THE ADOPTION OF EXPOSURE LIMITS: INDOOR AND OUTDOOR

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Before discussing what might be appropriate exposure limits or regulations for the use of asbestos, either in the workplace or in the general environment, I think it might be appropriate to review the principles behind exposure limit values. Some of these principles have already been alluded to by Dr. Glenn. Permissible exposure limits (PEL's) have evolved from threshold limit values (TLV's) that were discussed earlier, which in turn have had an extensive history in controlling exposure of workers to toxic substances. TLV's have evolved, from crude standards designed primarily to prevent fatalities, to sophisticated levels based on detailed toxicological and metabolic considerations. In general, however, their use has been most effective in limiting exposures that would produce short-term acute effects such as irritation, narcosis or alteration of body functions. In such circumstances, it was not difficult to determine a level below which the effect in question would rarely be seen in exposed individuals. By applying a safety factor to epidemiological data, a TLV was established which would be sufficient to assure safety in virtually all work circumstances. The extension of this concept, however, to the control of carcinogenic substances raises serious questions which I would like to consider briefly.

The first problem in the application of a PEL for a carcinogen is that, despite considerable research on the effects of carcinogenic substances, no data exists that would define an absolute threshold for any carcinogen. The task confronting one who defines a level below which no carcinogenic risk exists for human populations is virtually an impossible one. The difficulties include:

1. The absence of sufficiently large populations for observation,

2. the absence of exposure information during previous decades,

3. the need for sufficiently long observations to observe carcinogenic effects,

4. the statistical uncertainties reflected in the epidemiological data, and

5. uncertainties associated with potential biases in the conduct of epidemiologic studies. Negative results serve only to define the upper limits of risk from a given exposure circumstance.

I would just mention at this time that there are such studies for asbestos which are not correct. The study for example, that was conducted on the mortality of individuals living in the asbestos mining towns of Asbestos and Thetford cannot be used to establish a threshold; that study in particular showed that the lung
cancer mortality of women in these towns had a SMR of 107, that is a 7% elevated risk of lung cancer compared to the entire province of Quebec. In fact, the lung cancer in Quebec is largely dominated by a very high lung cancer rate in Montreal, and in Quebec City. If that mortality experience of the women in the asbestos mining towns were compared with that of the province of Quebec, except Montreal and Quebec City, the SMR would have been 170, a very substantially elevated and statistically significant level. So, the evidence would point to a fairly substantial risk in the environmental conditions of the mining communities and Dr. Allison McDonald has identified additional data: three cases of mesothelioma among family contact members of mining workers.

Well, a definition of a threshold is not possible on epidemiological basis; in the case of asbestos it is a biologically possible concept; but for public health matters, it is prudent to adopt a policy that presumes that there is no threshold. I emphasize that we do not have data either for or against such a principle, but all available information would suggest that this should be the principle adopted for public health policy. Therefore, it would be appropriate to reduce population exposures to a minimum. In this endeavor, some practical public health principles apply:

1. If substitute materials are available that are equally effective and of similar cost, they should certainly be utilized. However, if substitute materials are adopted, sufficient information should be available on their potential health effects so that one could be assured that safer materials replace hazardous ones.

2. It must be recognized that the use of a carcinogenic agent will involve some human exposures, no matter how well one controls their use. The cancer risk from these exposures must be evaluated and a social decision made as to its acceptability, taking into account current and past uses and sources, and benefits of the agent. For example, asbestos could be banned, however, exposures to asbestos could not be totally eliminated by such prohibition, inasmuch as there is an excess of 1,000,000 of friable asbestos in place, as thermal, acoustic or fireproofing insulation in buildings, ships, factories or power plants in the United States.

3. If carcinogenic agents must be utilized or are already in place with a potential for continuing exposures, PEL's should be adopted that would limit exposures to the lowest feasibly achieved by existing or readily developed control technology. Such values are maximum exposure limits. If work practices or feasibly applied technology exists that would achieve lower concentrations, these should be adopted. Work practice standards are particularly important in those circumstances where routine monitoring of air concentrations is not feasible, such as during the maintenance of asbestos materials in buildings and other structures. So a much greater effort should be devoted to adopting and providing information on safe practices that workers can utilize. This would directly involve safe working conditions, or at least safer working conditions.

