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ASBESTOS AND HEALTH
Information File

April, 1973

Enclosed for your review is a General Reference File on the subject of asbestos and health. Because of increasing attention to the occupational health hazards associated with the worldwide use of asbestos products, you may find this File useful as a source of background information for news and feature material dealing with OSHA regulations, occupational disease, worker safety and health and the nature of asbestos.

The File contains five position papers, in addition to medical papers and supplemental data on the subject of asbestos and health. You may also wish to file other asbestos reference materials in this folder. In addition, we will send you more information, as it becomes available, to continually update your File.

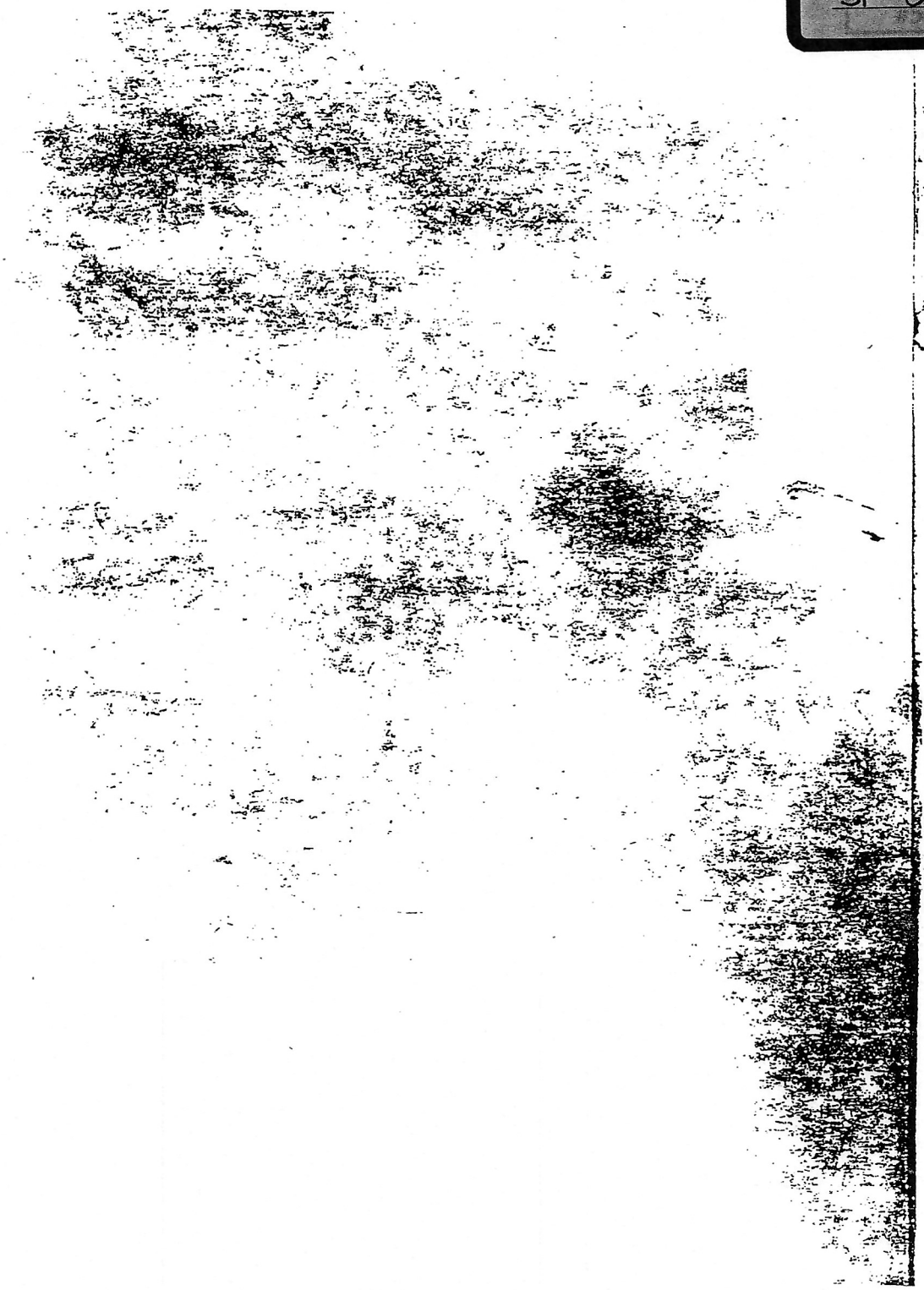
Part I	Asbestos and Health
Part II	What Asbestos Is
Part III	Protecting the Asbestos Worker
Part IV	Asbestos and the General Public
Part V	Profile of the AIA/NA
Part VI	Medical Papers and Other Material

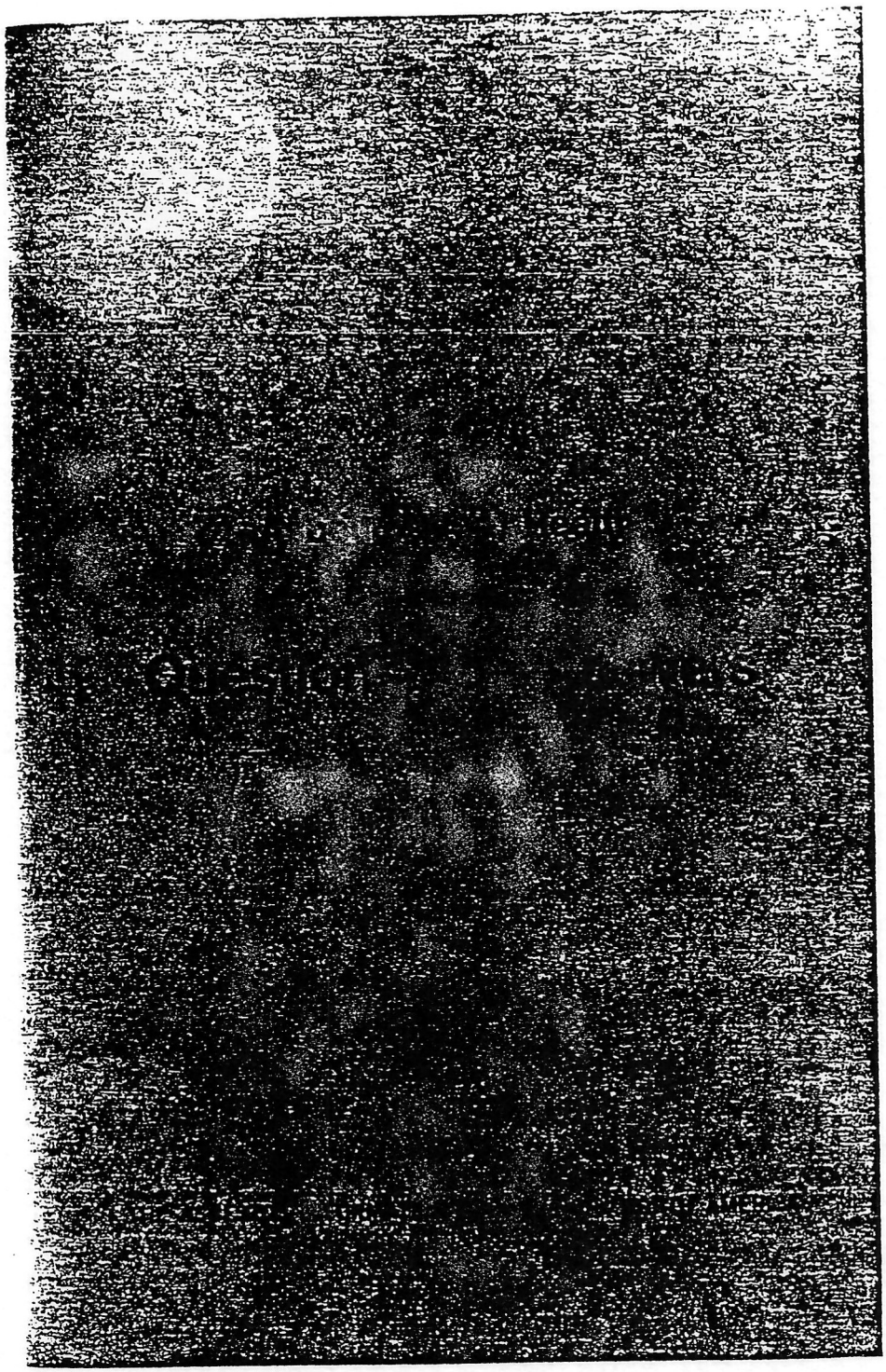
Asbestos Information Association/North America

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Asbestos and Health
QUESTIONS & ANSWERS

Much has been printed and said about asbestos and health, much of it inaccurate, misleading or completely false.

