PLAINTIFF'S
EXHIBIT
FD-199

PRESENT THRESHOLD LIMIT VALUE IN THE U.S.A. FOR ASBESTOS DUST: A CRITIQUE

E. L. Schall

Occupational Health Program, New Jersey State Department of Health Trenton, N. J.

The present threshold limit value for asbestos dust in the U.S.A. is 5.0 millions of particles per cubic foot of air for a daily eight-hour exposure, 40 hours per week. This value was adopted many years ago by the American Conference of Governmental Industrial Hygienists and reaffirmed at the annual meeting in April, 1964.[1] It refers to airborne concentrations of asbestos dust which represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse affect. However, threshold limits should be used as guides in the control of health hazards and should not be regarded as fine lines between safe and dangerous concentrations. These limits are based on the best available information from industrial experience, from experimental human and animal studies, and when possible, from a combination of the three.

Referring to the *Documentation of Threshold Limit Values* published by the American Conference of Governmental Industrial Hygienists[1] we learn that the basis for the threshold limit value of five mppcf for asbestos dust results from studies conducted by Miller and Sayers which showed that intraperitoneal injection of amosite, chrysotile and crocidolite in guinea pigs produced the reaction of an inert dust.[2] Vorwald, Durkan, and Pratt confirmed this for short fibers (under three microns) but observed that long fibers produced a fibrous reaction.[3] Continuing unpublished work by Gardner, these workers demonstrated that long fibers (20 microns and above) produced peribronchiolar fibrosis in lower animals, and developed evidence that this resulted from mechanical rather than chemical action.

That exposure to asbestos is associated with development of a potentially disabling pneumoconiosis in man has been amply demonstrated by industrial experience. The present threshold limit relates to the prevention of asbestosis. It was recommended by Dreessen, Dalla Valle, Edwards, Miller, and Sayers after study of 631 employees in three asbestos textile plants using chrysotile. Only three doubtful cases of pneumoconiosis were found in those exposed to dust concentrations under five mppcf, whereas numerous well-marked cases were found above five mppcf. Counts were from impinger-collected samples in ethyl alcohol and distilled water. Both fibrous and nonfibrous particles were counted, but the latter greatly predominated. While chemical analyses of collected samples of airborne dust corresponded to those of settled dust samples, it is believed that dust counts of particulates by conventional methods can be expected to give only an indirect

measure of the
of long fibers.
When consid
is pertinent to
tile Industry w
the beginning
be given to oth
bestos dust exc
The study wa
is used in man
of plant has no
grades, sizes ar
tilation system
environmental
the time of th
to use chrysotil
poses. That wa
nadian Asbesto
Again on page
asbestos used i
per cent comes
Russian and Au
In textile wo
fibers as well as
The asbestos
American. This
textile plants. P
from American
countries but i
more generally
ize in the produ
practice." If th
today, we would
ish factories. W
is made, it sho
Page 7 states "
tos textiles proc
tion could be m
It is believed
piece and objec
brated was emp
as mentioned in
Dalla Valle, *Th*

8000 1028

80.32

PRODUCED BY FORD

measure of the *risk of asbestosis* because of the great relative importance of long fibers.

When considering the value of five mppcf resulting from this study, it is pertinent to remember that *A Study of Asbestosis in the Asbestos Textile Industry* was published in August 1938. The study was limited from the beginning to the disease asbestosis and no consideration appeared to be given to other possible diseases which may result from exposure to asbestos dust excepting possible complicating tuberculosis.

The study was limited to textile plants only. At the present time asbestos is used in many other industries. The utilization of asbestos in this type of plant has no necessary relationship to its use otherwise since different grades, sizes and varieties might be used. Different types of exhaust ventilation systems possibly served other kinds of machinery under varying environmental conditions than was found to exist in the textile plants at the time of the study. It should be noted, too, that textile plants tend to use chrysotile only since this fiber is much more suitable for textile purposes. That was true in this study since on page 19, footnote 2 states "Canadian Asbestos (chrysotile), the asbestos used in these factories. . . ." Again on page 3 is the statement that "Approximately 90 per cent of the asbestos used in these plants is obtained from Canada. The remaining 10 per cent comes from Arizona or South Africa, and, infrequently, from Russian and Australian sources."

