I am Richard A. Lemen, Director of the Division of Standards Development and Technology Transfer (DSDTT) of the National Institute for Occupational Safety and Health (NIOSH). With me today are Dr. Paul Baron, Larry Reed, and Heinz Ahlers, senior staff from NIOSH, each of whom has expertise in various aspects of the asbestos problem. My purpose for appearing at this hearing is to support the State of Michigan's Department of Public Health efforts to promulgate a new standard for asbestos.

The United States Public Health Service (USPHS) first published a study describing the adverse effects of exposure to asbestos in the asbestos textile industry in 1938, and recommended a guidance concentration to protect workers from adverse effects of asbestos. This concentration was 5 million particles per cubic foot (mppcf) of air. This recommendation was not officially adopted until 1960, under the Longshoreman's Act, administrated by the Department of Labor (DOL). This standard remained in effect until 1969 when DOL lowered it to 2 mppcf or 12 fibers/ml under the Walsh-Healey Act.

In November 1971, the Director of the newly created NIOSH, an agency of the USPHS, in a letter to the Assistant Secretary of Labor for OSHA, recommended a reduction of the then current asbestos standard from 12,000,000 to 5,000 000 fibers greater than 5 microns in length per cubic meter of air (12 fibers/ml to 5 fibers/ml) as an 8-hour time weighted average (TWA). In December of 1971, OSHA issued an emergency

pg 1

temporary standard specifying an 8-hour TWA permissible exposure limit (PEL) of 5,000,000 fibers per cubic meter greater than 5 microns in length per cubic meter of air. Concentrations above 5,000,000 fibers per cubic meter, but not to exceed 10,000,000 fibers per cubic meter, were permitted for up to 15 minutes in an hour, for as many as 5 hours in an 8-hour day. That standard specified respirator use where engineering controls were not feasible (36 FR 23207).

Subsequently, on February 25, 1972, NIOSH submitted a Criteria for a Recommended Standard....Occupational Exposure to Asbestos to OSHA. This NIOSH criteria document recommended an 8-hour TWA of 2,000,000 fibers per cubic meter based on a count of fibers greater than 5 microns in length as determined by the phase contrast microscope. Peak exposures for any 15-minute sampling period at greater than 10,000,000 fibers greater than 5 microns per cubic meter of air were not permitted. Periodic medical examinations were also required, and respirator types were specified for various concentrations in excess of the TWA. Under the NIOSH recommended standard, it was also required that workers be informed of the hazards of working with asbestos, symptoms of diseases, and precautions to be taken to reduce the risk of adverse effects. On June 7, 1972, OSHA issued a final asbestos standard having an initial PEL of 5,000,000 fibers per cubic meter to take effect immediately, and a reduced PEL of 2,000,000 fibers per cubic meter to take effect on July 1, 1976. In this OSHA standard, engineering controls were required to meet the PEL and only

ST0072293

limited use of respirators was permitted during installation of engineering controls or when engineering controls were not feasible or during emergency. Labels were also required.

In December 1976, NIOSH submitted a revised recommended asbestos standard to OSHA recommending that the current 2,000,000 fibers per cubic meter standard was inadequate to protect against asbestos-related disease. Since phase contrast microscopy was the only generally available and practical analytical technique at that time, the concentration recommended by NIOSH was 100,000 fibers > 5um in length/m^3 (0.1 fibers/cc) as an 8-hour TWA with peak concentrations not exceeding 500,000 fibers > 5um in length/m^3 (0.5 fibers/cc) as determined in a 15-minute sampling period. This new recommendation was intended to protect against the non-carcinogenic effects of asbestos and to lower the carcinogenic risk since cancer risks had been demonstrated at all fiber concentrations studied to that date. The available data at that time provided no evidence for a threshold of response or for a "safe" level of asbestos exposure. To date, no new evidence would disprove this.

In the fall of 1979, at the request of the Assistant Secretary of Labor for Occupational Safety and Health and the Director of NIOSH, a joint NIOSH/OSHA working group on asbestos was established. In November 1980, the committee's report was released. The working group was requested to review the existing scientific information concerning asbestos-related disease and assess the adequacy of the current OSHA standard of 2,000,000 fibers greater than 5 microns in length per cubic meter of air. This NIOSH/OSHA committee reviewed previous NIOSH criteria documents, the report of the British Advisory Committee on Asbestos (completed in 1979), and the 1977 International Agency for Research on Cancer (IARC) monograph on the carcinogenic hazards of asbestos. Among the recommendations made by the joint committee was a recommended definition of asbestos for regulatory purposes.