Some of the more prevalent of these fallacies are discussed in a question and answer format in the following pages.

QUESTION

Is asbestos a major air and water pollutant in our society?

ANSWER

Asbestos exists naturally in small though detectable amounts in serpentine rock formations throughout the world and is constantly being released into the atmosphere through erosion by wind and water. Asbestos is thus natural to our environment, and — as analysis of dated ice from the polar caps have revealed — has been for thousands or even millions of years.

Man therefore probably evolved into his present form in an atmosphere containing a natural background level of asbestos — both in the air he breathed and in the water he drank. While precise comparisons are impossible, today's atmospheric levels of asbestos, even in urban settings, are still only marginally higher than in the distant past and are many thousands of times lower than any levels known to result in disease in occupational settings.

There is no indication that levels of asbestos in community air and water have been increased significantly by modern uses of asbestos. The only exceptions that have been found were in the past in environments close to manufacturing and mining facilities, and in applications where simple controls were not implemented — such as unrestricted spraying of asbestos fireproofing in construction. These emissions are currently under control, in accordance with federal, state and local standards that are designed to help keep asbestos in ambient air everywhere at levels that are not injurious to health.

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AC/LA 007665

QUESTION

Do asbestos-containing brake linings used on trucks, busses and automobiles release harmful amounts of asbestos dust into community air?

ANSWER

Brake linings used in transportation vehicles contain up to 55 percent asbestos fiber, but this fiber is locked into the linings with various resins and polymers. When brakes are applied, enormous amounts of heat are generated, which changes the chemical nature of the asbestos in the lining, thus producing a non-fibrous, non-toxic material called fosterite. Studies conducted in the United States and Great Britain have shown that brake lining dust contains only traces (one to three percent) of free asbestos fiber.

In fact, the total amount of free fiber released by brake lining wear throughout the United States in an entire year is less than 20% of the total emissions of particulate matter in a city the size of Los Angeles in a single day!

In addition, tests conducted in New York City at specially selected locations where traffic is heavy and braking frequent have shown that asbestos dust levels are only marginally higher than normal background levels, and many thousands of times lower than levels which could be considered potentially hazardous.

QUESTION

Is asbestos used in the manufacture of clothing worn by the general public?

ANSWER

In 1971, a clothing manufacturer imported cloth from Italy that contained 8 percent asbestos fiber and was used to make 200,000 women's overcoats. An emotional outcry resulted, but Food & Drug Administration tests showed that the amount of asbestos dust which could be generated from such a coat, even under extreme conditions, would not pose a health hazard to the wearer of the coat.

The FDA, nevertheless, decided to ban the manufacture of such "general use" garments in the future because they felt it constituted an "inappropriate use of asbestos fiber, one in which none of the special properties of the fiber that contribute to the welfare of the public are utilized." The Asbestos Information Association officially concurred in this decision.

Garments in which the special properties of asbestos are utilized, such as fireproof suits, barbecue mitts and aprons, etc., were not banned by the FDA because the asbestos fibers are "locked in" the garments by chemical agents or other means.

QUESTION

Will there be an "epidemic" of asbestos-related mesothelioma in the future among people who worked in United States shipyards during World War II?

ANSWER

Despite the predictions of some doctors to the contrary, it appears highly unlikely that such an "epidemic" will occur. Predictions of this nature have been based primarily on the experience of workmen in British, not United States, shipyards, where a relatively small number of mesothelioma cases have been reported among yard employees not known to have worked directly with loosely-bound asbestos products in their jobs. There are several important factors, however, which do not make the British experience comparable with that in American shipyards. These are:

1. The prime method of applying asbestos-containing insulations aboard British warships was by spraying, a notoriously dusty method of application. Dust counts taken during spraying in British shipyards have been recorded as high as 1500 fibers per cubic centimeter of air (300 times higher than the current United States standard for asbestos exposure). Counts taken during the sweeping and bagging of asbestos debris have reached the astronomical figure of 3815 fibers per cc (more than 750 times the U.S. standard). This resulted in very high dust levels throughout the shipyard area.

2. Spray application methods were never used in United States shipyards during the Second World War. The alternative methods used in this country, while creating dusty conditions for the men doing the actual work, did not result in hazardous conditions throughout the yard, as was the case in Great Britain.

3. The type of asbestos fiber most used in British shipyards for insulation purposes was crocidolite, the variety of fiber most medical experts agree is the most likely to cause mesothelioma. Crocidolite was not used in U.S. shipyard work.

4. The actual number of shipyard mesothelioma cases reported in Great Britain, while of great concern, cannot be considered of "epidemic" proportions. In the Scotish yards, for example, 49 cases have been reported in the 18 year period ending in 1967.

5. Millions of men were employed in United States and British shipyards during the First World War and in the intervening years down to World War II. Asbestos insulations were used extensively during this period. The practices employed for the application of these insulations were similar, if not dustier, than those used in U.S. yards during World War II, yet no "epidemic" of mesothelioma occurred as a result of these exposures. If thousands of cases had developed, this disease would certainly have come to the attention of asbestos-health experts much earlier than it did (early 1960s).

This is not to say that a few cases of mesothelioma will not develop among indirectly exposed United States shipyard workers, however the printed medical and exposure data does not support the prediction that a hundred thousand or more will die as a result of their World War II exposures.

QUESTION

Are cosmetic talcum powders, including baby powders, contaminated by excessive amounts of asbestos fibers?

ANSWER

A form of asbestos called tremolite can be found in nearly all talcum powder, since it is a naturally occurring contaminent in talc stone. In some industrial talcs, not intended for human use, the percentage can be quite high. In cosmetic talcum powders, however, including baby powders, the percentage has been found to be very small. A 1972 study by the Office of Product Technology of the Food and Drug Administration showed that, of 40 cosmetic talcum powder samples tested, 39 contained one percent asbestos or less, while the 40th had to be retested for traces. This is far below the 15 to 25 percent figures quoted in some newspaper reports.

QUESTION

Do asbestos-containing filter materials release asbestos fibers in potentially hazardous quantities into liquors, beers, wines, soft drinks and other liquids offered for sale to the public?

ANSWER

Asbestos-cellulose filter pads have been used in the filtration of liquids since the beginning of this century. These filter pads play an important role in clarifying and improving the taste of certain beverages, as well as removing potentially toxic substances from the finished product. The mass production of many of our more important injectable drugs would be virtually impossible without the use of asbestos-containing filter media.

While is is possible that very tiny amounts of electron microscope sized asbestos fibrils are released into some beverages from the use of asbestos-containing filter pads, there is no evidence whatever that the size and quantity of the fibrils released constitute any hazard to human health.

This same question was raised in Great Britain a few years ago with regard to fibrils of asbestos found in beer. The furor died when it was shown that the total amount of asbestos fiber found in British beer added up to only two-one-thousandths of an

ounce in the total United Kingdom beer production of over a thousand-million gallons a year.

In addition, a concensus report from a 1972 international meeting on asbestos-health sponsored by the World Health Organization found no "evidence of an increased risk of cancer resulting from asbestos fibers present in water, beverages, food or in the fluids used for the administration of drugs."

QUESTION

Is the atmosphere being polluted by asbestos sprays used to fireproof the superstructure of buildings under construction?

ANSWER

The use of asbestos-containing, spray-on fireproofing compounds in high-rise building construction has been banned in the United States by the Federal Environmental Protection Agency (EPA) because the methods developed for the control of emissions of fiber from these sources proved to be ineffective.

Once this fact became established, the asbestos manufacturing industry concurred with the EPA that the use of spray fireproofing compounds should be prohibited.

QUESTION

Are asbestos-containing modeling compounds still being used by school children in art classes in the United States?

ANSWER

From time to time, a newspaper will carry a report that children in a local school or YWCA are using asbestos as a modeling compound to construct puppets or sculpt heads. This normally results in excited denunciations by local politicians and others, who demand that the practice be stopped. Simply speaking, the asbestos industry agrees with them — the practice should be stopped!

