solutia Incorporated

Thomas Calzavara—Johns Manville

Angus E. Crane—North American Insulation
Manufacturers Association

Adam M. Finkel—OSHA, Denver, CO

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**AIHA
PRESS**

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PREFACE

Fibers comprise a diversity of materials that have become profuse and nearly inextricably woven into the patterns of our lives today. But the production of many new synthetic fibers has been accompanied by increased awareness among manufacturers, workers, and the occupational safety and health community of the need for exposure characterization, product stewardship, and education about safe work practices and handling procedures. This awareness has been driven by the recognition of potential respiratory hazards for workers exposed to some airborne synthetic fibers. Toxicological evidence from experimental animal studies also indicates potential health effects associated with exposure to fibers and warrants further concern. To explore these issues, AIHce 2000 (Orlando, FL) RT 223, "Forum on Synthetic fibers in the Workplace: Where Less Fiber is Healthier," was assembled, pulling together representatives from the synthetic fiber industry, labor, government, and academia. The intent was to recognize efforts to characterize workplace fiber exposures, to identify and implement safe work practices and controls, and to communicate safety and health messages about the potential hazards of airborne fibers.

Historically, occupational safety and health practitioners have a basis for concern with exposure to airborne fibers; the most controversial case-in-point being the asbestos legacy. Judging from the focus and discussion of the roundtable, participants and audience members were aware of the history with asbestos fibers and eager to draw from this experience in addressing issues with newer and different synthetic fibers. In light of the uncertainties about the health risks for many synthetic fibers, the roundtable focused on preventive measures and stewardship programs initiated and being developed to ensure safe production and handling of synthetic fibers. In so doing, the major objective was to create a forum for examining these programs and to stimulate collaborations among participants and other partners with an interest in this area. Topics of presenters included:

- Potential health risks associated with exposure to synthetic fibers;
- Sampling and analytical techniques for characterizing fiber exposures;
- Industry efforts to promote safe work practices and use of appropriate controls; and
- Strategies to develop and disseminate information and guidance on the safe handling of synthetic fiber products.

The discussion frequently focused on universal concerns and strategies for addressing safe handling of synthetic fibers, and each panelist contributed a unique perspective for identifying the pertinent issues for this topic.

*Thomas J. Lentz, Arranger
AIHce 2000, RT 223
April 2001*

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- John M. Dement, Duke University Medical Center
- William H. Kojola, American Federation of Labor, Congress of Industrial Organizations
- Dean E. Venturin, Unifrax Corporation
- Steve Hacker, Solutia Incorporated
- Tom Calzavara, Johns Manville
- Angus E. Crane, North American Insulation Manufacturers Association
- Adam M. Finkel, Occupational Safety and Health Administration

Ralph Zumwalde is also recognized for his expert role in serving as the session moderator. The assistance of Claire Davis-Jones (American Industrial Hygiene Association) also proved invaluable in the planning and coordination of the roundtable.

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Synthetic Fibers in the Workplace:

*Where Less Fiber
is Healthier*

Roundtable 223

Presentations

INTRODUCTION

MODERATOR: I know there are a number of other technical sessions in other roundtables that I suspect will be quite interesting. I appreciate your attendance at this roundtable. My name is Ralph Zumwalde, and I'm with NIOSH. I'm the moderator for this session. I would like to acknowledge two other people who have assisted in setting up this roundtable: Kathleen MacMahon and T.J. Lentz.

I would like to first introduce the speakers in the order they will be giving their presentation. The order of the program has changed in order to accommodate someone who is giving another presentation. I don't think it will adversely affect what we will be talking about.

The first presenter will be John Dement with Duke University. John is going to be talking about the background of health issues as they relate to synthetic fibers. Following John will be Bill Kojola with the AFL-CIO. Bill will be talking about labor's perspective on the hazards of synthetic fibers and the control of exposures.

Following Bill will be Dean Venturin with Unifrax. Dean will be talking about the Product Stewardship Program that has been initiated under the Refractory Ceramic Fibers Coalition (RCFC) in dealing with health and safety issues within the industry.

Following Dean will be Steve Hacker who is with Solutia. Steve will be talking about the monitoring and the analysis of organic fibers in the workplace.

Following Steve will be Tom Calzavara with Johns Manville, and Angus Crane with NAIMA. They will be talking about their health and safety program that was initiated with OSHA as part of a voluntary agreement.

Finally, Adam Finkel who is with OSHA will also be talking about OSHA's initiative in developing health and safety programs, and he will be talking a little bit about their particular program that they initiated with NAIMA.

Also in the audience is Loretta Schuman who is with OSHA, and will be here to help share and contribute to this roundtable discussion.

The first question that I would ask myself is why synthetic fibers? If you take a moment and look around the room, you will see that synthetic fibers make up a large part of our life; in the clothing that we wear, the carpet, even the ceiling tiles. It is a large commodity product within the United States. Millions of workers are potentially exposed to synthetic fibers in the workplace.

One of the emphases behind looking at health and safety as it deals with synthetic fibers has to do with the issues of the uncertainties that exist and to try to define the potential health risks of

synthetic fibers. Many of the fibers that exist both in the workplace and also in a commercial setting don't pose a health risk to workers. Although there is a continuum of health risks that generally apply to certain kind of fibers that deal with the dimensional characteristics—the biopersistence of a fiber and, of course, dose.

I think the focus of what we would like to talk about today is the health and safety initiatives that have been taken within the synthetic fiber industry, and establishing health and safety programs given the uncertainty about the health data, and trying to develop the important aspects of dealing with any potential problem—trying to instill some kind of preventive measures.

I am hoping today, this discussion on the roundtable can provide a forum where you as the audience and the participants can talk about what we know about health and safety programs, especially as they apply today and are being developed within the synthetic fiber industry. I would like to define what particular issues may remain that are still yet to be resolved, or where there are differences of opinion.

Then at the end of the roundtable, I would like some discussion or some thought in terms of what kinds of collaborative efforts—whether it be between government, labor, and industry—that can be done collectively that would help address or fill the need in terms of improving upon already existing health and safety programs.

MODERATOR: With that said, let me introduce John Dement, who will be talking about some of the health issues as they relate to synthetic fibers.

DEMENT: Ralph asked if I would make a brief presentation outlining some of the health issues relative to synthetic fibers. This presentation is not intended to be a comprehensive review but should provide a little background for discussion.

First, a little bit of nomenclature with regard to what we mean by 'synthetic fibers (Slide 1).' This slide is not all-inclusive; there are other classification schemes that have been used. There are two broad classifications—the vitreous fibers and organic fibers. Within each of these classification there are several subclassifications of fibers as shown in this slide.

In this slide (Slide 1), I also have summarized information concerning fiber size, which is very important with regard to the health risk of these fibers. The continuous glass fibers (for the most part because of the method of production and the fairly close tolerances about fiber size) really pose very little human health risk, at least with regard to an inhalation hazard due to the large diameter of these fibers.

I have classified insulation wool and microfibers

CLASSIFICATION OF SYNTHETIC FIBERS

- Synthetic Vitreous Fibers (SVF)
 - ◆ Continuous Filament Glass Fibers (3-25 μm)
 - ◆ Insulation Wool (0.1-8 μm)
 - ◆ Ceramic Fibers (1-3 μm)
- Synthetic Organic Fibers (SOF)
 - ◆ Carbon/Graphite (5-15 μm)
 - ◆ Polyamide (e.g., 'Nomex', 'Kevlar' > 10 μm , fibril 'peeling' may produce finer fibers.)
 - ◆ Polyolefin (most > 5 μm , microfibers 0.1-2 μm)

Slide 1

together as one group, but there are many, many subgroups of these. As can be seen, the fiber ranges of these starts at about a tenth of a micrometer for the smallest up to about 8 micrometers. Many of these fibers certainly would fall within a range of respirability, which we is predominately a function of the actual fiber diameter; although length, in my opinion, is actually very important for some of the longer airborne glass fibers. Longer fibers may be deposited in the upper airways by direct interception.

Regarding organic fibers, I will talk a little less about these because these organic fibers are somewhat large. Also, there is less information—certainly less human health effect information.

For the organic fibers, there are a couple of exceptions to fiber size and respirability, and this has to do with the polymers and a phenomena called 'peeling,' which produces a respirable particle or fiber as a result of the process. The subclassification known as polyolefins are produced as submicron fibers and these would certainly be considered respirable.

For the most part, this presentation concentrates on the vitreous fibers because that is where we have most of our human data. First, a little bit about exposure and the methods that we use to measure exposure. Typically, we have expressed concentrations in terms of fibers per cc (f/cc) measured by the standard face contrast method.

I think a couple of points to note: first of all, with regard to vitreous fibers, we don't see the same phenomena with regard to splitting along the length of the fiber. Therefore, the PCM counts nearly everything that is in the air, with the exception of the extremely small diameter micro fibers, which are likely to have a subfraction that are smaller than the resolution limit of the optical microscope.

AIRBORNE FIBER CONCENTRATIONS (fibers/cc) IN US AND EUROPEAN SVF PRODUCTION PLANTS

TYPE	PRODUCED	# PLANTS	MEANS BY PLANT	MEANS BY OPERATION
US PRODUCTION PLANTS				
Glass	Loose	5	0.02 - 0.78	< 0.01 - 0.92
	Continuous	2	< 0.01 - 0.04	< 0.01 - 0.09
	Mixed	4	0.01 - 0.04	< 0.01 - 0.38
Rock	Loose	1	0.34 - 0.34	0.15 - 0.43
Slag	Loose	3	0.02 - 0.05	0.02 - 0.19
Rock/Slag	Loose	1	0.10 - 0.10	0.03 - 0.58
EUROPEAN PRODUCTION PLANTS				
Glass	Wool, Loose	4	0.02 - 0.20	< 0.01 - 1.00
	Wool, Loose	6	0.05 - 0.15	< 0.04 - 0.67
Glass	Filament	3	Not Given	< 0.01 - 0.02

Source: Esmen et al. (1979), Cherie et al. (1986)

Slide 2

CONCENTRATIONS of FIBERS < 1 μm IN DIAMETER (fibers/cc) in US SVF PRODUCTION PLANTS BY TEM

FIBER TYPE	MATERIAL PRODUCED	# PLANTS	RANGE OF OVERALL MEANS BY PLANT
Glass	Loose	4	0.01 - 4.40
	Continuous	1	0.0004 - 0.0004
	Mixed	4	0.0004 - 0.10
Slag	Loose	3	0.01 - 0.04
Rock/Slag	Loose	1	0.02 - 0.02

Source: Esmen et al. (1979)

Slide 4

FIBER CONCENTRATIONS (fibers/cc) IN FACILITIES PRODUCING SMALL DIAMETER GLASS FIBERS

STUDY	# PLANTS	OPERATIONS SAMPLED	MEANS BY PLANT	MEANS BY OPERATION
Dement (1975)	2	Fine/Superfine	1.0 - 9.7	0.10 - 33.6
Small diameter fibers have nominal diameters < 3 μm				
Esmen et al. (1979)	1	Superfine	0.78 - 0.78	0.09 - 1.56
Hammand & Esmen (1984)	3	Fine/Superfine		0.032 - 6.77

Small diameter fibers have nominal diameters < 3 μm

Slide 3

FIBER CONCENTRATIONS (fibers/cc) DURING USE OF SVF FOR DUCT, PIPE INSULATION

STUDY	RANGE OF MEANS BY OPERATION
Esmen (1982)	0.01 - 0.65
Hallin (1981)	0.15 - 0.57
Schneider (1984)	0.05 - 0.35
Head & Wagg (1980)	0.10 - 0.10

Slide 5

I have a few slides that summarize the published information concerning airborne fiber concentrations. Currently, exposure levels in most situations would be considerably lower; however, it is the older information that ties to the epidemiology. Looking at the concentrations by operation and by plant in the US and European plants, we see that fiber concentrations are usually below 1 f/cc for operations producing glass, rock, and slag wool (Slide 2).

A little information exists with regard to the superfine fibers as shown in this slide (Slide 3). Some work that we did early on found concentrations in the fine and superfine above 1 f/cc, and some operations can be very high. This happened to be an operation where compressed air was used for cleaning process machinery. Typically, you

would expect that to be a high concentration although a short-term exposure. Others have found similar types of fiber levels as shown in this slide. With the fine fibers you can produce, certainly in the user operations, a more significant exposure.

This slide provides concentrations of fine fibers for glass, slag, and rock wool (Slide 4). This is expressing it for fine fibers, those that are less than 1 micrometer in diameter. As can be seen, except for the microfiber operations, the concentration of very small fibers is relatively low in typical glass, slag, and rock wool operations.

The next two slides provide information with regard exposures measured during the use of glass, slag, and rock wool fibers in the field (Slides 5 and 6). We see a little higher exposure in the field than in production operations. Higher exposures are seen

FIBER CONCENTRATIONS (fibers/cc) DURING
SPRAY APPLICATION AND ATTIC INSULATION

STUDY	RANGE OF MEANS BY OPERATION
Esmen (1982)	0.02 - 5.30
Hallin (1981)	0.51 - 1.11
Schneider (1984)	0.89 - 0.89
Head & Wagg (1980)	0.77 - 8.19

Slide 6

FIBER CONCENTRATIONS (fibers/cc) IN TWO
UK CERAMIC FIBER PRODUCTION PLANTS

FIBER TYPE	MEAN	RANGE
Ceramic Fibers	1.27	0.06 - 6.14
Alumina Fibers	1.09	0.03 - 5.82

Source: Head & Wagg (1980)

Slide 8

FIBER CONCENTRATIONS (fibers/cc) IN FACILITIES
USING SMALL DIAMETER GLASS FIBERS

STUDY	# PLANTS	OPERATIONS SAMPLED	RANGE OF MEANS BY OPERATION
Dement (1975)	2	Aircraft Insulation	0.8 - 14.1
	2	Paper Production	1.9 - 21.9
Esmen (1982)	2	Aircraft Insulation	0.02 - 0.56

Small diameter fibers have nominal diameters < 3 μ m

Slide 7

FIBER CONCENTRATIONS (fibers/cc) IN THREE
US CERAMIC FIBER PRODUCTION PLANTS

PLANT	MEAN	RANGE OF MEANS BY OPERATION
A	3.30	0.09 - 8.70
B	1.50	0.68 - 2.60
C	0.23	0.03 - 0.28

Source: Esmen et.al. (1979)

Slide 9

in blowing and spraying applications. In the field, there certainly is a greater potential for exposure in certain circumstances. There is a need for better engineering controls and work practices as well as worker education and training in order to minimize these exposures.

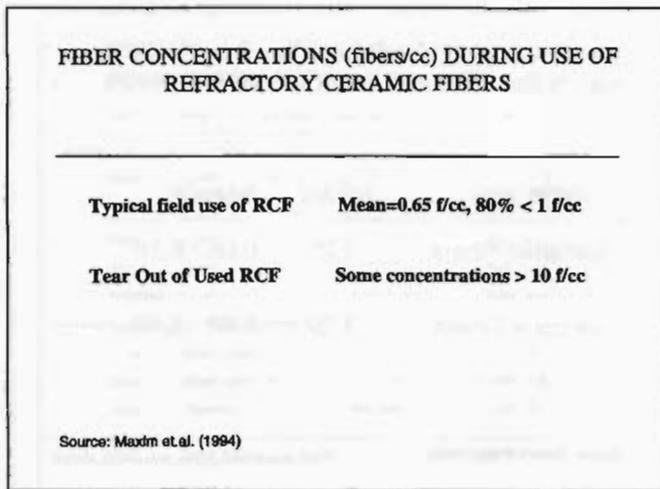
This slide provides information on secondary users of superfine fibers (Slide 7). Again, higher exposures are seen in these operations than typically seen in fiber production.

The next few slides provide concentration data for ceramic fibers (Slides 8 and 9). Certainly, there is currently more information available than existed even a few years ago. In production plants where ceramic and aluminum fibers are produced, mean fiber concentrations are slightly higher than 1 f/cc. This is to be expected since fiber diameters for

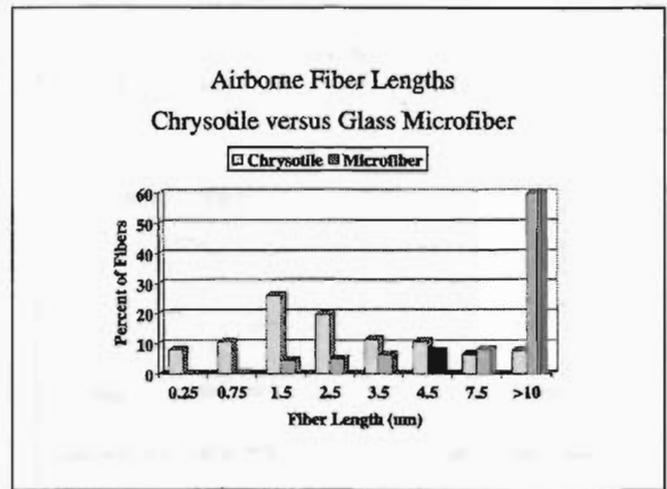
ceramic fibers are smaller than in typical insulation wool (so predictably concentrations can be higher). Similar information for three US plants is provided in the next slide (Slide 10), where mean concentrations of over 3 f/cc have been measured.