> "Asbestos is defined to be chrysotile, crocidolite, and fibrous cummingtonite-grunerite including amosite, fibrous tremolite, fibrous actinolite, and fibrous anthophyllite. The fibrosity of the above minerals is ascertained on a microscopic level with fibers defined to be particles with an aspect ratio of 3 to 1 or larger."

At present, NIOSH knows of no compelling scientific argument upon which to change this definition.

The committee also recommended sampling and analytical techinques for airborne asbestos and concluded that using these techniques would permit airborne asbestos to be accurately quantitated to 100,000 fibers greater than 5um in length per cubic meter averaged over an 8-hour workday; the joint committee recommended that this be the

ST0072295

occupational standard for asbestos exposure in the workplace. A modification to this recommendation will be presented in the final recommendations of this testimony.

In addition, the j[illegible]mmittee stated that "Regardless of the choice of a permissible exposure limit, the best engineering controls and work practices should be instituted, and protective clothing and hygiene facilities should be provided, and their use required all of workers exposed to asbestos." The committee further emphasized that "<u>Respirators are not a suitable substitute for these control measures</u>." The joint committee also concluded that "...even where exposure is controlled to levels below 100,000 fibers, [sic] there is no scientific basis for concluding that all asbestos-related cancers would be prevented." In addition, the joint committee also recommended provisions for medical surveillance. Because of the widespread current and past uses of asbestos products in the maritime and construction industries, the joint committee stated that "...it is vital that any new asbestos standard address these industry sectors as well as other workplaces with employees exposed to asbestos." The joint committee further recommended that:

> "...manufacturers of asbestos-containing products such as construction materials should perform detailed monitoring of exposures which could result from all foreseeable uses of their products, including misuse. This monitoring should

ST0072296

include electron microscopy to identify fiber type, mix and exposures to fibers less than 5um in length. This monitoring data should accompany these products downstream so the users not only know that asbestos exposures may occur, but also know the nature of potential exposures. This monitoring data could, if appropriate, avoid the need for small employers who use asbestos-containing products to have to conduct monitoring on their own."

Also, the joint committee urged that "...because cigarette smoking enhances the carcinogenic effect of asbestos exposure on the lung, particular emphasis should be placed on this in any educational program developed under a new standard." NIOSH continues to believe that both asbestos and smoking are independently capable of increasing the risk of lung cancer mortality. When exposure to both occurs, the combined effect with respect to lung cancer appears to be multiplicative rather than additive. From the evidence presented, we may conclude that asbestos is a carcinogen capable of causing, independent of smoking, lung cancer and mesothelioma.

Finally, the joint committee stated that "...due to the fact that other agencies regulate occupational exposures to asbestos (such as the Mine Safety and Health Administration), these agencies should be urged to participate in the development of a new standard and adopt this new standard."

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NIOSH continues to recommend an asbestos standard of 100,000 fibers greater than 5 um in length per cubic meter averaged over an 8-hour workday. It is our contention that there is no safe concentration of exposure to asbestos. Any standard, no matter how low the concentration, will not ensure absolute protection for all workers from developing cancer as a result of their occupational exposure; however, lower concentrations of exposure carry lower risks. This is consistent with the conclusions of the NIOSH 1976 criteria document and the joint NIOSH/OSHA report of 1980. This also is consistent with the conclusion of the Consumer Product Safety Commission (CPSC) Chronic Hazard Advisory Panel on Asbestos in 1983. They concluded that "on scientific grounds and as a matter of public health prudence, the Commission should regard asbestos at all levels of exposure as a potential human carcinogen." The CPSC report also concluded that:

> "All major fiber types studied (i.e., chrysotile, amosite, crocidolite) appear to be capable of causing lung cancer and, except for anthophyllite, pleural mesothelioma in humans."

This is consistent with the joint NIOSH/OSHA report which stated that:

> "On the basis of available information, the committee concludes that there is no scientific basis for differentiating between asbestos fiber types for regulatory purposes."

