Bell Laboratories

Exposure to asbestos fibers while drilling ebony power boards

Cases 48102-1 Asbestos
48100-1

date: June 7, 1974

from: W. J. Schreibeis

PLAINTIFF'S EXHIBIT

SWB-285

MEMORANDUM FOR RECORD

In a letter of April 26, 1974, J. P. Dunn, M.D. Assistant General Medical Director, WECo., requested a study be made of the exposure to asbestos fibers of an individual drilling ebony power board. On May 22, 1974, the Rolling Meadows, Illinois facility of WECo. was visited for the purpose of evaluating the exposure of an employee drilling ebony power boards in a simulated central office environment.

Arrangements were made by Mr. A. A. Skriptunas, WECo. Rolling Meadows, to set up a simulated central office installation and to provide the material and the installer. Mr. V. Hudson, an employee at Rolling Meadows, had at one time worked as an installer in central offices and had actually made installations on ebony power boards on numerous occasions. He stated that the drilling of holes in ebony power boards to accept additional fuse posts was a very brief and infrequent operation. This operation was restricted to midnight to 6 a.m. because of the possibility that operating power could be lost in the office due to an accident on the power board. Thus, the typical exposure in a workday would be one five minute drilling period followed by a brief cleanup. An installer might be expected to do this job once or twice a year. No other reason was given for drilling ebony power boards.

The ebony board is described in "Impregnated Asbestos Composition Panels," Western Electric Co. Material Specification [illegible], Issue 5, February 28, 1974, "1. Scope. The material is an asbestos and portland cement mixture pressed into a hard, uniform panel and impregnated with a bituminous dielectric. It is intended for use as a panel for electrical switchboards." According to Miss Celine Paul, Manufacturing Engineering, Chicago, the panel contains [illegible] to 40% asbestos.

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Sampling Method

Sampling was performed in accordance with the NIOSH[1] procedure outlined in Appendix I Air Sampling Methods, pages VIII-1 to VIII-8 (see attached reference). Air was drawn through a 37 mm diameter Millipore® filter disc MAWG 037 A0 Type AA white gridded filter mounted in a preassembled monitor. The rate of air flow was calibrated at 2.0 liters per minute as determined by use of a one liter buret as a primary standard before and after the survey.

Two MSA Monitaire® Samplers Model S with Approval No. 2F-2004 issued by the U.S. Bureau of Mines and equipped with a pulsation dampener were used as air pumps. The sampler was attached to the belt of the employee and was connected to the monitor via a clear plastic tube. The preassembled monitor containing a Millipore® filter was opened immediately prior to sampling and was pinned to the shirt of the employee. The filter assembly and air pump can be seen in some of the illustrations included in this report.

Sample Analysis

All samples and a blank were submitted to George D. Clayton and Associates. 25711 Southfield Road, Southfield, Michigan, for evaluation of the fiber count using the recommended method page VIII-6 of Appendix I of the NIOSH[1] document. The following are the details of the method they use:

"The sample preparation of Millipore® Type AA (membrane) filter samples consists of cutting out a preshaped section, placing it on a glass slide, dissolving it with a drop of clearing solution and finally covering it with a cover glass. The clearing solution is a 1:1 diethyl oxalate-dimethyl phthalate mixture containing 0.1 gram of pure membrane filter material per milliliter of solution. The filter material is added to reduce the rate of solution of the sample filter and thus minimize the migration of dust particles. As soon as the sample is cleared completely it is ready for examination."

"The fiber counting is accomplished using a 40X phase contrast objective and periplan 10X eyepieces equipped with a Porton reticle. The Porton reticle has a series of calibrated circles to which each fiber is compared. A minimum of 20 fields is examined to assure a representative count."

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[1] Criteria for a recommended standard.... Occupational Exposure to Asbestos, National Institute of Occupational Safety and Health 1972.

Test Procedure

A typical central office ebony power board panel is illustrated in Fig. 1. The job involved an employee drilling a set of holes in such a power board for installation of additional fuse posts.