Ceramic fiber concentrations in secondary use operations, field applications, and tear-out can be higher than those in fiber production (Slide 10). Most of the concentrations are less than 1 f/cc; however, occasional operations such as tear-out produce higher exposures, at least on the short term. In these cases, some measurements around 10 f/cc have been measured.

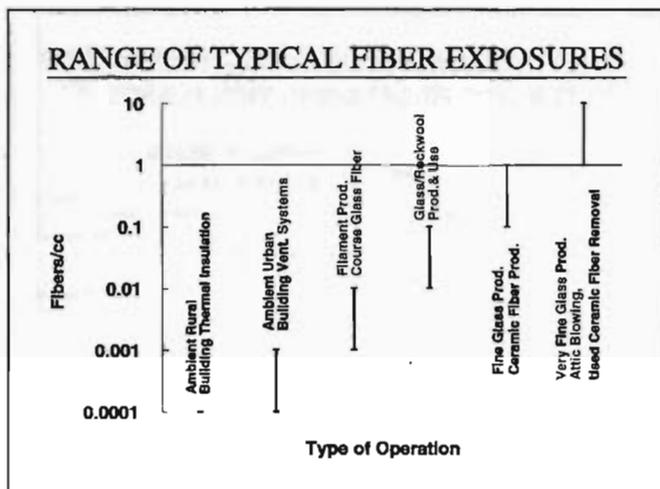
In order to summarize these concentration data for comparison, these data were summarized in the next slide (Slide 11). A horizontal line is shown at a concentration of 1 f/cc. As can be seen, fine fiber/



Slide 10



Slide 12



Slide 11

SVF Health Effects Human Studies

Synthetic Vitreous Fiber	Non-Malignant Lung Disease	Pleural Changes	Lung Cancer	Meso
Continuous Glass	-	-	- +	-
Insulation Wool				
Glass	-	-	- +	-
Slag/Rock	+ -	-	+ -	-
Ceramic Fibers	- +	+	NS	NS

Slide 13

glass fiber operations as well as some of the field applications of these fibers can produce concentrations greater than 1 f/cc. Historically, in lass, slag, and rock wool fiber producing plants, exposures have been less than 1 f/cc in my opinion; even historically going back in time; therefore, the existing epidemiology is also tied with this type of exposure level.

For comparison purposes, this slide compares asbestos with microfiber in terms of fiber length (Slide 12). With the PCM counting method (i.e. those greater than 5 micrometers) the proportion of fibers that are counted for microfiber operations is much greater than for asbestos. For asbestos (I think this is a textile operation, which would be the longer fiber), if you sum all of these up, you

are still counting typically less than 10 percent of the actual airborne fiber by that PCM method. This is sort of a paradox. Concentrations are expressed as in fibers per cc, we compare asbestos with man-made fibers; however, this method is simply an index of exposure. We should be concerned with the total distribution of airborne fiber size. TEM also has limitations with regard to fiber counting as you can only count up to a certain fiber length before the length is cut off by the size of the counting field.

I've tried to summarize what we know with regard to health risks, and I've tried to divide it into continuous glass, insulation, and ceramic fibers (Slide 13). This is not intended to be a quantitative assessment. Continuous glass fibers, for the most

SVF Health Effects Animal Inhalation Studies

Synthetic Vitreous Fiber	Lung Fibrosis	Lung Cancer	Meso
Continuous Glass	NS	NS	NS
Insulation Wool			
Glass	- +	- +	-
Slag/Rock	- +	-	-
Ceramic Fibers	+	+	+

Slide 14

part, are not respirable. There is one case-controlled study that suggested an increase in lung cancer for these fibers; however, it is probably confounded considerably by other exposures. Again, for the most part, these are not respirable fibers.

With regard to glass (and I've put slag and rock together), both the European and US studies have basically not shown an increased risk for nonmalignant lung disease. Certainly, we have not shown fibrosis and have not shown pleural changes by chest x-ray, nor have we seen mesothelioma in the mortality studies. There are some suggestions from both of a slight increase in lung cancer—more with the slag and rock operations than the glass operations.

There is a lot of discussion about confounding in those studies. Certainly smoking is a potential confounder. Asbestos in some of the plants is a confounder. Taken as a whole, the data do suggest a slight increase in lung cancer. The ceramic fibers, we only have only chest x-ray information from the epidemiology and relatively little information concerning mortality or cancer incidence. I would say we do not have enough information to say much about lung cancer among these populations. And the University of Cincinnati is seeing some early pleural changes among workers engaged in ceramic production.

A summary animal inhalation studies is given in this slide (Slide 14). I have chosen not to summarize

SVF Fiber Carcinogen Classification

	IARC	NTP
Continuous Filament Glass	Not Classifiable	Not Listed
Glass Wool	Possibly Carcinogenic to Humans	Reasonably Anticipated Human Carcinogen
Rock/Slag Wool	Possibly Carcinogenic to Humans	Not Listed
Ceramic Fibers	Possibly Carcinogenic to Humans	Reasonably Anticipated Human Carcinogen

Slide 15

the data from implantation or injection studies. This does not minimize their importance as these studies do provide value information concerning the biological mechanism of action. There is really no inhalation with continuous glass fibers and there is probably no reason for it to be. Regarding the insulation wools, a '-/+' means there are more negative data than positive data on balance with regard to glass fibers and fibrosis and lung cancer and no mesotheliomas have been associated with these fibers. For ceramic fibers, on the other hand, positive results have been recorded for all three effects.

This is a summary of how these two organizations, IARC and NTP, have classified these materials with regard to the carcinogenicity (Slide 15). IARC is basically classified as glass, rock/slag wool, and ceramic fibers as 'possibly carcinogenic to humans.' This classification is primarily based on the animal data. NTP classifies glass wool as reasonably anticipated to be a human carcinogen as well as ceramic fiber. Their ninth edition of *Annual Report on Carcinogens* retains this classification.

In closing, what are the research and prevention questions (Slide 16)? I think we need more study and definition of constitutes a respirable fiber. Fiber diameter is obviously important; however, I don't think we have paid adequate attention to length. There is room for developing sampling techniques that might define that a bit better. Good information is being produced on fiber durability. This may be

an important factor in the health risk posed by these fibers; however, there is a gradient in durability, starting with the asbestos fibers on the one end and the glass fibers on the other. Unfortunately, appropriate cut points relating durability to actual human risk as not well defined at present.

We don't know much about the in-service use of the area of these fibers and their effect on health. As I said before, with most synthetic vitreous fibers, you do not see fibers splitting along their length; however, this is seen with some organic fibers and this needs further investigation.

Certainly, fiber size and pathogenicity is still being studied in much greater detail for most fibers including asbestos, glass fibers, ceramic fibers, and others. The relationship between fibrosis and cancer must also be assessed.

Lastly, we need to continue to follow the cohorts of workers included in the US and Europe studies. These studies might also concentrate on health ef-

**Fiber Characteristics & Health Effects
Research Questions**

- Respirability (< 3-4 μm diameter)
- Fiber Durability in the Lung
- Surface Area and Splitting
- Fiber Size and Pathogenicity
 - ◆ Fibrosis
 - ◆ Lung Cancer
 - ◆ Mesothelioma
- Fibrosis — Lung Cancer Relationship

Slide 16

fects of microfibers, although these are much smaller cohorts.

This presentation was intended to be a recap and overview. It is not intended to be a scientific critique of the studies. ■

MODERATOR: Thanks, John. I would like to try to move through all of the discussions so we can have some sort of a dialogue, and focus on some of the preventive efforts that have been going on for a while, and seeing where we can move forward in terms of those efforts.

Are there any questions or clarifications for John?

Our next speaker is Bill Kojola.

KOJOLA: Thank you, Ralph. What I want to do is offer some perspective on some of the issues regarding health hazards and control measures for reducing worker exposure to synthetic fibers. I am going to confine my comments and perspective to the synthetic vitreous fibers, which is the area where labor has spent most of its focus.

I think it should come as no surprise to you that the views that labor has, particularly with regard to the health hazards of synthetic vitreous fibers, is colored by our experience with asbestos. Amongst our union members, as well as many nonunion workers, tens of thousands of families have been impacted by the tragic consequences of exposure to asbestos, the cover-up with regard to the adverse health affects that were known for many years, and the resistance to a remedy to make the situation right with regard to control of worker exposure. All these factors have made organized labor essentially suspicious from the outset about the health issues with regard to all fibers.

I think that suspicion is cast in this light: we would like to be shown that this substance or this particular fiber is not hazardous. Otherwise, our tendency is to lean toward being very concerned about the potential health impacts.

With regard to labor's perspective on the health effects and the classification, I think John did a very good summary on the overall impact on both animal and human studies on synthetic vitreous fibers. Suffice it to say with regard to refractory ceramic fibers (particularly in the animal inhalation studies where you have the development of lung cancer, you have the development of mesothelioma, and you have the development of fibrosis), from our perspective

as well as some others, that logically leads you to the consequence that we consider refractory ceramic fibers as carcinogens, and that they ought to be handled like asbestos.

We know that the University of Cincinnati has a cohort of RCF manufacturing workers that they are following. They have seen some pleural changes. John is correct in saying that they have not yet seen the development of cancers or mesothelioma. Clearly, it is a cohort that is worth following very carefully.

We have some concern with some evidence that has suggested that crystalline silica is also present in after-service refractory ceramic fibers and we are concerned that workers may be exposed to crystalline silica during RCF tear-outs after service RCF materials. The concern with silica has to do with fibrosis and cancer. NTP last week has reclassified silica as a known human carcinogen.

The issues with regard to fiberglass and mineral wool are a little bit fuzzier. John has summarized it appropriately. There is some evidence in human studies of cancer risks. It makes us suspicious, but we're not quite sure we ought to be on 'yes cancer' or 'no cancer' with regard to fiberglass and mineral wool, but clearly we have a level of concern.

There is clearly a problem with skin irritation. If you talk to workers on the end-user side with fiberglass and mineral wool, there is a problem or an issue with skin irritation. One of the areas that John touched on, and I know that the industry is expending some considerable time and money in research efforts, is looking at the durability and solubility of glass fibers. The more soluble the fiber, the less hazardous the fiber is or may be. I think

that is an intuitive idea. If the characteristic causing the adverse outcome is a fiber, whatever you define the fiber as, there is sort of an intuitive idea that if it is more soluble, that may make it less hazardous. There is some suggestive evidence that this may be the case, if you look at the continuum of durability or solubility for a variety of fibers, from asbestos to some of the glass fibers that are much more soluble.

In my view, I don't think this issue of durability or solubility is a settled question, at least scientifically. We don't understand the mechanism by which fibers cause cancer. We don't know if the event initiating the cancer is largely dependent upon the duration or the persistence in the body. In other words, can the event happen shortly after the introduction of the fiber into the physiological system? From our point of view, those are not settled questions.

With regard to control of workplace exposure and regulatory action, it is not likely there will be an OSHA standard. Fiberglass and mineral wool were identified in OSHA's priority planning process, and you will hear a little bit more about that in a presentation this afternoon in the roundtable. For OSHA to move forward, there is not going to be a standard in my lifetime.

Standard setting at OSHA is difficult at best. I think we all recognize this as professionals in this field from our point of view, given OSHA's limited capability of promulgating standards for a whole variety of reasons, including political. From labor's point of view, there are other more pressing needs for moving forward with regulatory efforts on the part of OSHA, like ergonomics, safety and health programs, silica, and hearing conservation in construction. And what about the whole PEL update process dealing with a variety of chemicals as opposed to just one substance?

What are the alternatives? The alternatives are a voluntary standard or guideline, or some labor/management cooperative effort to move forward and address an issue, in the absence of any regulatory requirement to enforce compliance.

From our point of view, we do support genuine labor/management/government efforts to develop voluntary standards and guidelines to advance

worker protection. This is an activity that organized labor is involved in throughout the country on a whole variety of issues in the absence of an OSHA standard or regulation, or in the presence of a minimum regulation (where now labor and management want to move beyond that).

Our perspective on these voluntary standards and guidelines is that, from labor's point of view, we want to have an equal voice—not the sole voice, but an equal voice. In terms of labor's participation, it is important to include worker and labor perspective in this process at the earliest possible part of the whole initiative.

There is a problem with a voluntary standard. The problem is that it is voluntary in nature and by definition, so you lack coverage. You lack an ability to enforce a voluntary initiative. That is the problem side of things. On the plus side of things, those voluntary efforts can and do make a significant difference for worker health and safety across the United States.

In the field of synthetic vitreous fibers, there are some initiatives that are ongoing, several that you will hear about in more detail this afternoon. ACGIH has TLVs® for synthetic vitreous fibers and RCFs. You will hear about a voluntary program in the United States (NAIMA, installers, and OSHA) for fiberglass and mineral wool. You will hear about some initiatives that the RCF folks are undertaking. These are all important steps in this process.

There is also the International Labour Offices (ILO), which is developing and finishing a code of practice. They had a meeting of experts in Geneva in January. A final document is still in the internal process of being reviewed and approved. I think worldwide it will be an important step toward controlling worker exposure.

From a worker-protection point of view, we would like to use the best practices incorporated in all of these elements. We also think it is important to use manual methods of working with fibers rather than with power tools where possible. And where power tools are used, if possible, to provide dust collection systems to minimize exposure.

Of course, we support and advocate extensive training of both workers and supervisors. It is im-

portant for supervisors to have training on how to work with these materials appropriately.

We have some concerns about take-home issues and take-home contamination, particularly on the end-user side, where workers are installing fiberglass or synthetic vitreous fibers in buildings and homes, where installations are in largely uncontrolled atmospheres, and where workers wear their clothing in their personal cars and take it home for cleaning. That is an issue we are concerned about.

Another issue is respiratory protection. If you talk to workers, they don't like to wear respirators. I think it is obvious that the respirators are uncomfortable and they don't work effectively, in workers' minds. With regard to synthetic vitreous fibers or other fibrous materials, some workers have a real problem with the use of the single-use filtering face piece, disposable dust mask for several reasons. One is that many workers are not confident that you will get an adequate level of protection from the single-use disposable respirator. Some workers would prefer that if respirators are to be used, that they be given a half-mask respirator. They are critically aware that the single-use respirators are not used or permitted for use with asbestos. So they make the link between asbestos and other fibers.

In many workers' experience (and mine as well), employers whose only respirator is a single-use disposable respirator frequently have poor or no respiratory protection program, so they hand out a single-use respirator like they hand out aspirins. And workers have little or no faith that they're being adequately protected.

The last issue I want to talk about is the irritation piece on the end-user side, especially on the end-user side with the construction workers (and I used to work for the laborers for a number of years before coming on the with AFL-CIO). Construction workers, at one point or another, are exposed to fiberglass in the course of their work. Some of them have a lot of complaints about skin irritation.

One construction laborer, a Finlander in northern Wisconsin, called a couple of years ago and said that, yes, he and his crew are often exposed to fiberglass. He said the only way they found that addresses the issue of skin irritation is to sit in the sauna for a couple of hours. He said there are all kinds of benefits to sitting in the sauna besides addressing the irritant problems of fiberglass.

With that, I will close. I am trying to offer a little bit of our perspective and can add a little bit more when it comes to the roundtable part.

Thank you very much. ■

DEAN VENTURIN

VENTURIN: Good afternoon. I would like to thank the moderator and AIHA for inviting us here to speak today. I would like to spend a little time this afternoon talking about ceramic fibers and our product stewardship program that is directed toward managing the risks associated with ceramic fiber.

On the agenda today, I would like to review the evolution of our product stewardship program for refractory ceramic fibers, and would like to spend a little time reviewing the toxicology and epidemiology of ceramic fibers in addition to the results of a recent risk assessment that was performed on ceramic fibers.

The strategic and management initiatives that we call product stewardship (some of the more important ones being worker communication and education, the development and promotion of engineering controls, process controls, and respiratory protection) are elements that I would like to spend a particular amount of time discussing.

