MEDICAL SURVEILLANCE OF ASBESTOS WORKERS

Presented by

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at the

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A Standards Advisory Committee for Asbestos (OSHA) has recommended an exposure limit of two fibers greater than five microns in length per cubic centimeter. This proposal, based on a (National Institute of Occupational Safety and Health) NIOSH criteria document, would not be effective for two years, in order to allow the installation of the necessary engineering controls. This advisory committee, representing government, labor, and industry, also suggested that the future standard include a program of comprehensive medical surveillance which will be the topic of my discussion today.

According to the proposed recommendations, medical surveillance is required, except where a variance from the medical requirements of this proposed standard have been granted, for all workers who are exposed to asbestos as part of their work environment.

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For the purposes of this requirement, the term "exposed to asbestos" will be interpreted as referring to "time-weighted average exposures above 1 fiber/cc or peak exposures above 5 fibers/cc."

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The major objective of such surveillance will be to insure the proper medical management of individuals who show evidence of reaction to previous dust exposures, either due to excessive exposures or unusual susceptibility. Such medical management might include job placement, improved work practices, cessation of smoking, or specific therapy for asbestos-related disease or its complications.

However, medical surveillance cannot be a guide to adequacy of current controls when environmental data and medical examinations only cover recent works experience because of the prolonged latent period required for the development of asbestosis and neoplasms.

According to NIOSH criteria, medical surveillance should include pre-employment medical examinations of applicants, periodic medical evaluations of exposed workers, and other recommendations such as a comprehensive medical examination on termination of employment and the maintenance of medical records by the employer. First, let's talk about the components of the preplacement medical examination as recommended by NIOSH. In taking a medical history on a new employee,

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it is of special interest to know whether or not there was a past exposure to asbestos or other "fibrosis-producing" dust. Previous exposure, in conjunction with a history of cardiopulmonary or gastro-intestinal disease, might contraindicate the placement of a new employee in an area of asbestos exposure. Smoking habits are also an integral part of a medical history and may influence job placement since the peril of lung cancer from asbestos exposure is increased by smoking. In fact, tests conducted by Selikoff and Hammond have shown that asbestos insulation workers who smoke have 90 times the incidence of lung cancer compared to smokers with no asbestos exposure.

The second part of the preplacement examination would include a complete physical with special attention to pulmonary rales, clubbing

of the fingers, and other cardiopulmonary signs often associated with fibrosis in the lung. Laboratory tests should incorporate routine clinical chemistry, a chest roentgenogram (PA 14" x 17"), and measurements of pulmonary function. In the NIOSH criteria, the measurements of pulmonary function which are required include:

1) forced vital capacity (FVC), i.e., the greatest amount of air that can be expired after a maximal inspiratory effort, and
2) forced expired volume in one second (FEV_1), i.e., the fraction of the vital capacity expired in one second. The vital capacity (FVC) may be normal but the timed vital capacity (FEV_1) greatly reduced in diseases such as asbestosis, due to lower airway constriction and subsequent increased resistance to flow. Thus, if the results from a pre-employment examination revealed a pre-existing lung disease, placement of that individual in an area of asbestos exposure should be discouraged.

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In addition to a comprehensive pre-employment examination, periodic medical surveillance of asbestos-exposed workers is also a recommendation in the proposed NIOSH criteria. History and physical examination will be similar to that of the pre-employment examination. However, NIOSH criteria specify the frequency of chest x-rays and pulmonary function tests. These tests, to be performed at the employer's

expense, will be done every two years on all employees exposed to asbestos and annually on those individuals:

1) who have a history of 10 or more years of employment involving exposure to asbestos or,
2) who show roentgenographic findings (such as small opacities, pleural plaques, pleural thickening, or pleural calcification) which suggest or indicate pneumoconiosis or other reactions to asbestos, or
3) who have changes in pulmonary function which indicate restrictive or obstructive lung disease.

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Other proposed recommendations in the NIOSH criteria entail a comprehensive medical examination on termination of employment. This examination is to be performed on all workers exposed to asbestos and should include the previously mentioned components of the periodic medical examinations. Maintenance of all medical records of exposed employees is the responsibility of the employer; such records will be kept for a period to be determined by the Secretary of Labor in consultation with the Secretary of Health, Education, and Welfare. However, the present emergency standard for asbestos specifies that all records be maintained for at least 20 years. As far as access to medical records is concerned, the proposed criteria state that these be made available only to Health, Education, and Welfare and Department of Labor physicians and medical consultants, and physicians

designated and authorized by the employee. Whether or not the medical representative of the employer would have access to these records is not clear at this time.

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On the request of the Director of NIOSH, Dr. Marcus Key, the American Industrial Hygiene Association (AIHA) has submitted its comments on the proposed NIOSH recommendations which are to be incorporated into the proposed standard for asbestos. The AIHA had several reservations about the details of the medical surveillance program and has recommended the following changes:

1) Sputum cytology is of limited value and should not be included. Because of their sporadic appearance and, in the case of fibers, their relation to recent dust exposure, the AIHA was of the opinion that the quantitative assessment of asbestos bodies and fibers in sputum was not, in the light of present knowledge, a very useful procedure.

2) X-rays should include both a lateral and posterior-anterior view. The AIHA feels that periodic x-rays can be extremely beneficial in detecting early lung structure changes if a lateral, as well as a posterior-anterior view, is taken.

3) Medical records should be made available to those physicians to whom the employee releases the information, and to the employer's medical representative. Since the employer is responsible for the health of the employee, it was felt that his medical representative should have access to the medical records.

In reference to the proposed NIOSH recommendations on medical surveillance, the Industrial Union Department of the AFL-CIO has submitted its comments to the Occupational Safety and Health Administration. The NIOSH criteria on medical surveillance are acceptable to the union with the following qualifications:

1) Medical examinations should be paid for by the employer and performed by the physician of the employee's choice. The union feels strongly that the employee should have his choice of physicians and that examinations by a company physician might, in some way, jeopardize the job security or job placement of the employee.

2) All medical records and results of such examinations should be the property of the employee and released only to such persons as he chooses and to HEW who may not release them to the employer and who shall hold them under conditions of strict confidentiality. Again, the union stresses that an employer should not have access to such records in the event that he (the employer) might use them against the employee. Should this right of workers to confidential handling of medical information be incorporated into law, medical surveillance of exposed workers would be a difficult, if not impossible, problem.

In summary, I have discussed the proposed recommendations on medical surveillance which may eventually be incorporated into the new standard for asbestos. Whether or not all of these items will be incorporated is not known. However, most of the recommendations -- such as periodic medical examinations which include chest x-rays and pulmonary function tests -- are sound and should be used in monitoring workers exposed to asbestos.

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SLIDE #1

DEFINITION

THE TERM "EXPOSED TO ASBESTOS" WILL BE INTERPRETED AS "REFERRING TO TIME-WEIGHTED AVERAGE EXPOSURES ABOVE 1 FIBER/CC OR PEAKS ABOVE 5 FIBERS/CC."

SLIDE #2

OBJECTIVE OF MEDICAL SURVEILLANCE PROGRAM

1. PROPER MEDICAL MANAGEMENT OF INDIVIDUALS WHO SHOW EVIDENCE OF REACTION TO PAST DUST EXPOSURES DUE TO
   - EXCESSIVE EXPOSURES
   - UNUSUAL SUSCEPTIBILITY
2. CANNOT BE A GUIDE TO ADEQUACY OF CURRENT CONTROLS

SLIDE #3

PREPLACEMENT EXAMINATION

1. History
   - A. Past exposure to asbestos or other dusts
   - B. History of cardiopulmonary or gastrointestinal disease
   - C. Smoking habits

2. Physical Examination
   - Special attention to pulmonary rales, clubbing of the fingers, and other cardiopulmonary signs

3. Laboratory Tests.
   - A. Routine tests
   - B. Chest X-ray (PA 14" x 17")
   - C. Pulmonary function tests (FVC and FEV_1)

SLIDE #4

PERIODIC MEDICAL SURVEILLANCE OF EXPOSED WORKERS

1. CHEST X-RAY AND PULMONARY FUNCTION TESTS
   - A. PA - 14" x 17"
   - B. FVC AND FEV_1
   - C. EVERY TWO YEARS ON ALL EXPOSED WORKERS
   - D. ANNUALLY ON THE FOLLOWING WORKERS:
     - THOSE WITH $\geq$ 10 YEARS EXPOSURE
     - THOSE WITH X-RAY CHANGES
     - THOSE WITH PULMONARY FUNCTION CHANGES

2. HISTORY AND PHYSICAL EXAMINATION
   - A. CARDIOPULMONARY SIGNS OR SYMPTOMS
   - B. SMOKING HISTORY
   - C. EXPOSURE HISTORY

SLIDE #5

OTHER PROPOSED RECOMMENDATIONS

1. COMPREHENSIVE TERMINAL MEDICAL EXAM
   - A. ON ALL WORKERS EXPOSED TO ASBESTOS
   - B. SHOULD INCLUDE COMPONENTS OF PERIODIC EXAMS

2. MAINTENANCE OF MEDICAL RECORDS
   - A. FOR A PERIOD TO BE DETERMINED
   - B. EMERGENCY STANDARD STATES 20 YEARS

3. ACCESS TO MEDICAL RECORDS ONLY BY:
   - A. HEW AND DEPARTMENT OF LABOR PHYSICIANS AND MEDICAL CONSULTANTS
   - B. PHYSICIANS DESIGNATED AND AUTHORIZED BY THE EMPLOYEE

SLIDE #6

COMMENTS ON NIOSH MEDICAL SURVEILLANCE PROGRAM

1. AIHA

   A. SPUTUM CYTOLOGY OF LIMITED VALUE AND SHOULD NOT BE INCLUDED.

   B. X-RAYS SHOULD INCLUDE BOTH A LATERAL AND POSTERIOR-ANTERIOR VIEW.

   C. MEDICAL RECORDS SHOULD BE MADE AVAILABLE TO THOSE PHYSICIANS TO WHOM THE EMPLOYEE RELEASES THE INFORMATION, AND TO THE EMPLOYER'S MEDICAL REPRESENTATIVE.

2. AFL-CIO (INDUSTRIAL UNION DEPARTMENT)

   A. MEDICAL EXAMINATION SHOULD BE PAID FOR BY EMPLOYER AND PERFORMED BY PHYSICIAN OF EMPLOYEE'S CHOICE.

   B. ALL MEDICAL RECORDS AND RESULTS SHOULD BE THE PROPERTY OF THE EMPLOYEE AND RELEASED ONLY TO:
      - DESIGNATES OF EMPLOYEE
      - HEW (UNDER STRICT CONFIDENTIALITY WITHOUT RELEASE TO EMPLOYER)

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DISCUSSION OF PRESENTATION

Henry J. Trochimowicz

Q. This standard is started primarily for asbestos workers but what about other workers that have exposure to asbestos? I can see by the criteria what they are attempting to do, but how many people are we going to keep under medical surveillance?

A. Evidently it is going to be, at least the proposed recommendation says, an employee doesn't have to be a "so-called asbestos worker". If the employee had an exposure to asbestos greater than the definition (1 fiber/cc) or peak values above 5, then he is an asbestos worker under the law and the medical surveillance part of this law will apply to him.

Q. If this occurs just one day over a ten-year period, does that keep him under surveillance?

A. Dr. Zapp It's like, if you exceed the speed limit on one occasion only, if you don't get caught at that moment by radar, you're probably all right. But this is not defined as a man whose occupation statistically exposes him to asbestos, like an insulation applier, but rather any employee who is exposed to more than 1 fiber/cc time-weighted average. That, by definition, brings him under this program.

Q. What are some of the other dusts in addition to asbestos that you made reference to in your speech that should be considered?

A. Silica, coal dust, beryllium.

Dr. Zapp I think the important thing to note here is the direct head-on collision between the labor point of view and the management point of view (the AIHA point of view) in respect to the confidentiality of medical records.