The tests were conducted on a simulated central office frame on which were mounted three separate ebony power board strips. The strips consisted of (1) a 3 inch wide, 1 inch thick "hard" ebony board 46 inches from the floor (Fig. 2), (2) a 3 inch wide, 1 inch thick "hard" ebony board 23 inches from the floor (Fig. 3), and (3) a 3 inch wide, 5/8 inch thick "soft" ebony board 61 inches from the floor (Fig. 4). All three boards were bolted to a plywood back to simulate the actual installation. They had been randomly selected from a pile of scrap board and no information on the specifications was available. The determination of "hard" or "soft" was made by Mr. Hudson based on his experience. Mr. L. J. Dykstra, Manufacturing Engineering, Chicago, indicated that 1 inch thick "hard" ebony board is no longer stocked and the only thickness currently available in "hard" or "soft" is the 5/8 inch thickness. The thickness of ebony board available are 3/8, 1/2, 5/8, 1, 1-1/2, and 2 inch "soft" and 5/8 inch "hard".

The test room was "L" shaped 32 feet by 8 feet with a projection 14 feet by 14 feet and a height of 13 feet and normally functioned as an enclosed storage area for the loading dock. There was no air supply or exhaust system for the room, thus simulating a worse case. Mr. V. Hudson did all the drilling using a hand held 1/2 inch Thor drill at 500 RPM. Breathing zone samples were collected during a 15 minute period and included the actual drilling cycle (cleaning out of the holes and drill bit, checking the hole diameters and sweeping up the floor) and the time interval following the drilling during which the holes were checked and prepared for installation. The drilling was completed in 5 minutes or less, but the samples were continued for 15 minutes as recommended by NIOSH[1]. The tests were repeated without changing the test conditions or ventilating the room. Each breathing zone sample represents one complete drilling operation and simulates the extent of an installers exposure in the field. Continuous room air samples were collected during the entire tests for a total of 4 hours.

Results

The results are reported in Table 1. The general room air concentration of airborne fibers greater than 5 micrometers per cubic centimeter was 0.011 for the first hour, 0.016 for the second hour and 0.011 for the third and fourth hours. These samples were collected at nose level. The filter can be seen on the stand behind the man drilling in Fig. 2.

The breathing zone samples collected during actual work operations are samples Nos. 2, 3, 5, 6, and 8. The concentration of airborne fibers greater than 5 micrometers per cubic centimeter was 0.044, 0.080, 0.044, 0.067, and 0.097. Sample No. 8 was the last sample of this series and was collected while sweeping up the debris resulting from all the previous drilling.

Conclusions

The samples collected were designed to evaluate conditions found at the employees breathing zone during drilling and cleanup and in the general room air. All samples were within the requirements of the Occupational Safety and Health Standards, Federal Register, Vol. 37, No. 202, page 22142, paragraph "1910.93a Asbestos. (a) Definitions (2) Standard effective July 1, 1976. The eight hour time-weighted average airborne concentration of asbestos fibers to which any employee may be exposed shall not exceed two fibers, longer than 5 micrometers per cubic centimeter of air,... ."

Based on the results reported it is concluded that this simulated operation was completely within the OSHA requirements. It is recommended that this be verified in actual central office conditions.

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MH-8435-WJS-el

Copy to
Mr. J. P. Dunn, M.D. - WECo.

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Table 1. Airborne asbestos fiber during drilling of ebony power board at Rolling Meadows, Illinois, May 22, 1974