To begin, understand that refractory ceramic fibers (RCFs) are synthetic vitreous fibers. They belong in a family of materials along with fiberglass, rock wool, mineral wool, and they are produced through a process of melting alumina and silica, or kaolin clay, and then allowing the molten mass to be fiberized through one of two manufacturing processes—either blowing or spinning. Some of the important qualities of ceramic fibers include their very high temperature stabilities, extreme low weight, and their low thermal conductivity.

A couple of important factors for us to keep in mind when we're talking about the health effects or risks associated with ceramic fibers is the length-weighted geometric mean diameter of the product. It does tail off into the respirable range, below three microns in diameter.

Like all synthetic vitreous fibers, it also has a transverse breakage property. Where this comes into play is as you apply mechanical energy, as you process these materials, the fibers get shorter and shorter in length but they do not change diameter, eventually becoming a nonfibrous articulate.

This is the emergence of the health issue. RCF was actually invented in 1942 and commercialized in the early 1950s. It saw accelerated growth in the 1970s as a result of the energy crisis. There were some early health studies in the 1950s. The industry started doing industrial hygiene monitoring, both fibrous and dust, in the 1970s. We basically started doing some toxicology and epidemiology work also in the 1970s and 1980s; however, the early results were ambiguous. It was considered to be a relatively benign material.

It wasn't until 1984 when the Thermal Insulation Manufacturers Association conducted a study at the Los Alamos National Laboratory—an animal study using hamsters, where at the maximum tolerated dose, we came across pleural mesothelioma in a single hamster.

As you might imagine, this promoted a number of responses, including, not the least of which, is a TSCA 8-E notification (which was made in 1985), the development of extensive hazard warning labels, and MSDSs. An epidemiology investigation, including current and former workers, was initiated in 1987 for RCF manufacturing facilities in North America.

The industry also sponsored a number of additional toxicology investigations conducted at RCC in Geneva, Switzerland, both a maximum tolerated dose study and a multidose study. All this led to the development of what the industry now calls our product stewardship program for refractory ceramic fibers, which, in essence, is the strategic management of risks associated with the use of ceramic fibers.

If you were to boil down our product stewardship program into its basic elements, they would include exposure assessments. Looking at the population of potentially exposed workers and the United States, it would include a study of workplace controls and the development of new control technologies. It would include workplace monitoring, and not only at the manufacturing facilities, but also at end-user operations and down line at final-use operation.

It includes product research. Whenever we're looking at developing new fiber types, safer products, more soluble products, and special studies (many of which have been conducted in conjunc-

tion with EPA, OSHA, and NIOSH), which include things such as a ceramic fiber testing consent order, a risk assessment, and stack studies.

It also includes health effects research (which I am going to summarize in a minute), toxicology, and epidemiological research that is being conducted by the industry, and a very intense communications and worker training outreach program that the industry has initiated.

The most recent tox studies were performed using lifetime chronic exposures to specifically prepared rodent respirable ceramic fibers—the target being 0.8 microns in diameter by 16 microns long. To give you an idea of how difficult it is to get rodent respirable ceramic fiber, it took roughly 2,000 pounds of the bulk material we produce to produce 20 pounds of material that we can introduce into the animals. We did the studies at the maximum tolerated dose and at a multidose level. At the maximum tolerated dose, we were able to produce cancerous endpoints with these specifically prepared rodent respirable fibers at the maximum tolerated dose. At the multidose, we were able to produce levels where we had no adverse observable effects. In other words, we were able to look for and produce a dose-response curve.

Additional questions (and there are many) have to do with the different pathologies in the test species. We used hamsters and rats, and the endpoints (the results) that we saw were different for both species. How does this relate to what we might see in humans? That's a big question.

The concentration of particulate contained in the specially prepared rodent respirable fibers tested was roughly 18 times higher than what we would typically see in the workplace. The question arises as to how did this affects clearance and exacerbates the toxicology that we think we saw with regard to the fiber. Those questions are yet unanswered.

With regard to our epidemiological investigations: in North America, we have a longitudinal study that is going on with the University of Cincinnati. It was initiated in 1987 using both current and former workers. It is a relatively small cohort, but represents better than 90 percent of the people who are manufacturing ceramic fiber—both current

and former employees. It also represents employees from 1 to 30 years of exposure, so we do have a number of very long-term exposed employees here, many of whom have had a number of years in retirement since their last exposure.

In ECFIA, the European Ceramic Fiber Industry in Europe, there have been two cross-section morbidity studies; the first one in 1986 and the second one in 1996. If you look at the results of these studies in combination, there is no evidence of RCF-related disease in either of these studies. We have no fiber-related fibrosis, lung cancer, or mesothelioma in either of these studies. In the US study, the longitudinal study, we do have roughly a 3 percent incidence of pleural plaques.

Taking the toxicology and epidemiology data that we have, can we do a risk assessment? The answer is yes. It is difficult, but we have attempted it. Sciences International has done the risk assessment funded by the Refractory Ceramic Fibers Coalition, and we used most conservative, worst-case assumptions to come up with a calculated risk at 0.5 fibers per cc of 0.073 per thousand. To put this in perspective, if you look at the significant risk threshold used by OSHA, such as 1 in 1,000, or some of the statistics that have been put out by the DMV for highway fatalities in North America, you can see where the risk from exposure to RCF at 0.5 fibers per/cc is far less.

The bottom line, as a result of the risk assessment, is under the current conditions. The study found no elevated risk of fiber-related disease in the entire cohort.

With that, what is the health issue? We know that chronic exposures to ceramic fiber can produce cancer in test animals. We don't know the biological mechanisms that cause this. This is a big question. We also don't know how this relates when we expose animals to 400 times what the normal workers would see. We do know there is no evidence of fiber-related disease in the RCF manufacturers, both current and former workers that have been studied both here and in Europe.

What do we do from here? What is our management strategy? This is what the industry calls our 'Product Stewardship Program.' It is a system by

which we manage potential risk in light of the uncertainty in the science that currently exists. We want to control workplace concentrations and focus on driving our exposures down, minimizing the exposures. We want to promote proper handling practices.

Our exposure reduction goals are very simple. As mentioned earlier, there is currently no regulatory standard for refractory ceramic fibers in the United States. The Refractory Ceramic Fibers Coalition, with the goal of driving exposures down, have established recommended exposure guidelines and continually dropped our recommended exposure guidelines. In fact, cutting them in half twice, from 2 fibers per cc in the 1980s, to 1 fiber per cc in the 1990, to 0.5 fibers per cc as a recommended exposure guideline that was put out in 1997. It is equal to the lowest international regulatory standard in Europe.

Our recommended exposure guideline is based on prudence and feasibility, not significant risk. Our product stewardship program focuses on exposure reduction and risk management.

If we look at the mechanisms for exposure reduction, what we are really talking about is four-fold. It is worker communication and education programs; it is the development and evaluation of new and unique control technologies designed specifically for fiber control; it is the promotion of proper handling practices and process controls; and it is a promotion of the proper use of personal protective equipment where appropriate.

Worker and education communication is extremely important. As our friends in labor know, informed workers are better able to protect themselves against the hazards that they encounter every single day in the workplace. What the industry has done is develop a plethora of communication tools.

In addition to the standard warning labels and MSDSs, we have study results that have been summarized in a number of different ways—regulatory updates, best practice bulletins, newsletters, and preferred work methods. We have handling practices videos, which are often used as a part of the hazard communication training for the end-user

facility. We have worker and customer support, which includes industrial hygienists going to our customer and end-user facilities and conducting exposure monitoring, conducting employee training, and giving technical presentations to the engineers and the management of these facilities that use these products.

It includes industrial trade show presentations and presentations at technical conferences such as this.

The communications we put out are not only in English, but are in the languages of French and Spanish. Safe handling guidelines are used throughout the country and North America.

In addition to communications, we want to develop new engineering control technologies designed specifically for fiber. When you look at control technologies designed for spherical particulate, they do not always work as effective as we would like when you try to apply those to fiber control. We want to look specifically at point of generation dust collect techniques.

Water lance removal involves a technique by which you use a high-pressure, low-volume water knife to remove after-service fiber from a furnace wall, which reduces your airborne fiber emissions and resulting silica emissions (if there are crystalline silica some formations).

We look at specific hood designs developed to capture the fiber at the point of generation. And we look at filtration media, which is designed specifically to work with fiber as opposed spherical particulate. We have developed unit operational codes of practice designed specifically for this product and used in specific applications, that being the cutting of vacuum-formed material or the manipulation of furnace models.

We've also joined up and partnered with NIOSH to look at engineering control studies and evaluations so that we can develop and communicate new control technologies to the end-user population.

With regard to process controls, we want to focus on workplace design, in particular, minimizing your handling of the product. We want to look at product handling guidelines where we look at dust reduction techniques, specifically. Not only what do you need

to make, but how do we make it so as to reduce the amount of dust we product while we are handling the product.

We promote the use of hand tools, which reduces the amount of mechanical energy applied to the product, therefore reducing the amount of potential airborne fiber being generated, and last, but not least, we promote good housekeeping techniques, which means eliminating the air hose and using techniques such as HEPA vacuuming and wet sweeping to keep your fiber levels down in the workplace.

With regard to personal protective equipment, we try to help our customers and their employees understand the aspects of OSHA's respiratory protection standard, and try to help them implement a sound respiratory protection procedures of their own. Now the RCFC policy tries to go above and beyond the minimum requirements that OSHA set forth in that we recommend the use of a respirator when your exposures are unknown, whenever your exposure exceeds the recommended exposure guideline in addition to whatever is desired by the employer. As was mentioned earlier, the industry specifically recommends, if a respirator is required, to use a half-face respirator—not to use a disposable paper mask.

We have also established task-specific guidelines based on 6,000 time-weighted average exposure point measurements that we have gathered both in manufacturing and end-use populations where we can look at homogeneous exposure groups, communicate the overall exposure from those homogeneous exposure groups to the potentially exposed population so they have some idea of what exposures they would likely see.

If you look at the results of the efforts we've just been talking about, they are very clear. The customer-monitored the results as well as the manufacturing-monitored results are getting closer and closer. What that means is that we are successful at getting the best practices that we have developed and implemented internally, communicated out to the customers and end-users, so that they can apply the same technologies to reduce air exposures.

In summary, what do we know? We know that

chronic exposure to specifically prepared respirable RCF can produce a cancer in the animals—hamsters and rats—that we've tested.

Secondly, we know that the medical surveillance in North America and Europe has shown no instance of RCF or fiber-related disease, and in particular I'm talking about fibrosis, lung cancer, or mesothelioma in any of the manufacturing employees.

Third, we know that the potential risk is still there, and there still is some uncertainty. Yes, it is still prudent for us to promote the risk management techniques that we're talking about under the product stewardship program.

Last but not least, we know that it is responsible for us to continue to promote the risk management techniques that I've outlined through our product stewardship program well into the future.

To conclude, looking to the future, PSP 2000, what is this? This is the next generation of the agreement that the industry had with EPA to perform workplace monitoring, both internally and at our customer's facilities, and to continue to promote safe handling practices and the communication of these safe-handling practices to the end user.

The RCFC is working with OSHA, EPA, and NIOSH together to make this happen. We want to continue the international dialogue that we have been generating today, which mean communicating with Europe and understanding their results, and communicating with Australia and South America so that we put our heads together to develop these control techniques.

We want to maintain the positive relationship that we developed with regulators and continue to further foster that relationship into the future. We want to continue the mortality and morbidity studies that were initiated under the University of Cincinnati epidemiological investigation. We want to maintain a comprehensive communications programs, which includes a very comprehensive user/employee training outreach program. And last, but not least, we want to continue to support further scientific studies.

I would like to thank Ralph, our moderator, and the AIHce for giving us a chance to present. Thank you very much. ■

MODERATOR: Our next speaker is Steve Hacker from Solutia, who will be talking about some of the work that will be going on within the organic fiber industry.

HACKER: Thank you, Ralph. It is a pleasure to be here. I am going to deviate from the first three speakers. My title should be called 'Synthetic Organic Fiber Dust Sampling.' I am going to talk about something that the American Fibers Manufacturing Association (AFMA) has sponsored, of which Solutia, for whom I work, as well as a number of synthetic organic fiber manufacturers, have developed a synthetic fiber dust air sampling protocol. I'm a member of the Fiber Dust Working Group, which has toxicologists, industrial hygienists, epidemiologists, medical, product safety, and other disciplines on that particular working group.

There is no significant health concern (Slide 1). I am talking about synthetic organic fibers. To distinguish us from our vitreous friends, there is no significant health concern. As John mentioned, there are very little data. However, we do routine employee medical surveillance for a variety of reasons. We've done mortality studies and epidemiology studies. We have been working with many of these products for an excess of 50 years. We have

done risk assessments at our plants, and as good practicing industrial hygienists, you look at where your greatest concerns are. Based on what I've just told you, we do not feel we have a concern.

However, if you have been checking the literature recently, at some flocking operations where they have been using Nylon 66, there have been some valid employee health concerns. We are concerned about that. We want to make sure that synthetic organic fibers are not painted with that broad brush of 'fiber' so that is why we are taking a proactive approach to this.

There is no established exposure limit for synthetic organic fibers, except nuisance dust. There is no standard methodology for analyzing the workplace for synthetic organic fibers—again, except for nuisance dust.

What are the available options? We've got NIOSH 0500, which is total dust gravimetric. There is respirable dust, which is gravimetric, but just respirable particles. There is a NIOSH 7400, which is for asbestos-type fibers. That is a different fiber than synthetic organic fibers.

More issues related to sampling; what do we sample for (Slide 2)? Are we looking for dust, fibers, the lubricants, or finishes that might be on our fiber types?

There are method validation issues. How do we generate consistent organic synthetic fibers because of their low melt temperature and other issues related to fiber generation? How do we get even distribution across the filter cassette when we sample? We will talk about static electricity in a second.

Let's talk about sensitivity. We have done exposure assessments in our plants. We have looked at the total dust method, and we get very low results compared to the established exposure limit of 10 or

Background

- No significant health concern
 - No established exposure limit
 - except nuisance dust (NOC*)
 - No standard sampling methodology
 - Available options:
 - total dust (NIOSH 0500)
 - respirable dust (NIOSH 0600)
 - respirable fibers (NOISH 7400)
- * not otherwise classified

Slide 1

Issues Related to Sampling

- What do we sample for?
- Method validation issues
 - fiber generation
 - even distribution
- Sensitivity
- Definition of “respirable”
- Definition of a “fiber”

Slide 2

Fiber Generation

- DuPont challenged to generate consistent fiber concentrations
- Evaluate counting techniques
- Evaluate fiber counting
- Evaluate cowl washing

Slide 4

Issues (cont.)

- Counting methods
 - PCM
 - SEM
 - TEM
- Density of synthetic fibers compared to organic fibers
- Static electricity

Slide 3

15 milligrams per cubic meter. We use the asbestos protocol (NIOSH 7400), and we get nondetected or very low levels of respirable fibers as well.

From a sensitivity standpoint, if we do microscopy, do we look at scanning electron or do we look at polarized light (Slide 3)? What degree of sensitivity is required or needed? Again, consider the low melt point and the problems associated with the fiber melting on the microscope slide. What is the definition of respirable or inhalable? What is the effect of shape, density, length, diameter, and aspect ratio? What is the physical shape of a fiber? It is not like asbestos. Synthetic organic fibers are typically curly. What we found is that it is more of a function of how we cut it. There is a shearing or tearing action that causes the respirable fibers.

Some other issues include counting methods,

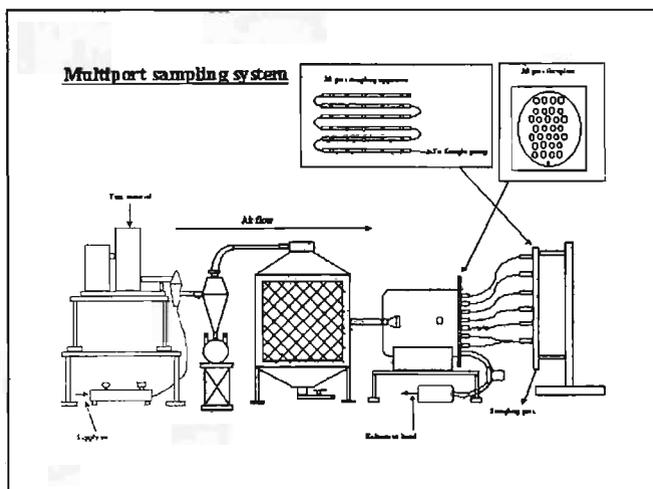
curly/straight, and density. As you probably know, synthetic organic fibers are much less dense than mineral fibers, so that causes us some problems. Synthetic organic fibers have a tendency to pick up moisture, so they are hygroscopic.