In textile work there is a tendency to use cleaner fibers and more flexible fibers as well as longer ones.

The asbestos textile industry studied by Dreessen *et al.* was entirely American. This does not allow conclusions to be drawn with regard to other textile plants. Page 15 states that "British practice differs in many respects from American practice. The same type of machinery is used in both countries but in British factories, dust-control equipment seems to be more generally used than in American factories. British factories specialise in the production of fine yarn and this involves numerous differences in practice." If the textile plants in this country were to produce finer yarn today, we would expect that the practices would differ from those in British factories. When a batch of asbestos fibers consisting of various blends is made, it must be mixed with cotton before it can be spun and woven. Page 7 states "As a rule, from 5 to 15 per cent by weight of all the asbestos textiles produced in this country is cotton." Page 43 states "No distinction could be made between cotton and asbestos fibers."

It is believed that an ordinary microscope provided with a suitable eyepiece and objective and fitted with an Abbe condenser, and properly calibrated was employed to count dust particles using the light-field technique as mentioned in the bibliography on page 118 number 2 (Bloomfield and Dalla Valle, *The Determination and Control of Industrial Dust*). Thus,

8000 1029 PQ

PRODUCED BY FORD

there was no separation of the type of particles studied so that stone dust, cotton dust and other particles were counted. No count was made of very small particles beyond the resolving power of the optical microscope or of such particles which now can be seen using a Kohler light source instead of the ordinary small electric microscope lamp.

There are considerable difficulties in separating each process even within the textile plant. Such difficulties are compounded by the contiguity of different operations, the particular type of activity of the plant at the time of sampling, one loom or many, etc. On page 26 it is noted that counts may vary even with one operation, with the different speeds of the machine (page 27), with the grade of material used (page 28), the nature of weaving requirements (page 28) and with wet or dry weaving (page 29). The counts may vary with the end product (page 29). It should also be noted that the counts were made against a constant background count (page 30). We now know that this cannot be ignored since cases both of asbestosis and neoplasia associated with asbestosis have been recorded following the minimal exposure of community environment.

Variations in the nature of the dust were not considered. This may have played a significant role in this study. For example, of the four plants investigated, two converted crude asbestos into yarn and woven goods while the other two purchased yarn and ended with finished goods (pages 3-4). The size of the plants varied and the size and number of processes usually make a difference in environmental conditions found. Two were large and two were small (page 16-17). The number of employees varied from 32 in the smallest to 281 in the largest. Tables 2 and 3 on page 20 and figures 13 and 14 on pages 21 and 22 show that while the chemical composition of the dust did not vary, the gross appearance did in each of the occupations. However, this variance was not allowed for and all dusts were lumped together. Figures 13 and 14 also show that the dusts at each occupation were different. Pages 22, 23, 48 and 50 showed differences in the proportion of fibers to particulate matter in the dust. Presumably much of the particulate matter was serpentine rock dust which has been reported to be innocuous. It is also known that the rock dust in the Canadian chrysotile area has a very low silica content which would correspond with the innocuous nature of serpentine dust. Inasmuch as chrysotile is now being supplied much cleaner, with a consequent change in the per cent of particles and fibers in any dust derived from it, the same count might now have different meaning.

It is not commonly appreciated that the five mppcf indicates a total count, including background dust which may vary greatly including cotton, rock dust, asbestos fibers, etc. On page 23 is stated "The measurement of dust particles suspended in the air of asbestos textile plants is difficult because of the presence of both asbestos and cotton fibers. The differentia-

tion of these fi
when the fiber
jet apparatus
estimate the p
technique coul
Table 4 on
in the samples
twisting, cardi
26 per cent in
phenomenon m
retention whic
Thus, if many
is no insurance
per cent will be
At the time
counts observe
before. In two
presumably th
However, in o
examination be
Page 32 state
pations in plant
than prior to e
approximately
by workers wi
though an effor
workers, a maj
personnel chan
unusually low a
workers with le
try and an abno
or more in this
male industrial
than it is in 14
made similar st
on page 173 "
with Dr. Lanza,
diffuse fibrosis
seemed to have
180 we find "Me
high concentrat
nine years, and
tration, fibrosis

8000 1030

PRODUCED BY FORD

tion of these fibers under the microscope is not always possible, especially when the fibers are short and fine. Several samples obtained with the Owens jet apparatus were examined with a petrographic microscope in order to estimate the proportion of asbestos and cotton fibers, but no satisfactory technique could be developed for this purpose."