This statement by the joint NIOSH/QSHA committee continues to be NIOSH policy today and is supported in our written comments to the docket.

DOSE-RESPONSE RELATIONSHIPS

The available evidence indicates that larger doses of asbestos will produce greater biological effects than smaller doses. Although there appears to be little dispute that a larger dose of asbestos poses a health risk, the exact nature of the dose-response relationship for lung cancer mortality is subject to considerable debate. This is primarily because of the uncertainty of exposure estimation. Methods of measuring asbestos concentrations have changed over time. Sampling instruments (thermal precipitation versus midget impinger versus membrane filter), location of sampling (personal versus area), dust counting (particles versus actual fibers), and evaluation techniques (whole fields versus eyepiece graticule) have all changed. As a result, conversion of asbestos concentrations obtained by one method to those obtained by another is far from simple and is subject to considerable error. Another factor which may lead to differences of opinion on the exact shape of the dose-response curve is the measure of the dose. The commonly used measures are cumulative dose and the duration of employment. Since using cumulative dose as a measure of exposure gives equal weight to the concentrations of asbestos experienced in each year of exposure, exposures that occurred many years ago are implicitly considered to be as important as recent exposure. This assumption is unrealistic for the chronic diseases having a long latency period. Duration of employment has also been used as a measure of exposure with the assumption that increasing the exposure duration approximates increasing the dose. This procedure has the same problem as using the cumulative dose. Furthermore, in the absence of reliable past exposure data, the duration of employment may not be directly proportional to the total dose of asbestos.

Data available to date provides no evidence for the existence of a threshold level. Virtually all levels of asbestos exposure studied to date demonstrated an excess of asbestos-related disease.

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ASBESTOS SAMPLING AND ANALYSIS AND RECOMMENDED EXPOSURE LIMIT

In the 1980 NIOSH/OSHA publication, Workplace Exposure to Asbestos; Review and Recommendations, we presented and evaluated several methods for sampling and analysis of asbestos that had been developed since the publication of the NIOSH criteria document on asbestos. Based upon that evaluation, it was concluded that: "The phase contrast method is clearly capable of measuring airborne fiber levels down to 0.1 fibers/cc...".

We also recognized that phase contrast microscopy lacked specificity when asbestos and non-asbestos fibers occurred in the same environment. To cope with the problem of specificity we concluded:

"The most likely choice for fiber identification in airborne dust samples is electron microscopy where both electron diffraction and microchemical analysis may be used to identify fibers." (NIOSH Method 7402 is a transmission electron microscopy (TEM) method that provides a means of determining the percentage of optically visible asbestos fibers on a filter sample.)

We also concluded that it is reasonable that such determinations only need be made for a sample which is statistically significantly above the blank with subsequent determinations made only upon process or product modifications.

In making a recommendation for an occupational exposure limit for asbestos, NIOSH's ultimate goal is to eliminate asbestos exposures. However, we realize that at this point in time such a recommendation is neither feasible nor practicable due in part to limitations imposed by currently accepted methods of sampling and analysis.

Since 1980, NIOSH has developed modifications to our existing phase contrast method for asbestos determination. By employing this modified method (NIOSH Method 7400), it is possible to measure personal asbestos exposure at concentrations as low as 20,000 fibers per cubic meter of air (when a 2 cubic meter air sample is collected). However, in some sampling locations the filter may become so loaded with non-asbestos particulates that accurate counting may not be possible.

> 4l/min

It is assumed that NIOSH Method 7400 will be used for monitoring, which requires a minimum fiber loading of 100 f/mm^2. This method is able to achieve precision which meets the established NIOSH accuracy standard of 12.8% RSD at an exposure limit of 100,000 fibers/m^3 determined as an 8-hour TWA in a 400 liter sample. Using the new method 7400, it is also possible to measure 50,000 fibers per cubic meter with an overall precision of 20% RSD and to measure 20,000 fibers per cubic meter at 30% RSD.