Labor wants to keep them entirely secret from the employer. They have a reason for it. We don't understand that particularly in Du Pont because we've never operated in this way. Some of the trades represented by the international unions have been burned in the past. When the employer finds out that a man begins to show some signs of pneumoconiosis, he's fired--that's the end of it. These people are fighting for their jobs; they're protecting their positions. They're saying, don't let the employer know that I have spots on my lungs because if you do, he's going to fire me. There is a lot of bitterness there and there's been a lot of trickery, in a way, too. Under the Coal Mine Safety Act this issue came up and it was agreed that the employer would not take the chest x-rays. He would get them done by some independent person or a group of doctors who were consultants. They found out that some of these independent consultants had agreed with the employer that when they would do a chest x-ray, they would have two films in the cassette. The employee would get one and the employer the other one. As a result, the United Mine Workers simply boycotted the whole program and demanded that all x-rays be taken by the Department of Health, Education and Welfare. This fortunately didn't carry. HEW wouldn't pick that up. Now I think that there are some severe penalties for doctors who do take double films. The Regulations specifically say that you are not allowed to do it; it will be a violation of the law if you carried out this kind of trickery. Labor's demand has been backed that the information be confidential to them and to HEW. It is too bad that this kind of employee-employer relationship exists in these industries. Fortunately, we haven't had to contend with that kind of thing in Du Pont.

We wouldn't take advantage of labor on this point. I hope we can work out a satisfactory compromise because certainly in our own Company, it is essential in the workings of our medical program to let the doctor know the condition of his employee. I don't see how you can possibly justify having a plant doctor on the payroll if all of the labor people are going out and having their examinations done by someone else at the employer's expense. Without any access by the plant doctor to those records, the whole system will hang or fall on how they resolve this issue. The final decision will be made by the Department of Labor.

Q. Is there any possibility of a dual standard along these lines of physical examinations, one for the transitory type employee versus the permanent employee with Du Pont? Has there been any discussion on it at all?

A. I would interpret the proposed regulation to say that if you put a man into a position where he is exposed to more than 1 fiber/cc, that he has to come under the medical surveillance program. He has to be examined every two years on periodic examination until he has accumulated 10 years exposure, then he goes on an annual basis. I think that is the only difference.

Q. I'm interested in how you keep track of the asbestos worker who works with forty different contractors over a period of years. Are there any guidelines to follow?

A. Dr. Zapp You will notice that on the pre-employment examination, you will have to take a history of past exposure. I think it would figure into that. If he tells you that he's never had an exposure in his life before and you take him at his word, I think you're justified.

Q. How does this time-weighted average of 1 fiber/cc relate to the 2 fibers/cc previously discussed in the recommended standard?

A. Dr. Zapp Just like with noise, you have a noise limit that is safe for human exposure and you don't have to wear protection but at a somewhat lower level they will probably specify that you go into a conservation of hearing program which is medical surveillance, and that's what they're doing here.

RJH/neh
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SURVEILLANCE OF THE ATMOSPHERE

This section will indicate the method that is currently recommended by the Department of Labor to be used for evaluating environmental conditions of asbestos operations. But, before this is undertaken a review is to be made of the first method--impinger collection and the subsequent change to the present procedure of filter collection.

The first standard for controlling exposure to asbestos was recommended in 1938. This was based on a study by Dreessen, et al.* of four asbestos textile plants. The study was a joint effort by the U.S. Public Health Service and the North Carolina State Board of Health. A tentative limit of 5 million particles per cubic foot (mppcf), using the impinger collection technique and light field microscopy, was suggested. These investigators found numerous cases of pneumoconiosis where concentrations exceeded this value and only three possible cases when the concentrations were below this value. To recall a point, the latent period for development of disease is on the order of 10 to 20 years. In this study, only five persons had been exposed for more than ten years to concentrations from 0 to 4.9 mppcf. None of 39 persons exposed to concentrations below 2.5 mppcf showed evidence of asbestosis. In addition, only six of these 39 had been employed more than five years. Another factor of this study was the length of employment of these workers. Of the total 541 employed, 333 of them had worked less than five years in the textile industry, 66 were employed for as long as ten years and only two for more than twenty years. The average age of these textile workers was about 32 years.

*Dreessen, W. C., J. M. Dallavalle, J. T. Edwards, J. W. Miller, and R. R. Sayers, A Study of Asbestosis in the Asbestos Textile Industry, Public Health Bulletin #241, 1938.

The investigators recognized these limitations and stated, "5 mppcf may be regarded tentatively as the threshold value for asbestos-dust exposure until better data are available."

What about the impinger collection technique that was used in this study to determine the degree of dustiness? The standard impinger method was used because it was the accepted means for assessing the dusty trades. Although it still retains that function today, the trend is toward the respirable fraction and gravimetric means of assessment.

In the impinger, air is drawn through a glass jet set at a fixed distance from the bottom of a flask. The jet is immersed in water, alcohol, or a mixture of both. As the particles strike the bottom of the flask they become suspended in the liquid. Collection efficiencies vary but are generally on the order of 98% for particles greater than 1 to 2 μm.

The sample must be counted within 24 hours of collection. This is to reduce the chance of the particles to flocculate or for some small particles to go into solution. A sample is withdrawn from the collecting flask and placed into a counting cell. The counting cell should be no more than 1 mm and no less than 0.25 mm in depth. Settling times of the particles in the cell vary depending on their size, density, and the collecting media. The period to allow for particle settling varies from 20 to 30 minutes. All of the particles will not settle in this time span. Once started, the count must be completed within ten minutes. All of these factors have to be recorded in order to reduce the known variabilities when comparing studies involving dust counting.

The microscope used for the standard dust counting method can be a laboratory grade optical unit with a 10 power objective lens. Counting is done under light field techniques at about 100 magnification. The area to be counted shall be defined preferably by an ocular grid or by rulings on the counting cell.

This method requires very clean sampling and counting apparatus, a dust-free area for both preparation of equipment and for counting, experience with the techniques of dust counting, and patience. This is a very tedious procedure and experience with it is not gained overnight.

What are some of the inadequacies of this procedure when comparisons are made with the new method? In those studies very few fibers were seen in the counting cell. There are two reasons for this; they are: 1) the impinger is not efficient for the collection of fine particles (fibers) and 2) the resolving power of the microscope is not adequate to detect small particles.

The impinger has a collection efficiency related to the aerodynamic size of the particulate and is not efficient for particles with falling speeds less than 1 μm unit density sphere. Electron micrographs reveal that many of the airborne asbestos fibers are on the order of hundredths to tenths of a micron in diameter. In comparisons with other methods, it was noted that the impinger collected only about one out of every hundred airborne fibers. Of the total dust count, fibers made up usually less than ten percent of the total count.

In addition to not being able to resolve very small particles, the small fibers would not settle in the allotted time to that plane in the cell where particles are to be counted. This would also reduce the number seen during the counting period.

Impinger samples are not handy for long personal samples. This is primarily due to both evaporation of the absorbing media (alcohol) and the movement of the worker.

The confidence limits of a dust count improve, as the number of particles counted increase. Because only a few fibers were seen in impinger samples, it was decided to count all particles in the counting cell at the established plane. This result gave an overall appraisal of dustiness rather than associating a fiber count to a degree of hazard. The original investigators realized this point. It was felt by them and others that if this level of dustiness (TLV) was not exceeded, that the asbestos hazard would be reduced.

The TLV of 5 mppcf, based on the early studies of Dreessen and others, was in effect from 1946 to 1970. However, in 1968 and 1969, tentative standards were proposed that were based on a new method of collection and counting.

It was evident from the preceding discussion on the impinger method that another procedure was needed to obtain a statistically useful index of airborne fiber concentrations. Interest in the fiber content arises from the need to measure that item in the environment that is the most relevant to the disease causing mechanism. A correlation between fiber count and disease or exposure and health was needed.

As this aspect of asbestos fiber concentration to disease was reviewed, it was made known that the British were using a method whereby asbestos fibers were counted in the workroom atmosphere. They had started out in 1951 with a thermal precipitator. But because this unit did not count fibers longer than 10 μm, a better method was sought. In 1960, they started using a long-running thermal precipitator and were able to collect and count the long fibers. They made a second change in 1965 when they started collecting samples with cellulose membrane filters.

As an informational note, in the standard thermal precipitator, dust-laden air is drawn vertically into the sampling head and down a narrow vertical channel between two glass coverslips. Halfway between these two coverslips is stretched a horizontal wire, heated electrically. Dust is deposited by a thermal effect, opposite the wire, in two strips on the coverslips. The coverslips are then mounted, dust side down, on microscope slides and the dust is then counted.

In the "long-running" thermal precipitator, the dust-laden air is drawn from a vertical passage and along a horizontal channel, the floor of which is formed by a glass coverslip. At first particles settle out from the air by gravity and the remainder are precipitated thermally beneath a heated wire.

With the British already using a method to count asbestos fibers in the workroom atmosphere, we felt it was necessary to arrive at a similar procedure..

In 1968 and 1969, the American Conference of Governmental Industrial Hygienists published notices of intended changes to lower the TLV from 5 mppcf to 2 mppcf based on light field counting techniques. In addition to this, a value of 12 fibers per milliliter of air was suggested as an alternative for the 2 mppcf. The fiber count was to be determined by the membrane filter method at 430 X magnification, phase contrast illumination. Only fibers greater than 5 μm in length were to be counted.

In 1970 and 1971, the light field technique TLV was eliminated and only the fiber count technique was recommended. Also in these years, the TLV was lowered from 12 fibers per ml to 5 fibers per ml. This change in the sampling and counting technique was brought about by work carried out by the Division of Occupational Health of the U.S. Public Health Service. Their study carried out in asbestos textile plants, was concerned primarily with obtaining some relationship of dust counts by impinger sampling to fiber counts from membrane filters using a higher resolution microscope objective for the latter. The information they obtained was not meant at that time to replace the standard impinger method. With the ratios they obtained they attempted to:

1) indicate an approximation of the relationship of impinger counts to fiber counts from Britain,

2) give some indication of fiber counts from personal samples,

3) determine some index which may be used in the absence of better information to estimate the proportion of asbestos in a mixed dust exposure.

From this study the following relationships were determined:

Light Field Technique	Membrane Filter Method	Fiber Length
1 mppcf	10 fibers/ml	all fibers
1 mppcf	6 fibers/ml	> 5 μm
1 mppcf	3 fibers/ml	> 10 μm

This study shows the effect on the TLV intended changes of 1968 and 1969 of 2 mppcf or 12 fibers/ml for fibers greater than 5 μm in length.

Based on the established TLV of 5 mppcf still being used at the time of the study the following equivalent relationships can be stated:

Total fibers - 50 fibers/ml

Fibers longer than 5 μm - 30 fibers/ml

Fibers longer than 10 μm - 15 fibers/ml

If the suggested level of exposure was to be limited to 5 fibers/ml for fibers greater than 5 μm in length, it can be seen that the impinger technique would require a TLV of less than 1 mppcf. This would be near the lower practical limit of sensitivity of the impinger technique. Accurate measurements would be very difficult by the impinger method.

Another fact was that this relationship was obtained for asbestos textile mills and would not necessarily be valid for other industries. In fact, the results could not be related from one plant to another for the same operation.

One definite result of this study was that the estimate of risk of disease should be based on fiber counts since this method yielded a more direct estimate of airborne asbestos concentrations.

This leads us to the procedure recommended by the National Institute of Occupational Safety and Health to be used for airborne determinations of asbestos concentrations.

Collection of Sample

The sample should be collected on a 37-millimeter "Millipore" Type AA filter mounted in an open face filter holder. 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-cups should be removed. The filters just described are often referred to as Field Monitors. They come preassembled from the Millipore Corporation. The stated pore size of these filters is 0.8 µm. Collection efficiency is very high for particles below the stated pore size. Particles are collected on the surface of the filter. They do not penetrate into the filter structure.

It must be emphasized that this procedure is only good for Millipore Corporation filters. If any other membrane filters are used a relationship has to be developed between both types of filters.

There are three choices of filters that can be ordered for the Field Monitors. The one recommended is the white with no grid markings. This filter is selected over the one with grid markings for two reasons.

They are as follows:

1) the mounting media does not clear the grid markings on the filter, and

2) sometimes the grid markings may interfere with fibers that are to be counted.

The other choice, the black filter, is not able to be cleared.