In assessing what might be an appropriate level for carcinogens, an impor-
tant factor will be the number of people that are potentially exposed. This consideration leads to substantially different acceptable risks and consequently different exposure limits for the workplace and the general environment. On the one hand, in the workplace, one may be concerned with the protection of tens of thousands or perhaps hundreds of thousands of individuals, whereas in the general population, tens, even hundreds of millions of individuals may be subjected to exposure. What may be an acceptable risk in one circumstance is a public health disaster in the other. Another criterion of importance when considering standards for environmental exposure to carcinogens is that children may constitute an especially sensitive subgroup of the general population whose risk per unit of exposure is considerably higher than that of adults. We will see shortly that this is the case in fact with mesothelioma because of the longer life expectancy of a child. In the case of radiation it is found that infants may have ten times the sensitivity of adults because of rapid turnover of cells during childhood. Clearly, standards which may be acceptable in the workplace have no relevance for the general population.

Let us now turn to a consideration of procedures to limit environmental exposures to asbestos.

**OCCUPATIONAL ASBESTOS-RELATED CANCER RISKS**

Data are now available that provide information on the age, dose and time dependence of the risk of lung cancer and mesothelioma from asbestos exposure which allow estimates of cancer risk to be made in a variety of exposure circumstances.

The first slide shows the ratio of the observed deaths to those expected from lung cancer among a group of asbestos insulation production employees according to time from onset of exposure. The group under observation was one that was employed, on average, for a very short period of time, about one and one-half years. Thus, the time course of cancer is not complicated by the effects of continuous exposure. As can be seen, a rise to a significantly elevated relative risk occurs within ten years, after which the relative risk remains constant throughout the observation period of the study.

Furthermore, the study showed that the relative risk from the exposure was independent of the age at which the exposure began. The same data were obtained for those workers first employed in younger years as those that were employed after the age of 40. For this particular exposure the consequences were such that the underlying risk of lung cancer in the exposed group was increased by five times after a delay of about five to ten years. It should be noted that this five-fold increase risk continues for an additional 30 years, even though the underlying risk that is multiplied increases by about fifty-fold during the course of the observations. So you have an enormously increasing background risk that continues to be multiplied by an asbestos exposure that occurred in previous decades. This constancy of relative risk implies that when evaluating the risk of lung cancer it does not matter too much when the exposure to asbestos occurred. All exposures ten or more years previously would contribute equally to the relative risk at a given point in time; that is, the relative risk of 10 years is roughly the same as the relative risk
of 30 years, and you can reverse the process for that previous conclusion.

Since it is found that the relative risk of lung cancer is independent of age, the time course of the absolute risk is largely governed by the time course of the risk in the absence of asbestos exposure. Thus, most lung cancers in asbestos exposed groups occur between ages 45 and 65, the period of high risk of death from lung cancer in the general population. In workers, this is usually 20 to 40 years after first employment in an asbestos industry. This multiplicative relative risk model for asbestos implies that a multi-stage model of cancer is acting at a late stage in the process and is acting like a promoter in the carcinogenic process.

This multiplicative effect is also completely consistent with the data that Dr. Markowitz showed on the relative risk of lung cancer in cigarette smokers and non-cigarette smokers. And I would state here that the data presented are directly the data of Dr. Selikoff; in that study there were 8 individuals who had claimed never to have smoked cigarettes, their relative risk of lung cancer was 5.2, there were 8 deaths observed versus 1.5 deaths expected.

In the case of continuous exposure to asbestos, results such as these are shown. Under observation here is the group of insulation workers studied by Dr. Selikoff, who are continuously exposed to asbestos during their work as applicators of thermal insulation to pipes, boilers and other high temperature equipment. In this case the increased relative risk from each year's exposure adds to that which had been accumulated previously, giving rise to a linearly increasing risk as exposure continues over the years. After 30 to 40 years from onset of exposure, when most insulator cease employment, one would expect that the risk would remain constant as it did in the previous figures. It falls, however, largely because the population now under observation after 40 years from exposure, contains far fewer cigarette smokers than would have been in the group under observation at earlier years. Most of the cigarette smokers would have died during earlier years because of their exceptionally high risk of lung cancer and of cardiovascular diseases. There may be other survival effects playing a role as well, in the decreasing risk seen there.