In November 1971, the Asbestos Information Association sent a caution letter on this subject to nearly 5,000 teachers associations, hobby and craft publications, state boards of

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AC/LA 007670

education, boy and girl scout councils, YMCA's and YWCA's, etc. This letter said in part:

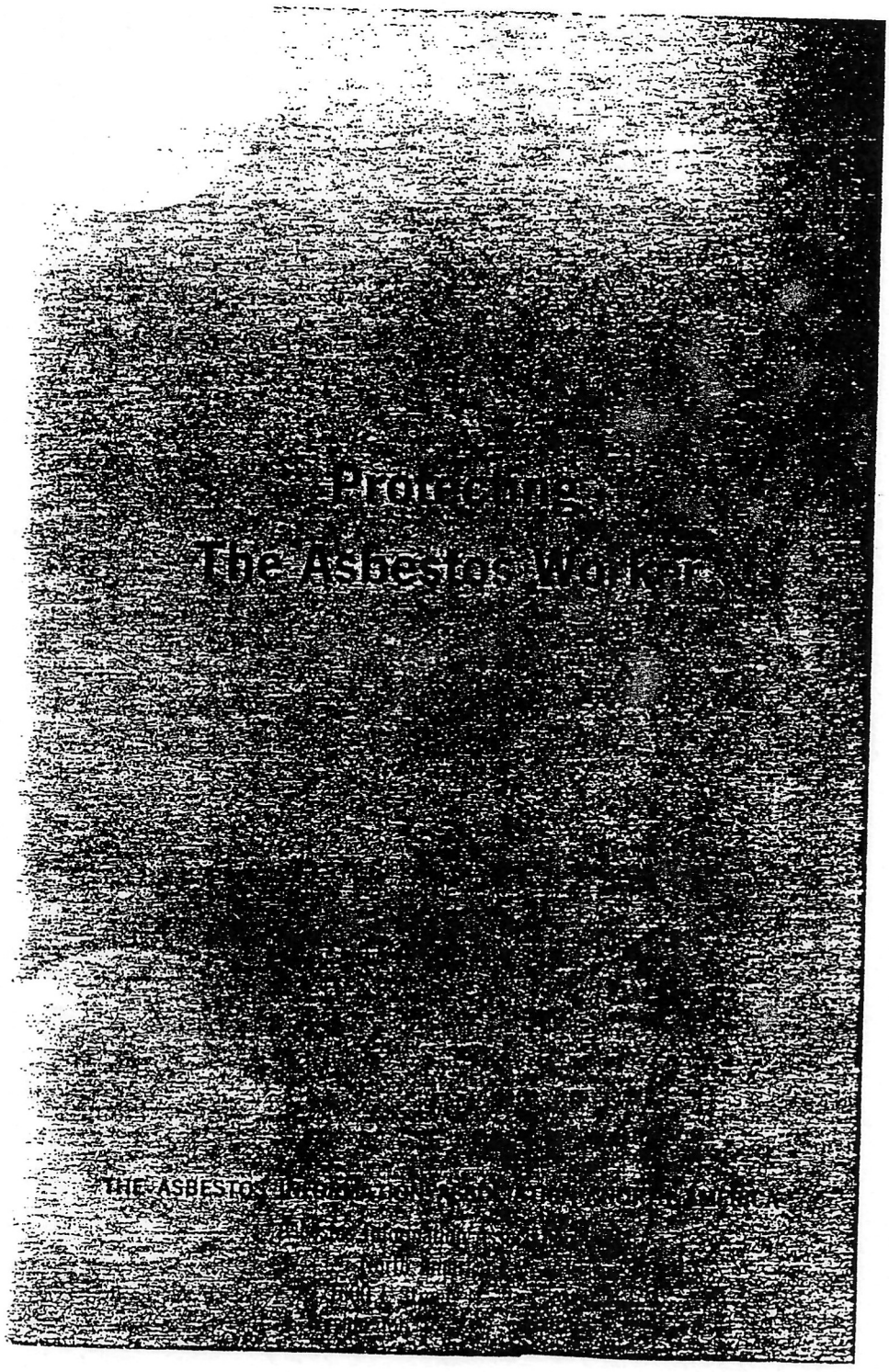
"It has come to our attention that on occasion the leaders of youth activity groups have used asbestos fiber as an inexpensive substitute for modeling clay and papier-maché.

"We feel strongly that this use of asbestos should be discontinued. Although the levels to which children may be exposed are probably very small and present no hazard to health, we do know that heavy exposure to asbestos in occupational settings can be a cause of illness.

"For this reason we feel that it is prudent that the use of asbestos for hobby purposes be eliminated."

As a result of this letter, appropriate steps were taken by many of the groups contacted to discontinue this particular use of asbestos. When the Association learns of instances where this practice has not been discontinued, appropriate letters of warning are sent to the parties involved.




Protecting
The Asbestos Worker

Protecting The Asbestos Worker

The asbestos industry has invested millions of dollars in equipment and techniques to prevent the inhalation of asbestos dust by workers involved in the mining and milling of asbestos and in the manufacture of asbestos-containing products. Many more millions are earmarked today for continued improvement in the years to come.

Establishing Safe Dust Levels

When asbestos is mined, milled or processed in manufacturing plants, its minute dry fibers become airborne like dust particles. Long exposure to heavy concentrations of asbestos dust has been linked directly to an increased incidence of such diseases as pulmonary fibrosis (asbestosis), bronchogenic carcinoma (lung cancer) and mesothelioma among long time workers in the asbestos industry.

The first epidemiological study of the effects of asbestos dust on workers was reported in 1930. From that time on, it was generally recognized in industry that asbestosis serious enough to interfere with respiratory or cardiovascular functions could be prevented by reducing dust levels to a specified threshold limit value (TLV).

The American Conference of Governmental Industrial Hygienists (ACGIH) set the industry's first standard in 1938 by establishing a threshold limit value of five million particles per cubic foot of air. Independent research supported by the Johns-Manville Corporation concluded at about the same time that a TLV of one million fibers, 10 microns in length or longer, per cubic foot would be an adequate level for safe occupational exposure.

In 1968, the ACGIH established a new standard with a TLV of 12 asbestos fibers, five microns or longer, per cubic centimeter, and this was later modified in 1970 by reducing the time-weighted average to five fibers per cubic centimeter with a maximum or peak of 10 fibers per cubic centimeter at any one time.

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AC/LA 007674

This standard was adopted as a temporary measure in 1972 by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor, and is the present accepted level. However, on July 1, 1976 a new standard is scheduled to go into effect that will reduce the TLV to only two asbestos fibers, five microns or longer, per cubic centimeter on a time-weighted average.

Protecting the Worker

While there are many differences of opinion within the medical profession concerning the problem of asbestos and health, it is universally accepted that levels of asbestos dust in the workplace must be kept to a minimum.

Industry has attacked the problem in a number of ways. Typical methods implemented to control dust levels include sophisticated dust collection systems (which combine high-power exhaust fans, duct networks and high-efficiency filters); special methods of waste disposal; use of protective clothing and portable dust respirators; and innovative wetting and dampening methods which minimize dust generated during production.

The asbestos industry has developed a completely automatic fiber bag opening station that will permit workers to open the bags, remove the fiber, dispose of the bags and introduce fiber into the manufacturing process without creating dust. In general, greater use of automation is being sought throughout the asbestos industry to reduce dust levels and to minimize exposure of employees to airborne asbestos fiber.

Basically, the requirements of an effective dust control program are twofold: (1) Design fabrication processes and production equipment so as to minimize dust generation as much as possible; and (2) Implement highly organized programs of industrial maintenance (including hygiene surveys) to insure that safe levels are maintained. Periodic monitoring of dust concentrations should reveal dust levels which exceed the threshold limit value (TLV).

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AC/LA 007675

It is obvious that good preventive maintenance must go hand in hand with effective dust control measures if the standards recently announced by OSHA are to be achieved.

OSHA Regulations

On June 7, 1972, the Occupational Safety and Health Administration established by the Williams-Steiger Occupational Safety and Health Act of 1970 issued standards regulating asbestos dust exposures. These occupational standards deal with (1) permissible concentrations of asbestos fibers, (2) methods of compliance, (3) warning signs and labeling of potentially dangerous products, (4) monitoring of dust levels, (5) medical examinations for employees, and (6) recordkeeping by employers. These standards have one basic purpose — to protect employees from exposure to potentially hazardous amounts of asbestos dust in their workplace.