Sample No.	Time CDT	Duration Minutes	Sample Volume liters	Description	Asbestos Fibers > 5u/cc
1	9:27 a.m. 10:27 a.m.	60	120	General room air behind man drilling ebony board. Sample at nose level, during sample Nos. 2 and 3.	.011
2	9:52 a.m. 10:07 a.m.	15	30	Breathing zone (BZ) of man drilling 10-1/8 inch ϕ holes. Some holes enlarged with 1/4 inch ϕ and 5/16 ϕ drills. Ebony board "hard" 1 inch thick located 46 inch off floor.	.044
3	10:10 a.m. 10:25 a.m.	15	30	BZ of man drilling 4-1/8 inch ϕ holes; 4-1/8 ϕ alignment holes and enlarging to 4-9/16 inch ϕ. Ebony board "hard" 1 inch thick 23 inches off floor.	.080
4	10:28 a.m. 11:28 a.m.	60	120	General room air behind man drilling ebony board. Sample at same location as No. 1 collected during samples Nos. 5 and 6.	.016
5	10:32 a.m. 10:47 a.m.	15	30	BZ of man drilling 15-1/8 inch ϕ holes and enlarging 11 to 1/4 inch ϕ. Ebony board "soft" 5/8 inch thick 61 inches off floor.	.044
6	10:55 a.m. 11:10 a.m.	15	30	BZ of man drilling 8-1/8 inch ϕ holes and enlarging 4 to 9/16 inch ϕ. Final drilling slowed due to dull drill. Ebony board "hard" 1 inch thick 46 inches off floor.	.067
7	11:30 a.m. 1:30 p.m.	120	240	General room air in same position as sample Nos. 1 and 4 during sweeping of floor.	.011
8	11:33 a.m. 11:48 a.m.	15	30	BZ of man using push broom to carefully sweep up material from all the above drilling operations.	.097

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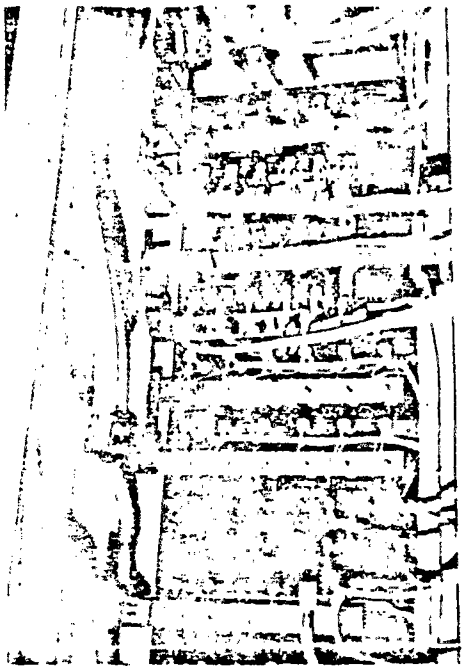


Figure [illegible] view of a central [illegible] of ebony power [illegible].

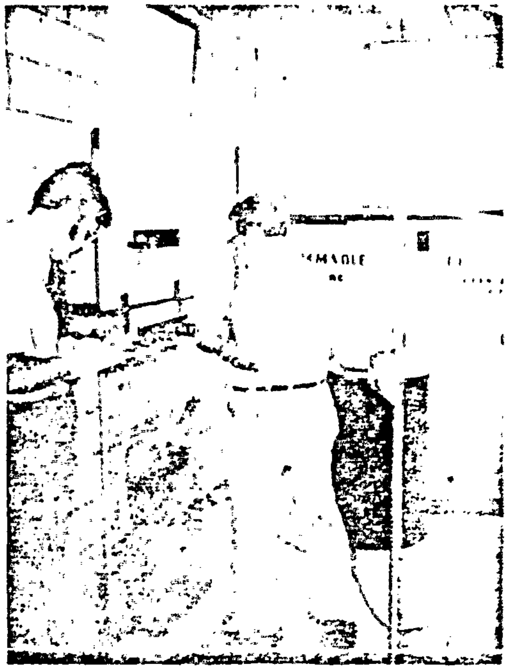
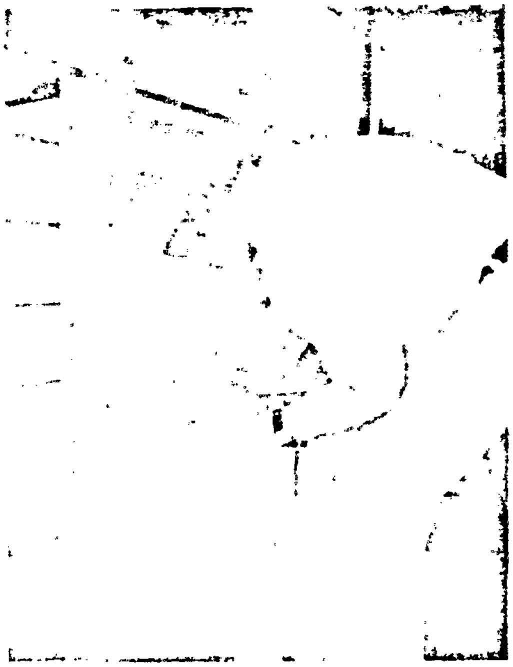
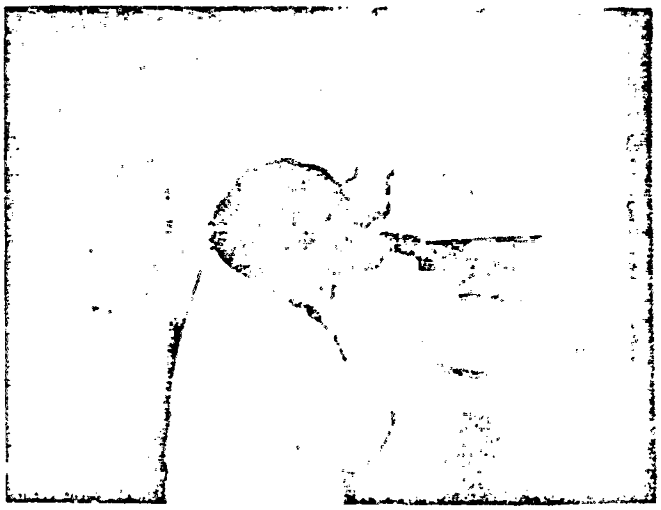