We wanted to take a proactive approach, so we challenged DuPont to generate consistent fibers (Slide 4). Because of some Nylon 66 issues and their experience with polyaramide, they were able to finally do that but not without much delay and a lot of work. But they were able to generate consistent fiber concentrations, and I will show you some equipment that they used for that.

We asked them to evaluate counting techniques (which one we should use); evaluate fiber counting; and evaluate the cowl washing because of the static electricity concern.

This is the system they use to generate polyaramide (Slide 5). What we have is a multiport sampling system. The fibers are generated in here and they go through cyclones to concentrate the respirable fibers. Then they go across this membrane. There are 30 sampling ports across here where they've taken 30 filters and collected the fibers. Then they've done round-robin sampling counting to verify counting techniques and consistency.

The purpose for doing this particular study was to make sure that we could generate the fibers and, secondly, to determine if the concentration across that filter plate was uniform such that when we get to do toxicological testing on animals, we know



Slide 5

Methods

- Atmospheres of p-Aramid RFP were generated in an inhalation chamber
- 30 filters (15 PC and 15 MCE) were exposed to p-Aramid aerosol for 5 minutes at estimated concentrations of 20-30 fibers/cc

Slide 7

Round-Robin Counting

- Compare aerosolized organic fiber counts from three labs and four different counters using light microscopy methods
- Same slide for all labs and counters

Slide 6

Methods (cont.)

- Methyl cellulose filters were used for PCOM counting
- Prepared slides were first counted at Haskell Lab, then sent to Denkendorf (Germany), and finally to IOM (Scotland)
- For quantification, the NIOSH 7400 method was used at Haskell, while the WHO/EURO MMF method was used in Europe

Slide 8

they would all get the same dose. You just have to trust me on their data. I don't have them with me.

The next thing we did was to make sure the DuPont lab was counting total fibers as well as other accredited labs (Slide 6). We did round-robin counting, like a proficiency analytical testing (PAT) sample where you send a sample around to different laboratories and you give them the same slide. We did three labs and we had four different counters to evaluate the data.

They generated atmospheres of polyarimide (Slide 7). They used 30 filters in the apparatus that I showed you; 15 were polycarbonate filters and 15 were methylcellulose acetate filters. They were exposed for 5 minutes of what we thought was a concentration of 20 to 30 fibers per cc.

We used methylcellulose acetate filters for

PCOM counting (Slide 8). For fiber counts, we used the NIOSH 7400 method. Since DuPont is worldwide (and many of our organizations are worldwide), we also sent them both to Germany as well as Ireland for counting.

One lab had consistently lower counts when compared to another lab (Slide 9). In other words, the mean value for the 15 filters was about 18.4, plus or minus 4.3, versus 27.7. At DuPont, two counters were used, and they were somewhere in between the other two labs. We felt fairly comfortable that statistically we—or the DuPont lab—were counting satisfactorily.

The differences in fiber count may be due to variability among the counters. There is a slight difference in definition of what is defined as a fiber (Slide 10).

Results

- One laboratory had consistently lower counts when compared to another lab (mean values for the 15 filters = 18.4 ± 4.3 fibers/cc vs. 27.7 ± 4.3 fibers/cc)
- The third lab, with 2 different counters was intermediate between the lower and higher counts (i.e., 24.2 ± 1.1 fibers/cc and 22.1 ± 2.2 fibers/cc)

Slide 9

Electrostatic Electricity/ Cowl Washing

- Hypothesis is that aerosolized synthetic organic fibers will adhere to the cowl wall during collection
- Tested p-Aramid (high affinity to charge) and cellulose (low)

Slide 11

Conclusions

- The differences in fiber counts may be related to the variability among counters or to the slight differences in counting rules between the US and European methods
- The intralaboratory variability between counts was lower than the interlaboratory variability in fiber counts.

Slide 10

Test Method

- Challenge filter
- Count filter normally (filter # 1)
- Use fresh filter (filter # 2), wash cowl with deionized water, redistribute, and recount
- Determine significance of washed count when compared and added to initial count

Slide 12

The intralaboratory variability was lower than the interlaboratory, which kind of makes sense. We felt comfortable that our fiber counts that DuPont provided were fine.

The next concern we addressed was the potential for synthetic organic fibers to develop an electrostatic charge during collects (Slide 11). This may cause the fiber to adhere to the cowl walls. One of our member companies had done some preliminary work in employee exposure in the workplace and determined that because of static electricity, instead of it making a uniform fiber count across the entire fiber, it was adhering to the cowl wall. So the hypothesis was that the fibers were going to stick to the cowl wall. What do we do about that? Again, we went back to DuPont and they tested polyaramide, which has a high affinity to static electricity build

up, and cellulose, which is the low one. So we took fibers at both ends of the electromagnetic spectrum.

We challenged the filter (Slide 12). We counted the filter normally, which we call filter 1. We then used a fresh filter, washed the cowl down with deionized water, redistributed, and recounted. The process was to determine the difference when we compare those. Polyaramide has a higher affinity to static build up.

The results, as you can see, are pretty similar (Slide 13). In fact, it was almost the reverse or what we expected. We expected the polyaramide to have an increase in fiber counts because of its affinity to static electricity.

Another reason we did this is because we were involved with people at the Brauhafer Institute in Germany, they determined that due to static elec-

Cowl Washing Results

	Fiber Counts (fibers/cc)	
	Control	Cowl wash
p-Aramid	41.4 ± 3.7	39.5 ± 5.7
Cellulose	23.3 ± 2.7	24.7 ± 1.5

Slide 13

Air-Sample Strategy

- Characterize exposure in workplace
 - total dust
 - respirable fibers
 - personal
 - area
- Task and time-weighted average
- NIOSH 0500—total dust

Slide 15

Cowl Washing Conclusions

- F1 ~ F1+F2
- No significant differences
- Still gathering data in actual workplaces
- One company—15 Nylon 66 cassettes. Of 15 samples, only 1 with detection limit of 5 fibers/mm². Remainder were below detection limit

Slide 14

Air-Sample Strategy (cont.)

- Respirable fibers
 - Modified NIOSH 7400
 - “A” counting rules (modified)
 - Diameter < 3 µm (WHO fiber definition)
- Field validation (cowl washdown)
- Accredited lab

Slide 16

tricity concerns, we needed to look at gold impregnated filters with aluminum cowls with static discharge lines. And the experts in Germany did a lot of work. They determined that SEM and TEM were the only way to go. Fortunately, we did not come up with those same results. Because the gold filter itself was about \$150 per filter, and I can't see many companies doing a lot of work with filters that are that expensive, unless it is justified, and we couldn't justify it.

The conclusions were that the filter, unwashed, was about the same as the filter that was washed added to the filter that wasn't washed (Slide 14). There was no significant difference. We are still gathering data. Because we are in the process of validating our method, Solutia has tested 15 Nylon 66 filter cassettes. Of the 15 samples, there was

only one filter that resulted in the detection limit of fibers per millimeter squared to be added. That one result was not statistically significant. We feel fairly comfortable. All the data from our member companies has not been distributed yet, but we will take a look at that when it comes in. I suspect we are not going to require cowl washing because it just doesn't seem to be justified.

So now as industrial hygienists, what do we want to do about evaluating employee exposure (Slide 15 and 16). We've developed an air sampling protocol, if you will, or a strategy, for synthetic organic fiber. I made about 50 copies of that. They are on the table in the back if anybody wants one. If you have questions, let me or any of the authors know.

We were going to characterize exposure in the workplace. Again, we don't think it is high. We are

Fiber Types

- Nylon
- Polyester
- Acrylic
- Polyethylene
- Cellulose acetate
- PBI
- Lycra
- Polyaramid
- Rayon
- Tencel

Slide 17

going to look at total dust and respirable fibers. We're going to look at personnel samples as well as area. We're going to do task samples and time-weighted averages. We're going to evaluate two different ways. We're going to look at total dust using the NIOSH 0500, as well as a modified NIOSH 7400. As you know, for the 7400, there are A-counting rules and B-counting rules. The A-counting rules are for asbestos; the B-counting rules are for other man-made fibers, such as fiberglass.

Due to the density concerns of synthetic organic fibers, we're not going to count anything greater than three microns in diameter. That is consistent with what our toxicologist tells us happens within the lungs of humans and laboratory animals for synthetic organic fibers, and it is consistent with the World Health Organization's definition of a fiber.

We're looking at the cowl wash down. The concern here is that DuPont had done polyaramide and one other fiber that was on the ends of the spectrum. But we thought perhaps because the concentrations of the initial fiber was so high, that it was skewing our results. We're going to look at that in the field as well. We did something with Nylon 66 and it was insignificant. If we're using standard methodology, the NIOSH 0500 and the 7400, we can go to any accredited lab and they fully understand what kind of technique to do on your analytical work.

The different fiber types that our member companies will be looking at are listed on Slide 17. We are collecting those data even as we speak.

Acrylic Manufacturing Area Full-Shift Samples

<u># samples</u>	<u># Range</u>	<u>Geo. Mean</u>	<u>Units</u>
38	< 0.05 - 0.43	0.08	mg/m ³
35	< 0.002 - 0.006	0.003	fibers/cc

Slide 18

Nylon 6,6 Manufacturing

<u># samples</u>	<u>Type</u>	<u>Range</u>	<u>Geo. Mean</u>	<u>Units</u>
12	P TWA	0.04 - 0.63	0.12	mg/m ³
13	P TWA	0.003 - 0.060	0.008	fibers/cc
15	P JT	0.11 - 4.3	0.48	mg/m ³
9	P JT	0.01 - 1.30	0.032	fibers/cc

Slide 19

The data that I have submitted to AFMA are unpublished to date (Slide 18). At one of our acrylic manufacturing facilities, we did some area full-shift samples. We did 38 samples for total dust using the NIOSH 0500. We got a range of less than 0.04 to 0.43 mg/m³, with a geometric mean of 0.08. Again, that is total dust, milligrams per cubic meter. Anything that is in the atmosphere, we're going to pull through that filter and measure.

We did 35 samples for counting—area full shift with a range of 0.002 to 0.006 respirable fibers per cc. We feel confident that we don't have a significant problem in acrylic manufacturing.

At our Nylon 66 manufacturing and handling facility, we sampled all three different locations (Slide 19). The PTWA stands for personal time-weighted average. We took 12 time-weighted aver-

ages—milligram per cubic meter. We had 0.12 for geometric mean in fibers per cc, 0.008; job tasks (which you would assume give you higher exposure) did, in fact; the geometric mean for the job tasks were 0.48, and for the respirable fibers 0.032. Those were determined using the NIOSH 7400 A-modified rules, so we excluded anything that was greater than three microns in diameter.

The conclusions are consistent fibers can be generated for sample validation and animal testing (Slide 20). It is not easy. To give you a little bit more information, DuPont was hoping to generate 80 to 100 fibers per cc Nylon 66 so that we could test the laboratory animals. They have done heroic efforts to try to generate that. We can only get up to about 25 fibers per cc. We feel comfortable that would be adequate because it is several orders of magnitude below what we're seeing in the workplace.

The NIOSH 7400 method for fiber counting is valid. It doesn't appear, at least on the preliminary data that we have, that cowl washing is required. Exposure results, at least in manufacturing facilities, are very low. In the next steps, we are going to summarize the data of all of our manufacturers and

Conclusions

- Consistent fibers can be generated
- Modified NIOSH 7400 method for fiber counting is valid
- Cowl washing not required
- Exposure results quite low
- Summarize data of manufacturers
- Next steps—animal testing
- Gather customer exposure data

Slide 20

do animal testing. Then we're going to ask our customers to evaluate their workplace exposures and gather and summarize data for that as well.

I would like to thank American Fibers Manufacturing Association for funding and helping me. I learned a tremendous amount by being on the fiber-dust working group. I want to thank DuPont for all of their efforts and the co-authors.

Thank you. ■

MODERATOR: Our next speakers are Tom Calzavara from Johns Manville and Angus Crane from NAIMA, talking about health and safety program initiatives with OSHA.

CALZAVARA: Good afternoon. I have the distinguished pleasure this afternoon to have Angus Crane sitting with me. Angus is the senior vice president and general counsel for the North American Insulation Manufacturers Association (NAIMA). Angus was the champion within our industry who moved forward so that what we have now is a health and safety partnership program.

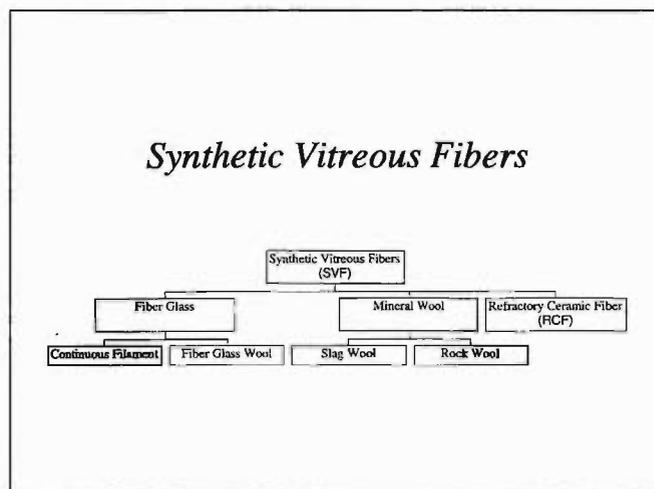
This presentation covers a couple of areas: the health and safety partnership program and what is occurring in European Union with regard to the issue that Bill Kojola talked about regarding bio-solubility.

If we look at this presentation, it has three major wins. It deals with worker protection, number one. Two, it saves OSHA's valuable resources. And, three, it was the first time a cooperative agreement was reached to remove a substance from OSHA's Priority Planning Process.

In 1995, OSHA came out with the priority planning process. There were a number of chemicals that OSHA wanted to take action on. Angus has the details on that.

CRANE: There were 18 chemical substances. There were issues that were not necessarily substances of chemicals. In that document, OSHA indicated that they wanted to take formal rulemaking action on 5 of those issues and the remaining 13 would be available for voluntary rulemaking or agreement.

It is important to recognize that OSHA specifically stated that what they were looking for was a cooperative or voluntary agreement. Synthetic mineral fibers, which are what our products were called in that particular document, were designated as 1 of the 13. NAIMA and its member companies approached OSHA and indicated that we were



Slide 1

interested in moving forward with a voluntary agreement.

CALZAVARA: Synthetic vitreous fibers, as Dean says, covers three major groups (Slide 1). You have fiberglass, mineral wools, which are made up of rock and slag wool, and refractory ceramic fibers. NAIMA represents 95 percent of the fiberglass manufacturers here in the United States and 100 percent of mineral wool manufacturers. When I refer to SVF during this presentation, it relates to fiberglass wools; the slag wool and rock wool. As you heard from Dean, they already had a product stewardship program that they were working with the EPA on (earlier today).

In 1996, Angus sat down and took a look at what OSHA did with regard to the priority planning process. He thought this was an opportunity that this industry has been pushing for. A lot of the companies that are involved with NAIMA had product stewardship programs. What Angus did was he sat down and put together a diverse work group to see if we could come up with some kind of general plan for the entire industry.

Angus, could you give us some background on that?

CRANE: The objective was to create a worker practice program that would effectively protect workers and essentially satisfy OSHA. We wanted the work practices and program to be pragmatic and practical. In order to achieve that, we invited people with business backgrounds to keep us practical. We invited the industrial hygienists from various different companies to make certain we were providing an effective program that would protect workers. We had all sorts of lawyers to make certain that we drafted this properly and had what we wanted. We also hired a consultant, Dr. Dan Boyd, who was formerly OSHA's director of health standards. He was able to get us in with OSHA and explain to them what we wanted to do. We also retained outside counsel, Kirkland and Ellis, in order to help us. They also had an existing relationship with OSHA. That was our team.

CALZAVARA: Once we had the team assembled, we started collecting codes of practice that were being applied throughout the world. Dr. Tony Well in Canada wrote one. We also went to each one of the manufacturers because they put together their own work practice documents. We used the material safety data sheets from a number of companies. We boiled it down into a set of work practices. Once we had our straw man, we went out and started talking to the people who fabricate products out of glass insulation; those who cut pieces that will be used in cubicles and duct lining (those kinds of customers). We also started talking to the association of installers. These folks install all types of different products. It could be installation or cellulose installation or foam products.

What we wanted to do was make sure that we had the input from the manufacturers and users as the straw man was being put together. We talked to labor because we had organized labor in our own facilities and we wanted to show them what we were moving forward with and have their input. At that time, we could consolidate something into a product that we were able to introduce to OSHA.