The major obligations placed on employers, and industry in general, by the new standards can be summed up as follows:

A. The employer shall maintain a healthy workplace, making sure that no employee is exposed to concentrations of airborne asbestos fiber in excess of established limits.

B. Where the exposure limits are exceeded, the employee shall be notified in writing of the situation by his employer and shall be informed of corrective measures being undertaken to reduce his exposure to a safe level.

C. Engineering controls and the implementation of safe work practices are the approved permanent methods of correction.

D. While corrective measures are being instituted, the employee shall be protected by other means, such as the wearing of an approved respirator provided by his employer, or by shift rotation.

E. The use of respirators or shift rotation to achieve control is not permitted except (1) during the time required to install engineering controls or implement safe work practices, or (2) in situations where such controls or practices are not technically feasible, or (3) in emergencies.

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AC/LA 007676

F. No employee shall be assigned to a task requiring the use of a respirator if his most recent yearly medical examination indicates that he would be unable to function properly while wearing one, or if the wearing of a respirator would endanger the employee's health or safety, or that of another workman on the job.

G. Special protective clothing, change rooms, and separate clothes lockers shall be provided for employees in certain situations.

H. The personal and environmental monitoring of a workplace shall be conducted by the employer to assure that the standards are being met. Employees shall have access to the results of the monitoring of their jobs.

I. Warning signs shall be posted at entrances to areas where dust levels are in excess of the standard.

J. Caution labels shall be placed on any finished asbestos-containing product that is likely to release free asbestos fiber in excess of the standard during handling, application, or fabrication.

K. The employer shall provide yearly medical examinations for employees exposed to concentrations of asbestos dust. Pre-employment and termination medical exams also are required.

L. Upon request, an employee's medical records will be made available to his family physician.

Other requirements included in the standard require that: (1) where respirators are permitted, they must be selected from among types approved by the U.S. Bureau of Mines or the National Institute for Occupational Safety and Health (NIOSH); (2) no asbestos cement, mortar, coating, grout, plaster or similar material containing asbestos can be removed from shipping bags or their containers without being either wetted, enclosed or ventilated; (3) insofar as practicable, asbestos must be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state to reduce fiber emissions unless this would diminish the usefullness of the product; (4) hand tools that may produce or release asbestos fibers in excess

of the limits must be provided with local exhaust ventilation systems; (5) external work surfaces must be kept free of excessive accumulations of asbestos fiber; (6) waste must be collected in sealed impermeable bags or other closed, impermeable containers.

The Asbestos Industry's Commitment

The asbestos industry is firmly committed to the protection of its employees from health problems related to asbestos dust.

This commitment is evidenced by three major factors:

(1) **Past and Present Research.** The industry has spent millions of dollars to improve mining, milling and manufacturing methods during the past 30 years. Accompanying these advances have been increasingly safer working conditions in mines, factories and at job locations. This work continues unabated. The asbestos industry is working openly and enthusiastically with the Federal government and with independent medical researchers.

(2) **Cooperation in Setting Work-Safety Standards.** The asbestos industry has participated without reserve on government committees, investigative panels and at public hearings to review and improve work-safety regulations and asbestos control standards.

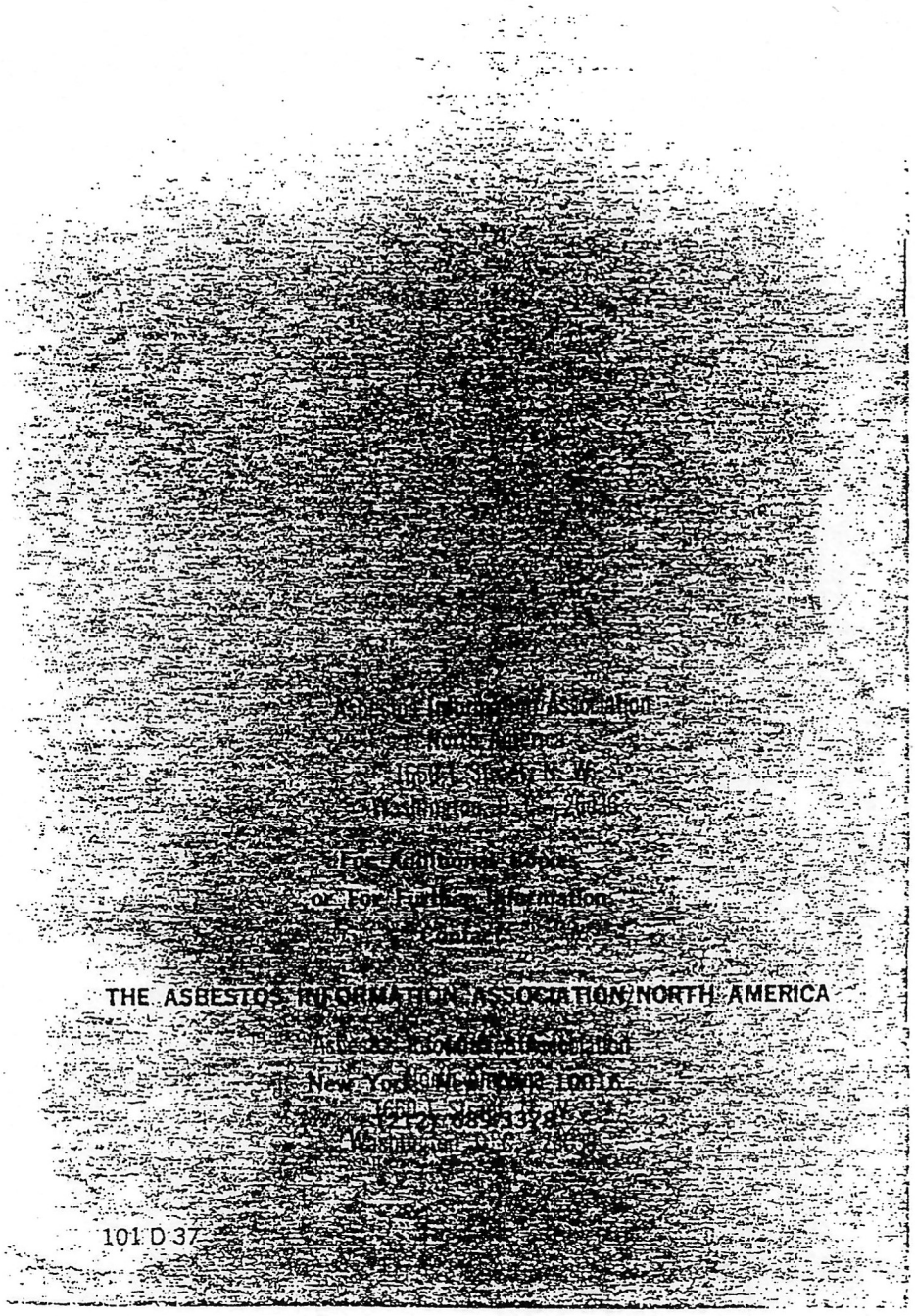
(3) **Implementation of Controls.** In the past decade, the industry has spent some $110 million to implement work-safety controls in its mines and plants. At least another $95 million will be spent during the next three or four years to upgrade facilities to meet the standards set by OSHA. Through its organizations — principally the ASBESTOS INFORMATION ASSOCIATION/ NORTH AMERICA — the industry shares information on new control technology with its own members, its customers, and small producers and users not associated with its industry groups.

The asbestos industry also is striving for better communication between all concerned parties — workers and

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AC/LA 007678

their unions, government agencies, basic producers and end users. The ultimate goals are the reduction of dust to a minimum level, the protection of all workers from asbestos-related diseases, and protecting the general public from future exposures to levels of asbestos dust that could be potentially hazardous to health.



CONFIDENTIAL- In Re: Bickham, et al. v. Met Life, et al.

PART I

ASBESTOS AND HEALTH

Asbestos, used since antiquity, has widespread and important applications in our modern technological society. Approximately 3,000 different products containing asbestos are in daily use throughout the world. Its increased use in the 20th century has lent urgency to the need to cope with occupational health problems related to the excessive inhalation of asbestos dust.

Such problems are not unique to the asbestos industry. Many substances and materials in common use today can be detrimental to the health and safety of industrial workers under uncontrolled conditions. A vital and widely used raw material, asbestos is but one of a number of potentially harmful substances used by industry.