In contrast to the risk of lung cancer in which the relative risk is found to be independent of age, it was found that the absolute risk of mesothelioma is independent of the age at which the exposure takes place. In other words, that same curve, according to time from onset of exposure, applies independent of age. Data on insulation workers are shown in the Slide. As can be seen, the risk in terms of deaths per year per 100 000 persons increases very steeply with time. Among individuals exposed continuously, the risk increases to the fifth power of time from onset of exposure. That means that the risk at 10 years would be about 30 times the risk at 5, that at 20 years about 30 times that at 10. Every doubling in time increases the risk 30-fold. After about 50 years there may be some flattening, maybe due to the improper diagnosis of mesothelioma in individuals over 80, or it may in fact, be due to survival effects that have been seen in the lung cancer case, but it is an uncertain curve after about 50 years from onset of exposure.

Thus, time from onset of exposure can be a much greater factor in the risk of death from mesothelioma than the exposure itself, although the latter certainly is important as well. In one case we believed that the risk would be doubled if the exposure were doubled, or that the risk would increase by about 30 times if one doubled the time from onset of exposure.
Finally, the last issue in assessing the risk of lung cancer is the dose-response relationship. The *Slide* shows representative dose-response relationships for five studies of asbestos-exposed workers. They are depicted according to the measuring techniques current in earlier years. Millions of particles per cubic foot times years of exposure. This may be slightly different for the different studies, but roughly the value in millions of particles per cubic foot would be about 1/3 the corresponding value in fiber years per cubic centimeter. In all cases, a linear dose-response relationship according to estimated cumulative exposure is seen with no evidence of a threshold. In none of these studies is there any evidence of an exposure below which there is no risk. Fairly substantial data indicate that the relative risk for lung cancer as shown here, is proportional to the cumulative exposure with perhaps a delay of ten years; less substantial data (there are few available) suggest that the risk for mesothelioma is also proportional to the cumulative exposure of asbestos in a period of time. Here, however one must be careful to account for the time course of cancer in order to ascertain the dose dependence of mesothelioma. But to the extent that that can be done, it would indicate linear dose-response relationships also obtained there.

I might just point out that at 20 ft/cc which would correspond to about 6 mppcf, if a worker was employed at that value for 40 years, he would achieve a dose in the order of 300, where there would be a substantially elevated risk of lung cancer in the lowest curve which is that of the mining and the milling workers. So I think one can certainly say that employment at that level in the mines and mills does indeed produce cancer.

One feature of this graph is the considerable difference in dose-response relationships seen in the studies depicted here. The relative risk of lung cancer in exposures to chrysotile asbestos in textile production is the highest of any study for a given exposure. The textile dose-response relationships are those very steeply rising lines on the left side of the graph, the first two. The next two intermediate ones. One is largely textiles, the other one is a study of retirees in the Johns-Manville plants and the one with the lowest slope is that of McDonald's in mining and milling. So in contrast to textile workers exposed, the risk per unit of exposure of chrysotile miners is much less. A small proportion of the difference arises because of the measuring instrument, particles rather than fibers were counted, and there would be some slight difference of the ratio of fibers to particles in different work places. This is a very small factor difference; let us see this in more detail.

This *Slide* shows the estimated fractional increase in lung cancer in 14 different studies from an exposure to 1 ft/cc for 1 year. In other words, longer terms of exposure circumstances have been adjusted such that this graph displays what the risk would be from an exposure to 1 ft/cc for 1 year. The value of KBL = 0.01 would indicate a lung cancer risk that would be increased by 1% for a 1 ft/cc exposure for 1 year. The horizontal bar in each of the 14 different sets of data indicates the best estimate of risk in a given study. The thick vertical bar indicates the uncertainty of the mortality data on which that excess risk estimate is based; it is largely the statistical uncertainty of the number of lung cancer deaths. The narrow vertical bar extending above and below the thick bar is the additional uncertainty ascribed to exposure estimates of previous years. As can be seen, many of the studies have very large uncertainties.
With the exception of friction products and chrysotile mining and milling, most risks range about the value of $K_L = 0.01$. That for mining and milling is seen to be approximately 10 times lower and is statistically different at the 95% level from textile production and all other asbestos-using processes. The risks for friction products, I should mention, are highly uncertain. In the study of Berry and Newhouse in Great Britain, the average exposure of the group under observation was 37 fibers/years per cc, that is their average exposure for the equivalent of a 40 year period was less than 1 f/cc. The risk uncertainty due to the very small number of excess lung cancers was very large. It was such that it could be as high as 0.009 based upon a direct calculation of Berry himself, so that large vertical bar indicates how high the lung cancer risk could be, given this uncertainty of the data itself. Because of these large uncertainties of those risk studies, it is not possible to make definite statements about risk in friction material production.