Table 4 on page 23 demonstrates that very few fibers were encountered in the samples collected. One to eight per cent were observed in crushing, twisting, carding, and picking operations, while 12 per cent in one plant, 26 per cent in another were present in weaving operations. A biological phenomenon might have relevance here; there is frequently a differential retention which varies with the concentration of the inhaled material. Thus, if many fibers were inhaled and only a certain per cent retained, there is no insurance that with a small number of fibers inhaled only a small per cent will be similarly retained — it may be very much more.

At the time of the study, correlation was made with disease and dust counts observed, with exposure presumed to have taken place 5 to 15 years before. In two of the three plants there had been no major change and presumably the dust counts were unchanged from the onset of exposure. However, in one plant exposure was probably higher at the time of the examination because of plant expansion than when men were being exposed. Page 32 states "Hence, it may be assumed that the exposures of all occupations in plant B following carding were probably higher during the study than prior to expansion." About 15 months before this study was begun, approximately 150 workers in these asbestos textile factories were replaced by workers with little or no previous asbestos exposure (page 46). Although an effort was made to examine as many as possible of these former workers, a majority could not be examined. Partly as a result of these personnel changes, the group of employees examined in this study had an unusually low average age. There was an abnormally large percentage of workers with less than five years' employment in the asbestos textile industry and an abnormally small percentage of persons who had worked 10 years or more in this industry. On page 47 we read "The average age of white male industrial workers is less in the asbestos textile factories studied than it is in 14 other industries in which the Public Health Service has made similar studies." The book *Silicosis and Asbestosis* by Lanza[1] states on page 173 "In some roentgenograms of asbestos factory workers seen with Dr. Lanza, we noted that there was a direct progression into a terminal diffuse fibrosis without any nodular predominance. This terminal state seemed to have been reached in about 20 years on the average." On page 186 we find "Merewether and Price state that, with continued exposure to high concentration dust, fibrosis may be fully developed in from seven to nine years, and that death may result in about 13 years. With less concentration, fibrosis may not be fully developed for 15, 20, or 25 years." Yet,

8500 1091

PRODUCED BY FORD

in this study 333 of 511 employees have worked for less than five years! Only 66 of 511 had worked for more than 10 years. Seventy-three of 511 actually were employed for less than one year (page 47). Moreover, of the 511 studied, 76 were "controls" which consisted of 49 office workers and other employees "not exposed to asbestos dust" and 27 persons seeking employment in the asbestos industry for the first time (page 48). It should be noted that these were not true controls since on page 42 it is learned that even in these areas atmospheric dust concentrations ranged from 120,000 to 1,200,000. We now know that the effect of the environment is potentially very important. In Wagner's studies in South Africa most of the mesotheliomas occurred in association with environmental asbestos exposure and not in an industrial exposure.[6] Controls should have been sought in an area in which asbestos was not present at all. Thus, the baseline eight per cent cough and seven per cent dyspnea may be at least partly significant (page 52) and the findings with less than 25 million-particle-years of 14 per cent cough and 12 per cent dyspnea may have greater significance.

It is important to stress that the five mppcf value is based upon dust counts of all particles, fibrous and particulate, asbestos or not. Therefore, it cannot be presumed to represent a safe limit of asbestos in all applications.