Figure [illegible] View of man dril[illegible] middle ebony power board [illegible] No. [illegible] and general room air sampler mounted on stand [illegible] operator ([illegible] No. 1).





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VIII. APPENDIX I

Air Sampling Methods

In the study of asbestosis conducted by Dreessen *et al.*[63] midget impinger count data were used as an estimate of dust exposure. All of the dust particles seen, both grains and fibers, were counted since too few fibers were seen to give an accurate measurement. The resulting count concentration was a measure of overall dust levels rather than a specific measurement of the asbestos concentration. This method was satisfactory at that time since exposures were massive and the control measures installed to reduce overall dust levels also reduced the asbestos dust levels.

As dust levels were reduced, it became necessary to measure the biologically appropriate attribute of the dust cloud. At equal levels of overall dustiness, the concentration of asbestos could vary considerably from textile manufacture (75-85%) to insulation (5-15%). Furthermore, if the limit were lowered below the 5 mppcf used previously and dust counts taken by the impinger technique, it would be necessary to consider the effect of background dust, which could be as high as 1 mppcf.

A number of methods for measurement of asbestos dust concentrations have been used in the NIOSH epidemiological study of the asbestos product industry.[73,74,75,76] Based on these data, the preferred index of asbestos exposure is the concentration of fibers longer than 5 μm counted on membrane filters at 430X with phase contrast illumination.[71,72] This index is utilized in the method adopted as the standard field sampling method by the Public Health Service.

Taken from: Criteria for a recommended standard... . Occupational Exposure to Asbestos, National Institute of Occupational Safety and Health 1972.

Fibers longer than 5 μm in length are counted in preference to counting all fibers seen in order to minimize observer/microscope resolving ,over variability. Furthermore, the British define a "fibre" as a particle, "of length between 5 μm and 100 μm and having a length-to-breadth ratio of at least 3:1, observed by transmitted light by means of a microscope at a magnification of approximately 500X."[62]

Although the British have refrained from standardizing on a single method of measurement, recent measurements have been performed by a method essentially identical to the fiber-count method described in detail below, and the British hygiene standards for use with their asbestos regulations are stated in these terms.[62]

Principles of Sampling

A dust sampling procedure must be designed so that samples of actual dust concentrations are collected accurately and consistently. The results of the analysis of these samples will reflect, realistically, the concentrations of dust at the place and time of sampling.