We had a number of meetings with OSHA. Dr. Adam Finkel who was OSHA's champion, and on

Health & Safety Partnership Program

“OSHA does not, at this time, consider SVF a regulatory priority.”

Charles Jeffress

Slide 2

the employer side we had Angus. After a couple of years of negotiation, we came up with an agreement that everybody (e.g., manufacturers, fabricators, and installers) finally signed with the assistant secretary of labor, Charles Jeffress, on May 18, 1999, prior to last year's conference.

At this point, labor was in support of what we were doing, but did not formally support the document. Angus, do you have any comments?

CRANE: Yes, if I could just speak a moment. We went out and made several different presentations to the AFL-CIO, GNP, and some of the smaller union groups that were specifically affiliated with local companies. They listened to us and provided us some feedback, but when it came to actually endorsing or supporting it, they indicated that they wanted to remain neutral for a variety of reasons.

CALZAVARA: The health, safety, and partnership program (HSPP) has a number of key points (Slide 2). The first one establishes a better, more stringent permissible exposure limit (PEL). It requires respiratory protection for specific jobs regardless of what that exposure would be.

You're looking at training, lots of training—diverse training throughout the United States in train-the-trainer programs. We are looking at talking to employers so that they can train their workers. It also requires us to report back to OSHA annually. Angus, we just did that?

CRANE: Yes. We signed the agreement on May 18, 1999. On the one-year anniversary, we filed our first annual report. The idea of an annual report

was first suggested by the industry because there was obvious concern on the part of OSHA that we would just come to an agreement and then disappear. We wanted to assure them that we would not only do what we were committed to but that we would let them know when it was done. We have an obligation under the health and safety partnership program for the next 8 years—with 3 years of implementation and preparation and 5 years of full compliance. Each of those years, we have to file a report with OSHA that essentially updates and provides a report on what we have done.

This was a first annual report that we submitted to OSHA. We were very pleased to submit this because not only did we successfully meet all of the commitments and goals that we had established for that first year, but we had exceeded most of our goals and gave OSHA a clear indication that we were in earnest about this program.

CALZAVARA: In addition to some of the other key points, if you would use Johns Manville's material safety data sheets or Owens Corning's MSDs, you might have different types of health and safety phrases for essentially the same products. Installers use a number of different manufacturers products for the same standard types of products. One of the main reasons for going ahead and using the best industry practices is to consolidate—standardizing phrases making it easier for users to comply.

In addition to that, synthetic vitreous fibers, or SVF, are no longer an OSHA priority. This was the first time through a cooperative agreement that a substance was removed from OSHA's priority planning process without a formal rule making. This is very significant.

CRANE: Tom, if I could just point out that the quote you have on your slide is from Charles Jeffress and the letter that he presented NAIMA on May 18, 1999 (Slide 2).

CALZAVARA: Here is the part that gets exciting for industrial hygienists: exposure characterization. I talked about a more stringent PEL. Up until 1999, the synthetic vitreous fibers were regulated as nuisance dust; 15 milligrams cubic meter for total dust; 5 for respirable. Now we have better indices of exposure of 1 fiber per cc.

CRANE: I think it is important to note that one of OSHA's main goals with regard to synthetic mineral fibers was to establish a permissible exposure level, and so they achieved that goal when we did this voluntary agreement.

CALZAVARA: Thanks, Angus. In addition to setting a PEL, the industry will sit down and characterize all of the occupational exposure data that they have been accumulating for the past 10 years. A number of NAIMA companies, because they have product stewardship programs in place, have this data sitting in their files. But under the Health and Safety Partnership Program, there is now an effort to pull all of that data together in one place. At this point in time, the industry has greater than 4,000 samples that have been collected from 1990 to the year 2000 being formulated into a single database. This database will reside at Arizona State University who will also act as its independent auditor.

In addition to that, once we hit the year 2002 and up to the year 2007, the industry is committed to collecting 400 samples per year, which will be divided up by industry segment. The things that we are looking for here are areas that we don't have data on already, such as repair and maintenance, and any new products being introduced into the marketplace. Thirdly, where we have historically low exposure data that shows air concentrations to be in control, that they stay that way.

CALZAVARA: There are four jobs that require respiratory protection regardless of exposure. They are blowing wool into attics, blowing sidewalls, pouring and dumping unbonded products without local exhaust ventilation, and removal (which would include significant repair and/or demolition). These are cases where, if you look at the data, historically you can see exposures greater than 1 fiber/cc. I've been up in attics collecting samples on workers and this slide is a very clean shot; however, I've been up in some attics where you have to crawl around on your stomachs to change the sampling filters. I've also been in attics where there have been 18-foot-high ceilings and where airborne levels are very low. But you don't know what conditions a blowing wool installer will be in, so these are prudent recommendations. The same thing applies

with removal. We just don't have the data on this type of operation. If someone doesn't wet down the material and they just start ripping it off, who knows what the airborne level will be? It is prudent to wear a disposable respirator when removing large sections of insulation.

There are some general requirements in the HSPP, so when you exceed 1 fiber/cc (in a manufacturing setting or as a fabricator), you can apply engineering controls. But the construction worker on the site might not have that option. What is recommended for these cases is basic work clothing where installers wear long sleeves and pants, gloves (cotton or leather), safety glasses, a head covering or hat if you're working overhead, and a reusable or disposable respirator with a filtration rating of N95 or better.

We also have some other general requirements as manufacturers that we might have control over, and we do have control over the products packaged and how it goes into the marketplace. How many of you have bought insulation at a Home Depot or Hugh M. Woods? A number of you? What happens when you take the bundle of insulation and cut it open? What happens? Boom it opens up. The fiber glass insulation expands seven times more than the package itself. So we're looking at ways that when you open up the product or how you open it up, you don't get hit in the face with a bunch of dust.

Others areas that we looked at include tools that generate the least amount of dust. Fiberglass is very easy to cut. You really don't need to use power tools. A knife is sufficient, and that really reduces an installer's exposure. However, if power tools are going to be used, they need to have local exhaust ventilation associated with it.

The industry recommends that compressed air should not be used when working with these materials. If you've been using compressed for clean up, you should have air monitoring data to demonstrate what those levels are, and also make sure the people performing the work are wearing the appropriate personal protective equipment to do the job. Also, make sure that the area is roped off because irritation is a major problem for people working around the area where this is occurring.

First aid recommendations are also made. I get

Specific Work Practices

- Blown SVF in attics
- Cavity fill insulation
- Batt, blanket & roll
- Pipe, board & other
- Ceiling tiles
- Spray applied fireproofing
- Bulk unbonded products
- SVF product removal

Slide 3

calls all the time about skin irritation. I happen to be the 24-hour/7-days-a-week person who answers all the emergency response calls for my company. In February, I always get calls for bloody noses because of the low humidity in the air, and the fibers can irritate the nose and cause nosebleeds when the air is dry. I've been doing this for 7 years. It is typical that every February I will get a few calls. What do you think happens the first part of the summer? I get skin irritation calls. Most people get used to working with the fibers and their skin gets tough and after awhile it doesn't bother them.

If you listen to the workers, they work with the stuff day in and day out and they have the best advice in the world. They say, 'when they get slivers in their skin, to take them out—if you try to pull it out with tweezers, it will break. The best way to pull it out is with cellophane tape. Lay the tape over the sliver, and slide it right out.'

We also have an area that requires specific work practices (Slide 3). I'm not going to go into details on those specific work practices, but there are eight jobs. Angus, there is information that they can get on these specific jobs, right?

CRANE: Yes, we have the actual work practices on our websites, so you can actually download them. You can also order the commercially printed one. They are free of charge and we ship them freely. Downloading them is the quickest.

CALZAVARA: So what I would like to do right now is wrap up this portion of looking at worker

safety, and the control an industrial hygienist has in the workplace. This is the HSPP wrap up.

We (OSHA, NAIMA, NIA, and ICAA) are significantly improving worker safety with this program. We heard today that regulatory action is unlikely because the processes to have formal mandates are going to take forever. This is a way (voluntary process) to have significant impact on worker protection right away. This agreement leveraged OSHA's resources, and for the SVF industry, this is the first time that a stigma associated with these fibers has been lessened here in the United States.

We are also looking at the affirmation of an exposure limit of 1 fiber/cc, which some companies have been recommending since 1985. Also, affirming standard work practices and respirators. To me, this area of product stewardship is what I would call—if you get into a car—the seatbelt. What I would like to talk about now deals with what I would call the air bag—the extra level of safety added to glass fibers.

This portion of the presentation deals with what occurred in 1997 and 1998 over in Europe. They have been looking at the science (epidemiology and toxicology) for a number of years now, and there are a series of regulations that have come out that classifies SVFs differently. They have established a number of studies, which exonerate glass fibers from being classified as a possible carcinogen, and they are all animal studies.

The EU has four types of studies: chronic inhalation, injection (where they inject the fibers into an animal's stomach), intratracheal (where they inject fibers into the throat) and, lastly, short-term inhalation. The health endpoints for long-term studies are fibrosis, lung cancer, or mesotheliomas.

The shorter-term studies are designed to evaluate fibers that dissipate very quickly from the animals lung, which have set time and concentration limits. To pass a short-term inhalation study, half the fibers must be gone within 10 days. Or, if you inject the fibers into an animal's throat, half the fibers have to leave within 40 days. If you have a historical fiber (or if you change your fibers chemistry today) and you pass anyone of these tests, that fiber is no

longer considered a possible cancer hazards within the European Union. Germany has its own set of tests, similar to the European Union's, which require specific work practices. Also, Australia and New Zealand have adopted the same EU protocols, so now there are 17 industrialized nations affirming the significance of biosolubility.

What you are looking at now, which is absolutely fantastic, is that SVF manufacturers can develop new products and fibers that will go out into the marketplace that are biosoluble. There are now science-based regulations out there where manufacturers of these fibers can use short-term tests (no longer requiring a 2-year chronic study) to understand how safe their fiber is—tests that are approved by the European Community, Australia, and New Zealand. That's significant. That is an added level of safety on top of following the permissible exposure limit.

What the SVF industry is looking at is improving worker health. A 1 fiber/cc exposure limit has been set and is out there; we have work practices and we have training. And there are a number of other work practices—not just here in the United States, which is a voluntary one. You have a voluntary program in Canada also. Bill talked about the International Labor Organization. They did finalize their Code of Practice in March, and I was very fortunate enough to be on the committee that wrote the document representing the employers.

When we see these types of programs in place—the seatbelt is there. In the United States, we need to start discussing what has already been discussed and agreed upon in Europe, and that is in regards to biopersistence or biosolubility. We need to see if we can either adopt their processes right now—so we (US and Canada) can have some harmonization with the rest of the world—or maybe we need to develop our own series of tests? I think that is where the future is right now. I think we have the seatbelt in place—let's keep exposure levels below 1 fiber/cc, let's get out there and communicate this, let's get out and evaluate these workplaces, and then let's let the toxicologists and the epidemiologists push the other end of the envelope concerning biosolubility. With that, we are finished. Thank you. ■

FINKEL: Thank you, Tom. Thank you, Angus. The timing for this is propitious because Charles Jeffress and I just heard last Thursday the presentation from NAIMA, their first annual progress report, as a year has now passed since the signing of the HSPP.

I will talk briefly about the rationale for entertaining this overture from the industry several years ago and give some reactions to their presentation. Unfortunately, it won't be responses to what Tom just said, which I didn't hear all of.

When Angus and several other people approached me several years ago, the calculus in my own mind was not as well developed as it is now with hindsight. Initially, as persons working on occupational health standards and dealing with chronic issues of underfunding and lack of personnel and all those things that we are not supposed to complain about in government, it appeared to be a question of whether we could broaden our ability to get worker-protective measures in place while conserving the very scarce resources we have to write rules. Again, the number of people and the budget for doing that were decreasing, and the hurdles that Congress and Office of Management and Budget (OMB) and the courts were putting in our way to get to the finish line were only increasing during that time.

At the outset, my hope was that this kind of a nonregulatory product stewardship program might end up trading one thing for another. Trading, on the plus side, speed of outcome, conservation of our resources and increased cooperation, and trading that off of the stringency and the magnitude of the worker-protection benefits at the far end. We were looking at the wisdom of swallowing hard and saying, 'the reality is maybe we ought to be receptive to this overture because we can get something at the far end, and the something we would have gotten through rulemaking was by no means a certainty, and something that those of us at OSHA might not have lived to have seen, given the pace of rulemaking and the changes in our congressional oversight.'

Frankly, it was also a matter of asking myself, 'What would a typical OSHA regulation for SVF look like?' Certainly the model we would have used would have been the substance-specific rulemaking (such as to ones OSHA promulgated for lead, benzene, asbestos, etc.) with an exposure limit, work practices, medical monitoring, recordkeeping, and so forth.

In these debates, people always tend to focus on the numbers, the bottom line and certainly OSHA could have. And as I will say later, we still can look at exposure limits below one fiber per cc. But the question strategically is always how hard can the risk assessor push the envelope given the uncertainties in the science and the realities of the rulemaking process? Could we have come out of that with a limit lower than one fiber? That is a function of not only uncertain changes in the external environment with Congress and OMB and the courts, but also internal agency issues about the ability, perseverance, and creativity of the staff persons involved to push through an ambitious science-based rule that would be subject to a great deal of scrutiny by myself, by the assistance secretary, and by and various other parts of the Executive Branch and Congress.

But as the discussions proceeded, I confess I had a minor epiphany and began to see an opportunity for not only achieving some worker protection faster and more consensually than we could have through rulemaking, but actually achieve greater and more secure protections than any foreseeable rule could have. As I talked to my colleagues at EPA who have had much more experience than we at OSHA dealing with the concept of product stewardship, I began to realize that if all went well (and I think it is too early to say whether all will go well), we could come out with something that not only was quicker and more certain an outcome than rulemaking, but would have features that would provide more worker protection than rulemaking ever could. That came as somewhat of a revelation to me. Maybe I will be proved wrong about this, but it seems to me that the structure of this type of agreement holds the promise for surpassing the regulatory regime in a number of key ways.

Basically, what I have come to hope—if not yet to believe—is that the hypothetical OSHA standard on fiberglass that would have set an exposure limit and done a lot of other things, might have looked very good on paper. But then the question would be: ‘What would this do to the tens of thousands of small companies whose behavior had to change in order for that limit to be met?’

One thing for sure, under that scenario of a regulatory approach, they would not have had any hope of benefiting from the financial and other resources of the prosperous companies who make the products in the first place. They would have been cast adrift to the tender mercies of OSHA to lower their limits and change their behavior. The open question would be to what extent these tens of thousands of firms would be willing to do that, and to what extent OSHA would be willing or able with its constrained enforcement resources to go out and see to it that would actually happen.

In my mind, that is the way to judge, from a worker-protection point of view, whether this is a bad deal for the workers or not. It is not against some hypothetical stringent OSHA standard that would be enforced with the full power of a massive agency (and an agency experienced at and committed to collecting data to ensure the success of the risk reductions it sought), but a real on-the-ground standard that would have to trigger significant behavioral change in a fairly recalcitrant segment of industry. (I’m talking about the contractors, who I will get to in a minute.)

The key about the HSPP is that it puts, if not all the responsibility, a significant portion of the responsibility where it belongs, which is with the companies (with all of their financial resources) who start this product chain in the first place. These companies would not have had any significant work to do under any conceivable OSHA rulemaking, as the exposure to their own employees are well below any limit we might have set.

I apologize for not having heard all the previous presentations, but I will briefly reiterate that in my mind, the most salient features of the HSPP are the exposure level (1 fiber/cc) and some of the language implementing to that level. There is a provision that

you could call the ‘no backsliding’ provision, trying to assure that wherever levels have gone below 1 fiber/cc, all efforts will be made to see that whatever it is about the job or the controls that are keeping exposures low will be maintained so that exposures don’t float back upward toward this new limit.

We are also very pleased that there is language in the HSPP that says wherever it is readily possible to continuously improve and go well below 1 fiber/cc, that it is the prudent responsibility of the producers and customers to do so. That is the kind of language that would not be a part of an OSHA rule, this continuous improvement exhortation.

Respiratory protection is a key part of the HSPP. I did hear that portion of the previous talk, and I think it is very important to get people who work with loose-fill insulation and who do demolition and removal work to wear well-fitting N-95 or better respirators. I’m not sure Tom mentioned that as part of the agreement, the respirator usage will be classified as ‘employer required’ under our respirator standard. This is a term of art, and it means that the full force of 1910.1349 (OSHA respiratory protection standard) kicks in and any employer who provides respirator under this program has to comply with all of the provisions of the fit testing and monitoring, medical exams, and other aspects of that standard.