It is advisable to seal that portion of the filter holder that is not removed during the sampling procedure. After sampling, the top section that is replaced to cover the face of the filter, should also be sealed.

Sampling flow rates may vary from 1 lpm to 2.5 lpm which is just about the maximum flow rate obtainable by personal sampling pumps. In one Federal Government publication the recommendation was to use 2 lpm as the flow rate and a minimum sampling time of 15 minutes when an evaluation was needed to determine if there was the possibility that the excursion limit of 10 fibers/ml might be exceeded. There are some definite problems with such a recommendation. They are:

1) When it is evident that the TLV is being exceeded, a 15-minute sample may be too long in duration. If too much material is collected on a filter, there may be sloughing-off of some of the heavy deposits of material, there will be overlapping of fibers with some actually being hidden during the counting phase, and with heavy deposits, there may be some shifting of the fibers when the clearing material is used.

2) The pump that may be used at this time may not have the capacity of 2 lpm. Does this mean the sample cannot be taken? No. What is required though is the known flow rate and the length of sample time.

This recommendation that is referred to above, probably is attempting to relate to the counting requirements that are needed in order to obtain a statistically acceptable sample. In order to have an accurate estimate of the number of fibers, the statistical error resulting from the random distribution of the fibers must be kept reasonably low. To quote from the Criteria Document on Asbestos:

"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:"

Sampling Time (minutes)	Flow Rate (lpm)	Number of fields for 100 Fibers 2 fibers/ml	20 fibers/ml
10	2	435	91
15	2	286	58
30	2	143	29
90	1	100	20
90	2	50	10
240	1	26	7
240	2	18	4
480	1	18	4

They do not recommend counting a field with more than 20 fibers because particulates may be present that would interfere with the accuracy of the count. This restricts the sampling parameters that are recommended to those underlined in the above table.

It is suggested that at least 100 fibers be counted in a sample and that the minimum number of fields should be 20 and the maximum 100. Presently the sources we use for counting filter samples only count 20 fields.

Some judgement is needed in terms of what we are looking for and how to apply this idea of statistical accuracy. We know that when we are in a high dust atmosphere that we are not going to sample for such a long period that we will overload the filter and make counting difficult. In this case 20 fields would probably be sufficient. When we are in a light dust atmosphere we will automatically sample for a longer period with the idea that enough fibers have to be collected to obtain a good count. Even if very few fibers are collected on a long-running sample

and for which only 20 fields are counted, it would still be possible to say that the airborne concentration is less than some value which would automatically be very low.

Location of Filter

The filter should be located as near as possible to the breathing zone of the worker. The most logical place is on the worker's lapel. Normally either side would probably be acceptable. However, observations should be made of air currents in the area as the dust may be directed to one side or the other of the worker.

Sampling Pump

There are a number of battery-powered personal sampler pumps on the market. Their sampling rates as indicated earlier vary from 1 to about 2.5 lpm. These pumps usually are able to operate continuously for eight hours. The three manufacturers' pumps available are Mine Safety Appliances' Monitare, Bendix's C-110 Personal Sampler and Casella's Personal Sampler. Only the Casella pump does not have a visible rotameter. This is a definite disadvantage because as the charge decreases on the battery, the flow rate could be reduced without it being noticed. With the other units it is possible to continuously check on the flow rate during sampling and make required adjustments to keep a uniform flow rate. However, keeping a uniform flow rate is not as critical as knowing the volume of air sampled.

Knowing accurately the volume of air sampled is essential. The accurate calibration of a sampling device is necessary to the correct interpretation of an instrument's reading. Personal sampling pumps

should be calibrated prior to their being used. In the laboratory a wet test meter is suggested and in the field a rotameter is convenient. The calibration chain is as follows: the flow rate standard instrument, the filter and the pump.

Sample Preparation - (In addition, see article by Public Health Service included with these proceedings.)

The mounting medium used in this method is prepared by dissolving 0.05 gms of membrane filter per milliliter of a 1:1 solution of dimethyl phthalate and diethyl oxalate. The index of refraction of the medium thus prepared is ND 1.47. It is desired to have some separation of the indices of refraction between the mounting media, the membrane filter, and the asbestos fibers. This is not as critical in phase contrast as in light field techniques. The index of refraction for chrysotile asbestos is 1.55 and for membrane filters is about 1.5.

The filter as received from the field should have the face cups sealed in place. This is to assure unnecessary contamination and the prevention of damaging the filter.

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 an 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. If the mounting solution was placed on top of the filter, air bubbles could be formed and it may be possible for displacement of the fibers on the filter surface. 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. This usually requires about 15 minutes. The sample should be counted within 2 days after mounting.

Evaluation of the Filter Sample

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. 10 X eyepieces, one of which contains a calibrated reticle at the level of the field-limiting diaphragm, should be used. Two suggested reticles are the Porton or Patterson Globe and Circle. The Porton reticle is probably used more than the Patterson reticle. In the Porton reticle the left half of the field serves to define the counting area of the field. In referring to the counting accuracy, a minimum of 20 fields or 100 fibers should be counted. A fiber is any particle that has an aspect ratio of three or greater to one. All fibers longer than 5 μm are counted.

Sample Calculation

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

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

the effective area of the 37 mm filter is 855 mm^2

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

The field area used has to be calibrated prior to counting with a microscope stage micrometer. For this example, the assumption is made that it is 0.005 mm^2.

Therefore: 1) $K = \frac{855\ (mm^2)}{0.005\ (mm^2)} = 171{,}000$

Assuming the average net count per field of 20 fields was 5 fibers and the sample was collected at 2 liters per minute (2000 ml/min) for 90 Minutes: Then:

2) $\frac{5\ \text{(fibers)} \times 171{,}000}{2000\ \text{(ml/min)} \times 90\ \text{(min)}} = \frac{855}{180} = 4.7$ fibers/ml

Principles of Sampling - (This section is quoted from the Criteria Document on Asbestos; reviews the topic very concisely.)

"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, seansonally, 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:

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

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."

Some information has been done on insulators and the various tasks that they perform in their work. The jobs performed by the insulating worker have been divided into six areas and are outlined as follows with the approximate time spent at each task:

1) Prefabrication (10%)

materials are pre-cut and shaped using hand or power saws

2) Application (40%)

materials are fitted, hammered, or carved and attached to the surface to be covered

3) Finishing (30%)

materials are coated with asbestos containing cements, resins, asbestos or cotton cloth, or sealers

4) Tearing Out (10%)

removal of old or unusable materials in the process of insulating or reinsulating

5) Mixing (5%)

cements are mixed separately or in combination in buckets or troughs

6) General (5%)

cleaning up of old insulation, transporting of materials, etc.

In one set of studies the following asbestos fiber concentrations were found at the various tasks:

Operation	Concentration (fibers/ml) Mean	Range	Appr of Mean
Prefabrication	9.0	0.1 - 25	7.0
Application	5.8	0.1 - 65	3.7
Finishing	2.9	0.1 - 25	2.9
Tearing Out	9.2	0.2 - 27	5.8
Mixing	2.6	0.2 - 18	8.5
General	5.0	0.1 - 23	1.6

From the values in the range column, it will be noticed that there is a wide variability of airborne concentrations. It seems that there are two definite operations of significant exposure--prefabrication and tearing out.

This table is not meant to indicate what the specific problem areas are and the airborne concentrations that may be expected. Every situation is different--time spent on each operation, the environmental influences on the area (wind currents primarily), the work load, individual work habits, etc. Every location must be evaluated individually.

RJH/neh/jtd
June 28, 1972

DISCUSSION OF PRESENTATION

Richard J. Rubiak

Q. If you take your dust samples, does the care and handling of them in a Millipore capsule have any significant effect upon the quality of the fiber count?

A. Not really, unless, like I mentioned, you run into a situation where there is excessive buildup of fibers, it will not be retained. So that under normal handling, there will be enough of the various collection parameters that the asbestos fibers will adhere to the filter holder. However, one thing I should caution you, there is an electrostatic charge built up in the plastic holders when sampling and a lot of times you will notice a dust buildup around the sides. It is usually wise to try to remove this as much as possible, otherwise you might knock this down upon the filter and this might look like it slipped out of the filter; really you didn't collect this at all. This is one point to consider in collecting your membrane filter sample.

Q. What techniques do you recommend for taking 15-minute peak concentration determinations? The standard is five and the maximum limit is ten fibers for a 15-minute period. How do you assess that 15-minute period because the dust gets into the air and stays there for a period of time? Would you take just this 15-minute sample and see how long the dust cloud passes?

A. That would probably be as good as any. Because you are going to have different factors. For one thing, you might get too much of a buildup in 15 minutes and you couldn't collect a 15-minute sample. So, in this case, you would have to collect a series of samples right in line but if you're

talking about a situation where you know that you're going to create excessive dust concentrations, where you think you're going to exceed these values, what I have done is, set up a mock procedure and go through this type of operation and see what range you're talking about. Really try to get it under the worst conditions to see how much or what you're really doing. This way you can also break down the sampling period. You might say 10 minutes here and 15 minutes there. I'd be surprised if you can get 15 minutes at a high exposure. I think that you'll have to break them down into shorter periods. Timing of this 15 minutes is critical. You have to consider that portion of your time involving opening the sample, getting into position, the time lag in dust generation, etc. so this is a point that you have to watch as close as possible to reduce the error.

RJH/neh
7/18/72

Dr. Zapp We talked about what is required in the way of medical surveillance and environmental surveillance so I guess the next question is: you found too much asbestos in the air; you have exceeded the speed limit; what are you going to do about it? How can you control the dust and get it down to the legal limit? Maybe you can't always do it, but there are some things you can try and for this discussion we have brought in a non-Du Ponter because of his experience and expertise in the field. I refer to Commander S. H. Barboo, Jr. of the United States Navy.

Commander Barboo is the Head of the Industrial and Environmental Control Branch in the Division of Industrial and Environmental Health, Bureau of Medicine and Surgery, Navy Department. He is the Senior Industrial Hygienist in the Navy. He has been in the field of Preventive Medicine for approximately 18 years and in the field of Industrial Hygiene for 10.

Commander Barboo obtained his B.S. and M.S. from the University of California at Berkley and his Doctorate in Public Health from the University of California in Los Angeles. He is also on the faculty at George Washington University.

MEANS OF DUST CONTROL

by

Commander S. H. Barboo, Jr., U.S. Navy

I'm going to give you a brief discussion on asbestos control in naval shipyards. Let's go back to prerecorded history when asbestos was known. Many commentators had written about it. It was used by the Romans as a cremation shroud. It was a plaything of the wealthy in the ancient world. They used it for tablecloths and in one case I read where one Roman emperor threw it in the fire to clean it up and so astounded his guests that he was held in great reverence. Modern industry might be said to begin in 1868 in Italy where 200 tons of asbestos was produced. The North American mines opened in Quebec, Canada in the year 1880. Coarse asbestos is a family of mineral silicates. You have to be a graduate in the field of geology to separate it out according to its genesis and molecular structure and molecular formula. Chrysotile is a hydrous magnesium silicate which is a fibrous variety of the serpentine family. One of the only commercial kinds in that family. The rest are amphiboles and amosite is the most prominent commercial member of that family--at least from U.S. Navy experience. The British have been prominent in the use of crocidolite asbestos.

Now there are four distinct pathologies related to the inhalation, or, if you will, ingestion of asbestos. The first of course is asbestosis, which is simply a fibrous condition of the lungs; however, with those simple words you begin to get into the great disputations that occur in this clinical field among radiologists, clinicians, pulmonary physiologists and so on. They say, what is the definition? What is the criteria for

a diagnosis of asbestosis in an individual? I have sat with great attention with physicians and listened to their criteria for diagnosis and I do submit to you, there is some dispute in this area. Most physicians will say they depend on at least three factors--one is lung function or vital capacity studies (lung function studies); the others are certain symptoms such as basal râles, etc. Third, is a work history, and some of course will use x-ray densities or x-ray readings. I think those that are the purists among clinicians would use, if they had access, the diffusion capacity of the lung to diagnosis asbestosis. I throw into this great pool of knowledge the first rock--the first wave. What is the diagnostic criteria for asbestosis? It slips nimbly off my tongue, but when you want a diagnosis to compare it with the airborne samples, sometimes you will run into disputation, definitely.