It would appear that the origin of any difference in risk between these processes lies, not in the fact that the mining exposure was to chrysotile for example: the risk in pure chrysotile textile production was as high as any observed. Rather, it would appear that the difference in risk was due to the fibrous size distribution in the mining environment compared to that of textile production. In the mining environment, many of the fibers are large, curly and often non-respirable, but easily countable. In the textile environment and in other working environments, fiber bundles are broken apart and thin fibers are released into the air during high speed processes, particularly spinning and weaving. Many of these fine fibers are invisible by optical microscopy, but can be highly carcinogenic. Thus the ratio of fibers counted to potentially carcinogenic fibers in the mining environment may be much higher than in the textile environment, giving rise to the lower unit exposure risk in the mining work environment.

There would appear to be a relatively little difference in the unit exposure risk for amosite compared to chrysotile. Pure amosite exposures detected, as you can see, in the graph where it is labelled amosite, demonstrated a somewhat higher risk than that from pure chrysotile exposures in textile production; however, in asbestos insulation work where the exposure was to both chrysotile and amosite, the unit exposure risk was lower. In general, no substantial difference was seen in unit exposure risks where some crocidolite was present, compared to circumstances where it was not. However, no unit exposure risk values exist for pure crocidolite exposures. In contrast to lung cancer, there would appear to be some greater risk of death from mesothelioma in circumstances where the exposure is predominantly crocidolite asbestos, compared to those where the exposure is predominantly chrysotile and/or amosite. There is for example, little difference in the risk of pleural mesothelioma between individuals exposed to chrysotile and amosite or mixed fiber exposures: there is, perhaps a two to three times greater risk in individuals exposed to crocidolite. There is little risk related to peritoneal mesothelioma associated with chrysotile exposures. There is a risk in both amosite and crocidolite exposures, although the risk of peritoneal mesothelioma in those circumstances is generally less than that seen in pleural mesothelioma. In the case of the peritoneal mesotheliomas, the statement that I made is tempered by the possibility of inadequate diagnosis of the disease in many cohorts that have been studied, where only death certificate information on cause of death was utilized.
Using the above information on the age, dose and time dependence of lung cancer and mesothelioma, estimates of mortality in occupational exposures have been made (Slide).

This table lists the estimates which I have supplied to OSHA as part of their risk assessment in their proposal for a reduced asbestos standard. As can be seen, the risk at 2 f/cc, the current U.S. standard, is such that more than 6000 of 100,000 individuals exposed would be expected to die of asbestos-related cancers. I think this is an absolutely intolerable risk. The three columns there indicate: firstly, the risk of death of lung cancer in the exposed groups, using as a background the current lung cancer rate in the general population of U.S. males. The second column, that one starting with 82, is the mesothelioma risk. The third column is the risk of all other cancers, particularly gastrointestinal cancers and is taken simply to be 10% of that of lung cancer, because we have inadequate data on the full-time course of this type of cancer to make separate estimates of the risk. But it is a small contribution to the total value. Higher exposure limits clearly lead to much greater risks from a 45-year exposure, which in this case begins at age 25, but even at 0.2 f there is nearly a 1% increased risk of cancer for a 45-year lifetime exposure, so the lower levels proposed by OSHA are not without some risk.

Parenthetically, I might mention that OSHA has published a proposed standard for the construction industry to supplement the proposed standard for fixed-space industries. In that standard they have mentioned a time-weighted average concentration of 0.2 f/cc and have not mentioned the 0.5 f/cc earlier standard, so the implication is that that would seem to be the standard that OSHA would seriously consider adopting in the latter case, the case of the fixed installations.

In calculating these risks, the average value of the risks found in asbestos-using industries that I illustrated previously was utilized, it did not include the risk for chrysotile mining. It would be expected that that risk would be less than indicated here. If the exposure was to pure crocidolite, it would be expected that the mesothelioma risk would be higher than that indicated in this Slide. However these data are the best estimates for virtually all exposure circumstances in the United States, where mining is not a major industry and where crocidolite is used very little.