The NIOSH accuracy standard mentioned above is based on the within laboratory RSD with the assumption that any analytical method biases between laboratories can be eliminated by appropriate corrective action. Most analytical methods are instrumental procedures and have adequate reference materials. For these, biases between laboratories have largely been eliminated and the within laboratory RSD is a useful indicator of method accuracy. However, in the case of asbestos fiber counting, a human counter is the analytical instrument and is not easily calibrated. In addition, attempts to provide good reference materials and interlaboratory comparison programs have not been adequate to eliminate all interlaboratory biases. Efforts have been made to improve agreement between laboratories by improvements in the analytical method, increased training requirements and requirements for interlaboratory sample exchanges. However, there are studies that indicate that the interlaboratory biases are not as well controlled as with other methods. Several studies have shown that if one treats these biases as a component of variability, the RSD of the method for asbestos field samples can be 45%. This value is recommended for calculating confidence limits about a measured value, in lieu of interlaboratory data showing otherwise. Method 7400 (Revision 2, 8/15/87) indicates a conservative (protective of health) approach to calculating such confidence limits. To meet a 100,000 fibers/m^3 standard, this means that the measured value needs to be approximately 1/3 of this value, or 30,000 fibers/m^3 (with a 400 L sample). This will provide confidence that any other laboratory reporting on that sample will likewise indicate (95% of the time) that the PEL has been met.

NIOSH and others have recommended exposure limits for asbestos based on 8-hour TWA concentrations. While this is a well understood practice, we cannot find compelling arguments to prevent a recommendation based on alternative sampling periods. In fact, such an approach may provide more protection than an 8-hour based sampling period that allows short-term exposures 6 or 10 times greater than the 8-hour exposure limits being considered by OSHA. Furthermore, since there is uncertainty regarding the cumulative dose required to initiate disease, it seems reasonable to make every attempt to control exposures to as narrow a range of concentrations as possible. We believe that one way to accomplish this may be by restricting the period over which workplace concentrations can be averaged. Four liter per minute personal sampling pumps are presently available which would allow a sampling time of 100 minutes. NIOSH is currently evaluating this information.

We recognize that there will be certain situations in which overloading of the filter at this flow rate may be of concern. In those situations, the judgement of the professional taking the sample must be applied to determine a more appropriate sampling time keeping in mind the requirement that a minimum fiber density of 100 fibers per square millimeter is required to achieve the NIOSH acceptable precision at a concentration of 100,000 fibers/cubic meter of air.

Finally, we still believe that there are occasions, such as mixed fiber exposures, where fiber specificity is necessary. Therefore, we recommend the use of electron microscopy in the event of process or product modification, in mixed fiber exposures, or when there are other reasons for characterization of fiber type.

Control of Exposures

Effective control involves a system of engineering, work practice, personal protection, and monitoring/feedback measures, with engineering as the preferred control measure by professional occupational safety and health professionals. There are clear advantages to using engineering measures to prevent or contain emissions at the source. Effective containment prevents problems associated with housekeeping and with secondary workplace emissions from settled dust; it also prevents the prospect of emitting asbestos into the environment outside of the workplace. Thus, it addresses both occupational and public health concerns simultaneously.

The OSHA requirement that engineering and work practice measures be used to meet a 200,000 fibers/m^3 level is consistent with effective containment. However, the additional provision of compliance by respiratory protection below this level is not consistent with source containment, especially since engineering measures may, in fact, be able to control to below 200,000 fibers/m^3 (as discussed below). Proposed blanket exemptions for intermittent exposures without regard to feasibility are also not consistent with source containment. Worker rotation as a compliance measure must be forbidden, given the lack of a safe threshold for lung cancer caused by asbestos.

Potential asbestos exposures can be divided into two broad categories. The first involves the inclusion of asbestos in products which are currently being developed or manufactured (e.g., brake shoes, thermal insulation, floor tile, cement pipe) and additional handling of these products (e.g., replacement of brake shoes). The second involves construction activities, which consist principally of tearout or maintenance of previously installed asbestos in buildings or factories, and demolition of these buildings.