A key portion of the negotiations involved probably the single most prevalent job category, which is installation of batt insulation. Right now, that is not under the rubric of automatically required respiratory protection. It depends on the exposure level. My hope is that as part of the extensive industrial hygiene work that NAIMA has agreed to do, if it turns out that exposures in that job category are anywhere near 1 fiber/cc and I’m still around, we will revisit that and talk to NAIMA about the need to get that extra factor of 5 or 10 of protection, if those workers are continuously exposed to levels in the 0.5 fiber/cc range. That would be the prudent and appropriate thing to do given the ease with which these respirators can be purchased and fit.

Tom already talked about exposure assessment. My hope is that NAIMA will push the envelope in terms of making that databases truly useful because

many other similar databases are not useful for actually helping OSHA (and anybody else who wishes to look at the data) to figure out what works and what doesn't. We have been involved in some other projects where companies have collected data, and they tend to emphasize the bottom line of how many samples, but they also tend to come in and make presentations that emphasize fairly useless, I must say, measures of aggregate exposure. We get these very nice graphs that say, 'The average level across all job categories went down from 28 to 27 last year,' and there is no effort to say, 'Where are exposures higher than they should be? What are the controls that are or are not in place when those measurements are taken? What are the work practices being used? What is the job category broken down to a really comprehensible fine level of disaggregation?'

That is why we are going to keep pressing NAIMA over the next 5 years to create a database that will allow us to figure out the reason these levels have gone down in these specific settings with these specific companies (that won't be identified by name, but will be identified by some identifier so we will know longitudinally who they are). We want to know if their levels are going down, what works, what can be disseminated to other companies to replicate that success, and if their levels are not going down—or God forbid, going up—we need to know what is wrong and what needs to be fixed?

We were impressed in last week's NAIMA presentation by the effort already paid in the training and outreach area. We're about to have Mr. Jeffress appear in the epilogue to the free video NAIMA is putting out.

At this point, I should wrap up by talking about what is next and my hopes and apprehensions about the implementation of this agreement. First of all, I should say it was very interesting how much emotion and psychodrama played out in this set of discussions over a long period of time. If anybody outside of this community cared about it, I think it would make a good magazine article. The distrust and strong emotions were on all sides, but not just between industry and OSHA, but also between both

sets of industry players—the manufacturers and customers. The distrust and ill between the customers and manufacturers dates back to decades ago about asbestos—just as there was distrust and feelings that had to be worked through within OSHA and within Health Standards. All these things prolonged these discussions, but probably made them more fruitful.

Where are we now after 1 year of very early—we can't even call it implementation—groundwork that has to be done over the next few years? The main sticking point right now, frankly, are the customers. NAIMA presented to us an annual report with a lot of articles from the trade press and the various insider magazines about this. The ones written by members of the ICAA, the Insulation Contractors Association of America, are not very promising. That association signed their own version of the HSPP, chose not to appear at the ceremony marking the event last year, and I'm somewhat skeptical as to whether they are capable of being brought around. NAIMA has their work cut out for them to get this particular association—as contrasted to the National Insulators Association (NIA), the people who do more of the commercial work and who seem to be more forward thinking and less politicized than the ICAA is—to work. Without their cooperation, this is not going to work. Frankly, we will be back in regulatory mode.

The lack of union participation is another sticking point. I've missed Bill's presentation too, is that correct? Do you get a chance to rebut what I am saying? Feel free. We didn't have the kind of participation we wanted. From my personal end, that was not through lack of overtures made, but overtures rebuffed. Bill probably has another view of that and I don't mean to try to get the last word on that by any means.

Tom talked about biosolubility. We are not as sanguine about that science as the industry is, obviously. We are interested in it and reviewing what it has to say. We certainly don't want to discourage companies in any way from pursuing avenues that they believe can lead to inherently safer products. I haven't heard any suggestion from NAIMA that the more soluble fibers ought to have any kind of

relaxed exposure limits. I think the issue really is whether the limits for the less soluble fibers should continue to be pushed down below 0.5 fiber/cc or even 0.1 fiber/cc. Whereas for the more soluble fibers (if the research really does hold up), perhaps there won't be as much need to push exposures below 1 fiber/cc. I think the virtue of the HSPP will be to show, among other things, that 1 fiber/cc is a readily achievable level in virtually all settings. And given that fact, I don't see any reason for abandoning any of the measures that get people to 1 fiber/cc just because the bioengineering of the product may make it less persistent in the body.

The bottom line is that we have several years to let this play out. We are pleased, from an enforcement end, that the agreement the manufacturers and installers put forward has some fairly unique language in that it recognizes OSHA's authority to enforce the provisions of the agreement under its general duty authority.

We think that the language has what it takes for our enforcement arm and legal arm to, if it becomes necessary, go out with 5(a)(1) (OSHA general duty clause) citations on the grounds that the producers and the main customers of this material have pledged to follow the provisions of this agreement

(on the grounds that they are necessary for worker health and are achievable). That is the cornerstone of the general duty authority, and we hope not to have to use it, but we are glad that it is in there and gives us that option.

I want to close with a vote of confidence for NAIMA. They have put a lot of work into developing the HSPP and into the first year of implementation. We are cautiously optimistic about the next few years. That optimism is tempered by what we read in the annual report from the actual companies who are using the material and whose employee exposures are the highest. As I said, NAIMA has the will to work hard and try and turn these folks around. Ultimately, we think we have entered into a true product stewardship partnership.

Product stewardship, at the end of the day, means the willingness of the producers to say to the customers that you don't have to be our customers if you can't abide by common sense practices necessary for the health of your workers. We hope it doesn't come to that, but we hope NAIMA is standing by ready to drop the final hammer if it needs to do that, because we are ready to pick up our hammer if we have to do that down the line. ■

Synthetic Fibers in the Workplace:

*Where Less Fiber
is Healthier*

Roundtable 223

Discussion

FINKEL: Thank you. I will be happy to take any questions you have.

PARTICIPANT: Could you explain the scope of the NAIMA/OSHA agreement in terms of who it applies to? This PEL; is it conceivable that you could be at a job site with two installation companies—one covered by the PEL and the other not covered?

FINKEL: As a technical matter, the answer is no. But it is a matter of degree and the arcane nature of the law. The way the general duty clause works is that it depends upon knowledge of the employer. Part of the reason we stressed outreach and training so much in these negotiations is that we want to make sure that nobody can claim that they were completely ignorant of the fact that either their association or an association to which they don't belong but their colleagues belong have said that this is the right thing to do.

It will be easier for us in the future to issue a citation and make it stick against someone who is an ICAA or NIA member, but we hope if it becomes necessary, we can do that against nonmembers as well.

PARTICIPANT: This is a clarification. The actual documents cite four areas where [inaudible]: the installer, manufacturing workers, fabricators [inaudible]. If you are using a part and it increases as much dust as it would in one of those other job categories, would you cover that?

FINKEL: Generally you're saying the take-home point is that 1 fiber/cc is the new PEL regardless of

the foggy issue of whether they are part of NAIMA or not.

KOJOLA: The trade off we made at the very outset was that it certainly is not as good from a worker protection certainty of outcome perspective as a citation of the Code of Federal Regulations (CFR) that says one fiber is the law. But the general duty authority is out there for the taking, and we think it is crafted properly to do that.

PARTICIPANT: Along the same lines, if there is a complaint and an OSHA inspector goes out to the job site now, is he going to do sampling based on a fiber count? If so, if they exceed the fiber count, have there been any instances of citations based on the fiber count?

KOJOLA: There haven't yet because the dates in the agreement have not begun to come near their effective dates. But starting in 2003—this is not my department—if the OSHA compliance wing is willing to put the work in (and I have no indication they won't be), then starting in that year, the samples would have to be crafted just the way any CFR violation would be. This would be based on analytic results of sampling, but also based on failure to use respirators when they are required, failure to use the work practices, and so forth.

PARTICIPANT: So until that 2003 date, if a compliance inspector went out tomorrow, do you think he would even do a fiber count or do you think he is holding off until 2003?

KOJOLA: I would assume it is status quo before the agreement, at this point. If anybody has a reason to believe the nuisance dust standard is being exceeded, that can always be used as an absolute violation.

CRANE: NAIMA's interpretation and understanding and what we were assuming we were agreeing to was that the first 3 years is implementation; getting things in place. There is no enforcement action during that period of time. Once the first of the 5 years begins, then we are in a different category.

FINKEL: If a manufacturer is listing a 1 fiber/cc exposure limit is on their material safety data sheet, it does behoove the people working with it to follow that recommendation.

CRANE: And they have been making that recommendation for quite a few years.

PARTICIPANT: I wonder, can I say something that was said by the last speaker about exposure limits and biosolubility? My name is Brown. I have been working on the protocols with the European Union and represented the synthetic fiber industry for a number of years now.

We don't think there is something magical about biosolubility or biopersistence. The level in your body depends on the rate fibers arrive and the way they leave. If they leave faster because they are soluble, you have less; but if you expose people to more, it will be more there.

The only way to get the benefit of reduced biopersistence is to ensure that exposure does not increase. You keep exposure the same, less biopersistence, there will be less in the target organ. Therefore, the chance of a carcinogenic interaction is going to be reduced.

There is nothing magic about dose, I think. Most toxicologists, especially in this universe, most of us believe that it must be a role in determining biological outcome. You certainly don't (because you have a less biopersistent fiber) want to start lowering your exposure standards or encouraging people to

be careless with products. Let's keep the exposures down and also increase the biosolubility.

FINKEL: That's what I hoped I would have said if I had not been sleep-deprived.

PARTICIPANT: My sleep is disturbed having come from Europe. But yours last longer, believe me.

MODERATOR: There is no question that the results from PEL studies, whether they are animal or human, tend to be the impetus in terms of establishing and structuring how you want to have a health and safety program. I am using that very broadly, and it could include an exposure limit, but includes all the other important elements of what would constitute both controlling of exposure and preventing exposure at the worker level.

The issues that surround the health science on synthetic fibers, if you are familiar with the literature, are fairly complex. We had some on the overview today.

I think to give it justice, when talking about health risks on synthetic fibers, it really deserves another forum that could constitute a whole week of discussion in terms of understanding the issues that are related to the science.

What is important, I think, is that while we often spend a lot of time disagreeing on issues—in particular, it often stems from disagreements on how we interpret the science—but we spend less time in terms of the positive things on things we agree with.

Today, I think we had a sense in terms of what is happening in the synthetic fibers industry. Many of us would agree they are positive steps. Even though we may have some disagreements in terms of how we interpret the science, we would agree that the initiatives undertaken are positive ones.

One of the questions I have for the audience (and especially for those of you who are practitioners, industrial hygienists, or safety professionals) is since many of the initiatives that have been taken, including the outreach, what are your perspectives in terms of your perception of these types of initiatives? What does it mean to you in terms of its practice

and your interpretation of your profession at your workplace?

I know some questions just came up now to Adam Finkel about how to interpret the 1 fiber per cc on glass fibers. But I am interested in your perspective in terms of overall issues in terms of health and safety programs being established and the outreach that the industries are trying to make for communicating to their users. Is that reaching you? Is this something that affects you? Do you see something more that needs to be done?

PARTICIPANT: I'm Morton Corn, a former OSHA administrator. In terms of reality, this is the direction we must go. We've learned the limitations of OSHA and OSHA rulemaking, as Adam has said, and of OSHA enforcement. I think this experiment has a lot associated with it for the future. If the people who undertook it fail, it could turn the tide on such approaches.

I too have concerns in that in every standard industrial classification, there are the laggards and the leaders, and there is a tendency in associations to protect the laggards. I think it will require courage and initiative to direct the finger at those who lag here, and to not use the umbrella of the association to protect them. That requires explicit reporting in the agreement, and not targets in terms of averages.

This is what our field is faced with, an experiment in volunteerism and good will as we learn that OSHA can do 60,000 inspections a year, the states another 60,000, and the power to resist rule-making on standards, as Adam has said, is extreme.

Those of us in favor of prevention and worker health have been driven to new potential solutions. I have been involved in some of these solutions. We must try them. If they succeed, we must extend them; if they fail, we must seek other solutions. But this is a very important initiative.

CALZAVARA: I just want you to know that the industry is fully aware of the position that they are in. They are in a position that their leadership is going to make all the difference in the world. There are a number of factors that will assure our success in this. One, we are committed in earnest about

completing this program. Second, we have a lot of big egos and they want to have that distinction of creating this or being the pioneer in this. That always helps. Lastly, as long as I'm there, it will work.

KOJOLA: I think we need to be honest with ourselves, and that one of the driving forces behind this voluntary initiative is the question of liability—the question of liability on both sides of the fence. The question of workers who are exposed AND potentially suffer as a result of adverse health consequences from exposure, and the liability that might accrue to the industry that manufacture the products. This is like the asbestos situation with the cloud hanging over this industry.

Voluntary initiatives are important to the extent that they move workers' health and safety forward. But to think that this is an experiment (assuming that it is successful) that can be used to advocate for reducing or abandoning a compliance, regulatory, and standard-setting approach from OSHA is, from our point of view, faulty.

Despite that OSHA has, in the current environment, an insufficient amount of resources and is working in the political environment that makes it very difficult to promulgate regulations and standards, I think in the absence of those regulations, it is hard to get employers—all employers across the board who have these hazards in the workplace—to do what is necessary to protect the health and safety of workers. From our point of view, that hammer (i.e., OSHA regulatory enforcement) is essential. It doesn't negate, it shouldn't eliminate any voluntary efforts to move forward. But in the absence of the hammer, I think worker health and safety will suffer.

FINKEL: OSHA is a big place. There are lots of different jurisdictions within it, and there is going to be a 'wait and see'—if there is to be a gap between the letter of what is written in this agreement and what actually happens. With all those caveats, we wrote and crafted something with NAIMA that has elements of volunteerism. We think it is an enforceable agreement. There is legal language in there that may not be taken advantage of fully in the future, or it may be taken advantage of. It substitutes sub-

stance-specific CFR enforcement for general duty enforcement. That is one key feature.

The second thing I want to emphasize is that in an ideal world, I would have put two things together: along with those who still believe regulation is always preferable to the alternative, to some meeting of the minds. But again, the people whose behavior has to change in this case are not the people with the resources. If I could have written a regulation that said 'NAIMA member companies have to buy equipment, have to pay for respirators, have to do training, have to be on the hook legally with OSHA if their customers fail to meet 1 fiber/cc,' I would have done that. But our lawyers wouldn't hear of that, and we probably couldn't legally have done it that way.

The hypothetical '1 fiber/cc, 0.5 fibers/cc, or 0.15 fibers/cc and let's let NAIMA off the hook'—I don't think that's a good outcome.

CRANE: Just from the industry perspective, Bill, I understand your desire to still have a formal rulemaking, and I think that would continue to be available. But when OSHA issued its Priority Planning Process list, it was very clear that it deemed some issues or some substances worthy of a formal rulemaking, and others not as important. And that it was willing to satisfy itself with a voluntary agreement on that to cover a large segment of the workforce that most likely would never have been covered under any kind of formal rulemaking. The formal rulemaking I don't believe will go away, but it will augment and enable OSHA to address a much larger workforce.

Lastly, with regard to the liability issue, we were getting accused every time we met with our customers that we were only doing this because we wanted to shift liability to them. We wanted to do this because there was a public announcement by OSHA that we were on a priority list and we wanted to address that.

What is put into the health and safety partnership program is essentially already out there. It is already an industry standard because it has been placed on different companies' material safety data sheets and various documents. Our view is all this is done to

consolidate and obtain a formal OSHA seal of approval.

MODERATOR: The positive outcome of any program depends on whether you are able to bring in all the people who are ultimately affected by the program, including the workers and industry, and to some extent, the government. Having a little bit of knowledge in terms of the programs that NAIMA has initiated, that RCFC has initiated—I know some of the frustrations in terms of those discussions and wanting to identify those people who should be part of the discussions. Also, trying to gather buy-in and input from everyone that needs to have input in developing any type of program, especially in which it is designed to have some type of voluntary agreement with OSHA.

I am raising the question knowing the experiences we've shared. What are some of the difficulties as an industry that you see in terms of bringing those partners into the process? From your perspective and industry perspective, what are you looking for in terms of the other government agencies and labor? What do you want them to bring to this discussion in terms of developing a voluntary standard? Tell me about a little bit of experience that you've had, and maybe that will help direct us in terms of how something can be done that might improve upon that.