In order to collect a sample representative of airborne dust, which is likely to enter the subject's respiratory system, it is necessary to position a collection apparatus near the nose and mouth of the subject or in his "breathing zone".

The concentration of dust in the air to which a worker is exposed will vary, depending upon the nature of the operation and upon the type of work performed by the operator and the position of the operator relative to the source of the dust. The amount of dust inhaled by a worker can vary daily, seasonally, and with the weather. In order to obtain representative samples of workers' exposures, it is necessary to collect samples under varying conditions of weather, on different

days, and at different times during a shift.

The percentage of working time spent on different tasks will affect the concentration of dust the worker inhales since the different tasks usually result in exposure to different concentrations. The percentage can be determined from work schedules and by observation of work routines.

The daily average weighted exposure can be determined by using the following formula:

$$\frac{(\text{Hours X conc. task A}) \quad + \quad (\text{Hours X conc. task B}) \quad + \quad \text{etc.}}{\text{8 Hours (or actual hours worked)}}$$

The concentration of any air contaminant resulting from an industrial operation also varies with time. Therefore, a longer sampling time will better approximate the actual average.

With the following recommended sampling procedure, it is possible to collect samples at the workers' breathing zones for periods from 4 to 8 hours, thus permitting the evaluation of average exposures for a half or full 8-hour shift—a desirable and recommended procedure. Furthermore, dust exposures of a more normal work pattern result from the use of personal samplers. In evaluating daily exposures, samples should be collected as near as possible to workers' breathing zones.

Collecting Sample

The method recommended in this report for taking samples and counting fibers is based on a modification of the membrane filter method described by Edwards and Lynch.[71]

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The sample should be collected on a 37-millimeter Millipore type AA* filter mounted in an open-face filter holder. The holder should be fastened to the worker's lapel and air drawn through the filter by means of a battery-powered personal sampler pump similar to those approved by NIOSH under the provisions of 30 CFR 74. The filters are contained in plastic filter holders and are supported on pads which also aid in controlling the distribution of air through the filter. To yield a more uniform sample deposit, the filter-holder face-caps should be removed. Sampling flow rates from 1.0 liter per minute (lpm) up to the maximum flow rate of the personal sampler pump (usually not over 2.5 lpm) and sampling time from 15 minutes to eight hours are acceptable provided the following restraints are considered:

(a) In order to obtain an accurate estimate of the number of fibers the statistical error resulting from the random distribution of the fibers must be kept to an acceptably low level. Since fiber counts follow a Poisson distribution, a count of 100 fibers in a sample would have a standard deviation of $\sqrt{100}$ or 10 fibers or ± 10%. Thus the 95% confidence limits would be approximately 2 standard deviations or ± 20%. Since the 37 mm filter has an effective collecting area of 855 mm^2 and the projected field area of the Porton reticle is 0.005 mm^2, each field represents 1/171000 of the sample. Based on this ratio the following number of fields must be counted to measure the various limits in various sampling times:

*Mention of commercial products does not constitute endorsement by the Public Health Service or U. S. Department of Health, Education and Welfare.

Sampling Time Minutes	Flow Rate lpm	Number of Fields for 100 Fibers 0.2 fibers/ml	2.0 fibers/ml	10 fibers/ml
10	2	4350	435	91
15	2	2860	286	58
30	2	1430	143	29
90	1	1000	100	20
90	2	500	50	10
240	1	260	26	7
240	2	180	18	4
480	1	180	18	4

(b) Do not count a field containing over 20 fibers because in addition to the fibers being counted, there are also present a number of grains, which interfere with the accuracy of the count.

Based on these restraints, i.e., number of fields to be counted and maximum number of fibers per field, acceptable sampling parameters for the various limits are underlined in the above table.

The following conclusions may be drawn from this analysis:

(1) The short-term limit should be for a period of at least 15 minutes and preferably 30 minutes.

(2) The 2.0 fiber/cc limit may be evaluated over periods of from 90 to 480 minutes.

As many fields as required to yield at least 100 fibers should be counted. In general the minimum number of fields should be 20 and the maximum 100.