In asbestosis, we go into the pleural reactions. Again, very little is known. The physicians use such words as pleural plaques, pleural fibrosis, effusions. Most of these are quite dramatic on x-ray film, have little if no physiologic response, and most physicians do not alarm the patient if there is no other symptomatology present. The pleural reactions are, however, open to some question by investigators that perhaps are precursers or indicators of later pathology. Then we have the serosal tumors, those of the serous membranes. The two membranes that we are dealing with here are the peritoneum and that of the pleura or lung thorax. I know of none around the heart or pericardium. These are primary tumors of the pleura or peritoneum. If you can pronounce it, a mesotheliomata, of very recent vintage. Most cases of mesotheliomas are not listed in international

statistics. I'm sure young resident pathologists today are looking at them. They are circulating among their slide sets of rare entities in medicine, the mesotheliomas. The only ones I have seen of great authority were those presented to us in a recent visit to the British practices. They have, I think, presented this subject very well to the world.

When you get into the mesotheliomas, it is interesting as is any other disease complex which has a histological point of view. You find many of these things because there are many more pathologists that know how to recognize it. In the past they probably recognized the pathology but they were unable to say what it was. Now they have a name. So always be aware that when you see a new name, a new moniker, my school, my colors, I know about this subject, you're going to see a greater amount of recording of it. However, it is a frightening situation in the clinical progress. The prognosis, is to say the least, poor--it's months. It's totally epidemiological relationship to asbestos--there is no proof. There is no pathogenesis; no way to describe how asbestos may produce this rare tumor and rare indeed it is. There are the other malignant tumors, of course, those all again epidemiologically related to increased incidence of malignancies of the lung and the gastrointestinal tract. Everything I have said so far in the way of pathology is speculative. Cancer is among, most authorities believe to be, a collage of diseases, probably associated with the cell systems of the disease. We have only one association in industrial hygiene, occupational medicine and that is statistically--statistical association.

What is the asbestos-related disease history? It follows a rather interesting sequence. About 1906 a distinguished British epidemiologist, Montague Murray, described at autopsy, a fibrotic condition of the lungs which he attributed to asbestos exposure of 33 years in a textile worker. Like most playthings of the literature that remain dormant until it was finally, you might say commissioned in 1938, as you say Dr. Hubiak, with a first, a recognized environmental standard that was put forth. Then it became the property of we, the industrial hygienists and we began to match our environmental airborne densities with those of the medical.

Another area which has been obscured by one elemental problem, we began with millions of particles per cubic foot, not with fibers. I think there is no one that would dispute that the etiology is somehow related to fibers and fibrils and not to the other detritus and artifacts that appear under the microscope. We have had, how many years, since 1938, of environmental data that bear no relationship except retrospectively under the microscope to the suppositions of what the industrial hygienists thought was a fiber count at the time. Being a Navy shipyard man, I know that we have gone through many types of materials in this insuing period. We've used fiber glass and burlaps. We have had all kinds of minerals, non-minerals, organic fibrils and so on. Many of them turned up in the lung and they were given the very fancy name of ferruginous bodies lately, or asbestos bodies. We have a great preponderant amount of literature based on a rather interesting subject under a microscope. Not necessarily related to the epidamiology or to the industrial hygiene effects of asbestos.

In 1946 something happened that was of great interest and this does occasionally occur rather rare and, certainly, in the case of asbestos, interesting. Flasher and his associates wrote an article, an article as a result of a study of some 1,074 shipyard workers in naval shipbuilding activities. They found that only three of them demonstrated what would be called asbestosis or a concensus of opinion what involved asbestosis. They immediately stated that the control measures in shipyards at that time were sufficient to prevent asbestosis or the disease controversy. What was the problem? It was a rather simple problem--there is an incubation period in a chronic disease so to speak--a so-called latent period. We were dealing with people who had just come from the rural areas who went to work in our shipyards. We had only given them four or five years experience in the shipyard. There is a great deal of mobility. Many of them went from the shipyard experience into the services. Some came out of the services and went into the shipyards. Many of them were ladies. So that our study was glaringly a defect in one respect--we simply didn't look at this thing from the chronisity point of view. Today, still the same thing, there are people that will say we can have instant asbestosis. There is no such thing nor is there such a thing as a zero threshold limit value, which causes me to become cross-eyed and gag with scientific premonition of how can this be. We went along blithely since 1946 and then an industrial hygienist who had returned to the Navy, now works with our shipyard in Mare Island, Mr. Bill Marr, did a study at Long Beach in 1965. Now we have 20 years

since 1946 and he found five of seventy insulation workers had retired with a disability and a rather brief check of their disability revealed dyspnea, the various signs--stigmata, etc. of asbestosis. That opened, I think that most industrial hygienists will agree, the flood gates in 1965. Then speculation was rampant and people began to take a very, very close look at airborne asbestos densities but they were still doing one thing--they were still counting millions of particles per cubic foot. In that study they were collected in the Konimeter, which is the grabbiest of all grab samplers; it is not a time sequence by any means. The decade of the sixties, they stacked the deck here, epidemiologic descriptions of asbestos deaths related to malignant tumors of the lung and gastrointestinal tract. There was a great collection of literature in this area.

Bronchogenic cancers--now you have an interesting study. If you want to get money and you want to get recognition, study an occupational carcinogen. But then stack the deck with a possibility of a domestic exposure; that is, daddy comes home from the shipyard and shakes out his overalls in front of everyone or the neighborhood exposure which has to do with asbestos throughout the airborne community environment and you've got a full house. You've got the ace of hearts right on to the jack, no one can beat you. You can hold the cards moneywise, politically, scientifically--scientific indignation, not always authenticity but indignation, and in the 1960's we have seen a plaphora of literature of speculation. There was something that professors, when I went to school, loved to step on and that was a hypothesis before you mouthed it. Yet

today, I see hypotheses put forth with so little statement of this, it may be speculative, or, let us further examine this, or, I'd like to see some grad student take it on and give it a little bit of massaging from a laboratory first hand observation point of view.

What have we led to today, the seventies? We know nothing about cancer. No one knows even the slightest thing about cancer except statistically, and I think chimney sweeps were a statistical surety. Since then we have played with them on a P level of 0.01. We have these rare and malignant tumors which are being recognized for the first time going up on the graph and at the same time some association with asbestos. The biostatisticians don't even step in and say whoa, let's look at this. It might have to do with the spacing of the telephone poles in the town or some other relationship. I will catbird this; this is my personal opinion and it does not represent the United States Navy's opinion, but why should we give over political expediency and pay the price of scientific authenticities? I would call a halt to a great deal of speculation because when it gets into the mass media, you are misquoted, outquoted and quoted out of context.

So allow me to do it with the Criteria Document. I presume, this morning, you were made acquainted with the Criteria Document. The first document to be presented to the United States government at the petition of the AFL-CIO to the Department of Labor. Last December, they said, we need a criteria document for asbestos. How could they lose? Carcinogenic, neighborhood, environmental and we have a number of people who epidemiologically relate to asbestosis and perhaps cancer.

I'll agree with their epidemiological relationships. But listen to them quote it out of context.

"To refine our knowledge of the biological actions of asbestos, it is imperative that the character of the exposure as to concentrations, size and type of fiber be known. At present, data of this complexity, are scanty or often non-existent with respect to human exposure." What is a criteria? Let's quote them out of context again. "Thus, the effect after several decades of a one-time acute dose of limited duration which overwhelms the clearing mechanism and is retained in the lung may be as harmful as the cumulative effect of a lower daily dose of exposure over many years of work." Therein lies one of the wisdoms or one of the wise observations I believe of the Criteria Document. We know nothing, epidemiologically of one massive dose that exceeds all of the clearance mechanisms physiologically and macrophagically and all of the other points of clearing the lungs.

Finally, however as to be indicated, the development of the diseases has been proven in workers exposed to asbestos and environmental data does not exist for the last several years. So what I say in caution, to taking environmental data and translating it into medical facts is, the point of view that we do not have sound environmental data. We are translating from our past retrospectively and we are not sure what that means from the medical point of view.

On the recent hearings that were held on the emergency standard suggested in December and put forth in April or May, there were those proponents who have even more insidious a point of view and that is the

zero threshold limit value. The complete renegation of the idea that there is a dose-response relationship in the human body. I find this to be quite sinister in effect. With the zero threshold limit value, there has been put forth and shortly to be placed, I believe, before the Secretary of Labor, a recommendation 2 years hence, that the standard will be 2 fibers/ml greater than 5 microns in length. Now two fibers, as an engineer, you might suspect when I show you the slides is going to be rather difficult to exhaust ventilate 2 fibers. I would think of 2 fibers as somewhat a background count in an asbestos shop. I would put forward this point of view, what is the standard deviation among, let's say 10 fiber count technicians for fiber counts. If it's one fiber or three you can then play with the deviations between two and five. So playing with words, I find it rather deviant and rather low value and one that has, according to all my wining put aside, one thing for us to do in the Navy. That is substitution and that begins what we must now undertake.

Whether or not scientific authenticity reigns supreme in Washington, these standards will hold and we in the United States Navy have always set a pace in occupational health and will continue to do it today.

Let me further complicate the situation. Asbestos is an environmental health hazard, not only when you shake out your overalls but what happens when you blow it out of the plant, up, down, in the sewer, how are you going to collect it? I don't even know to this day what the National Emission Standard will be, nor have I found too much in the literature that tells me how I might collect it from the local exhaust ventilation. Asbestos fibrils and fibers are very fine matting. They are

used for filters in various chemical situations. Can we use a bag? What is going to be the loss in a bag house across the face of those collectors and how many will break through or will they break through? What kind of fabric? What kind of air moving equipment will we need? What kind of ducting will we need? What kind of fans will we need? Are fibers consistent with the bearings in the fans and this sort of thing? So we have a great number of problems from an engineering point of view. If someone would get some designs along this line using fiber technology as their basis for ventilation design, I think they would be in a very fine position today to sell at least a textbook.

Substitution is the only alternative. We began the use of amosite in the United States Navy in 1934 aboard what we called then high-speed destroyers. Twelve knots was high speed in those days. Certainly hair felts didn't work around the high heats and high pressures we have today. Amosite was then later applied to our flanges and our valves. In 1937 we used pipe covering for the first time instead of hand placing on all our pipes. We used pipe covering, bought pre-molded pipe which was of two varieties: magnesium or mag pipe as we call them, magnesium oxide; the other was calcium silicate, silicate pipe. They were used with binders in approximately weight ratios of 10 percent of chrysotile and amosite. We still have some old destroyers laying in mothballs with mag pipe and amosite binders. Incidentally, in our rip-out operations, even with total substitution within two years, which is the deadline, we are going to have amosite and chrysotile aboard our destroyers and other ships for the next 20 years. We'll be ripping it out in maintenance.

So I say the same thing you must keep in mind here, you have them in your steam pipes, your steam tunnels and various other confined places. You are going to be ripping out asbestos for 20 years, so substitute now and wait until you are ready for retirement and then you'll see the end of the problem and you can tell youngsters when they come aboard, we used to tear out amosite.

In 1942 we replaced, for sweat control on cold waterpipes, the hair felts and put in amosite there too. Our first substitution was in 1958, not for health reasons, but for sonar reasons, we began to use plastic elastomers for sub hulls. They were so nice in the sub hulls, we now use them for all antisweating applications for cool water pipes.

In 1962 we began to use calcium pipe instead of pure amosite pipe. Let me show you what happened when I came to the Navy Department. We have completely substituted the amosite pipe. Can you imagine a youngster, like me, going into the shipyard which has a rough and tumble bunch of fellows (they have two beers for lunch) and tell them we were quitting in five years with this amosite pipe. They were in love with it. They waited until they could become supervisors to use it. They say it will be used and no one will use anything else. We tell them by decree that they're going to use this. They don't like it. That is one of the problems of substitution you'll have. So what do you do, play them off against one another. You have to convince the next person in line to use the new and better material. So that when he becomes boss, he naturally carries through with your ideas. I think you too have that decentralized point of view. When you run into opposition, turn the other guy loose on the other.