Basically, the known facts about asbestos-related disease can be summed up as follows:

First, asbestos-related health risks today are almost exclusively confined to the occupational setting.

Second, the effects of excessive inhalation of asbestos are both time and dose related. This means that asbestos-related diseases may develop, generally, only after the inhalation of substantial amounts of asbestos dust over a substantial period of time. Thus, there are levels of exposure that will not result in any increased risk of disease.

Third, there is presently no evidence of risk to the general public from exposure to the minute amounts of asbestos that have been found in community air.

Fourth, because of the long latent period of asbestos-related disease, the disease being found today among some long-term industry employees is not an indication of present day conditions, but is a result of conditions existing decades ago, at a time when neither the industry, government, or the medical profession knew very much about the health effects of asbestos and even less about the proper means for their control.

These facts are well recognized by the asbestos manufacturing industry, which has made substantial progress over the years in protecting those who work with asbestos and in eliminating emissions of free asbestos fiber into the community air.

Known and Suspected Occupational Risks

There are three primary diseases known to be caused or exacerbated by prolonged and heavy inhalation of asbestos fibers. They are asbestosis, bronchogenic (lung) cancer, and mesothelioma. Prolonged heavy exposure does not necessarily result in disease and death—but there is little question that risks are significantly increased.

Asbestosis

This is an occupational disease characterized by lung scarring, and is one of the lung diseases called pneumoconioses. It is the most common of the three asbestos related illnesses and is found only among those who have worked regularly and continuously with asbestos under inadequately controlled conditions. The average time span from first exposure to the first clinical signs of asbestosis is 17 years, although some cases have been reported in as few as ten years.

Asbestosis is neither malignant nor necessarily fatal. Many asbestos workers with minor cases can and do continue to work and lead normal lives without difficulties. The asbestos

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AC/LA 007688

industry has long recognized the risk of this disease and has implemented safeguards to protect workers' health.

As far as can be determined, asbestosis never has been found in the general public, even among people living in close proximity to asbestos mines and processing plants.

Bronchogenic (Lung) Cancer

A number of medical studies have linked heavy asbestos exposure with an increased risk of lung cancer. While lung cancer occurs far less frequently among asbestos industry workers than asbestosis does, under some circumstances it occurs more frequently than in the general population.

As with asbestosis, the amount of fiber to which an employee is exposed is an important factor in lung cancer development. A continuing study of workers in a British asbestos textile plant has shown that dust control measures, which had substantially reduced the incidence of asbestosis, also reduced the incidence of lung cancer among the workers to that existing in the general public. In addition, it is the considered opinion of many scientists that lung cancer will not develop in an employee if he did not first have asbestosis.

Unquestionably, factors other than heavy asbestos exposure are important in the causation of lung cancer among asbestos industry workmen. The most documented example is cigarette smoking. Studies conducted of as many as 17,500 asbestos insulation workers show that those who smoke have a much greater risk of contracting lung cancer than non-smokers in the general public, but that those asbestos industry workmen who do not now smoke cigarettes and who have never smoked regularly, have no greater risk of lung cancer than the average man-in-the-street who does not smoke.

Mesothelioma

This disease is an extremely rare cancer of the lining of the chest (pleura) or the abdominal cavity (peritoneum). It is found more frequently among those with occupational asbestos exposure than among the general population. It also has been found among people who, in the past, lived in close proximity to uncontrolled crocidolite asbestos plants or mines, and even, on rare occasions, in the households of employees who worked in crocidolite asbestos factories or mines and who presumably brought substantial quantities of this particular type of asbestos fiber into their homes on their work clothes. This has not been found to be the case with individuals exposed only to chrysotile asbestos, which accounts for 97% of the asbestos fiber used in the U.S. today.

Since the latent period for mesothelioma ranges from 30 to 45 years, it is impossible at this late date to determine precisely the exposure levels experienced by these "neighborhood" and "household" cases. However, they were probably quite high by today's standards. In any case, as technology was developed for the control of asbestos dust levels, both in the plant and out, these potentially hazardous conditions were eliminated.

A relatively small number of cases have also been reported among employees in shipyards and on construction projects who, while not working directly with asbestos, were exposed to heavy concentrations of airborne fiber by working in close proximity to those who did. Exposures of this type have been reduced by strictly enforced industrial safety devices and procedures.

The search for answers to the mesothelioma problem is complicated by a number of factors. In the first place, the number of cases being found, even today, is still relatively small. In all of Canada, for example, only 165 cases were reported in the ten-year period ending in 1968. Secondly, it appears highly likely that certain varieties of asbestos (crocidolite and amosite) are more likely to cause mesothelioma than others. Thirdly, its diagnosis and recognition are still considered problems among medical experts. It is also certain that

there are other causes of mesothelioma besides asbestos. Unfortunately, what those other causes might be is still unknown. Until these and other equally important factors are thoroughly investigated, the mesothelioma question will remain unresolved.

Other Tumors

Some researchers have reported higher-than-normal rates of gastrointestinal cancer among some heavily exposed industry groups. Other researchers have reported no increase of this type of cancer. The consensus of medical opinion is that the evidence is too scanty for a definitive conclusion.

Asbestos and the General Public

Medical reports of excess asbestos-related disease among occupationally exposed populations have been frequently cited by some writers, environmentalists, politicians and others as "proof" that the health of the general public is endangered by the minute amounts of asbestos dust being found in community air. "Neighborhood" and "household" cases of mesothelioma are cited extensively in this regard, as are the frequent reports of the findings of free asbestos fibers and so-called ferruginous bodies (which sometimes contain asbestos) in the lungs of some city dwellers at autopsy.

The truth is, however, that there is no evidence—either from experience or from scientific research—that anyone in the general public has ever contracted any asbestos-related disease from exposure to these minute amounts of airborne asbestos, which are many times lower than levels which have been demonstrated to result in no excess of disease in occupationally exposed populations.

This conclusion is supported by both the Asbestos Panel of the National Academy of Sciences' Committee on Biologic Effects of Atmospheric Pollutants, and the 33 member Advisory Committee on Asbestos Cancers of the International Agency for Research on Cancer, a division of the World Health Organization.

In its 1971 booklet, entitled "Asbestos: The Need For And Feasibility of Air Pollution Controls," the NAS Asbestos Panel, which consisted of seven of the nation's top experts on asbestos and health, stated that "there is no evidence that persons in the general population—without occupational, household or neighborhood exposures—have any increased risk of neoplasm, even though there may be ferruginous bodies or fibers in their lungs."

Warning against conclusions of the type frequently reached by the uninformed with regard to asbestos, the report further stated: "One cannot extrapolate from the mortality experience of, on the one hand, those who are directly and indirectly exposed to asbestos in their employment to, on the other hand, the general public, who have had moderate or slight exposures from ambient air."

The report concluded with the statement that "there is no evidence that the small numbers of fibers found in most members of the general population affect health or longevity."

The report of the IARC Advisory Committee represents the consensus of present world medical opinion on all aspects of the asbestos-health problem. Meeting immediately after the October 1972 Lyon Conference on the Biological Effects of Asbestos, the Committee, with representation from ten different countries, drafted the following opinions on asbestos-related disease and the general public:

Asbestosis: "There is at present no evidence of lung damage by asbestos to the general public. The amount of asbestos in the lungs of members of the general public is very small, compared to those occupationally exposed."

Lung Cancer: "The evidence . . . suggests that an excess lung carcinoma risk is not detectable when the occupational exposure has been low. These low occupa-

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AC/LA 007690

tional exposures have almost certainly been much greater than that to the public from general air pollution."

Mesothelioma: "There is no evidence of a risk to the general public at present."

Because of some recent controversy in the United States and Canada on this subject, the question was also examined whether there is any "evidence of an increased risk of cancer resulting from asbestos fibers present in water, beverages, food or in the fluids used for the administration of drugs." The answer of the Committee was: "Such evidence as there is does not indicate any risk."

While the conclusions of these two eminent scientific bodies should be reassuring to those concerned with the presence of minute amounts of asbestos in the ambient air, the asbestos manufacturing industry in the United States will continue in its efforts to reduce asbestos emissions so that potentially hazardous levels will never be permitted to develop in the future.

