

ASBESTOS

This material, used extensively for protection against fire and heat hazards, ironically is a recognized hazard to health when asbestos dust is inhaled excessively, causing asbestosis, bronchogenic (lung) cancer, and mesothelioma. The industry's many problems and its far-reaching response to OSHA regulations are presented.

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

Asbestos is actually a general term used to describe several fibrous mineral silicates that occur as white, grayish, or greenish masses, either compact or as long, silky fibers. The most important types are:

- *Chrysotile*—a simple magnesium silicate;
- *Amosite*—a complex magnesium iron silicate;
- *Crocidolite*—a complex sodium iron silicate.

Some 97 per cent of the world as-

bestos production comes from chrysotile.

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

- 1) Asbestos-related health risks today are almost exclusively confined to the occupational setting;
- 2) 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;
- 3) 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;
- 4) Because of the long latent period of asbestos-related disease, the

disease being found today, among some long-term industry employees is not necessarily an indication of present-day conditions. It may, instead, be a result of conditions existing decades ago, at a time when neither the industry, government, nor the medical profession knew much about the health effects of asbestos, or proper means for their control.

What Is the Hazard?

More than 200,000 employees face risks from asbestos. The principal danger is caused by inhaling asbestos fibers. Recent studies also have shown the presence of asbestos fibers in the lungs of persons having no industrial exposure — probably due to their presence in the atmosphere near construction sites, where an asbestos mixture formerly was commonly sprayed onto steel beams as a method of making the structure fire resistant. This practice has since been banned by *Occupational Safety and Health Act* regulations.

Prolonged inhalation of asbestos fibers between 5 and 50 microns long (one millionth of a meter) can produce a lung disease known as asbestosis. The lungs cannot eliminate asbestos fibers, so the fibers coat the tissues. If this process continues over a period of 10 to 20 years with significant quantities of asbestos present, the tissue reaction progresses until a generalized diffuse fibrosis occurs, causing severe respiratory disability. There have been reports of increased incidence of lung cancer in persons with asbestosis.

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*.



Chrysotile is mined in open pit mines, such as this one in Canada. (Photo: courtesy Asbestos Information Association/North America).

What Asbestos Is and Where It Is Used

The term *asbestos* is derived from an ancient Greek word meaning *inextinguishable*. In reality, mineral asbestos is non-flammable even at extremely high temperatures, it inhibits certain types of chemical reactions, and is extremely flexible and durable. All these qualities combine to make it especially suitable for a wide variety of demanding uses, particularly those that protect human life and property. Asbestos may be unique in that its primary function is to save lives.

Asbestos is the generic name given to a group of hydrated silicate minerals that can be separated into relatively soft, silky fibers that have great tensile strength. Certain grades can be carded, spun, and woven; others can be pressed or layered to form paper. *Chrysotile*, *crocidolite* (or blue fiber), and *amosite* are the three varieties of asbestos that are commercially significant today. Each differs from the others, both physically and chemically.

Chrysotile is a flexible white magnesium silicate that can be attacked by acids. It differs from other asbestos minerals in that it has a positive rather than a negative electrical charge in water. It now accounts for 97 per cent of all asbestos used annually in the United States. This high percentage of use is due in part to industry awareness of medical studies that show *amosite* and *crocidolite* to be more potentially hazardous to health than *chrysotile* asbestos. Canada and the Soviet Union are the leading producers of chrysotile fiber, but small deposits are also found in the United States, Italy, South Africa, Rhodesia, and China.

Amosite, which is mined commercially only in the Transvaal district of South Africa, is a brown ferrous magnesium silicate that occurs in the same type of iron-rich sedimentary rock as does *crocidolite*. It is brittle and not as acid-resistant as *crocidolite*. *Amosite* is used principally in the manufacture of heat insulating materials.

Crocidolite, characterized by a deep blue color, is a ferrous sodium silicate that is acid-resistant but less flexible than *chrysotile*. The bulk of the world's supply comes from South Africa. *Crocidolite* was a strategic

material during World War II, when it was used as the filtering element in gas mask canisters. It can be spun or woven into materials and fabrics used in acid-resistant packings and flame-resistant clothing.

Properties and Advantages

As many as 3,000 different products are in daily use throughout the world containing some asbestos. The heat-resistant properties and fibrous structure of asbestos make it extremely desirable as a fire-proofing and insulating material. Typically, asbestos is used wherever fire and excessive heat are a threat to safety.

Companies now are looking at fibrous glass, plastics, ceramics, and various synthetic materials as possible replacements for asbestos in certain applications. However, there generally is no one adequate substitute material available, because increased costs, poor performance, and weight often make the substituted material unattractive.

How Asbestos Is Used

Asbestos fibers can be classified into two types: *spinning* and *non-spinning*. Spinning fibers comprise the longer grades of chrysotile and crocidolite; non-spinning fibers include the shorter grades of chrysotile and crocidolite, plus the long and short grades of amosite. Use of a specific grade of fiber depends greatly upon application, and to a lesser extent on price and availability.

Longer-grade chrysotile fibers can be carded, spun, and woven to make textile products such as yarn, rovings, tape, and cloth. Asbestos textiles are used to make fire-proof clothing, packings, friction materials, gaskets, lagging cloth, and laps that provide electrical and thermal insulation.