Another thing is the binder has been completely substituted and no one ever really liked it. It was a mess as you can see all over your deck. If you picked it up aboard ship and it shed, it just did not go on too well. This led companies to develop fiber combs. They are rather expensive but they are very fine substitutes. I'm not a Johns-Manville man by any means, but it just happens that they have some substitutes of interest. When you get these combs wet, you can pack it around various objects. I know you're not going to buy pre-molded stuff so you're going to have to buy some of these kinds of things that are wetted and will fit around various valves and flanges. These are usually easy to sell to personnel in insulation shops. One thing they like most of all is the fiber glass. It is soft and easy to cut and it has very high temperature applications, over 1200°F. It is a lot more accepted over amosite.

Then finally what do you do with the new requirements which say you must take care of the situation by placarding. Pointing out where they are doing asbestos rip-out. Asbestos rip-out is a very interesting subject. You have to get out of the classroom to see it. It is like an Indian raiding party, they go in and tomahawk this stuff off. There is no ballet, no time in motion stuff.

Now as to signs. I put down here the word "Hazards"; don't do that. That makes for extra pay and some other problems. People will believe the worst if you'll let them. Use "Restricted Access - Lagging" as possible wording for a sign. Leave that word "Hazardous" out because of the financial escalations.

I'm going to skip the percentage of time in shipyard work in the various aspects of asbestos work because I think that was very well covered in Dr. Rubiak's case. Only to say that I would emphasize the time-weighted average counting that only about 45% of an insulation worker's time is spent in working with asbestos or asbestos-containing products. Fifty-five percent of the time he is working with other materials, today, such as fibrous glass, rubber elastomers, cork, mineral wool and various other things. So that when you do a TWA count, you must know what he does during the work day because his exposure is somewhat diminuated by the amount of time, except for the one thing that has always plagued me epidemiologically--what is the meaning of one massive exposure? Now I got into another hornet's nest with some rather high-ranking Navy people. I said let's not allow our seamen, our machinists' mates, boiler tenders and other various people to go rip out asbestos before they go into the shipyards. Sometimes for money's sake, they'll turn a crew loose on ripping out asbestos. Then they move right into the shipyard and then there is that much less of a bid because you've got bare pipes ready to be relagged. Rather than having the civilian civil service people go in and rip it out, its already been done. It has been very difficult indeed to get this type of situation out and I tried to base it on one massive dose exposure and how to take care of it.

(Data from overhead slides) The data is of airborne densities of asbestos, we're experiencing both aboard ship and in our lagging shop. Look at those removal figures up on the top--148 fibers/ml. Now those

were short counts I'm sure. That filter paper would jam up in no more than 15 or 20 minutes at that rate. Another interesting figure there is right here. Forty-five minutes after exposure we have a zero count of fibers. Many people will ask you, how long afterward? This varies with the material. That is an interesting point of view. Now look at it from the 2 fiber limit. These are all rip outs. What does this mean? Well, I can wear this kind of mask up until then. Now how do you wear this kind of mask in the Charlestown Naval Shipyard, in July, down in the bowels of the ship which is cooling off. People are sweating at great rates down there, they're very confined and they don't like anything around their bodies. So a young commander comes down and tells them to wear a respirator. If they have to wear glasses, they fog up immediately but the worst part about this is, in the ship, the humidity builds up to such an extent that water resistance through this filter is pretty high. If you have old laggers with 20 years of duration in the trade, their lungs are a little fibrotic already and they are not going to breathe across water resistance. I would say rather that you should supply power packed air supplied respirators. Bill Burgess at Harvard is working on one of these and we hope he will come through. The British are using them but they have such a large miners pack on the back that you can't get around the steam pipes. These men get into some of the most extraordinary spots and they, by no means, have any phobias about close places. So when they have hoses on and packs on in hot areas, it is going to be difficult to get around. Have you ever tried to tell a civil servant to wear this or we're going to fire you!

Their grievance procedures are the most tortuous, byzantine, legalistic points of view you will have. I have always admired you of the civilian industry, profit-making industry, perhaps part of your employment with Du Pont is based on the fact that you'll wear personal protection. Think of that when you get excursions above 2 fibers/ml. Get the right kind of protection on these people and try out the little device I use--give them a choice of two or three and they'll develop factions and fight with each other over which one is more comfortable.

(Slides of some of the control measures) This is a Navy lagging shop. Notice the great amount of ventilation provided in the shop. This is our showcase yard, Bremerton, Puget Sound, Seattle. All of that ventilation will be obsolete in 2 years if the 2 fiber limit goes into effect. I cannot maintain it below 2 fibers in that shop. This is side hood ventilation, the kind that is the best for cutting asbestos containing products. This also illustrates a fine way to control dust by spraying as you lay it out. Some people put up rolls that are covered up and as you pull on it, water automatically sprays the material. But this problem will not be with us too much longer because we are almost completely substituting with glass fiber.

Here is a man cutting some of the glass fiber. The ventilation does serve some purpose in cutting down the requirements of certain nuisance dust standards we must meet.

Here we have exhaust ventilation on a band saw and a somewhat general exhaust ventilation in back of it. This does a great deal to reduce the dustiest operation in the insulation shop, that is, cutting any materials at that high rate. Those teeth go by at just the right resonance quality to produce dust in high concentrations.

This is some of the miter work they do. These men are quite interesting artisans. I can watch them by the hour. They do it almost without looking at it. They can fit pipes they haven't seen yet because they have seen them already many times.

This is a downdraft table in which most of the dust is taken out of the workers' breathing zone. Canopy hoods don't work by the way. I saw a canopy hood in a Navy shipyard installed by a Navy industrial hygienist. I'm afraid I lost a lot of respect for him.

Here is the dustiest operation, that is, cutting blocks for the sides of high temperature boilers. This exhaust is quite effective. I have no fiber counts for it. I do hope it falls below the five fiber limit.

Here are the teeth that slab out the block and that is the dust taken off the top with this ventilation. Now all of this material goes into these ducts. Therein it resides or is blown out into the shipyard. We haven't even begun to think of what we do now. I'm sure if you took an electron microscope and kicked up a little bit of dust around those shipyards, you'd find that environmentally we are an installation non grata. I don't know how we are going to clean up the amount of asbestos that resides right in our flower beds--right into the very soil of the shipyards.

Here is an interesting thing, if you can get it done, this man is dipping in water, his pipe sections before he works on them--the dust suppression method.

Look at that very fine downdraft table there. That costs the taxpayers quite a bit of money but it is a very fine way to control the dust from the work that these artisans do. Look at the mitering up on the upper right hand corner, that is an art. You don't interfere with the

way that's done. They have their own ways, their own markings, their own methods of doing it, and so on. It's always a partnership and quite a ballet to get it done right for both purposes.

Here he is bagging the pieces, getting them ready to take aboard ship. This way they can go in, they are still a little damp, and they mark them what space they go into. If you're taking them into a tunnel, you can mark what tunnel they're going into. That is the only way we could get them to bag them. They would mark the sections, but I killed two birds with one stone. Here, I was able to get them to bag their various compartments and mark them. Now they found that they have a better handle on the situation.

This slide shows the use of the respirator on a very dusty operation. This man is bagging the various pipe sections and then sealing them in polyethylene bags.

This is the insulation storage area and that is a set stage. They're not that clean. That was done for the picture. Here is one area where you have a great deal of asbestos and sometimes it looks like a Christmas scene--asbestos on the rafters--asbestos all over. It looks like a snow blizzard.

Here is the way we get around without having to fool around with short elbow space or confined spaces. This shipyard brings in the pipes and then sets them up on jigs ready to place the pipe insulation material around them.

Here is a sewing machine of the percussion type. Dust production is very voluminous and he is using, as you see here, a local exhaust flexy duct. This is essential with sewing machines. As with welding

operations, you have to build a duct that is not permanent. You have to build one that allows that man to move that table. One man will sit a different way with the wind from another man. Two men that are not speaking sit back to back. You have to have these ducts so that they can be fitted to their personal dispositions or indispositions.

Again, a close-up of the exhaust ventilation here. By the way, I know we cannot meet the standards on this one. These men are seamstresses and they are quite prima donnas about their work. This is the best I've been able to do for them. This is a very dusty operation aboard ship and the industrial hygienist showed an incredible amount of ingenuity when he built these downdraft tables. He put flexible pipes into them so that the man can stand there and saw at his leisure in the ship.

This slide shows the vacuum cleaning that goes on. You can see the short spaces and all the narrow accesses. Insulation workers are not good housekeepers and they never will be, but this is one area in which you can hope that you can improve. These are barrel eductors. We have them out on the weather deck on the ship and these are the hoses that lead down to supply the various tables and vacuum cleaners which are located sometimes two or three decks below. If you're lifting air, as you do water, you have a head. You cannot go too far down in the ship.

This is a jury-rigged design. We do these because we have yet to find good exhaust ventilation procedures for asbestos, as I earlier advocated. Notice the makeshift manifold there to control noise exposures.

Finally, I have a slide of a man wearing this single service asbestos respirator. He's wearing glasses. Those glasses will fog up and he'll have to change that respirator within two or three hours depending on

the relative humidity in the lagging shop. That ends the slides and some of the control measures.

I know they have been crude indeed, but they are crude because we are not yet ready to meet the problems engineeringwise for the low levels of asbestos that we must contend with.

So, I leave you with this thought--substitute or drop out. In the mean time you can use as much ingenuity engineering as possible. The great challenge is to develop a respirator that people will wear when they rip out for the next 20 years.

RJH/neh
7/10/72

Dr. Zapp The next speaker and the last speaker on our program is George Lang, the consultant on thermal insulation of the Engineering Department. I think that this is such a logical continuation of what Commander Barboo has talked about that we won't entertain any questions of the Commander at this time. I agree with Commander Barboo that substitution is great. I think of the soap industry and how they quickly substituted for phosphates with NTA and got thrown out of that. Then they substituted for NTA with silicates and finally the Surgeon General of the Public Health Service said you better go back to phosphates boys because the substitutes are worse than the things you're substituting for. So this is a great problem and because we don't have 20 years of experience yet with some of the substitutes, we may be in for some surprises.

SUBSTITUTES FOR ASBESTOS BEARING THERMAL INSULATION MATERIALS

G. E. Lang

Good afternoon gentlemen.

The subject of my brief talk is "Substitutes for Asbestos Bearing Thermal Insulation Materials".

I say brief because the very unique and accommodating physical and thermal characteristics of asbestos make it very difficult to replace.

As asbestos is used in thermal insulations, as a fibrous binder, a filler, or a woven textile, we ask it to withstand very high temperatures, very high rates of change of temperature or thermal shock, and to resist chemical attack. We also say it must be compatible with the only high temperature adhesive we know of, sodium silicate. All of these conditions which asbestos meets so well are not met by any one of the potential substitutes for the asbestos fiber. Plant or animal fibers, polymeric fibers, and glass type fibers all fail in at least one of the required characteristics.

In thermal insulation systems our current areas of concern are the high temperature calcium silicate type basic insulations, and the woven asbestos or "A" cloths.

The asbestos-free calcium silicate situation is presently very dim with not much hope for the near future. The main reason for this is that the two largest manufacturers of calcium silicate

insulations, which control 80% of the U.S. insulation business, have been the least progressive in developing an asbestos-free material.

We presently have available only two asbestos-free calcium silicate brands. One is Super Caltemp Type NA from the Fibreboard Corp. and the other is Careytemp 1500 from Philip Carey.

Keene Corp., manufacturers of Thermasil, and Johns-Manville, manufacturers of Thermabestos, state they expect to have asbestos-free calcium silicate products on the market by the end of 1972. Owens-Corning, manufacturers of Kaylo, don't expect their asbestos-free material to be on the market before mid-1973.

We are presently investigating a new product of the U.S. Gypsum Co. known as K-fac. It is a high-grade mineral wool formed in rigid boards by the fourdrinier paper making process. It avoids many of the disadvantages of mineral wool in that it is a fairly clean material and is relatively water resistant.