In the first case (currently manufactured products), the recommended control strategy is to modify the product so that asbestos or a substitute is not required at all. The continued use of large quantities of asbestos presents the prospect of large-scale introduction of asbestos into the workplace, and ultimately into the environment as these products are used and disposed of. Rajhans and Bragg discuss substitutes such as: alkaline-resistant glass fiber for asbestos in cement; iron or plastic pipe for cement pipe; steel and glass fiber composites (still under development) for brakes; fibrous glass and various refractories for thermal insulation. The Royal Commission Report from Ontario, Canada states that, "in 1980, semi-metallic disc pads were used on the front brakes of approximately half of all new North American vehicles, and it is expected that this fraction will approach 100 percent by 1985." Further, they report that, for packing materials, "New packing materials appear to be more than viable alternatives (to asbestos), offering less abrasion and thus lower operating and maintenance costs. It appears that only sales and engineering resistance stand in the way of a total switchover to non-asbestos packings." For asbestos-cement pipe, they report that, "for most applications at least one alternative to asbestos-cement pipe will offer satisfactory performance, and the main factor of choice is economics." For plastic fillers, they report that, "substitutes are economically competitive with asbestos and yield satisfactory product qualities." They report that more work may be necessary to provide completely acceptable non-asbestos substitutes for floor tile and roof coatings or paints.

Where asbestos is used, rigorous engineering source controls should be employed. Bragg stated that, "Emptying asbestos out of bags, or debagging, is one of the most difficult processes to control." Bragg indicates that even if substitutes are not available, engineering containment measures should generally suffice to keep exposures at or below 500,000 fibers per cubic meter for most manufacturing operations using asbestos. NIOSH has studied controls for two of the most difficult operations involving asbestos processing. NIOSH found exposure levels around 200,000 fibers per cubic meter at an asbestos debagging operation which used an automated debagger. Furthermore, the exposures that did occur in the NIOSH study seemed to be from contaminated incoming bags rather than from the debagger itself. Newly available automated debaggers with improved bag disposal combined with improved cleaning of incoming bags may offer even further exposure reductions.

NIOSH also found exposures of 100,000 fibers per cubic meter at a well controlled asbestos bag filling operation. Therefore, the blanket OSHA exemption of engineering measures for control below 200,000 fibers per cubic meter is not warranted for the manufacture of asbestos-containing products.

In the second case (tearout and maintenance), rigorous engineering and work practice containment measures are available. Techniques such as wetting, local exhaust, and HEPA filtration are appropriate.

Workforce mobility and rapidly changing worksites in construction activities complicate both engineering and environmental/medical monitoring activities and may justify a separate standard for this industry. In general, NIOSH feels that there is a need for a validation, specification and uniform enforcement of specific engineering and work practice controls in asbestos-related construction activities. It is important that competing bidders be required to address a minimum level of safe performance, since the growth and highly competitive nature of the asbestos removal industry has resulted in strong incentives to cut costs.

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RESPIRATORS

Respirators can effectively reduce employee exposures to asbestos. However, a number of problems must be overcome before any confidence can be given to using respirators as a solution to preventing excessive exposures. Some of the problems include:

- Discomfort associated with wearing respirators including dermatitis, heat stress, difficulty in breathing, and feelings of claustrophobia.

- Inadequately fitting respirators.

- Psychologic stress, such as claustrophobia, associated with the wearing of respirators.

These problems can exist even when the proper respirator has been selected and an adequate respiratory protection program including training is in place. If a respirator training program does not exist, the chances of respirators providing adequate protection are much less.

NIOSH has stressed that worker exposures to airborne contaminants should be controlled through permanent engineering controls. However, prior to the installation of or during the malfunction or maintenance of engineering controls, for certain short-term intermittent exposures, and for certain operations that are performed at constantly changing locations, respirators may be required. Because respirators are and will be selected and used in industry, NIOSH wants to ensure that the respirators will be properly selected and worn, and that the quality of each respirator produced will meet certain performance criteria.

Because asbestos is a known human carcinogen and because there is no known safe level of exposure, NIOSH recommends that, when technically feasible, only the most protective respirators be worn for exposure to asbestos. These respirators are: (1) any self-contained breathing appartus (SCBA) equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode, or (2) any supplied-air respirator (SAR) equipped with a full-facepiece and operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in a pressure-demand or other positive-pressure mode.

Finally, NIOSH disagrees with Michigan's determination of the upper limit concentration of asbestos for wearing different classes of respirators. For example, for the half-mask respirator, Michigan recommends an upper limit concentration of 2 f/cc. This value of 2 f/cc was apparently derived by multiplying the proposed PEL of 0.1 f/cc by an assigned protection factor of 20 for the half-mask respirator. Both NIOSH and Federal OSHA recommend that the assigned protection factor for half-mask respirators is 10. Multiply 10 times the proposed PEL yields a 1 f/cc upper limit concentration. The assigned protection factors for all respirators appear to have been arbitrarily changed by Michigan. We recommend that the NIOSH or Federal OSHA assigned protection factors be used in determining the upper limit concentrations.