ENVIRONMENTAL ASBESTOS-RELATED CANCER

Turning now to environmental exposures and their control, we have made measurements of the asbestos concentrations in U.S. cities in earlier years. These have shown that the average concentration of asbestos in quarterly samples of 48 cities was about 3 ng/m$^3$ of air, that is 3 billionths of a gram per cubic meter of air, which would correspond roughly to a fiber concentration of 0.0001 f/cc, that is one ten-thousandth of a fiber per cubic centimeter. About 5% of the samples exceeded 10 ng/m$^3$ of air, in some cases one went as high as 90 ng/m$^3$ of air. That was taken in a city that had 4 uncontrolled factories operating at that period of time. In general, specific sources could account for exceptionally high concentrations. We have also measured air concentrations in circumstances where asbestos was used as acoustic or fireproofing material in buildings. The following Slides show some of the conditions that exist in some schools in the United States. This is a
school in New Jersey where, as the students went by, they would reach up and grab the asbestos, knocking it down and sometimes throwing it at one another. When such disruption occurred, fiber concentrations in excess of 2 f/cc (sometimes in excess of 5 f/cc) would exist for some period of time. In several schools, conditions of the asbestos surfacing material was completely untagged and there was no evidence of release. In the use of asbestos acoustic material there is a wide spectrum of conditions, in some cases it is exceptionally bad with material literally hanging down like Spanish moss and falling unto the students desks as they were eating, without aggressive action. The aggressive action in other cases would certainly lead to eye exposures. Average exposures without the release of such materials in these buildings averaged about 300 ng/m$^3$. A value of 2 000 ng/m$^3$ of air was found in one case. So we are looking at exposures without the disruption of material in schools with such damaged material being about 0.1 f/cc or more than 100 times background. And such findings have led to the efforts being made by the Environmental Protection Agency to induce school districts to protect school buildings, particularly when the material is in extremely bad condition, to abate such exposures. On the other hand, there are certainly places where the material is best left in place because it is providing no exposure at this time; it should better be managed by a program of watchfulness instituting appropriate controls, such that it would not be disturbed during maintenance and repair activities.

We have also measured asbestos air concentrations in and about buildings constructed of asbestos-cement products located in Puerto Rico which may have relevance to conditions elsewhere in Latin America, this has already come up. The following photographs show some of these buildings. This is a house that was built entirely of asbestos-cement material; except for the concrete slab, the roof, side-walls and the interior walls are made of cement containing asbestos. Entering some houses, it was often found that the material could be damaged; in some cases they would actually expand the rooms by cutting open the asbestos material to, in this case, make one room out of two rooms. The next Slide shows the fiberloose nature of the material at the cut. I do not think the individual who did that cutting had a nice device for extracting the dust that would become airborne, and I do not think he was aware of what precautions he might have taken to minimize the dust that would be released. We also sampled air concentrations in these homes, and in schools constructed of asbestos-cement products. This is a school, here again, some of the buildings that you can see on the right, both the ceiling and walls were of asbestos-cement. Additionally, this walkway was of asbestos-cement. We were not able to find any substantially elevated concentrations of asbestos in conditions where no recent activity had taken place in those homes that were largely of asbestos. In contrast, in terms of environmental concentrations, we found that these schools had very high concentrations of asbestos. The next Slide shows some of these data, where in the schools the samples ranged up to 49 ng/m$^3$. However, in the case of classrooms constructed of asbestos-cement products, concentrations as high as we have ever measured in the general environment were seen, with an average concentration of 1 300 ng/m$^3$ of air being found. Much higher concentrations came about because of what I mentioned earlier, rain wash-off from the roof onto the walkway and rain onto the walkway itself, had released a thin layer of fibers which then were brought into the classrooms by the students as they went
in after a rainy day. At the time, we recommended that the walkways be removed because they were a prime source of fiber exposure and that all other surfaces be covered with an appropriate coating so as to eliminate that potential source of asbestos.

The erosion of asbestos has also been identified in the Environmental Protection Agency in the analysis of rainwater used for drinking collected in the runoff from asbestos-cement roofing. Here water concentrations in excess of 100 millions fibers/liter were measured.

It is clear that asbestos exposures occur from the use of asbestos-cement products. The risk from such exposures in the general environment is certainly much less than that encountered in the workplace. Nevertheless, I think it is important to answer the questions that I asked at the beginning. Firstly, are there substitute materials available that would serve the same purpose as asbestos and be economically feasible? Are there other fibers available that would be equally effective, particularly for cement products? I think the efforts of the Swiss Eternit to eliminate asbestos from their cement products is an admirable step in accomplishing the goal of eliminating asbestos exposures.