We are presently getting elbow covers (such as this one) cut from this material with the promise of getting pipe section and block in the near future. Pricing is expected to be in the range of inhibited calcium silicate or slightly higher. The present fabricator of this material is Starr Davis Co. of Charlotte and Greensboro, North Carolina; but it is certainly not limited to one fabricator.

There are a number of mineral wool products which have been and are on the market that are adaptable to insulating piping and equipment. These unfortunately have the disadvantages of this type material; poor damage resistance, prone to getting wet and holding moisture and insulator discomfort.

However, we are fast getting in the position of a beggar that can't be a chooser.

Eagle-Picher is about to put on the market the first U.S. manufactured, molded mineral wool pipe section insulation. This is a small sample of it.

I might mention here that the mineral wools, including K-fac, can be dipped in sodium silicate, after being formed to final shape, to make them acceptable for use on austenitic stainless steel. The manufacturer or fabricator can do this at a minimal cost compared with doing it in our plants.

Of the asbestos-free calcium silicate insulations on or expected to come on the market, only one, Fibreboard's Super Caltemp Type NA, will be inhibited by the manufacturer for use on austenitic stainless steel. This is another facet of our thermal insulation problems which we don't have time to cover here.

The insulating cements, Du Pont Code 502, and the insulating and finishing cements, Du Pont Code 502.1 listed in the April, 1972 issue of Engineering Standard SN500M are all asbestos free.

Finishing cement, Du Pont Code 712, has been removed from Standards as it by nature was a high asbestos quantity material.

Treated, woven glass cloths have been found, by lab tests and field trials, to be a satisfactory substitute for woven asbestos "A" cloths. The treated woven glass cloths showed no deterioration at temperatures of 1000° F, and they accepted the standard insulation finish coatings very well. They even showed no deterioration when cemented to calcium silicate insulation with a heavy coat of lagging adhesive or sodium silicate; and the insulation subsequently kept wet.

The sodium silicate cemented glass cloths, however, did have an unsatisfactory rate of deterioration when placed against hot surfaces at 300° F and above.

In applications of the sodium silicate cemented, treated glass cloths that do not contact hot surfaces we have found the following materials satisfactory substitutes for asbestos "A" cloths:

J. P. Stevens and Co., Inc.
Style 1925/9351 "double coated" and
Style 84205/9351 "double coated"

DUP 0930599

"Nomex" woven cloth cemented to calcium silicate with sodium silicate, has also been found to be a satisfactory substitute for "A" clothes in contact surface temperatures up to 600°F. The "Nomex" works well with the sodium silicate adhesive and accepts standard insulation finish coatings very well. It can be ordered from Globe Albany Corp., Buffalo, N.Y., in 100 yd. rolls and would be designated "Nomex" N-7304.

It has the disadvantage of costing somewhat more than underwriters grade "A" cloth.

However, since materials costs are running about one third of labor costs in thermal insulation projects, this may not be a real objection when you consider the many hidden costs of handling asbestos bearing materials.

I believe we have time for a few questions.

G. E. Lang
ESD, Materials Engineering Group
Louviers 13W16, Ext. 3435

GENERAL DISCUSSION OF PRESENTED TOPICS

Q. What was the Du Pont standard that listed all of the asbestos-containing cements?

A. Cements SN-500M.

Q. What has Johns-Manville been doing in the area of research? I certainly don't expect them to be going out of the insulation business.

A. Johns-Manville has been very quiet about this. We know they are trying to develop an asbestos-free product but we've heard some adverse results of these materials in shipment. I might mention that all of the asbestos-free calcium silicates we've seen so far by appearance and we can imagine general characteristics are somewhat less than the previous asbestos-bearing calcium silicates. They have lost something. We're going to have to learn to live with it. I don't know other than J-M's Thermo 12 which is a calcium silicate type insulation if they're using a glass fiber binder. They make no prediction other than the end of 1972. In other products, I don't know what they're heading into.

Q. Is Johns-Manville doing anything in the way of research on better engineering controls?

A. In their *own shops*, I know nothing about. I can only assume they'd have to be, because of the volume of asbestos they handle for many products other than just thermal insulation.

Q. These substitutes, during fabrication or whatever, produce fibrous materials that satisfy the geometry of this regulation. Will they be

ruled out because they are made of a different substance or wouldn't it satisfy the geometry requirements of the length and diameter aspect of the fiber mentioned in the standard?

A. The standard indicates a fiber greater than 5 microns, it doesn't say anything about the chemistry of the particles. I think the problem is that the asbestos fibers are ideal in that they have this tremendous aspect ratio. It is very difficult to grow any kind of synthetic crystal to come anywhere near it. You can get the diameter but you can't get the tremendous lengths. I think people have gotten some degree of chemical resistance and some degree of diameter but to get this nice combination that asbestos does have, physically and chemically, is pretty hard.

Q. I was inquiring about the fact concerning monitoring and not why synthetic fibers cannot be found to replace the asbestos fibers. What I'm interested in is, what if you use substitute insulation with non-asbestos fibers? What do you go by in terms of evaluating the air samples? Will these fibers look like asbestos fibers and could you distinguish between the two if they both existed on the plant at the same time in the insulation material? Would the sampling technique now stipulated tell whether you were indeed exceeding a fiber concentration?

A. This is a point I'd like to make, when we can get totally away from asbestos, which of course, has all the nasty things said about it in OSHA. We're going to have to monitor for diatomaceous earth, glass fiber, mineral fibers, silica and what have you. So there is still going to be a monitoring program but I don't know what the law makers have up their sleeves. When we get away from asbestos, this will take a lot of teeth out of this thing that we're now working on.

Q. I think what you were trying to refer to is as follows: If you were doing fiber counting, can you distinguish these artificial fibers from the asbestos fibers using the criteria of a 3:1 ratio?

A. If you look at asbestos fibers under phase contrast, they will vary in diameter and length. You will recall that the fibers are made of fibrils and therefore each fiber will vary depending on the number of fibrils making up the fiber. There will be differences in length and diameter of each fiber. If they go to these artificially manufactured fibers, more than likely they will be fairly uniform and easily distinguishable from the natural asbestos fibers.

Q. What I was wondering about in the analysis of the samples, would we know by looking at it under the microscope whether we had asbestos or not?

A. Probably one of the criteria that will come out and that I expect is that the insulating material would be labeled that it does contain asbestos.

Q. At the last conference it was indicated that chrysotile could be distinguished by its being comprised of a series of circumscribed circles. Can you tell that through a microscope?

A. By an electron microscope, yes. But you won't be able to pick up these characteristics at the magnifying levels that you count at. You would also have to get a cross-section of the fiber to detect this factor.

Q. Let me rephrase my question. Let's say I had a Johns-Manville product with 10 percent asbestos fiber and 90 percent calcium silicate which I ran samples on and sent them in to be counted. They would report the densities and include the fibers and the calcium silicate. How will they tell if the fibers are asbestos in the mixture?

A. George Lang To the best of my knowledge, there are no other types of fibers in the thermal insulation other than asbestos at this time. It is my feeling that when these people convert, they will convert to only one type of fiber in the insulation.

A. There is another factor when determining fibers and that is refractive index. Slight changes in your refraction mechanism will change the viewing of your particles and I assume that these other materials will have a slightly different refractive index. You might be able to pick it up in this way.

Q. Are we ready to substitute now for asbestos thermal insulation?

A. No sir, unfortunately as I said, it was the smaller outfits who made the greatest gains in the manufacturing of non-asbestos bearing materials. The one outfit I know of is a single production line and if they get a construction type order for a couple of carloads, they're just going to go up in smoke. This is the problem. Our only hope here is that they will lead the big ones and start frightening the big ones about how much business they are losing or are going to lose. The small ones are clamoring in this direction and seem to be a little less encumbered with their investments.

Q. Dr. Zapp This floor tile here may well contain asbestos, pretty well locked in. Is there any hope in exploring new methods in applying asbestos that will permit you to use this material have it so applied that it will be locked in and be no dust problem? Is that being looked at?

A. George Lang I'm sure it is by Johns-Manville but of course you end up cutting floor tile by a number of methods. I don't know what they're doing on this but we have the same problem in a sense in the mastics

we use to finish insulation. I don't know what percentage they contain but they do contain a fair amount of asbestos filler. We have reason to believe we're on the safe side of the coin and manufacture this product which is rather reputable. I have done some asking around and it has apparently gotten a fairly clean bill of health because when you spray this mastic, you don't have individual fibers. It's like spraying tar and the fibers are totally captive and it is very unlikely that you could do anything to that mastic, even after it is cured or dried to free up the fibers. They are trapped.

Dr. Zapp That's what I'm getting at. Perhaps we can still continue to use asbestos if we used different techniques of applying and containing it after it is applied.

Q. Does the law now read that you shall not spray material containing asbestos?

A. Yes, I think so.

Q. Why can't mineral wool be looked at if asbestos is being ruled out due to its toxicity? Why can't mineral wool be adopted by the asbestos processers?

A. They can. This is the direction that a lot of people will go in but due to the diversity, outdoor nature and geographic locations of most of our plants, mineral wool has very poor abuse resistance. If it gets wet, it pretty well stays wet. It will deteriorate also in cyclic wetting and drying. If we could keep our thermal insulation dry, which would mean no damage and with satisfactory workmanship, our whole problem here is almost eliminated.

Q. Everybody is putting the "kiss of death" on asbestos, but who will put the "kiss of death" or blessing on a new product that will replace asbestos?

A. I heard a rumor somewhere that after they get the asbestos under their belt, they're going to start picking on some of the other materials. What these are, I don't know. Let's hope they let us get this one beaten down.

Q. Is the January 12 issue of the Federal Register the latest on the proposal for the public hearing?

A. James Morgan That's the latest I know of in the Federal Register.

Q. The ENA Reporter has something else and it is a little confusing. One aspect of the public hearing included the section on the warning signs. Do you know where that stands? The warning signs that the Commander passed around wouldn't meet the specifications of the January 12 issue of the Federal Register.

A. The diamond sign was absconded from the National Fire Protection Association. Of course, asbestos has nothing to do with fire. Of the three diamonds, two are zeros and one is 4, for the health hazard.

Q. What I was concerned about was the one that says "dust hazard" on it. It had to include such words as - "Asbestos dust - may cause asbestosis, a severe lung disease and is implicated with the development of certain cancers. Control of exposure to asbestos dust helps to protect against the hazard." These would have to be on the signs.

A. It seems like we're better off with the diamond sign.

Q. What about where to put these signs. We know the insulation shop areas and storage areas are probably some prime areas for placement, but what about the guy in the field that applies the insulation? Do the Commander's signs meet the intent of the law?

A. The placarding of areas in the field or during rip out will be necessary I'm sure and will be a portion of the law. Many investigators who did a thorough industrial hygiene survey found that many individuals who were suffering from asbestos-related diseases were not laggers but only worked in the area around the laggers. So placarding in the areas where they are applying or ripping out asbestos will probably be part of the requirement. Now whether these signs meet the intent of the law, we in the federal government will meet the intent of the law and these are the signs that I intend to use at the present time.

Q. One other question regarding this same promulgated ruling or proposed rule. This has to do with medical examinations. It says that they shall be provided in the way that it has been described. In the case of any employee who is exposed to asbestos dust and to limits specified in the paragraph of this Section (a), a 5 fiber limit. I think it was indicated earlier that 1 fiber/ml would be a point to keep people under medical surveillance. Is there any connotation here?

A. One fiber is the proposed limit in the NIOSH Criteria Document which has been forwarded to the Secretary of Labor for his consideration. Anyone exposed to more than 1 fiber/ml is, by definition, exposed to asbestos and comes under the surveillance program. Presumably if that were adopted, the rules could be changed.

A. There will be a final regulation sometime between now and June 7 and this will be effective in so many days. There is one thing that I think you might keep in mind. We talked about 1 fiber/ml or 5 or 10, these are very small numbers. But in terms of industrial hygiene the ml is a very unusual volume to talk about. We talk about million particles per cubic foot for dust counts and for all the numbers that are listed

in the table of threshold limit values, we have usually two numbers, ppm for volume or mg/m^3 for air. Let's take that 2 fibers/ml. When I put down the number for a cubic meter, it's up to two million. It's a much bigger number and if you figure that a worker is working for eight hours, consumes about or uses 10 m^3 of air; he could be taking in something like 20 million fibers per day. This is the way Selikoff has been stressing it. Two is not a small number--20 million fibers per day is a lot. Let's keep in mind that just by choosing the British designation of fibers per ml, we're making it look smaller than it would be if we were going by the usual American criteria of mg/m^3.