Asbestos and Health Research

Extensive medical and technical research into the health effects of asbestos and the proper means for their control is being conducted in laboratories throughout the world. A significant percentage of this research is being sponsored, co-sponsored or cooperated in by the world asbestos industry. In fact, two of the largest non-governmental sources of funds for asbestos-health research are the Institute of Occupational and Environmental Health (IOEH) in Montreal, which is sponsored by the Quebec Asbestos Mining Association, and the Asbestosis Research Council, sponsored by the British asbestos manufacturing industry. The results of research sponsored by these two agencies and also by individual companies acting independently have contributed significantly to our knowledge of the biological effects of asbestos.

In addition, industry environmental control experts are constantly working to develop new or improved methods of handling asbestos and asbestos-containing products safely.

Much has been learned about asbestos and health in a very short time—especially when you consider that the greater part of all medical information about asbestos-related disease is less than a decade old. According to Dr. Premysl Pelnar of the Institute of Occupational and Environmental Health, approximately 90 per cent of all information and data now available is the result of medical studies undertaken during the past ten years.

Much more is still needed: In late 1972, The International Agency for Research on Cancer made recommendations for further research and indicated priorities for work of immediate and long-term value. Emphasis was placed on epidemiological and pathological studies, and high priorities were urged for certain projects.

These included:

1. Usefulness of early detection in the prevention of progressive fibrosis and asbestos cancers and in the identification of hazardous conditions;
2. Assessment of excess cancer risks following exposure to only one variety of asbestos;
3. Amount and type of asbestos in the lungs of mesothelioma cases;
4. Secular changes in incidence of pleural and peritoneal mesotheliomas nationally and internationally;
5. Possible association between past exposure to asbestos and cancer of sites other than lung, pleura and peritoneum;
6. Relationship between asbestosis and risk of carcinoma.

The asbestos manufacturing industry will continue to support and cooperate in research projects of this nature. The Asbestos Information Association, for example, is presently

sponsoring a study at the Harvard School of Public Health on chest ausculation (breathing sounds) as an early detection device in the diagnosis of asbestos-related disease. While this needed additional information and data is being developed, the industry will take all steps necessary to assure a safe working environment for its employees and for applicators and fabricators of asbestos-containing products.

Protecting the
Asbestos Worker

AC/LA 007700

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PART III

PROTECTING THE ASBESTOS WORKER

The asbestos industry has invested millions of dollars in equipment and techniques to prevent the inhalation of asbestos dust by workers involved in the mining and milling of asbestos and in the manufacture of asbestos-containing products. Many more millions are earmarked today for continued improvement in the years to come.

Establishing Safe Dust Levels

When asbestos is mined, milled or processed in manufacturing plants, its minute dry fibers become airborne like dust particles. Long exposure to heavy concentrations of asbestos dust has been linked directly to an increased incidence of such diseases as pulmonary fibrosis (asbestosis), bronchogenic carcinoma (lung cancer) and mesothelioma among long time workers in the asbestos industry.

The first epidemiological study of the effects of asbestos dust on workers was reported in 1930.[1] From that time on, it was generally recognized in industry that asbestosis serious enough to interfere with respiratory or cardiovascular functions could be prevented by reducing dust levels to a specified threshold limit value (TLV).

The American Conference of Governmental Industrial Hygienists (ACGIH) set the industry's first standard in 1938 by establishing a threshold limit value of five million particles per cubic foot. Independent research supported by the Johns-Manville Corporation concluded at about the same time that a TLV of one million fibers, 10 microns or longer, per cubic foot would be an adequate level for safe occupational exposure.

In 1968, the ACGIH established a new standard with a TLV of 12 asbestos fibers, five microns or longer, per cubic centimeter, and this was later modified in 1970 by reducing the time-weighted average to five fibers per cubic centimeter with a maximum of 10 fibers per cubic centimeter at any one time.

This standard was adopted as a temporary measure in 1972 by the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor, and is the present accepted level. However, on July 1, 1976 a new standard is scheduled to go into effect that will reduce the TLV to only two asbestos fibers, five microns or longer, per cubic centimeter on a time-weighted average.

Protecting the Worker

While there are many differences of opinion within the medical profession concerning the problem of asbestos and health, it is universally accepted that levels of asbestos dust in the workplace must be kept to a minimum.

Industry has attacked the problem in a number of ways. Typical methods implemented to control dust levels include sophisticated dust collection systems (which combine high-power exhaust fans, duct networks and high-efficiency filters); special methods of waste disposal; use of protective clothing and portable dust respirators; and innovative wetting and dampening methods which minimize dust generated during production.

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1. E. R. A. Merewether, "The Occurrence of Pulmonary Fibrosis and other Pulmonary Affections in Asbestos Workers," *Journal of Industrial Hygiene,* 1930.

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The asbestos industry has developed a completely automatic fiber bag opening station that will permit workers to open the bags, remove the fiber, dispose of the bags and enter fiber into the manufacturing process without creating dust. In general, greater use of automation is being sought throughout the asbestos industry to reduce dust levels and to minimize exposure of employees to airborne asbestos fiber.

Basically, the requirements of an effective dust control program are twofold: (1) Design fabrication processes and production equipment so as to minimize dust generation as much as possible; and (2) Implement highly organized programs of industrial maintenance (including hygiene surveys) to insure that safe levels are maintained. Periodic monitoring of dust concentrations should reveal dust levels which exceed the threshold limit value (TLV).

It is obvious that good preventive maintenance must go hand in hand with effective dust control measures if the standards recently announced by OSHA are to be achieved.

OSHA Regulations

On June 7, 1972, the Occupational Safety and Health Administration established by the Williams-Steiger Occupational Safety and Health Act of 1970 issued standards regulating asbestos dust exposures. These occupational standards deal with (1) permissible concentrations of asbestos fibers, (2) methods of compliance, (3) warning signs and labeling of potentially dangerous products, (4) monitoring of dust levels, (5) medical examinations for employees, and (6) recordkeeping by employers. These standards have one basic purpose—to protect employees from exposure to potentially hazardous amounts of asbestos dust in their workplace.

The major obligations placed on employers, and industry in general, by the new standards can be summed up as follows:

A. The employer shall maintain a healthy workplace, making sure that no employee is exposed to concentrations of airborne asbestos fiber in excess of established limits.

B. Where the exposure limits are exceeded, the employee shall be notified in writing of the situation by his employer and shall be informed of corrective measures being undertaken to reduce his exposure to a safe level.

C. Engineering controls and the implementation of safe work practices are the only approved permanent methods of correction.

D. While corrective measures are being instituted, the employee shall be protected by other means, such as the wearing of an approved respirator provided by his employer, or by job rotation.

E. The use of respirators or shift rotation to achieve control is not permitted except (1) during the time required to install engineering controls or implement safe work practices, or (2) in situations where such controls or practices are not technically feasible, or (3) in emergencies.

F. No employee shall be assigned to a task requiring the use of a respirator if his most recent yearly medical examination indicates that he would be unable to function properly while wearing one, or if the wearing of a respirator would endanger the employee's health or safety, or that of another workman on the job.

G. Special protective clothing, change rooms, and separate clothes lockers shall be provided for employees in certain situations.

H. The personal and environmental monitoring of a workplace shall be conducted by the employer to assure that the standards are being met. Employees shall have access to the results of the monitoring of their jobs.

I. Warning signs shall be posted at entrances to areas where dust levels are in excess of the standard.

J. Caution labels shall be placed on any finished asbestos-containing products that are likely to release free asbestos fiber in excess of the standard during handling, application, or fabrication.

K. The employer shall provide yearly medical examinations for employees exposed to concentrations of asbestos dust. Pre-employment and termination medical exams also are required.

L. Upon request, an employee's medical records will be made available to his family physician.

Other requirements included in the standard require that: (1) where respirators are permitted, they must be selected from among types approved by the U.S. Bureau of Mines or the National Institute for Occupational Safety and Health (NIOSH); (2) no asbestos cement, mortar, coating, grout, plaster or similar material containing asbestos can be removed from shipping bags or their containers without being either wetted, enclosed or ventilated; (3) insofar as practicable, asbestos must be handled, mixed, applied, removed, cut, scored, or otherwise worked in a wet state to reduce fiber emissions unless this would diminish the usefulness of the product; (4) hand tools that may produce or release asbestos fibers in excess of the limits must be provided with local exhaust ventilation systems; (5) external work surfaces must be kept free of excessive accumulations of asbestos fiber; (6) waste must be collected in sealed impermeable bags or other closed, impermeable containers.