Secondly, for existing structures containing asbestos, practical control measures should be identified and utilized in order to eliminate the potential exposures. These might include procedures for repair and maintenance of asbestos-containing structures and when water erosion is of concern, suitable coatings could be applied. Clearly, public awareness of the variety of circumstances where asbestos exposure may occur is very important. Individuals whose homes may have asbestos material in them should know that, and be aware of procedures that would eliminate or minimize the release of fibers. People should be told what is the appropriate paint to put on their structures and where they can get it, what precautions should be taken, and what masks may be utilized if the material is to be cut.

Finally, the last Slide shows the extrapolated risks from environmental exposure circumstances based on the linear dose-response relationships and data that I presented previously. These are risks (just like those of the occupational circumstances) for exposure to 0.01 f/cc and they are given according to age at onset of exposures. They happen to be for females in this case. Corresponding data for males were somewhat different because of the different smoking habits. These risks would correspond to approximately 300 ng/m³ of air, a concentration that was exceeded several times in the schools in Puerto Rico and occasionally in some other severely damaged schools in New Jersey and also in some commercial office buildings.

As can be seen, the risks per year of exposure are in the order of 1 in 10 000. This sounds like a very small risk and indeed it is less than the risk of accidental death from cars or other sources of accidents that children might be exposed to. However, when considering this risk, one must recognize that it can be shared by thousands of children in schools. Just consider a school building with 1 000 children with such exposures that has a 50-year lifetime and these risk estimates would suggest that there are likely to be some deaths from those exposures in that school building. I think this provides justification for the removal of such materials or certainly their enclosure or abatement of the exposures, by school districts
where severely damaged circumstances are observed. But the concept that low
risks, even risks lower than others that have been acceptable, should be neglected
is wrong; a low risk may, in fact, translate into a substantial community risk. This
is a risk that, in many circumstances, could be abated at a relatively low cost.

Today, I have listened to various heated discussions about the health effects of
asbestos. I was delighted to have come to this meeting, because I thought it would
be one in which the problems of how to control asbestos exposure in developing
countries would be discussed. One could focus on avoiding the experience that we
are suffering in North America and on applying what we have learned to South
America. However, I have not heard substantial discussions pinpointing existing
problems of the use of asbestos. I have not heard how problems that do exist
might be attacked in a practical way. Instead, I have heard substantially distorted
health studies, denials of the problems of asbestos in existing structures and pro-
ducts, and denials of the problems of continued use. I think this is unfortunate
because the fact that there are problems with the use of asbestos should be recog-
nized, and must be recognized, if asbestos is going to be used safely. There are
problems in the workplace, even problems making asbestos so-called locked-in
fibers or encapsulated fibers. There are problems with the end use of that material.
I think that in Latin America there are also problems where friable asbestos is
used. Now, unless these problems are addressed in a realistic way, there is is going
to be a greater effort to ban asbestos and the consequences would be unhappy for
all concerned. I think the issue of the schools in Puerto Rico illustrates that well.
When we looked at them we saw that there was some asbestos exposure in those
schools. At that time it would have been difficult to even estimate the risks, but
now we have calculated some hypothetical risks that are very, very uncertain.
Whether the risks that I gave on that slide are correct or not, whether they are
higher or lower, cannot in fact be determined by any experimental data. But there
are risks that could have been eliminated at relatively low cost. Those school
buildings could have been painted. A program could have been developed telling
the population: “we see this problem, we have used this procedure to take care of it
and we are going to monitor it in the future so as to assure that your children are
not being exposed to any unnecessary quantities of asbestos”. Yet, little was done
in that respect, instead, political pressure developed and the schools were closed
down.

If the problems that exist now are not fully addressed and the people are not
assured that everything possible is being done to eliminate unnecessary exposures
to asbestos, the response will be to ban asbestos, which I think would be an unfor-
tunate thing.
DISCUSION/DISCUSSION

Cejudo (MEXICO)
Considero que debemos saber cuáles son los usos adecuados que los productos pueden tener. Por lo que se refiere a las escuelas en Puerto Rico, creo que hay un uso que realmente nunca se debió haber llevado a cabo. Nunca se debe hacer un piso de asbesto-cemento porque el asbesto-cemento se puede romper. Hay una diapositiva que no entendi muy bien porque se ve un panel como de fibras sueltas, friables, y no de asbesto-cemento; con esa fotografía yo dificilmente puedo creer que es asbesto-cemento. Si así fuera, tiene que haber alguna falla tremenda en el fabricante, porque no es posible que eso suceda. El asbesto-cemento que nosotros conocemos y la experiencia que tenemos, es que a través del tiempo, se vuelve más resistente a la intemperie, el agua lo hace todavía más resistente y sucede totalmente lo contrario de lo que usted nos explica que aconteció en Puerto Rico. ¿No quisiera usted hacernos el favor de aclarar esa situación?