I'm familiar with NAIMA. I am familiar with the product stewardship program that the Refractory Ceramic Fibers Coalition is putting together. I'm interested in your insights in terms of how you would like to see that partnership; those people brought into the process. What are the difficulties that you have encountered in terms of doing that? What is a government agency or Bill's position in terms of AFL-CIO? What can we bring to the table to facilitate those kinds of processes?

CRANE: I can just identify a couple of things. I think Adam would agree there were problems throughout the entire process. One of the major problems we had with our members was the argument back and forth as to the sanity of voluntarily going in and talking with the federal agency.

Then once we got to the federal agency, one of the frustrations was that we had Adam helping us out, but he encountered with people who would say to us 'we don't do voluntary standards here?' and 'what are you doing here?' We would hold up the priority planning process and say, 'But you said you wanted to do one.' So Adam had to fight that.

Then when we actually approached our customers, they were furious with this, accused us of trying to shift liability, attacked me personally as being involved in a conspiracy. They didn't trust us or know what we were up to. Eventually, everyone came around. Each player contributed a very important factor in creating a whole product.

Would you agree with that, Adam?

FINKEL: Yes. The pairs and triples and quadruplets of people who didn't want to be in the room with each other and thought there was something nefarious going on behind the scenes was certainly more than I expected. It is the first time I have been in discussions where the government, on occasion, relative to warring factions in industry, was the 'good guy.' We were in between customers and producers for some of these discussions, and not as foreboding a figure as they were to each other.

I don't know all of the audience here, but the ICAA and its members, and then the people who aren't even members of the ICAA, whatever route we were going to go by—regulatory, voluntary, general duty enforcement, with or without some agreement—they are the people whose behavior has to change, and they are basically invisible to OSHA, both before and after this agreement. The agreement is a possibility of shining some light on this, the laggards in some sectors.

Product stewardship means, to EPA and to us, ultimately people who make the product taking responsibility for its poor use by whomever it may be. We do not have under any rosy scenario of OSHA budget and an OSHA enforcement and OSHA popularity in the national scene the where-withal to find the 'one or two persons with a truck' who are out there blowing fiberglass all over the national scene. It is the producer who ultimately has at least a chance of finding and reaching those

people and saying, 'You're making us look bad because you're taking our product and spraying it all over the place.'

PARTICIPANT: Bob Glenn. I, like Dr. Corn, would like to think this type of volunteerism and these type of programs have some promise. Ralph alluded to what it takes to make these kind of programs work. What alarms me is that there is still not a commitment on everyone's part to make this program work. It seems like perhaps disarmament hasn't taken place yet.

I hear Dr. Finkel say, 'if I could, I would have a standard that required the producers of this material where I could cite them if the users have over-exposure.'

I don't think we can have it both ways, with ISO-1200 telling the chemical producers and manufacturers of materials that it is their obligation to pass information downstream to the users. My reading of that is that it is the employers' responsibility to provide a safe and healthful workplace.

I must say, the only party up there that has demonstrated a commitment is NAIMA.

CRANE: We've had tremendous support from NIA and some of the regional groups like WICA and MICA. We are working with individual companies that belong to ICAA. I don't think we're going to give up on them. I think we just have to mend some fences, and we are in the process of doing that.

We are committed and we're bringing these other people along. By the way, if you put that thing in about us having to do everything, there wouldn't have been a voluntary agreement.

FINKEL: And I should have made it more clear that was a personal observation and a personal philosophy. I believe that ultimately people lagging behind respond better to regulation than they do to anything that is done out of good will. As a matter of personal philosophy, there are cases where the producers of materials need to take more responsibility. If I had the authority and the law was different, I think there are cases where that ought to be done through regulation. I was just holding that up

as a counter-factual. Obviously, we both know that is not the way the law works. This was, I think, the best we could do under those circumstances—to work with producers to say ‘you don’t have the legal responsibility to do this, but there is some amount of public relations responsibility, and some amount of corporate citizenship.’ EPA has been successful, and we want to replicate some of that success.

I’m disappointed that the agreement doesn’t say, as some of the EPA agreements do, that among the tools that NAIMA will be willing to use will be cutting people off from the supply chain, but we don’t get everything that we want. I think in future agreements, it would be nice to have that in there. Whether or not the law requires that, producers ought to say that ultimately the remedy against a customer who flagrantly misuses the material is to cut them off. That is for another discussion.

PARTICIPANT: My name is Mike Wendell. I always think it is commendable when organizations can work together. Ultimately, there will be a report card on this process. How can we out in the field track how this is going? Will there be periodic updates? If this is the wave of the future, we can see how it is working and helping the dialogue as we go forward with what we can add. It seems like OSHA doesn’t have the resources to be the hammer Dr. Finkel likes to talk about, but maybe this is a better approach. But I really would like to know how this comes out. How can I track it?

CRANE: We do the annual report to OSHA, and we will post that on our website. This first year we did a couple of interim reports just to kind of calm OSHA down because I think they were afraid we weren’t doing anything. In the years to come, we probably won’t do interim reports. It will just be the annual report. You can check the website and you can always call our office and ask for me and say, ‘Are you keeping your promises?’ And I will say, ‘Yes.’

PARTICIPANT: Thank you.

FINKEL: I didn’t bring the agreement with me, but I’m pretty sure there is a provision that we are going

to be a recipient of the database as it grows, and we have the right to make that available upon request. It will not be, of course, identifiable as to the name of the company or job site, but all of the industrial hygiene data will be in our possession and we are obligated to share it.

CALZAVARA: Another attempt that we’re looking at is at the conference. This year, they divide up roundtables into roundtables and forums. Roundtables tend to be more controversial. A forum is to bring AIHA members up to date on a new process or something that has been put in place.

When they looked at the forum that I put together, it got kicked back from AIHA saying that it wasn’t controversial enough. Then I pointed out what their definition says. They got back to me and said they understood.

Hopefully, every year we can report back on this. Again, accountability; we are accountable for this.

PARTICIPANT: My name is Paulina Zoltereski. I have a question with regard to fiberglass boat manufacturers. Have you done any studies with regard to fiberglass exposures in that kind of setting or in settings with grinding disks and things like that? You talked about the installation and blowing operations. Can you elaborate on that?

CALZAVARA: I can talk specifically about the manufacturing area. We’ve got data going well back into the 1970s on all of our applications. We use that information because within most of the companies, we have ongoing mortality and morbidity studies. We have been tracking these workers to date.

We’ve provided all that information in 1990 to OSHA and now what we are trying to do is supplement that. What we tried to do in the mid 1980s is to understand the exposures at our manufacturing settings. Right now, we do a lot of spot checking, but we don’t have a real solid grasp on all the users, so we’ve been spending a lot of time finding out how they work with the product.

There have been cases at times—when we were in the refractory ceramic fiber business at Johns Manville back in the early 1980s. There was an

application where they were actually doing a spray-on, and I was the hygienist on the job. The fiber results came back at 100 fibers per cc. That product was cut immediately because we had to have people in self-contained breathing apparatus to apply that. Looking at the people that we sell to and the sophistication of what these employers would need for that type of installation, there was no way it could be installed safely. That is the product stewardship we're looking at.

The only time you see grinding fiberglass is if somebody is grinding continuous filament glass fibers, and those are the large ones that we talked about that aren't as much as a concern besides the irritation effect.

PARTICIPANT: Can you also elaborate on that 1 fiber per cc? When I go out into the field, as soon as you just say one fiber to someone, they look at you like 'wow, one fiber?'

CALZAVARA: I speak to a lot of workers all the time. I say, 'Picture a sugar cube. Picture one fiber in that sugar cube. Now, think of a room filled with sugar cubes. That is what we're looking at, and that's why we want to keep it below that level.' It seems to work with a lot of the people that I get it out in the field with. It is a nebulous term. If you tell somebody 15 milligrams per cubic meter, it is hard—it is metric.

PARTICIPANT: I would like to ask the members of the panel something of a slightly different nature. Several of you mentioned monitoring data that you have collected by various techniques. I wonder if the members of the panel are aware of a series of methods that were developed through ASTM for monitoring what was labeled single crystal ceramic whiskers. There are a series of methods there that include PCM, SEM, and TEM. They have some very well developed counting protocols that will address the unique properties of these materials. There is also a companion guide, which tells you how to select one of these methods. Were you aware of any of these methods or the availability of any of these methods?

CALZAVARA: Yes, we were. The reason we adopted the NIOSH 7400 method and the B-counting rules was because they give the closest results that you can compare with WHO counting rules. We're trying to harmonize. We wanted to make sure that the epidemiology studies and the exposure assessments over in European are compatible here.

We are also very aware of the SEM methods because most of the indoor air quality work that we do tends to go ahead and look at the fibers through scanning electromicroscopy. There was a poster session here that showed that even under SEM, the numbers got smaller because under the phase contrast method, you are counting all kind of inorganic and organic fibers. Depending on the situation, it could actually give you higher results.

PARTICIPANT; Understood. Thank you.

PARTICIPANT: This question is directed to NAIMA and to Dr. Finkel. On behalf of those in the audience who are not in the federal OSHA jurisdiction, what is the expectation of this agreement to all of the members in the state plans? Is NAIMA going to knock on the door of 23 programs and try to get a similar agreement?

CRANE: We have had meetings with Michigan OSHA and they have asked for all of our training materials. Michigan OSHA is going to start their own training program with our materials. When we had our annual report with OSHA, Mr. Jeffress told us that he would give us a list of the proper contact people in the other state OSHA offices.

PARTICIPANT: Was there a timetable?

FINKEL: No, it is a slow process and we're trying to make overtures to some of the state plans, both from a regulatory compliance point of view and hiring compliance assistance people in each of the regions and area offices. There is no timetable for it. We are hopeful that states will take notice of this and replicate it, and take advantage of the statements from the national industry and user groups about general duty authority.

MODERATOR: Any comment from Bill on whether this should be a national standard other than piecemeal?

KOJOLA: It would be great if it was a national standard. I think right now, we're in a case, like Dr. Corn says. How many substances are out there right now being addressed? OSHA just can't do it. Hopefully, in the future this might be the way we move forward, at least to get our arms around some of the substances that aren't even being addressed right now. It might not be the hammer. Maybe the hammer comes later. But if you truly care about worker health, this is the route to go. Get the manufacturers involved. Get labor involved. Get government involved.

CALZAVARA: I can tell you that there are companies within NAIMA whose employees would fight them on the recommended one fiber per cc. They would say, no, based on the union that follows the 15 milligram per cubic meter. Once we were able to get this agreement in, even though it was a voluntary agreement, it gave power for those people to use one fiber per cc in their plants and reduce exposures and, in some cases, put people in respiratory protection. I truly believe this is going to be the future.

CRANE: The plus side of the agreement is that where it is implemented, workers are likely to be more protected than they had been in the absence of the agreement. Like I said in my prepared remarks, this is the flip side of voluntary standards or voluntary initiatives where you can have certain segments of exposed workers who do not fall within the umbrella of the voluntary initiative.

You raised a question about state plan states. There is no requirement to adopt a regulation as effective as an OSHA regulation because it is not a regulation; it is a voluntary initiative. Those are the down sides. There can be cracks. God forbid there is something wider than that. Workers and employers sometimes do not comply.

PARTICIPANT: To what extent does the existence of this agreement allow OSHA state plans to cite

under the general duty clause? Because it exists? Because it is information? This is a legal question, I suppose.

FINKEL: Once in a while, I thank God I'm not a lawyer, and this is one of those times. It was our hope, obviously. It is not as good as 23 more separate agreements with separate states. But our hope was it was a national admission of authority by NAIMA and the two user groups, and it would be helpful in nonfederal states as well.

PARTICIPANT: One more question about the European short-term studies. Can you elaborate on the four tests, and whether or not there has been some validation of them in their predictive value?

MODERATOR: Please, Dr. Brown, if you were on the committee, you know firsthand.

PARTICIPANT: The first is a lifetime study rather like the famous RCC studies but using higher exposure levels, using verification, and using multidose with no significant pathology outcome. That's for a new fiber; for something unknown, really.

The IT biopersistence test is the administration of four times 0.5 milligram of dust on consecutive days followed by periodic lung digestions with, so far in the regulation, a weighted half life of 40 days for exoneration from the labeling requirements. It remains an irritant. It doesn't affect the irritant label at all.

The same rule would apply for 5-day inhalation exposure, and will also result in exoneration from the labeling requirement.

What is the fourth one? Interperitoneal is based on the German protocol; one of the most stringent German protocols. I don't actually see anyone using it. It would be a very high-dose experiment indeed.

But to stress the biopersistence ones under rule would result in exoneration from labeling as a category 3 carcinogen. If fibers fail this test, they will be labeled as having 'limited evidence of carcinogenicity.' At the most, it is 'the risk of irreversible effect,' but there is a much more intelligible phrase that is coming into force, which is 'limited evidence

of carcinogenicity.’ That will come off. The St. Andrew’s cross will remain on as an irritant label at the moment, though it might change to something like ‘mechanical irritation’ as a risk phrase. It is a very complicated set of rules.

But to stress again that the reason for taking the biopersistence route is not the fact that individual fibers do something, but that having the biopersistence is seen the same as having the exposure, roughly speaking. It is not quite that simple, but if you reduce the biopersistence, you have the same effects as exposure. If you keep exposure the same, you reduce the dose.

I was horrified to hear that people think there is some sort of science that needed to be tested on that. It seems to me fairly self-evident. I don’t know what people thought biopersistence was doing, or the ability of the fiber to persist in the body was doing otherwise.

Those are the four tests. We have reestablished protocols. We are testing them. There are round-robin tests going on with several laboratories testing the biopersistence tests at the moment. It is just starting.

We are also developing a subchronic study that has no legal issues; it is volunteer. Part of the rules when we established the classification is that the companies involved and the European authorities would try to establish a subchronic toxicity test. If you develop a new fiber, you can’t just have it exonerated on the basis of low biopersistence; you must demonstrate the absence of toxicity in some 90-day exposure with a year or 6 months survival afterwards. That is a test, which is not established yet, but probably will be within the near future.

PARTICIPANT: Have any fibers passed it yet?

PARTICIPANT: The biopersistence test? Many have passed this test. We probably are using 30 percent of the RCF uses being hammered out by fibers that were exonerated as their mineral wools were biopersistence below the threshold levels. And in 90-day studies on all of them as well. In fact, in lifetime studies on most of them have been an issue.

The glass fiber industry has also produced fibers

that pass, by a long threshold—not just narrowly avoided. There is some discussion about how you calculate the half lives and there always will be. Scientifically, this is a very complex issue. But it is something we can discuss another time.

FINKEL: I don’t think anybody is disputing the physics of this: that a less persistent fiber will have less integrated lifetime dose. But I think one of the key questions is the relevant measure of dose. I don’t want to make an inflammatory analogy, but if somebody designed a bullet that dissolved in the body in 40 days, if the time scale of the effect is much shorter than that, it is irrelevant.

PARTICIPANT: But what you’ve got in this position is that you have less bullets by the number of fibers in your body is going to be less. So the bullet itself may not be less dangerous, but you have less bullets. If you’re talking about 1 fiber per cc, you are inhaling many fibers per day if you are exposed to that kind of level. That exposure is high.

FINKEL: If the biologically relevant event happens within 40 days, then the fact that you have engineered the bullets to vanish after 40 days doesn’t change the fact that you don’t have fewer bullets during the important period of exposure.

PARTICIPANT: No, no. If the biologically relevant effect happens, that is for an individual fiber, but the total fiber burden at any one time will be lower. So the statistical change of an event or interaction between the fiber and its target will be less. If you don’t believe that, then you believe it doesn’t matter what dose you have. This is the one-fiber-can-kill story. One fiber can kill, but the chance of that is remarkably remote. We live in a statistical universe.

FINKEL: I still think we have a disagreement because if the relevant measure is the first 43 days of fiber exposure, then if every fiber magically goes away on the 44th day, you still have the same number of exposure to the relevant number of fibers. They just cease being there at a time after which their potency has ceased to be relevant.

PARTICIPANT: Let's put it the other way around. If the fibers persist, then the changes of the interaction occurring isn't within the 40 days; it is within many more days. So the changes of the more persistent fiber producing an effective interaction are higher. Put it that way if you like; the more persistent the fiber, the longer the fiber is there, the more chance of that statistical event. Persistent fibers have longer to do their harm. Would you accept that one?

FINKEL: Assuming they continue to do harm as long as they are in the body, and that something important isn't happening at a shorter time scale than days or months.

PARTICIPANT: We don't know from individual fiber what that interaction is, but the chance of it occurring is proportionate to the time it is there, isn't it?

FINKEL: Not necessarily.

PARTICIPANT: So we have a situation where the chance of an event occurring is not related to the time, and it is not related to the amount either. It is related to some metaphysical function.