Q. I was interested in the Commander's comments about exhausting the asbestos fibers from the insulating shops and scattering it about the countryside. I gather that there is not a great deal said about it. Will you comment a little about the disposal of the filtering media that you use for this exhausted air and the disposal of the tons of waste collected by the filters? How do you physically get rid of it?

A. The hardest material to dispose of is the material from the asbestos insulation during rip off rather than the exhaust wastes. Both of these present a disposal problem. We are now requiring large polyethylene bags for harvesting the material, picking it up as you rip it out and placing it in bags just like you'd pick oranges or apples. We also wet down some of the areas to try and cut down on the dust. This is one area where there is nothing, absolutely nothing in the literature about the collection methods for asbestos. We have yet to get our national emission standards. First the standard will come out and then we can engineer for a collection method.

Q. Do you bury it at sea?

A. No, first it goes to a collector who must be warned on what the hazards might be to him. We do this for the launderers also. We recommend sanitary landfill disposal.

Q. There is this recent promulgation of emission limits under the air pollution control act, it calls for bag filters on the exhausts. It is very specific.

A. Yes, it is and its interesting because when you rip out, you don't bring the job to the rip out sight and I've never heard of carrying bag filters to the rip out sight. I'm sure it can be done.

Q. A lot of our plants have shops that already have exhaust systems. Under the present regulation we're supposed to have bag filters on them.

A. You have to see what the national emissions standard is.

Reply They don't list that.

A. In other words, they don't have it.

Reply What they're requiring are the specifics of the handling system which is going to limit the discharge and this will provide controls. For a fixed installation they are requiring a bag filter.

Q. The considerable amount of information that was presented today was intended for informational purposes for engineers and the maintenance people at the plants. Is there a comparable amount of applicable material being sent to the plant physicians so that they are aware and can cooperate with the maintenance people?

A. Well, they should be aware of it and, in fact, we have several plant physicians here today.

Q. Are there seminars given by the Medical Division here in Wilmington expecially for physicians?

A. Yes, there was a tri-annual medical meeting of all the Du Pont physicians who could get to Wilmington and a presentation on asbestos was given at that meeting.

Q. One of the problems mentioned here earlier concerns the test proceedings. We collect the asbestos sample and ship it to some unknown place at a fixed cost. You get the results anywhere from two to six weeks later. By this time we have either definitely exposed somebody to severe doses of asbestos or we come out clean--one of the two. Unfortunately, it is too late at that point. The question was raised originally whether or not Du Pont can develop a local system where we can get quicker answers. Is there anybody that is working on a project that is quick and where you can take a sample and run it through a device and get an answer in an hour or two so that you know if you've got a problem?

A. It would seem to me that the OSHA people would like to know the answer to that one. Counting samples with phase contrast microscope is nothing in the way of the quickest method at the best. At the moment there has not been any acceptable alternative developed. I would like to ask Jim Morgan if he would comment on Bethlehem Steel's Central Laboratory. As I understand it, Jim, they have set up a sort of corporate center for industrial hygiene analysis and the samples would be sent in there for analysis. Do you have any idea what their time schedule or turnover rate is?

James Morgan They have a company messenger service that gets samples to the laboratory the next morning. Then it depends on the laboratory schedule.

Dr. Zapp Am I correct in saying that although they have a corporate responsibility for these analyses toward the plants, they have no worry

now about the impending burden under OSHA?

James Morgan That's correct. Before asbestos, they went through many other things and never increased the number of help. Someone asked this morning about assistance in tooling up for counting at the plant.

Reply Dick Hubiak said the procedure would be included in the package that each of us will get. That is the article that describes the counting technique.

James Morgan The technique will be given to you but I think you should go one step beyond that and arrange with them to count duplicate samples.

Q. Earlier we were given some information about average fiber counts on different operations. Is comparable information available for calcium silicate with 8 or 10 percent asbestos being used?

A. George Lang I'm trying to recall on my memory here, back to a test that Jim Morgan directed for us over at the Test Center. We hoped to test all of the calcium silicate insulations listed in the engineering standards. We hoped to put a hazard label on them and consider the possibility of dropping certain ones from the standards. The interesting thing was the fiber counts did not parallel the percentages of asbestos which ranges from 8 to 15 percent by weight, except for one material, which was 80 percent. Now the 80 percent by weight material was very dramatically different. With the other materials you couldn't draw a line on fiber counts and asbestos-bearing percentage.

Q. If you had a material with only 10 percent asbestos, could you expect only 10 percent of what you determine on a filter to be asbestos?

A. No, even for the same type of operation there are operator variations, wind currents, etc.

Q. I judge then that the minimum that a plant has to do is one, establish a proper method of sampling and an analytical program for asbestos in all their areas that have to do with the handling of asbestos. If, the NIOSH inspector came in, I presume he would first ask for our data from that test program and therefore the minimum that we would have to have is a properly established program for sampling and analytical work.

A. Dr. Zapp The mission of industrial hygiene is to recognize, evaluate and control hazards. Now the recognititon of the hazard is that asbestos is being worked with. The evaluation has got to be that point of phase one. Where do you stand? Are you within the limits or are you outside the limits? Of course, control is the important job. If you have an asbestos or a presumptive asbestos exposure, you should have it analyzed.

Q. I guess I have a little problem with that because of the fact that I'm all over the country in connection with asbestos in its many broad applications. I'm wondering if there is some way to get around this thing. If you categorize some of the things that I've seen like sawing and other insulation shop work, could these present hazardous situations and because of that, the operation be automatically barred? Can you then apply only those control measures that are necessary without having to go through a full sampling program on that particular aspect? Can you cut down on the sampling by techniques such as this and only measure when in doubt?

A. Dr. Zapp In your sawing operation, you'll see dust; you know you have a problem of control. So certainly you have to apply control measures. Then you'll have to check on them by analysis to see whether you've brought them down to certain levels.

D-R

December 26, 1975

N. K. WALTERS
EMPLOYEE RELATIONS DEPARTMENT
SAFETY & FIRE PROTECTION DIVISION

MEDICAL EXAMINATION - ASBESTOS
(DSI-WI Detweiler to Karrh 12/19/75-attached)

The Medical Division recommends that all employees whose occupation requires exposure to concentrations of airborne asbestos receive medical examinations. I interpret this to mean those employees whose job requires that they work with asbestos, such as insulators or employees removing old insulation. For these employees, there should be a pre-placement and annual exam consisting of, at least, a 14 x 17 postario-anterior chest x-ray, a history to elicit symptoms of respiratory disease, and screening pulmonary function tests (Forced Vital Capacity and Forced Expiratory Volume in 1.0 second).

Since we have discussed this problem before, I believe you should respond to Detweiler. I have written to him indicating this.

BRUCE W. KARRH, M.D.

BWK/bn
Attachments

EXHIBIT # Karrh-HH 80.
DATE 12-19-86
ASTROIANNI & FORTAGROLI, P.C.
CERTIFIED SHORTHAND REPORTERS

DUP 0930613

THE PNEUMOCONIOSES

Classification
(H.S. VanOrdstrand, M.D.)

A. Those that are non-disabling (so-called "Benign"; due to inert non-fibrogenic dusts):

1. Siderosis
2. Stenosis
3. Baritosis

B. Those that are usually non-disabling and which may only be temporary (such as some of the occupational immunologic diseases): Allergic Alveolitis Causing

1. Byssinosis
2. Baggasosis
3. Farmer's Lung
4. Maple Bark Disease
5. Mushroom Picker's Disease
6. Pigeon Breeder's Disease
7. Sequoiosis
8. Furrier's Lung
9. Coffee Worker's Lung
10. Vinayard Sprayer's Lung
11. Paprika Splitter's Lung
12. Cheese Worker's Lung
13. Malt Worker's Lung
14. Suberosis

C. Those which may be disabling and even fatal:

1. Silicosis
2. Asbestosis
3. Berylliosis
4. Coal Worker's Pneumoconiosis
5. Shaver's Disease
6. Talcosis
7. Cristobalite Silicosis
8. Diatomaceous Earth Pneumoconiosis

DUP 0931922

Revised March 1973
H. S. VanOrdstrand, M.D.

OCCUPATIONS POTENTIALLY ASSOCIATED WITH PNEUMOCONIOSES

ASBESTOSIS
- Asbestos weaver
- Auto mechanic
- Brake manufacturer
- Carpenter
- Clutch manufacturer
- Filter maker
- Floor tilemaker
- Insulator
- Logger
- Mill worker
- Miner
- Roofer
- Shingle maker
- Shipbuilder
- Steam fitter

BAGASSOSIS
- Cane worker
- Insulation maker
- Papermaker
- Wallboard worker

BARITOSIS
- Barite miner
- Barite miller
- Ceramics worker
- Glassmaker
- Paint maker
- Rubber worker
- Well driller

BERYLLIOSIS
- Alloy maker
- Bronze maker
- Ceramics worker
- Electronic tube maker
- Extraction worker
- Fluorescent lamp maker
- Metallurgist
- Missile worker
- Neon sign maker
- Nuclear energy worker
- Phosphor maker
- Propellant maker
- Toxicologist
- X-ray tube maker

BYSSINOSIS
Workers exposed to cotton dust

COAL MINER'S PNEUMOCONIOSIS
(See page 2 for complete classification)

COFFEE WORKER'S LUNG

DIATOMACEOUS EARTH PNEUMOCONIOSIS
Workers exposed to calcining of diatomaceous earth

FARMER'S LUNG
Exposure to moldy forage

FURRIER'S LUNG
Workers with furs

KAOLINOSIS
- Brick maker
- Ceramics worker
- China maker
- Miner
- Paper maker
- Potter

MALT WORKER'S LUNG

MAPLE BARK DISEASE
- Lumberman

MUSHROOM PICKER'S DISEASE

PAPRIKA SPLITTER'S LUNG

PIGEON BREEDER'S LUNG

SEQUOIOSIS
- Lumbermen

SHAVER'S DISEASE
Abrasives makers exposed to the heat treatment of the ore bauxite

SIDEROSIS
- Demolition man
- Fettler
- Flame cutter
- Foundryman
- Grinder
- Metal worker
- Metalizer
- Polisher
- Scarfer
- Shipbreaker
- Welder

SILICOSIS
- Abrasives worker
- Bricklayer
- Brickmaker
- Ceramics worker
- Coal Miner
- Diatomite worker
- Enameller
- Fettler
- Filter maker
- Foundryman
- Glassmaker
- Insulation worker
- Miner
- Motorman
- Polisher
- Sandblaster
- Shot blaster
- Stonecutter
- Stonedresser
- Stone driller
- Tunnel driver
- Quarry man

STANOSIS
Workers involved in the salvage of tin

SUBEROSIS
Workers with European oak trees from which cork is obtained

TALCOSIS
- Cable maker
- Ceramics worker
- Cosmetic worker
- Miner
- Papermaker
- Plastics worker
- Rubber worker

DUP 0931923

11/6

Bruce
Bob Wells has written a letter to Dr Allen suggesting that he remove the word "asbestos" from his radiology report.
I don't agree and would include the following points in a reply.

(1) There is no rubber stamp. Our replies are typed.

DUP 0931924

(2) The word "asbestos" is appropriate in the report because:
(a) the lesions described are frequently associated with asbestos exposure
(b) asbestos is probably the most common fibrogenic agent to which chemical industry workers have been exposed — particularly in the mechanic crafts.

(c) it is appropriate for a radiologist to suggest high probability differential diagnoses collectable with the errors described in the Dm.

(d) to equivocate in the report for the alleged purpose of deceiving the litigation proponents of our employees is not compatible with the philosophy of our employer and the goals of the current director program — start, inform, and evaluate.