Nicholson (U. S. A.)
Yes, the particular cut surface that I showed you was from an asbestos-cement panel that was that thick and had been made of two sheets with a kind of an asbestos-cement corrugation in between them. Whether you believe it or not, you would just have to accept that you could have asbestos-cement panels whatever type that you manufacture, and it was not Eternit’s. The point is that the individual in that house wanted a better, wider space to live in and so he just took a hand saw and cut it. The point I am making is that when these products are put on the roof, they will have to be sawn away with some device; the people are going to saw away inside their homes, and they need to know what the consequences of that are going to be, if they are going to disturb the fibers, and they are going to release them into the living rooms and that there are ways to prevent that. You cannot prevent it easily, unless unique circumstances, where you got a project and you have available in that project an exhaust-ventilated saw, but you could at least have the worker understand that he should wear a respirator and should undertake very thorough cleanup operations afterwards. The fact is that none of these people know any of that information and that is what I am wanting to get across.

Cejudo (MEXICO)
Tiene usted razón y creo que nosotros debemos enseñar o buscar aconsejar continuamente a toda la gente que corta el asbesto-cemento. Afortunadamente, la experiencia que tenemos en nuestro país es que la mayoría de la gente, como es de bajos recursos, utiliza un cuchillo o un serrucho de mano, lo cual permite que las fibras no sean esas fibras finas que vuelan por el ambiente y que son las más peligrosas cuando se usa una sierra eléctrica. Quiero hacer notar que ese uso específico que se llevó a cabo en Puerto Rico definitivamente no estuvo bien hecho. Quizás el fabricante no sabía cómo hacer el producto, o no sé qué sucedió. Normalmente tenemos una fibra de asbesto por 8 partículas de cemento, o sea que la fibra está totalmente envuelta. Es como tener una varilla de acero dentro de una losa de concreto, yo no veo la manera como pueda salir.
Nicholson (U. S. A.)

Well. I am sure that if one cut asbestos-cement and one takes fiber measurements (I have seen such measurements), individual fibers are released. I do not think you could say that whatever is released will not involve exposure to individual fibers. I think we are arguing about the wrong thing. We are in essence in agreement about the right thing, which is public awareness: that at the end of the line, the people having to live with this material have to know what they might do to assure that any exposures (whatever they are) can be minimized, and that activity is a relatively simple one. I think in most instances, paint would do wonders for many of the exposure circumstances. If it is possible to paint these materials with very nice coatings that would last for years. I think it should be done; so that if it is going to be in a house, you would do much better selling the stuff as well. I do not see this being done and that is what I am pleading for.

Pigg (U. S. A.)

Dr. Nicholson, I am not a medical doctor or a statistician as you are, and I would like to make a comment and then two questions. As you know, in 1978, the Government released a draft document that was entitled “An estimates paper on the occupational risk to asbestos”. 64 000. I recall, was the number per year. Not long after that, during an OSHA hearing on the Generic Cancer Policy, an expert dropped that number to 40 000 per year. Today Dr. Markowitz refers to your estimate now of 9 000 per year. One study by Doll and Peto, that was done for the U. S. Government, Office of Technology Assessment, lists one to two thousand per year (somewhere in that area, under 5). There is another study by Dr. Hall (NIEHS) which is also under 5.

My question is: all of you are very distinguished scientists in your work, but as a layman I am a bit confused about these numbers and I wonder if the statement that was made by the National Academy of Sciences about risk assessment, “that they are noted by their pervasive uncertainty”, might be something that ought to be addressed.

Now one final question: in your slide you made reference to the study that you had done for OSHA and you made the statement that you estimated an over 6 000 risk at a 2 fiber standard and you said that would be intolerable. we would all agree with that. So with my limited understanding of the basis for the development of risk assessment, I just wonder: is it not directly related to what studies might be selected for the use and development of the risk assessment, whether or not those studies use estimated exposures or whether they use actual exposures? And then also, whether or not allowances or consideration are made for smoking?

Nicholson (U. S. A.)