The Asbestos Industry's Commitment

The asbestos industry is firmly committed to the protection of its employees from health problems related to asbestos dust.

This commitment is evidenced by three major factors:

(1) *Past and Present Research.* The industry has spent millions of dollars to improve mining, milling and manufacturing methods during the past 30 years. Accompanying these advances have been increasingly safer working conditions in mines, factories and at job locations. This work continues unabated. The asbestos industry is working openly and enthusiastically with the Federal government, and with independent medical researchers.

(2) *Cooperation in Setting Work-Safety Standards.* The asbestos industry has participated without reserve on government committees, investigative panels and at public hearings to review and improve work-safety regulations and asbestos control standards.

(3) *Implementation of Controls.* In the past decade, the industry has spent some $110 million to implement work-safety controls in its mines and plants. At least another $95 million will be spent during the next three or four years to upgrade facilities to meet the standards set by OSHA. Through its organizations—principally the ASBESTOS INFORMATION ASSOCIATION/NORTH AMERICA—the industry shares information on new control technology with its own members, its customers, and small producers and users not associated with its industry groups.

The asbestos industry also is striving for better communication between all concerned parties—workers and their unions, government agencies, basic producers and end users. The ultimate goals are the reduction of dust to a minimum level, the protection of all workers from asbestos-related diseases, and protecting the general public from future exposures to levels of asbestos dust that could be potentially hazardous to health.

Relation of cigarette smoking to risk of death of asbestos-associated disease among insulation workers in the United States*

E. Cuyler Hammond, Sc.D., and Irving J. Selikoff, M.D.

SUMMARY

We conclude that employment in asbestos insulation work greatly increases the lung cancer risk of cigarette smokers. It is uncertain whether such employment increases the risk of lung cancer among nonsmokers. Cigarette smoking may also increase the risk of death from asbestosis, although to a much lesser extent. It is of interest that the risk of death among nonsmoking asbestos insulation workers is greater for asbestosis than for lung cancer. This indicates that even if asbestos workers were to stop cigarette smoking, it would still be necessary to reduce dust exposure below those concentrations associated with the occurrence of asbestosis.

Data have been reported indicating that cigarette smoking greatly increases the risk of death of lung cancer among asbestos insulation workers (Selikoff, Hammond and Churg, 1968). It was calculated that asbestos insulation workers with a history of regular cigarette smoking had eight times the risk of lung cancer deaths compared with cigarette smokers who did not do such work, and approximately ninety times the risk of men who neither worked with asbestos nor smoked cigarettes.

We have obtained further evidence on this matter, bearing on aspects of asbestos associated disease for which data were previously scant or incomplete.

Lung cancer among cigarette smoking asbestos insulation workers.

Recent experiences have confirmed that lung cancer among insulation workers is largely confined to those men with a history of cigarette smoking. Data are derived from observation of two cohorts of insulation workers. Since they differ in age of distribution and work experience, it is advantageous to consider them separately.

First, we have followed a group of 370 insulation workers from Jan. 1, 1963. These were survivors of 632 men who were members of the insulation workers union in the New York area on Jan. 1, 1943 (Selikoff, Churg and Hammond, 1964). Therefore, in 1963 these men were all at least 20 years from onset of employment (indeed, 333 had reached thirty or more years from onset) (Table 1). 283 of these men had a history of regular cigarette smoking; by April 30, 1967, 24 had died of lung cancer although, given their smoking habits, only 2.98 such deaths had been expected. No deaths of lung cancer occurred among the 87 men with no history of cigarette smoking. (Selikoff, Hammond and Churg, 1968).

The cohort has now been traced for an additional 56 months. Table 2 shows findings for the nine-year period January 1, 1963-December 31, 1971. Of 283 men who ever smoked cigarettes regularly 41 died of lung cancer while of 87 men who never smoked cigarettes regularly only 1 died of lung cancer. This man was a cigar smoker. Expected number of deaths shown in Table 2 are based upon United States mortality data for white males disregarding smoking habits. We are presently unable to calculate smoking-specific expected rates for this group, since death rates related to smoking are not yet available for the period 1967-1971.**

We have obtained data in a second far larger study of insulation workers. On January 1, 1967, we registered all members of the insulation workers union in the United States and Canada (including the New York-New Jersey locals mentioned above).*** There were 17,800 men so enrolled on that day (Table 3). 11,656 completed a questionnaire providing, among other details, information concerning their smoking habits (Table 4). We have followed this cohort

*From the Environmental Cancer Research Project, American Cancer Society and the Mount Sinai School of Medicine of the City University of New York. This research was supported in part by U.S. Public Health Service grant OH00320 to the Mount Sinai School of Medicine.

**We have reported smoking-specific death rates, 1959-1965, in a prospective study of 1,000,000 people (Hammond, 1966). This cohort is now being retraced, and rates, 1966-1971, will be available.

***International Association of Heat and Frost Insulators and Asbestos Workers, AFL-CIO.

through December 31, 1971 (Selikoff and Hammond, 1972). Although the total group differed from the cohort described above in being, on the average, significantly younger and with shorter duration of exposure, its lung cancer expetience has been very much in the same direction.

1,092 deaths occurred during the period January 1, 1967-December 31, 1971 (See Table 5). Of these, 213 were due to lung cancer; whereas only 44.4 were expected, had the experience of these men been the same as other U.S. white males of the same age distribution. Among the 9,590 men with a history of regular cigarette smoking, there were 596 deaths, 134 of which were due to lung cancer. Again, we are at this time unable to calculate smoking-specific expected and observed rates because, as noted, death rates related to smoking habits of individuals are unavailable for this period of years.

Lung cancer deaths among insulation workers who do not smoke cigarettes.

At the time of our initial report, we had had limited opportunity of studying the incidence of lung cancer among insulation workers with no history of cigarette smoking. There were 87 such men in our 1963 New York-New Jersey group, and by 1967, only 16 deaths had occurred, none of lung cancer. Only 0.18 lung cancer deaths were expected, however, and with such scant experience we concluded that our information ". . . does not prove that exposure to asbestos dust has no influence on the risk of lung cancer among nonsmokers. However, it does suggest that exposure to asbestos dust does not lead to an extremely high risk of lung cancer among nonsmokers." (Selikoff, Hammond and Churg, 1968.) Obviously, it was important to obtain further information on the lung cancer risk among nonsmoking insulation workers. This is now available, from experience of the cohort described above.

Among the 2,066 non-cigarette smokers in the nation-wide study, 73 deaths occurred January 1, 1967-December 31, 1971. Two were due to lung cancer. One of these two men was a cigar and pipe smoker and the other never smoked regularly. (Table 5)

It seems clear, then, that lung cancer is uncommon among asbestos insulation workers who have no history of cigarette smoking and that if the risk is increased, such increase is not great.

Pleural Mesothelioma.

In our previous report, we were unable to suggest whether or not pleural mesothelioma was related to cigarette smoking. Only three deaths occurred of this disease in our New York-New Jersey group from 1963 through April 1967. While all three of these men were cigarette smokers, the number was too small for reliable evaluation. Since then 2 more deaths of pleural mesothelioma have occurred, again among cigarette smokers. (Table 2)

In the larger cohort (see Table 5) there were 1,092 deaths of which 26 were due to a pleural mesothelioma. Of these 26 men, 17 had a history of regular cigarette smoking, 1 was a pipe smoker, 1 never smoked regularly and 7 were unknown as to smoking habits. We still refrain from drawing definite conclusions because of small numbers.

Peritoneal Mesothelioma.

As with pleural disease, no definitive statement could be made in 1968 concerning the relation of peritoneal mesothelioma to cigarette smoking. Of seven deaths of peritoneal mesothelioma, two occurred among men with no history of cigarette smoking.

In the large cohort (See Table 5) there were 51 deaths of peritoneal mesothelioma; 9 among the 2,066 never smoked cigarettes regularly, and 29 among the 9, 590 cigarette smokers. 13 occurred among 6,144 insulation workers for whom smoking histories were not available (Table 5).

These experiences suggest that cigarette smoking does not increase the already high risk of peritoneal mesothelioma among asbestos insulation workers.

Asbestosis.

Studies indicate that radiologically evident pulmonary fibrosis is augmented in asbestos workers by cigarette smoking (Weiss, 1971, Selikoff, 1972).