EXISTING

ASBESTOS DUST CONTROL

PURPOSE

This procedure outlines the measures to be taken and practices to be followed where personnel may be exposed to asbestos dust in the course of their work. Refer also to Du Pont Engineering Standard S4T, "Measurement and Control of Asbestos Dust Exposure", and OSHA Standard 1910.1001.

GENERAL

- The policy of the Du Pont Company and Belle Plant is not to purchase or use asbestos-containing materials if satisfactory substitutes are available.
- The principle remaining potential source for airborne asbestos dust is during removal and disposal of existing asbestos-containing insulation from pipe lines and equipment and from the sawing of transite.
- Exposure to asbestos dust can be controlled by dampening or wetting the insulating materials, using respirators, employing good housekeeping, good personal hygiene and careful handling of materials.

I. PROCEDURE

1. Removal and Repairing Asbestos-Containing Insulation - Asbestos-containing insulation to be removed or requiring repairs should be wet down prior to removal and the wetting down continued as insulation is removed. In addition, respirators must be worn. Consideration must be given to personnel working in the vicinity who are not directly involved but who may be exposed to asbestos dust. Scrap insulation is to be placed in sealed plastic bags for disposal. Specific caution labels (Stores Item 02-84-45-007) must be attached - See attachment "A".

2. Sawing Transite - Prior to sawing transite it shall be dampened whenever possible. In addition, because dampening does not completely satisfactorily control dust, respirators shall be worn. Scrap that can create airborne dust shall be carefully collected, placed in plastic bags and sealed. Consideration must be given to personnel who are not directly involved and precautions taken to avoid their exposure.

REVISED
8/9/78

II. ENVIRONMENTAL MONITORING FOR DUST

1. Method - Samples will be taken with a portable battery-operated air sampler equipped with a membrane filter of 0.8 micrometer porosity mounted in an open face filter holder. The sampler intake is to be attached to the employee's lapel within his normal breathing zone. The equipment is to be inspected by insulator supervision prior to each use. The air hose is to be purged with air before each sample is taken. All employees are to be instructed in the use of the equipment.

   NOTE: The sampler is not to be used in hazardous (explosive atmosphere) areas without first obtaining a permit to use a spark producing device.

2. Frequency and Duration - Initially, samples are taken to determine the 8-hour time weighted average [(TWA) - the average concentration occurring over a period of 8 continuous hours] airborne concentration and the ceiling (or highest) concentration of asbestos fibers at a given location. Where results indicate asbestos dust in excess of prescribed limits, the operation is to be reviewed to reduce exposure and resampled. Routinely, 1-2 samples will be taken each month. Each such sampling must be of at least 15 minutes' duration and be made in a pattern to accurately represent the employee's exposure to dust over his work day.

3. Sample Analysis and Record Keeping - Completed samples (exposed filters) are to be sealed in separate packages, individually identified, and sent to the Development Lab with a copy of the sampling record (PB-228) for analysis. Records of monitoring and results are to be maintained for 20 years minimum. Custodian of these records will be the supervisor responsible for insulating.

   Permissible exposure limits of airborne asbestos dust concentrations per OSHA Standards effective July 1, 1978, shall not exceed an 8-hour TWA of 2 fibers longer than 5 microns per cubic centimeter of air. At no time may the concentration exceed 10 fibers longer than 5 microns per cubic centimeter.

III. RESPIRATOR PROGRAM

A mechanical filter-type respirator is issued to each insulator on a permanent basis. Currently the NIOSH approved Dustfo 88 model is used.

1. Required Use - Respirators must be worn under the following conditions:

   • When sawing transite.

III. RESPIRATOR PROGRAM (Con't.)

- When removing insulation from pipe, equipment or vessels where wetting down is impractical, such as from hot steam lines.
- When power sawing insulation in the Fabrication Shop. (even though only non-asbestos insulation is used now)
- When emptying dust from separators, vacuum systems and waste containers, cleaning floors, shelves, work benches, cartons, and any other places where wetting down of the area or contents is impractical.

2. Testing and Care - Each employee provided with a respirator shall be instructed in testing for proper fit and is required to test the unit before each use. Filter pads in the respirators are to be changed after each use. Cleaning stations equipped with cleaning solutions and wipers, and replacement filter pads are located in each insulator headquarters. It is the responsibility of the individual to keep his respirator clean.

— Respirators are to be cleaned and sterilized prior to reissue.

IV. DISPOSAL OF ASBESTOS SCRAP AND WASTE

Dumpsters are placed at strategic locations throughout the plant, painted an alert orange, and prominently marked "FOR ASBESTOS SCRAP ONLY." Scrap and waste must be placed in plastic bags and tied before being placed in the dumpsters.

Asbestos-containing scrap insulation is disposed of via land fill.

V. HOUSEKEEPING & HYGIENE

1. Housekeeping

a. Fabricating Shop and Insulation Storage - Dry sweeping of shop power sawing room, work bench areas and asbestos storage areas should be avoided even though no asbestos-containing insulation is worked or stored in the shop; vacuum cleanup is preferable. The shop work bench areas and storage areas should be vacuum cleaned daily; these include cleanup of ledges, shelves, floors and machines. Respirators shall be worn when cleaning. All scrap and waste is to be put in plastic bags, sealed and placed in appropriate containers provided therefore.

REVISED
3/9/78

V. HOUSEKEEPING & HYGIENE (Con't.)

1. Housekeeping (Con't.)

b. Job Site - Scrap and waste is to be kept in plastic bags. Asbestos-containing insulation encountered at the job site must be kept dampened down when worked. If not practical, then a respirator shall be worn.

2. Hygiene - The abrasive nature and manner of handling insulating material is conducive to creating dust which accumulates on clothing and throughout the work area. To better control this condition the following hygienic rules are to be observed:

a. The carrying on the person, storage or consumption of food, gum, tobacco or other material that is placed in the mouth are not permitted in the fabricating shop or asbestos storage areas.

b. Before removing dust contaminated work clothes at quitting time, personnel are to vacuum the work clothes to remove as much dust as possible.

c. Asbestos dust contaminated work clothes are to be kept in a locker separate from street clothes.

d. When turning in asbestos dust contaminated coveralls to be laundered, the coveralls are to be placed in a plastic bag, tied and a caution label attached to the bag. The bag is then placed in the coverall locker for pickup in accordance with the coverall program.

NOTE: Should coveralls become excessively dirty to the extent that more than one change a week is necessary, then additional coveralls are to be provided in accordance with the coverall program.

3. Medical Examination - All insulators are to have a chest X-ray and Pulmonary Function tests annually and at termination of employment. Their complete medical history is to be retained by Plant Medical for at least 20 years.

VI. CAUTION SIGNS & LABELS

Caution signs conforming to Engineering Standard S4T shall be posted at all approaches to areas where asbestos concentrations may be above permissible exposure limits. Caution labels conforming to S4T shall be used to identify contaminated clothing.

REVISED BY AUTHORITY OF CENTRAL SAFETY COMMITTEE 8/9/78

TAK/mmk

DUP 0932708.

CAUTION

CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
BREATHING ASBESTOS DUST MAY
CAUSE SERIOUS BODILY HARM

DUP 0932709

ADDENDUM TO SAFETY MANUAL PROCEDURE L-4

ASBESTOS DUST CONTROL
AUDIT CHECK SHEET

I. PERMISSIBLE EXPOSURE LIMITS: Asbestos Dust Concentrations in air shall not exceed an 8-hour time-weighted average of 5 fibers longer than 5 microns per cubic centimeter of air. At no time may the concentration exceed a ceiling of 10 fibers longer than 5 microns per cubic centimeter. The 8-hour time-weighted average is the average concentration occurring over a period of 8 continuous hours.

II. MONITORING

1. Are sampling records up-to-date?
2. Do these records indicate a frequency and pattern of sampling representing accurately employees' exposure in their work?
3. Are samples actually taken in the employee's breathing zone?
4. Are affected employees given an opportunity to observe sample monitoring?
5. Do they have access to the records thereof?
6. How long are environmental monitoring records kept?
7. Is each sampling of 15 minutes' duration or longer?
8. Do the results indicate a level of asbestos dust within the control limits?
9. Are any sample results in excess of the permissible exposure limits?
10. If so, what has been done about the conditions that caused this?
11. Are samples taken of ventilation and vacuum systems dust collection discharges periodically to assure satisfactory performance of these systems?

III. CONTROL OF ASBESTOS DUST

1. Are local exhaust ventilation and dust collection systems adequate? Caps or dampers provided in each intake hose to maintain capacity of system?
   Any leakage to atmosphere or unfiltered discharge air? Can collection hoppers be emptied without creating visible emissions? Any torn, ruptured, threadbare or improperly positioned bags?
2. Are all hand-operated and power-operated tools which may produce and release asbestos fibers in excess of prescribed exposure limits provided with exhaust ventilation systems? Saws? Scorers? Drills?
3. Insofar as practical, is asbestos handled, mixed, applied, cut, scored, removed and otherwise worked in a wet state sufficient to prevent the emission of air borne fibers in excess of the prescribed exposure limits?
4. Are any cements, grout, coatings or similar materials currently in use which are not asbestos free? If so, is this material wetted, or enclosed, or ventilated when it is removed from bags, cartons, etc.?
5. Are cartons of new asbestos insulation vacuumed upon opening prior to removal of the materials? Is the insulation vacuumed as it is removed from the carton?
6. What about asbestos insulation cartons opened in the field?
7. How are empty cartons disposed of so that exposure does not occur from this source?

III. (continued)

8. Are all major power-cutting machines isolated in a separate working area? What is the "wetting down" policy in this area? How effective is the adherence to this policy?
9. Do the asbestos work areas have a vacuum clean-up system? Are the ledges, shelves, floors, machines vacuum-cleaned at least daily to prevent accumulations of dust?
Is dry sweeping prohibited?
Is the use of air hoses for blowing down prohibited?
10. Is insulation which is being removed dampened prior to and during removal whenever possible?

11. Is asbestos waste, scraps, vacuum system collections, etc. collected and disposed of in sealed impermeable bags? Are "caution" labels affixed to the bags warning of the presence of asbestos fibers?

12. What procedure is used for disposing of asbestos waste and debris to prevent exposure during disposal or afterwards?

13. What are the procedures for controlling asbestos airborne dust when asbestos is cut, sawed and worked in the field? How rigorously are these procedures adhered to?
14. What is done to avoid employee exposure whenever they empty or work on the dust collection systems on asbestos vacuum or ventilation equipment?
15. What is done to protect groups other than the insulators when they remove asbestos insulation in the course of their work, such as pipefitters?
16. What is being done to eliminate the asbestos problem at the source such as by using non-asbestos materials?

IV. HYGIENE

1. Are two separate lockers provided for employees exposed to asbestos to prevent contamination of their street clothes from their work clothes?
2. Is food, gum, tobacco or other materials placed in the mouth prohibited in work areas where asbestos is being handled or fabricated?
3. Do employees wear company-furnished coveralls when exposed to airborne concentrations of asbestos fibers which exceed the prescribed ceiling levels? What about men exposed to asbestos who do not normally wear Company coveralls?
4. Are contaminated coveralls sealed in impermeable bags and "caution" labels affixed to the bags before the coveralls are given to the laundry for cleaning?
5. What is done to prevent exposure during removal of asbestos-contaminated clothing?

V. RESPIRATORY EQUIPMENT

1. Has each employee been instructed in the fit-up, testing and use of respirators?
2. Are facilities available to the employees for cleaning and disinfecting respirators?
3. Are respirators available? Spare filters?
4. Are respirators cleaned and disinfected on a regular basis? What is the frequency? Who schedules this?

5. Who decides when respirator equipment is needed?
6. On what type of jobs are respirators normally always required?
7. Are these jobs listed somewhere so that the men know what they are? Who sees to it that they are worn when required?

VI. MEDICAL EXAMINATIONS AND RECORDS

1. Are medical examinations, including as a minimum, a chest X-ray and a pulmonary forced vital capacity test, performed at time of hire, annually thereafter, and at time of termination for all employees in occupations exposed to airborne concentrations of asbestos fibers?
2. Are complete and accurate records of such medical examinations retained for at least 20 years?

IBY:orm
2/27/74

DUP 0932712