The dust counts given were average. Yet the range was enormous and there is much biological evidence to indicate that peak exposures may be more important than constant overall background exposure since on these occasions the defense mechanisms of the lungs may be overwhelmed with huge retention at these particular times. Pickermen are listed in table 8 as being exposed to from 34.3 to 74.3 mppcf. However, during certain phases of their operations dust concentrations may range as high as 211 mppcf (page 26). In carding, for example, the exposure is listed in table 9 as 29.1 mppcf but when the machines are run slowly, concentrations were as low as 6.4 mppcf, and when operated at high speed, the concentration reached 139 mppcf. Similar statistics are available for other operations. Twisting frequently produced concentrations of over 20 mppcf and when low grade materials are used, the dust production is increased. Even the low counts associated sometimes with weaving must be accepted guardedly since proportionately there were more and longer fibers. Table 12 indicated counts of 4.7 mppcf, yet the dust created depended on many factors including the number of warp threads per unit of width, quality of material used, whether or not dry weaving was used, etc. In some weaving operations, counts of more than 140 mppcf were found. Although dry and wet weaving gave different results (table 12), operators were interchangable and the machines were often side by side. Counts also varied when all looms in a room were used or not, since the room size and exhaust ventilation were constant. What was woven also make a difference, brake lining weav-

8000 1032 PQ

PRODUCED BY FORD

as appeared to have lower exposures than broadcloth weavers but when heavy brake linings were woven, the counts again went up (page 29).

Medical data in the study suffered from several unavoidable difficulties. More than one-half of the male and female employees were under 30 years of age (page 47). As previously stated, this group had the lowest average age of *any group studied by the Public Health Service.* Table 22 states that the average age for the asbestos textile industry was 32.1 as compared with the post office and foundry industry of 37.8 and 33.1 for the rubber and chemical industries. One of the reasons, perhaps, for this was the fact that the asbestos textile industry was "of comparatively recent origin in this country. *Only one of the plants studied* had been in operation before 1920" (page 48).

This was a "point survey" of people at work with all the epidemiological difficulties it entails. In a survey of this type, the sick are missing and the dead are buried. Because of the relatively small number of individuals examined in each group, the percentage values as given "must be viewed with caution because they are based on small numbers of workers. This is particularly true in the groups with more than 10 years' employment," (page 58).

Finally, note should be made that Dreessen and his colleagues regarded the figure they *gave of 5 mppcf as simply a working figure for that time.* On the basis of their studies, they concluded that "5 million particles per cubic foot may be *regarded tentatively* as the threshold value for asbestos-dust exposure until better data are available" (page 91).

References

1. American Conference of Governmental Industrial Hygienists. 1964. Threshold Limit Values for 1964. American Conference of Governmental Industrial Hygienists. Cincinnati, Ohio.
2. Dreessen, W. C., J. M. Dallavalle, T. I. Edwards, J. W. Miller, R. R. Sayers, H. F. Smith & M. F. Trice. 1938. A study of asbestosis in the asbestos textile industry. Public Health Bull. No. 241. Washington, D.C.
3. Vorwald, A. J., T. M. Durkan & P. C. Pratt. 1951. Experimental studies of asbestosis. A.M.A. Arch. Indust. Hyg. Occup. Med. 3: 1-43.
4. Bloomfield, J. J. & J. M. Dallavalle. 1935. The determination and control of industrial dust. Public Health Bull. No. 217. Washington, D.C.
5. Lanza, A. J., Ed. 1938. Silicosis and Asbestosis. Oxford Univ. Press. London, England.
6. Wagner, J. C., C. A. Sleggs & P. Marchand. 1960. Diffuse pleural mesothelioma and asbestos exposure in North Western Cape Province. Brit. J. Indust. Med. 17: 260-271.

8000 1033 PQ

PRODUCED BY FORD

DISCUSSION

J. C. GILSON (*Pneumoconiosis Research Unit, Glamorgan, Wales*): I have a slight uneasy feeling about this meeting and it is a feeling I always have when attending this type of meeting, because I feel that it is really a form of the chicken and the egg. Everybody is unwilling to start using a particular method of counting or a particular instrument because they say we do not know whether it is the one that is the best. You never know unless you start using one consistently for a period of time, and observing the people whose environment you are measuring with a particular instrument. And it seems to me quite hopeless to go on expecting that some curious process which is quite undefined — perhaps the expectation that some animal experiments will somehow provide the philosopher's stone — will enable you to decide which instrument you should use.