You asked about a 15 minute question. First let me talk about the risk estimates. I showed you a slide with the uncertainties in individual measurements, and all the data for which it was possible to make such estimates, so there are some measurements of exposure involved. It may have been the work circumstances in recent years that were felt to reflect the actual work circumstances in earlier years. it may have been particle counts rather than fiber counts, but the best effort was made to extrapolate, to convert to fiber exposures. The exposure estimates were not the limiting factor on the uncertainty and in many of those
graphs there was many more larger, fat bars than skinny ones, due to the statistical and methodological uncertainties in the particular study. The uncertainties are very large, in an individual study they could extend, there could be two orders of magnitude in that risk. I listed the best estimates of that risk. Taking those best estimates and just doing the statistical analysis of the result that you get, I said it was roughly 0.01. The uncertainty in that value of 0.01 is (on averages) of about a factor of 3. It could be 3 times higher or it could be 1/3 as low, as an average value for all the exposure circumstances that we have looked at. Then go to a single exposure circumstance, it could even be greater; it could be as much as a factor of 10. So we have to recognize that there are very large uncertainties that we will never be able to improve upon because of the lack of appropriate data, because of the great variability that occurs from fiber size, fiber composition, etc. They exist and we have to live with them. We would assume that the methodology that led to the sixty some more thousand figure is correct. I think the methodology that I utilized and other methodologies that have been utilized and give roughly the same answers are more correct. Since I made that estimate (roughly right now 9 000 deaths per year) the figures rise close to 10 000 in the mid-1990's and then fall thereafter. The integrated projected cancer mortality from all past exposures before 1980 would be 350 000. The checks that one has are that the overrisks that are estimated (I can show you the slide afterwards) correspond very closely to the mesothelioma risks that can be attributed to occupation in males in the United States now, as seen in the SEER program. I think the risks of different people where basically the agreement is within a factor of 2, are within a range of the uncertainties of the assumptions made. and the point is not that my risk of 9 000 is right or that Hogan and Hall's of 12 000 or somebody else's 5 000 is; it is that the bulk part is roughly the 10 000 level; it is not hundreds, it is not hundreds of thousands, it is of that order. This provides a touchpoint for the social problem of how to deal with those deaths as they occur and what to do about compensation and all the social problems that now exist from those past exposures. I think it does give a sufficiently accurate measure of that problem so as to undertake the necessary social action for the potential disease that is coming.

Sandoval (CHILE)

Yo quisiera hacer un comentario sobre cómo se están dando diversos puntos de vista en esta reunión. Yo creo que la primera cosa en que estaríamos todos de acuerdo es que el asbesto representa un riesgo para la salud. La primera presentación que oímos hoy día fue sobre el uso seguro del asbesto, o sea que si es necesario usarlo, hay modalidades de uso seguro. Yo creo que eso es de lógica elemental. Si hay modalidades de uso seguro, es porque hay formas en que se usa el asbesto que producen enfermedades, porque aquí daría la sensación de que se está tratando de decir que no hay enfermedades relacionadas con el asbesto. Yo creo que eso sería una sensación que no beneficiaría el interés de los aquí reunidos, que es precisamente una orientación para cómo mejor trabajar el problema de la seguridad en el uso del asbesto, o de no uso, cualquiera que sea la conclusión a que lleguemos. Quisiera preguntar al Dr. Glenn ¿por qué la Administración de Higiene y Seguridad de los Estados Unidos está disminuyendo otra vez la concentración máxima permisible en los sitios de trabajo a valores entre 0.2 y 0.5 f/cc? ¿Esto está basado en su efecto carcinogénico o en el efecto fibrogénico?
Glenn (U. S. A.)

The OSHA proposal to lower their standard to either 0.2 or 0.5 fl/cc is largely to protect from the carcinogenic effect. But again, as mentioned in their proposed hearing, in their proposed rule-making and in my talk, they still support the case that even at a 0.2 level, they will not be totally protective of the cancer induction.

I was just going to make a comment that can actually wait for the cocktail party but, it has to do with the panels that were used in Puerto Rico. I think that actually it is not only a use problem, but also a quality control problem, and the industry people would agree. We had a similar problem that we evaluated in the Philippines and also in Thailand, where Cambodian refugees were living in temporary housing built out of asbestos panels. The manufacturer of the panels in the Philippines had gotten a very good price on some crocidolite asbestos and so they had increased their composition of crocidolite to a very high percentage. The weathering effects of the panels were causing some degradation and again it was a manufacturing error, rather, as much as a user error also.