Mounting Sample

The mounting medium used in this method is prepared by dissolving 0.05 g of membrane filter per ml of 1:1 solution of dimethyl phthalate

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and diethyl oxalate. The index of refraction of the medium thus prepared is ND = 1.47.

To prepare a sample for microscopic examination, a drop of the mounting medium is placed on a freshly cleaned, standard (25 mm X 75 mm), microscopic slide. A wedge-shaped piece with arc length of about 1 cm is excised from the filter with a scalpel and forceps and placed dust-side-up on the drop of mounting solution. A No. 1-1/2 coverslip, carefully cleaned with lens tissue, is placed over the filter wedge. Slight pressure on the coverslip achieves contact between it and the mounting medium. The sample may be examined as soon as the mount is transparent. The optical homogeneity of the resulting mount is nearly perfect, with only a slight background granularity under phase contrast, which disappears within one day. The sample should be counted within two days after mounting.

Evaluation

The filter samples mounted in the manner previously described are evaluated in terms of the concentration of asbestos fibers greater than 5 µm in length. A microscope equipped with phase-contrast optics and a 4-mm "high-dry" achromatic objective is suitable for this determination. 10X eyepieces, one of which contains a Porton or other suitable reticle at the level of the field-limiting diaphragm, should be used. The left half of the Porton reticle field serves to define the counting area of the field. Twenty fields located at random on the sample are counted and total asbestos fibers longer than 5 µm are recorded. Any particle having an aspect ratio of three or greater is considered a fiber.

The following formulae are used to determine the number of fibers/ml:

$$(1)\quad \frac{\text{Filter area (mm}^2)}{\text{Field area (mm}^2)} = K$$

$$(2)\quad \frac{\text{Average net count X K}}{\text{Air volume sampled (ml)}} = \text{fibers/ml}$$

For example, assume the following: area of the filter used was 855 mm^2, counting area of one field under the Porton reticle was 0.005 mm^2; average net count per field of 20 fields was 10 fibers; and sample was collected at 2 liters per minute for 90 minutes: Then:

$$\frac{355\text{mm}^2}{0.005\text{ mm}^2} = 171{,}000\ (K)$$

$$\frac{10 \text{ fibers x } 171{,}000}{2{,}000 \text{ ml/min x } 90 \text{ min}} = 9.5 \text{ fibers/ml}$$

Calibration of Personal Sampler

The accuracy of an analysis can be no greater than the accuracy of the volume of air which is measured. Therefore, the accurate calibration of a sampling device is essential to the correct interpretation of an instrument's indication. The frequency of calibration is somewhat dependent on the use, care, and handling to which the pump is subjected. Pumps should be calibrated if they have been subjected to misuse or if they have just been repaired or received from a manufacturer. If hard usage is given the instrument, more frequent calibration may be necessary.

Ordinarily, pumps should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The accuracy of calibration is dependent on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. For laboratory testing, a 1-liter burette or wet-test meter should be used. In the field, a rotameter is the most convenient instrument used. The actual set-up will be the same for all of these instruments. The calibration instrument will be connected in sequence to the filter unit which will be followed by the personal sampler pump. In this way, the calibration instrument will be at atmospheric pressure. Connections between units can be made using the same type of tubing used in the personal sampling unit. Each pump must be calibrated separately for each type of filter used, if, for example, it has been decided to use a filter with a different pore size. The burette should be set up so that the flow is toward the narrow end of the unit.

Care must be exercised in the assembly procedure to insure adequate seals at the joints and that the length of connecting tubing be kept at a minimum. Calibration should be done under the same conditions of pressure, temperature and density as will be encountered. The rotameter should be used only in the field as a check if the diaphragm or piston pumps are not equipped with pulsation dampeners. The pulsating flow resulting from these type pumps causes the rotameter to give results which are not as accurate as that obtained with a burette or wet-test meter. Calibration can be accomplished with any of the other standard calibrating instruments, such as spirometer, Marriott's bottle, or dry-gas meter. The burette and wet-test meter were selected because of their accuracy, availability, and ease of operation.