MEDICAL SURVEILLANCE PROGRAMS FOR ASBESTOS EXPOSED WORKERS

One of the principal questions of considerable public health importance is "Can we develop valid and reliable medical screening and biological monitoring tests to recognize the early effects of exposures to occupational hazards at reversible or treatable stages in order to complement and evaluate the effectiveness of environmental monitoring and control measures?" (Orchard, 1980; Becklake, 1982). Recent reviews of available epidemiological literature indicate that withdrawal from asbestos exposure will not ensure protection against progression of existing or development of asbestos-related disease (Becklake, 1982; NIOSH/College of American Pathologists Pneumoconiosis Committee, 1982; Craighead et al., 1982). Few would disagree with the view expressed by Dr. Hans Weill that radiographic evidence of diffuse pulmonary fibrosis should lead to the prudent course of avoiding further exposure (to asbestos) (Weill, 1980). However, it is uncertain whether medical removal protection should also be recommended for workers who exhibit only limited "benign" pleural abnormalities. Nor is it known whether removal from exposure will also favorably influence the risk of developing bronchogenic lung cancer or pleural mesothelioma (Orchard, 1980; Becklake, 1982; NIOSH/College of American Pathologists Pneumoconiosis Committee, 1982; American Thoracic Society, 1983). Exposure rate and cumulative dose appear to be the relevant parameters governing development of asbestosis and bronchogenic carcinoma. Therefore, while medical removal may not diminish the worker's lifetime risk of development of nononcogenic or oncogenic asbestos-related diseases, continued exposure will surely increase the risk (Becklake, 1982). For a worker who has evidence of asbestos exposure-related pleural or interstitial abnormalities, with or without associated impairment or disability, the effectiveness of medical removal as a method of reducing that worker's lifetime risk of developing mesothelioma is related to the time since first exposure, even for brief low level exposure (Day et al., 1980; National Research Council, 1984). In addition, the lifetime risk of developing pleural mesothelioma among asbestos exposed workers who smoke cigarettes is not diminished by cessation of cigarette smoking (National Research Council, 1984). Recent updates have been published concerning the principles and criteria which should underlie the design, conduct, interpretation, and evaluation of screening and surveillance programs for respiratory disease and cancer (American Thoracic Society, 1982; American Thoracic Society, 1983; Ferris, 1978; Coles et al., 1980; Halperin et al., 1984). Given the current state of knowledge, routine periodic chest X-rays and spirometric lung function tests do not meet the most crucial criteria for determining the suitability of screening tests for early recognition and primary prevention of any asbestos-related diseases.

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Although these diseases are eminently preventable by eliminating or limiting exposures to asbestos, they are not curable nor amenable to secondary preventive measures in affected individuals (Becklake, 1982; NIOSH/College of American Pathologists Pneumoconiosis Committee, 1982; Craighead et al., 1982). By the time these diseases are clinically detected among individual members of an asbestos exposed workforce by routine periodic screening, it is unlikely that the affected worker, or that worker's similarly exposed coworkers, will derive any primary preventive benefits. It may be of little consolation that recently hired workers may benefit from the resulting reductions in their future exposures.

While currently available screening tests may detect asbestos-related abnormalities among asymptomatic asbestos exposed workers years before pulmonary impairment, disability, or death occur, medical removal of these workers for exposure to asbestos may not be effective in preventing development of cancer or non-carcinogen disease. However, cessation of cigarette smoking among asbestos exposed workers with or without detectable evidence of asbestos-related pulmonary abnormalities does appear to effectively lower the overall risk of premature disability and death in these individuals (Becklake, 1982; NIOSH/College of American Pathologists Pneumoconiosis Committee, 1982; Craighead et al., 1982 Weill, 1980; Day et al., 1980).