Data now at hand suggest that the risk of death of asbestosis (respiratory insufficiency and cor pulmonale) may be increased by cigarette smoking. These data are reported with the realization that there must be a mixture of cigarette smoking effects in such cases, including increased asbestotic fibrosis, and the emphysema, bronchitis and smoking-associated fibrosis associated with cigarette smoking in general (Auerbach, Stout, Hammond and Garfinkel, 1963). These effects could be additive or less than additive, or multiplicative, in specific cases. Complex histological and physiological variations are possible.

In the nationwide study, of the 73 deaths among the 2,066 nonsmokers, 4 were due to asbestosis, as were 45 of the 596 deaths among the 9,590 smokers. (Table 5). We computed expected numbers of asbestosis deaths from age specific

death rates for the total study population disregarding smoking habits. The ratio of observed to expected asbestosis deaths was almost three times as high for men with a history of cigarette smoking as for men without a history of cigarette smoking. This was of borderline statistical significance.

Gastro-intestinal cancer.

There seems to be a definite, albeit limited, association between employment in asbestos insulation work and increased risk of death of cancer of stomach, colon-rectum, and esophagus. Data in this regard were first reported in 1963. (Selikoff, Churg and Hammond, 1964.)

Experiences since 1963 continue in the same direction with increased death rates of approximately the same magnitude. In the large cohort (See Table 5) there were 16 observed vs. 6.62 expected deaths from cancer of the stomach, 26 observed vs. 17.51 expected deaths from cancer of the colon-rectum, and 13 observed vs. 3.21 expected deaths from cancer of the esophagus. Because of small numbers of expected and observed deaths from cancer of these sites among the 2,066 men with no history of cigarette smoking, we will draw no conclusion concerning the possible interaction of cigarette smoking and asbestos exposure. However, these data are consistent with findings in other studies of high degree of relationship between smoking and the occurrence of cancer of the esophagus.

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Table 1

Members of New York-New Jersey Locals of Insulation Workers Union Classified by Age as of Jan. 1, 1963, and by Years From First Occupational Exposure to Asbestos Dust up to Jan. 1, 1963.

Age, Yr.	Total No. of Members	No. of Years Since First Exposure to Asbestos						
		20-24	25-29	30-34	35-39	40-44	45-49	50+
35-39	2	2	...	...	...	...	...	...
40-44	13	12	1	...	...	...	...	...
45-49	32	17	2	13	...	...	...	...
50-54	109	...	1	80	28	...	...	...
55-59	60	...	1	16	34	8	1	...
60-64	42	...	1	3	11	19	8	...
65-69	49	...	...	1	10	18	18	2
70-74	38	...	...	...	3	12	6	17
75-79	21	...	...	...	...	1	5	15
80-84	4	...	...	...	...	1	1	2
Total	370	31	6	113	86	59	39	36

Members Classified by Age and by Smoking Habits on or about Jan. 1, 1963

Age, Yr.	Total No.	Never Smoked Regularly	Pipe, Cigar, Only	Ex-Cigarette Smokers*	Current Cigarette Smokers*			
					1-9 A Day	10-19 A Day	20-39 A Day	40+ A Day
35-39	2	1	...	1	...	...	...	...
40-44	13	2	...	2	...	...	5	4
45-49	32	2	1	5	...	...	12	12
50-54	109	12	6	26	3	5	33	24
55-59	60	6	5	16	...	3	20	10
60-64	42	7	4	15	1	...	11	4
65-69	49	6	8	17	...	4	9	5
70-74	38	7	7	12	1	4	4	3
75-79	21	3	7	6	...	1	3	1
80-84	4	2	1	1	...	...	...	...
Total	370	48	39	101	5	17	97	63

*Includes cigarette smokers who also smoked pipes or cigars.

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AC/LA 007765

Table 2

Expected** and Observed Deaths among 370 New York-New Jersey Asbestos Insulation Workers, Jan. 1, 1963-Dec. 31, 1971

	Total		No history of cigarette smoking*		History of cigarette smoking	
Number of men Jan. 1, 1963	370		87		283	
Person years of observation	2,520		608		1,912	
	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observed deaths
Cancer all sites	15.74	94	4.75	15	10.99	79
Lung cancer	4.57	42	1.26	1	3.31	41
Pleural mesothelioma	***	5	***	–	***	5
Peritoneal mesothelioma	***	20	***	7	***	13
Cancer of stomach	0.94	6	0.30	2	0.64	4
Cancer of colon, rectum	2.15	6	0.69	2	1.46	4
Cancer of esophagus	0.37	–	0.11	–	0.26	–
Asbestosis	***	21	***	5	***	16
All other causes	69.22	53	22.28	15	46.94	38
Total deaths	84.96	168	27.03	35	57.93	133

* Included 39 men who smoked pipe or cigars.

** Expected deaths based upon age specific U.S. mortality for white males, disregarding smoking habits. Lung cancer estimates based upon U.S. rates for cancer of lung, pleura, bronchus and trachea, categories 162 and 163.

*** United States data not available, but these are rare causes of death in the general population.

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Table 3

Membership of Asbestos Insulation Workers' Union,* Jan. 1, 1967
Classified by Age and by Years from First Exposure to Asbestos Dust

Age-Yr.	Total No. of Members	Number of years since first exposure to asbestos								
		0-9	10-14	15-19	20-24	25-29	30-34	35-39	40-49	50+
15-19	244	244								
20-24	1,695	1,695								
25-29	2,412	2,066	345	1						
30-34	2,762	1,065	1,356	341						
35-39	2,987	313	1,140	1,342	192					
40-44	2,260	79	424	1,026	591	139	1			
45-49	1,589	49	131	433	442	487	47			
50-54	1,297	27	88	214	332	377	182	77		
55-59	983	12	49	129	206	176	146	193	72	
60-64	704	1	21	59	131	126	87	100	179	
65-69	417		6	18	40	57	46	28	200	22
70-74	255			6	14	22	21	16	105	71
75-79	111		1		4	8	4	7	37	50
80-84	52					2	1	2	16	31
85+	32							2	8	22
Total	17,800	5,551	3,561	3,569	1,952	1,394	535	425	617	196

*Membership in the United States and Canada of the International Association of Heat and Frost Insulators and Asbestos Workers, AFL-CIO.

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Table 4

Smoking Habits of 17,800 Asbestos Insulation Workers in the United States and Canada, on Jan. 1, 1967.

Age	Total	No History of Cigarette Smoking*	History of Cigarette Smoking	Smoking history not known
< 25	1,939	281	782	876
25-29	2.412	285	1,182	945
30-34	2,762	314	1,435	1,013
35-39	2,987	309	1,640	1,038
40-44	2,260	223	1,395	642
45-49	1,589	172	964	453
50-54	1,297	134	821	343
55-64	1,687	201	965	521
65-74	672	122	314	236
75+	195	25	92	78
Total	17,800	2,066	9,590	6,144

*Included 609 men who smoked pipes or cigars.

AC/LA 007768

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Table 5

Expected and Observed Deaths among 17,800
U.S. and Canada Asbestos Insulation Workers,
Jan. 1, 1967-Dec. 31, 1971*

	Total		No history of cigarette smoking**		History of cigarette smoking		Smoking habits not known	
Number of men Jan. 1, 1967	17,800		2,066		9,590		6,144	
Person-years of observation	86,300		10,163		46,615		29,522	
	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observed deaths	Expected deaths	Observed deaths
Cancer all sites	144.09	459	19.92	33	79.58	265	44.49	161
Lung cancer	44.42	213	5.98	2	25.09	134	13.35	77
Pleural mesothelioma	***	26	***	2	***	17	***	7
Peritoneal mesothelioma	***	51	***	9	***	29	***	13
Cancer of stomach	6.62	16	0.95	1	3.60	8	2.07	7
Cancer of colon, rectum	17.51	26	2.52	4	9.53	14	5.46	8
Cancer of esophagus	3.21	13	0.44	0	1.80	7	0.97	6
Asbestosis	***	78	***	4	***	45	***	29
All other causes	661.54	555	92.67	36	356.67	286	212.20	233
Total deaths	805.63	1,092	112.59	73	436.25	596	256.79	423

* Expected deaths based upon age specific U.S. mortality rates for white males, disregarding smoking. Lung cancer estimates based upon U.S. rates for cancer of lung, pleura, bronchus and trachea, categories 162 and 163.

** Included 609 men who smoked pipes or cigars.

*** United States data not available, but these are rare causes of death in the general population.