FINKEL: It is related to the integral of dose over the relevant time scale, which may be irrelevant to persistence beyond a specific time.

PARTICIPANT: Let's look at the other evidence we have. When we block persistent fibers, as we've done now several times, by putting more particles in to stop the fibers being cleared. That has been done by some German government experiments as well as our own industry experiments. If we decrease the clearance of the fibers, we increase the biological impact.

FINKEL: I agree with that.

PARTICIPANT: So if we block clearance, we see more biological impact. That is with the same type of fiber.

FINKEL: I am agreeing. It is looking like those questions are being answered. I am saying that is where some of the residual . . .

PARTICIPANT: I think we can answer the question at the level that says it could happen at some time, but not likely, I think.

FINKEL: That is why I didn't want to get into the science.

MODERATOR: Yes, ma'am.

PARTICIPANT: Hopefully, my question will be less controversial. Back to the health effects. I think one of those slides said that some of these fibers are rated as a possible carcinogen. Is that all based on animal studies? Have there been any proven or confirmed health effects on humans?

MODERATOR: That is not less controversial.

DEMENT: For the most part, the classifications are mostly from the animal data. Certainly, for the refractory ceramic fiber that is the case.

As I mentioned in the presentation, there are both European and North American studies that the glass wools have shown a slight increase in lung cancer collectively. It seems to vary somewhat from plant to plant. The dose response is not there. Duration used as a surrogate of dose or estimated lifetime dose doesn't necessarily correlate with an increased risk. So there are pros and cons on saying that the exposures are causing this increase.

What I said on my slide in my presentation is I think collectively there is an increase. Whether or not it is due to some residual confounding in the studies is really not proven. That will be for the glass mineral and rock wool, not for the refractory ceramic fibers and not for the continuous glass fibers.

FINKEL: We appreciate your question on health effects. It is difficult to interpret unless there are specific studies on an individual fiber, where you think you have some confidence in the data, whether it is animal or human.

When you go beyond that particular study and

the results of that study, then the issues come in terms of these other variables, whether it is the elemental make up or the dimensional characteristics; surface characteristics, some of which play into the issues of biopersistence. Then it gets a little more complex in terms of trying to extrapolate from one fiber data set to another data set.

PARTICIPANT: I'm a lowly IH at a chemical plant. Sitting here listening to this for the last 3 hours or so, I have a couple of questions. I am going to presume that NAIMA, when you talk about members, are manufacturers of vitreous fibers. Is that correct?

CALZAVARA: Yes.

PARTICIPANT: Then you say 'customers'. Could you please define who your customers are? I mean, I've got a plant and bunch of process equipment and a bunch of process lines that we bring in fibrous glass to have wrapped. Am I classified as the customer?

CALZAVARA: Do you do the wrapping yourself, or do you have a contractor come in to do that for you?

PARTICIPANT: Does it matter?

CALZAVARA: If you have your workers doing it then, yes, it would fall underneath the agreement.

PARTICIPANT: So what we have is a situation where NAIMA has set up an agreement with OSHA that impacts their customers?

CALZAVARA: Yes.

PARTICIPANT: And I have no idea what this entailed or when it occurred.

CALZAVARA: Hopefully, if you are using any manufacturer's fiberglass, you will get the material safety data sheet. This information will be on the material safety data sheet. In addition to that, outreach programs, like we are doing right now, we're meeting

with a lot of local sections throughout the United States to get this information out, to let people know that this voluntary agreement has been signed.

What we would like to do is in some areas . . . do you remove it as well?

PARTICIPANT: We remove it. Absolutely.

CALZAVARA: See, that is an area. I would like to talk to you afterwards. We were having trouble getting data. Maybe we can come in and get some of that. Or, if you have your own air-monitoring data on the removal, you can share that with us. But that is the outreach program that we're trying to get this information out. It has been in BNA. Do you read that?

PARTICIPANT: My concern is that you have a trade organization that is making policy with OSHA that affects a number of people in a number of locations, plants, facilities, in a way that they may or may not agree with the information that has been shared or agreed upon.

Dr. Finkel is talking about going in and claiming general duty clause violations if one of your customers does not agree with the agreement relative to exposures. At the same time, the preponderance of any information that is out there is dealing almost exclusively with animal studies, whereas the general duty clause, if I am not mistaken, deals with worker health and safety.

Don't get me wrong. I'm not saying it shouldn't be approached from the standpoint of worker health and safety. My concern is you are going to go to management and tell them, okay, you've got this agreement going on between a trade organization and OSHA. And, by the way, based on animal studies we are now going to have to comply with this agreement with the idea that OSHA could come in, claim general duty clause violations based on nothing more than animal studies.

There is going to be a lot of arguing going on back and forth that says this isn't real.

CALZAVARA: But you are already required if you're using my company's material and you have my material safety data sheet. Under the Hazard

Communication Standard, if I list the 1 fiber per cc exposure limit—voluntary PEL or recommended exposure guideline—OSHA could have come in from 1985 when we started to 1999 and cited you on that because you weren't following it. That is nothing that is new within the program.

You say it is based on animal data. You're looking at an IARC 2B, a possible human carcinogen. That is required to be on the material safety data sheet also, along with the National Toxicology Program (NTP) classification that came in 1994.

What we're looking at is pushing on the work practices and consolidating them so that, like I said earlier, if you install Owens Corning material or any other manufacturers material, you would only have to follow the recommendations under one MSD as soon as be covered under all of them. Right now, you're responsible for anything that they say. If one of the competitors out there who don't have the one fiber per cc, then you don't have to worry about that. Now, it is consistent.

PARTICIPANT: I understand. I just wanted to make sure.

FINKEL: We obviously didn't reach everybody. We had to depend on NAIMA to identify who the main customers were, and we chose to deal directly face to face with the two major user groups who represent installation contractors. In the future, if we do more of these, we want to have more players at the table, but the size of the room gets to be constrained at some point.

Life is not always entirely fair. There are going to be people who, despite the best efforts of NAIMA, are learning about this agreement further on down the line. It involves the people making the material doing the best they can to let their customers know that part of the condition of sale is responsible use. If the customer does not choose to take advantage of that information, then it is government stepping forward to say 'we have a role to play in making sure that compact is adhered to.'

CALZAVARA: In addition, when we have that database available out there, if we have the type of

work that you're doing, at least you can draw some confidence for those types of installations. That you would have a range of what you could see. If everything was below 1 fiber per cc, you have a pretty good chance that your folks are okay.

But as an industrial hygienist, if I knew there was an N of 2, and the average fiber concentration was below one, but the range was over, I would spend the money to take the air samples.

PARTICIPANT: The other part of this is you're talking about specifically requiring the use of respiratory protection, but there is nothing else in terms of other types of protective clothing, other than to have long sleeves, long pants, and gloves. Again, you end up with the same situation where, okay, I wear a respirator, go out, and strip a bunch of fiberglass insulation. It gets all over my clothing. I've got long sleeves. I go home and do the same thing that we ended up getting in trouble with asbestos.

CALZAVARA: That is an area that always comes up. There is absolutely no data that say that there is any hazard to bringing the stuff home besides irritation. The studies that we looked at said when somebody uses fiberglass, you go into the home and collect air samples, and the person washes the clothes. The levels that we saw of short-term exposure were well below 1 fiber per cc. This isn't asbestos.

PARTICIPANT: Again, the idea is when you're dealing with the workers and understanding where there can be a break down for requiring respirators for manmade mineral fibers, but not having to deal with the other types and level of protection that would be customary with making that connection with asbestos.

CALZAVARA: The jobs that we recommend require respiratory protections are one that we have no exposure monitoring on (or very little), or we have the data that shows that under the applications, you can exceed it.

PARTICIPANT: Basically you're talking about doing a negative exposure assessment, similar to the asbestos standard to establish that you don't have to fall under those requirements?

FINKEL: The NIA put in some type of negative exposure determination, but we put a lot of teeth in it, and I'm not sure it is going to be useful.

In this case, we have the ability, as the agreement progresses, to change the listing of tasks where respirators need to be worn. As of right now, even a negative determination that in your particular operation you think you can blow loose-fill safely and be below 1 fiber per cc, as far as we're concerned, inherently that is not a reliable determination. We believe that enough data have been collected in loose-fill for enough years to show that it is very easy to have exposures above 1 fiber per cc—so we want respirators to be worn in that category until there is enough weight of evidence over more years than it can be done safely.

PARTICIPANT: Okay.

CALZAVARA: The other point I would like to say about asbestos, when the clothes were taken home, the disease that you saw with the people within the home has been mesothelioma. In the case of all the synthetic vitreous fibers right now, the human data indicate that there is no increase in mesothelioma within the working populations.

MODERATOR: I would like to thank the panelists for their presentations and their willingness to openly discuss the dilemma as to how and to what extent you implement health and safety programs in the synthetic fiber industry where the health risk is unknown. I would also like to thank the audience for its participation in this dialogue. I'm optimistic that these discussions can lead to other forums where related issues about the safety of synthetic fibers, the types of research that remain to be conducted, and how to best educate and train workers can be objectively discussed and resolved.

BIOGRAPHICAL NOTES

John M. Dement

Dement is an associate professor in the Division of Occupational and Environmental Medicine, Duke University Medical Center. Dr. Dement has conducted research concerning exposures and health effects of asbestos and other fibers for approximately 30 years. Prior to joining the Duke University faculty in 1993, Dr. Dement served in the US Public Health Service for 22 years where he was employed in various research and management positions by the National Institute for Occupational Safety and Health (NIOSH) and the National Institute of Environmental Health Sciences (NIEHS). He has authored more than 50 peer-reviewed publications concerned with asbestos or man-made fibers. Dr. Dement is certified in the comprehensive practice of industrial hygiene and holds a BS in mechanical engineering, an MS in industrial hygiene, and a PhD in industrial hygiene/epidemiology.

William H. Kojola

Kojola is the industrial hygienist for the American Federation of Labor, Congress of Industrial Organizations (AFL-CIO) Department of Occupational Safety and Health. His experience in health and safety spans more than 25 years. During that time, Kojola has been the director of the Occupational Safety and Health Division of the Laborers' Health and Safety Fund of North America, an occupational safety and health specialist for the International Brotherhood of Boilermakers, and director of safety and health for the United Cement, Lime, Gypsum and Allied Workers International Union. Prior to this, he was a health research scientist at the University of Illinois School of Public Health, studying the human health effects of air and water pollutants.

With the AFL-CIO, Kojola is responsible for developing strategies for securing the new safety

and health protections through federal and state regulations, coordinating with affiliates on and leading a unified labor response to proposed OSHA and EPA regulations, and representing the AFL-CIO before government regulatory agencies, on federal OSHA and EPA advisory committees, and consensus standard-setting efforts.

Kojola holds a BS degree in biology and an MS degree in genetics from the University of Minnesota, and studied toxicology and industrial hygiene at the University of Illinois School of Public Health.

Dean E. Venturin

Venturin is currently employed as the manager of Health, Safety and Environment (HSE) for the Unifrax Corporation. Dean joined Unifrax, (at the time, Carborundum's Fibers Division), in October of 1991. Prior to his employment at Unifrax, he held similar positions at Washington Mills Electro Minerals, an abrasive grain manufacturer, and at Chemical Waste Management Inc., a hazardous waste treatment, storage, and disposal facility. Dean has his undergraduate degree in environmental sciences from the Ohio State University and his MBA from Niagara University.

Dean has published numerous papers pertaining to various aspects of industrial hygiene, product stewardship and risk management in peer reviewed scientific journals (e.g. *Regulatory Toxicology and Pharmacology*, *the Annals of Occupational Hygiene*, *Ceramic Engineering and Science Proceedings*, etc.), and has also given numerous technical presentations for various organizations (e.g., AIHCE, NIOSH, OSHA, EPA, etc.).

Steve Hacker

Hacker is a corporate industrial hygiene manager for Solutia, Inc., the former chemical businesses of

Monsanto. He has a bachelor's degree in chemistry from the University of Missouri, St. Louis. He is a certified industrial hygienist in comprehensive practice with 21 years of experience in industrial hygiene. He has been with Solutia/Monsanto for the past 13 years, with positions in St. Louis, MO, Pensacola, FL, and back in St. Louis since 1992. Steve is a member of the National Hearing Conservation Association and current chair of the AIHA Noise Committee. He has been active with the AFMA fiber dust working committee for the past 5 years.

Thomas Calzavara

Calzavara is responsible for domestic and international product stewardship issues for Johns Manville (JM), a Berkshire Hathaway Company. He interacts with trade associations, labor, and government concerning new and existing health, safety, and environmental regulations that involve JM's products and processes. He is a member of the North American Insulation Manufacturers Association's team that successfully developed a voluntary Health and Safety Partnership Program (HSPP) for Synthetic Vitreous Fibers that was signed by OSHA on May 18, 1999.

Currently, Thomas chairs the executive board for the Business Council on Indoor Air, the Asphalt Roofing Industry Scientific and Medical Group, and the Society for Chemical Hazard Communication's Professional Development Committee. He also serves on the advisory council for the University of Montana/Montana Tech Occupational Safety and Health/Industrial Hygiene Department, and is long standing member of the American Industrial Hygiene Association's Product Stewardship Committee.

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Angus E. Crane

Crane is vice president, general counsel to the North American Insulation Manufacturers Association (NAIMA) in Alexandria, VA (1995–present). Prior to joining NAIMA, Mr. Crane was an environmental lawyer with the Washington, DC, law firm of Dickstein, Shapiro & Morin (1990–95). Mr. Crane was appointed to an attorney position for the Appellate Section of the United States Department of Justice's Environment and Natural Resources Division through the Attorney General's Honor Law Graduate Program (1987–90). Before his service with the Department of Justice, he served as a law clerk for the Idaho Supreme Court (1986–87). Angus is a Truman Scholar and graduate of the State University of New York at Buffalo Law School. Mr. Crane is an author of numerous articles.

Adam M. Finkel

Finkel is one of the nation's leading experts in the evolving field of risk assessment and cost-benefit analysis, with 15 years of experience in both the scientific and public policy aspects of environmental and occupational health. Since 1995, he has been Director of Health Standards Programs at the US Occupational Safety and Health Administration (OSHA). In October 2000, Dr. Finkel began serving as Regional Administrator for OSHA in Denver, CO, responsible for enforcement, compliance assistance, and outreach activities in CO, MT, ND, SD, UT, and WY.

From 1987 to 1994, Dr. Finkel was a fellow at the Center for Risk Management at Resources for the Future, and director of its Rational Risk Reduction Program, a series of research and outreach activities examining the strengths and limitations of risk assessment for setting national environmental priorities. In early 1995, he was a senior fellow at the Cecil and Ida Green Center for the Study of Science and Society at the University of Texas at Dallas.

Dr. Finkel holds an ScD in environmental health sciences from the Harvard School of Public Health, a master's degree in public policy from Harvard's

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Zumwalde is a senior scientist at the National Institute for Occupational Safety and Health (NIOSH), Education and Information Division, Cincinnati, OH, currently working in the areas of risk assessment, policy development, and health communication. He received his bachelor's degree in interdisciplinary sciences and an MS in occupational health and industrial hygiene from the University of Cincinnati.

Mr. Zumwalde has been employed at NIOSH for 30 years and has been involved in diverse research activities that include the evaluation of health effects from exposure to low levels of ionizing radiation, conducting comprehensive epidemiology and industrial studies of workers exposed to synthetic and natural-occurring mineral fibers, establishing an electron microscopy laboratory for the Institute, and overseeing the development of criteria documents and other health communications for the Institute. As senior scientist, Mr. Zumwalde serves as a liaison representative to various institutions, committees, and governmental agencies that deal with the substances and hazards under NIOSH's purview, and provides scientific and technical direction in the

interpretation of human and animal data for the development of occupational health and safety standards. He has authored and coauthored over 30 scientific articles and numerous NIOSH policy and technical documents on occupational hazards.

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Lentz is an industrial hygienist with the National Institute for Occupational Safety and Health (NIOSH), part of the Centers for Disease Control and Prevention, in Cincinnati, OH. In this role, he performs research and investigations in occupational exposures to chemicals and other potential hazards, and uses this information to develop presentations and written materials with appropriate recommendations for protecting workers.

Specific research interests include exposure assessment, construction safety and health, and hazards in small business industries.

Kathleen MacMahon

MacMahon is a biologist with NIOSH in the Document Development Branch of the Education and Information Division. Her work includes reviewing the toxicology, epidemiology, and industrial hygiene literature on chemicals of occupational concern. She acquired a DVM degree at the University of Minnesota and an MS in zoology at the University of New Hampshire.

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