Surely, the way to start is to choose a method at some time. I do not really think that any major change has been made in the last 30 years. If a decision had been made to make systematic measurements 30 years ago, with almost any instrument, you would by now, in fact, have got quite a long way to getting a dose-response relationship in this industry. I think Dr. Roach's suggestion that you should use, therefore, a gravimetric sampler of respirable dust has enormous merits because it does enable you to use it in many places where you cannot use any other kind of instrument.

We have heard earlier today that obviously the risks, taking the whole industry at the present time, lie very largely in the insulation workers. I cannot see how you would expect to be able to use a Royco instrument. I am not certain that Dr. Roach suggested you should, but, clearly, we need some instrument that has a very wide applicability throughout the whole industry.

C. G. ADDINGLEY (*British Belting and Asbestos Ltd., Cleckheaton, England*): I would just like to make one point. Dr. Roach said that in Britain mention is made of a safe limit of four fibers per milliliter, and that this is lower than the American limit. I would like to say that this is the first time that any limit has been specifically stated as far as the United Kingdom industry is concerned. We do not believe there is any safe limit. We have our ideas as to how low we can get and we are always striving to get right down to zero. We also have our ideas about the American limit of 5 million particles per cu. ft. as a safe limit. We know that there is no scientific basis for that limit whatever, and I think that if Dr. T. Hatch had been here he would have agreed with that, because it has been taken up with him in the past. Therefore, I would like it to be clearly understood that we do not accept four fibers per cc. as a safe maximum limit in the asbestos industry.

JOHN WELLS (*U.S. Rubber Co., Newnan, Ga.*): I would like to briefly

8000 1034

80473

PRODUCED BY FORD

review the work that we have undertaken. The asbestos textile mill in Hoganasville has been producing textile products since 1941. In 1941, using the Midget Impinger, dust counts were begun at many stations, many times a week and have continued to be obtained for some 23 years. During this time two people have done all the dust counting. The person who is now doing it was trained by the person who used to do it. I should say we do not know what we are counting. We are counting everything we get in the chamber, but we are counting in the same manner.

When this program started we hoped to get some meaningful results. In order to do that, we averaged out the number of counts that were obtained at each station during the year in terms of million of particles per cubic foot and multiplied them by the years. In so doing we arrived at a figure which we called million particles per cu. ft. years, and we did this with each worker, many of whom we have been able to follow.

We constructed a scattergram in which we placed on the ordinate the years of exposure, and on the abscissa the million particles per cu ft. years. Using this as a baseline (for whatever meaningfullness it had), when we got to a period of some 50 to 60 million particles per cu ft. years, we began to find people with pulmonary asbestosis. As the million particle per cu. ft. years mounted, we began getting more patients with pulmonary asbestosis.

In terms of what has been considered a safe dust count in the area, we started out with a theory — because everybody said it was so — that 5 million particles per cubic foot was a safe figure. Our own conclusion, as we began seeing what was happening in our own process, was that the only safe amount of asbestos dust exposure was zero and that the efforts in terms of achieving that lay basically in engineering, and, secondly, in education. But as far as a safe level of asbestos dust is concerned, our own conclusion in Hoganasville, Ga., is that there is no safe level. The safe level is nil and anything above the safe level represents [illegible]

A. COUCH (*University of London, London, England*): I should like to say that the standards which we mentioned, four fibers per milliliter or 5 million particles per cu. ft., are simply standards, although I hope I did not use the word "safe." These are standards which are actually used, although they are not ever expressed as being safe standards. A further standard has been mentioned of 50 to 60 million particles per cu ft. years. I suppose this is the equivalent of some 2 million particles per cu ft. concentration. This would be another standard which might be used but it is not necessarily a perfectly safe level of dust.

L. SILVERMAN (*Harvard U., Boston, Mass.*): I have had some experience in specific uses of asbestos; in particular the asbestos tile industry which is a major consumer of asbestos fiber. With just a few simple applications of control such as switching from jute bags which were shaken out by the worker to be shipped back to the plant to paper bags which retain the

moisture in the fi
conveying system
has been eliminat
were used and al
going to the pap
was installed, it

8000 1035 PQ

PRODUCED BY FORD