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RECOMMENDATIONS FOR SURVEILLANCE

The previous OSHA standard for occupational exposures to asbestos was not designed to protect all exposed workers from the risks of developing asbestos-related cancer diseases (NIOSH/OSHA Asbestos Work Group, 1980). In fact, it may not have been adequate to protect all workers from developing nononcogenic asbestos-related diseases (Becklake, 1982; NIOSH/College of American Pathologists Pneumoconiosis Committee, 1982; Craighead et al., 1982; NIOSH/OSHA Asbestos Work Group, 1980).

The new OSHA standard is intended to reduce the risk to workers of developing asbestos-related disease based on consideration of (a) the estimated probability of developing significant disease following a given cumulative exposure; (b) a comparison of the risk estimate with the health and safety risks experienced among workers in a variety of non-asbestos producing or using industries; (c) the technical limits of reliable sampling and analysis; (d) the technical feasibility of measures to reduce asbestos exposure.

Thus, some proportion of asbestos exposed workers may still develop asbestos-related cancer diseases even if all workplaces are in compliance with the new standard of 200,000 fibers. As with all extrapolative estimates of risk, we know there is a great deal of uncertainty regarding the true risk among asbestos exposed workers. Ideally, a well-designed medical surveillance program would help quantify the risk and, therefore, reduce the uncertainty of the estimate.

An appropriate medical screening program should contain:

1. Both screening tests (X-rays and pulmonary function) should be conducted, at initiation of employment and thereafter every 5 years for the first 15 years, and thereafter every 2 years, using the standardized guidelines for instrumentation, training, and interpretation of recognized expert authorities (American

Thoracic Society, 1982; American Thoracic Society, 1983; Ferris, 1978; International Labour Office, 1980; Guidotti et al., 1983).

2. There should be specific guidelines for removal from exposure, with rate retention, in order to justify worker participation in a medical surveillance program which might otherwise jeopardize job security.

3. Cigarette smoking should not be permitted at worksites because of the known synergistic effects of cigarette smoking and lung cancer.

4. The results of required screening tests should be reported to OSHA and the state without personal identification within 2 months of the performance of the tests in order to enable OSHA and the state to evaluate over time the effectiveness of the medical surveillance and environmental control provisions.

5. Some consideration must be given to mandatory followup of all workers with any asbestos exposure. This is necessary because of the prolonged latency period of most asbestos-related diseases and the uncertainty surrounding the cumulative dose needed to initiate the disease process.

6. Routine periodic stool guaiac, sputum cytology, and bronchoalveolar lavage tests are not recommended as screening procedures based on the current state of knowledge concerning their diagnostic value in a massive screening programs. However, their use on an individual basis should be left to the discretion of the examining physician.

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SUMMARY OF NIOSH RECOMMENDATIONS

NIOSH urges that the objective or goal is to eliminate non-essential asbestos exposures, which requires substitution of suitable and less hazardous alternatives where they exist. Where asbestos exposures cannot be eliminated, they must be controlled to the lowest level possible. A significant consideration in establishing a permissible exposure limit should be the lowest level of exposure which can be accurately measured using currently available analytical techniques. At present this level would be 100,000 fibers greater than 5 microns in length per cubic meter, as determined in a sample collected over any 100-minute period at a flow rate of 4L/min using the NIOSH analytical method 7400. However, the presence of background dust in high sample volumes may be the limiting factor which may complicate the analysis under these sampling conditions.

The health effects of exposure to asbestos among workers have been well studied. The data available to date provide no indication of a thereshold level.

The ability to reliably quantify the level of asbestos exposure has been the limiting factor in recommending lower occupational exposure limits to asbestos. Current methods of controlling asbestos exposure can reduce levels of asbestos below reliably quantifiable limits.

NIOSH Analytical Method 7400 will reliably quantify the asbestos exposure level at the 100,000 fibers/m^3 level proposed by the Michigan Occupational Health Standards Commission and NIOSH fully supports them in recommending the 100,000 fibers/m^3 exposure limit.

In their final asbestos rule published in June 1986, Federal OSHA estimates that workers exposed to 0.2 f/cc of asbestos for a 45 year working lifetime can be expected to experience an excess asbestos-related cancer mortality rate of approximately 6.7 per 1,000 exposed workers. Even at an exposure level of 0.1 f/cc for a 45 year working lifetime, the excess asbestos-related cancer mortality rate is expected to be 3.4 per 1,000 exposed workers.

NIOSH would present the following exhibits for inclusion in the record of these preceedings.