Spinning grade asbestos fibers also are used in such non-spinning applications as compressed sheet packings and gaskets. They also are an ingredient of strong asbestos paper used in tape form to wrap electrical wires and cable.

The shorter-grade (non-spinning) chrysotile fibers make up the great

majority of chrysotile used in the U.S. These fibers go into numerous asbestos-cement products, including pipe, roofing shingles, flat and corrugated siding, millboard, cements and fillers, and insulated paper. Short chrysotile fibers are used extensively in brake linings and automatic transmission friction materials.

More than 90 per cent of the asbestos fiber used annually in the U.S. is incorporated into finished products where the fiber is entrapped, or locked in, and not free to serve as a possible contaminant in the atmosphere. Asbestos can be locked into a product with a binder, saturant, coating, or binding agent so that normal handling, application, and use will not generate significant quantities of asbestos dust. Asbestos-cement products are examples of "locked-in" materials, whereas many insulating materials and spray-on fire-proofing compounds are so-called "non-locked-in" materials.

Fire-prevention and retardation is a feature of such asbestos-containing products as: protective clothing; thermal, electrical, and acoustical-insulating materials, roof shingles, siding, and flooring; space vehicle heat shields, theatre curtains, boiler jackets, welding screens and blankets, gaskets for spark plugs, motor casings, and insulating tapes for wire and cable.

Fire-proofing plus protection against abrasive wear and tear (including the caustic action of acids) are qualities of asbestos that combine to make it useful in vinyl and asphalt floor tile, asbestos-cement pipe, asphalt paving, friction materials, packings and gaskets, asbestos-cement building materials, paper, felts and many textile products.

The adhesive and binding properties of asbestos fibers make asbestos a useful ingredient in reinforced plastics, paints, varnishes, roofing cements, wicks, rope, twine, protective coatings, and felts used in paper manufacturing.

The spinning and weaving capability of asbestos fibers is basic to the asbestos textile industry. Asbestos fibers also are used in filters that collect dust and other air pollutants, and in filtration systems used in the processing of beverages, liquids, and drugs.

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Asbestosis

An occupational disease characterized by lung scarring, asbestosis 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 10 years.

Asbestosis is believed to be 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 industry has long recognized the risk of this disease and has implemented safe-guards 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, according to the Asbestos Information Association/North America.

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. 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.

Factors other than heavy asbestos exposure are believed important in the causation of lung cancer among asbestos industry workmen. The most documented example is ciga-

Some of the most asked questions pertaining to asbestos and health are answered here by the Asbestos Information Association/North America.

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

A.—*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 (FEPA) because the methods developed for the control of emissions of fiber from these sources proved to be ineffective.*

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

A.—*It appears highly unlikely that such an "epidemic" will occur. Predictions of this nature have been based primarily on the experience of workers in British — not U.S. — shipyards, where a relatively small number of mesothelioma cases have been reported among yard employees not known to have worked directly with loose-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 include:*

- The prime method of applying asbestos-containing insulations aboard British warships was by spraying, a notoriously dusty method of application. Dust counts during spraying in British shipyards have been recorded as high as 1,500 fibers per cubic centimeter of air (300 times higher than the current U.S. standard*

for asbestos exposure). Counts taken during the sweeping and bagging of asbestos debris have reached the astronomical figure of 3,815 fibers per cc (more than 750 times the U.S. standard). This resulted in very high dust levels throughout the shipyard area.

- Spray application methods were never used in the U.S. shipyards during W.W. II. The alternative method 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.*

- 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 the U.S. shipyard work.*

Q.—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?

A.—*Asbestos-cellulose filter pads have been used in the filtration of liquids since the beginning of this century. The mass production of many of our most important injectable drugs would be virtually impossible without the use of asbestos-containing filter media. While it 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.*

*Editor's Note: One of the earliest cities to ban the practice of spraying of asbestos mineral fiber insulation in high-rise construction was New York. The New York City Council took such action effective February 25, 1972, under Local Law 49, 1971, Air Pollution Control Code, Section 1403.2-9.11(B), enacted Aug. 25, 1971.



Asbestos is automatically packaged at the mill and shipped in impermeable bags to prevent dust exposure. (Photos: courtesy Asbestos Information Association/North America.)



In the manufacturing plant, bags of asbestos are opened and fiber handled in ways preventing exposure.

rette 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 (*pleural*) 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 per cent of the asbestos fiber used in the United States today.

Because 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 have been greatly reduced, if not 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 air-borne 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.

Asbestos and the General Public

The Asbestos Information Association/North America states:

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 minute amounts of asbestos dust being found in community

air, which are many times lower than those levels that have been demonstrated to result in no excess of disease in occupationally exposed populations.

That 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, *Asbestos, the Need for and Feasibility of Air Pollution Controls*, the NAS Asbestos Panel, which consisted of seven of the nation's experts on asbestos and health, stated:

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.

According to the Asbestos Information Association, the report of the IARC Advisory Committee represents the consensus of present world medical opinion on all aspects of the asbestos-health problem.

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Meeting immediately after the October 1972 Lyon Conference on Biological Effects of Asbestos, the Committee — with representation from 10 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 occupational exposures have almost certainly been much greater than that to the public from general air pollution.

- **Mesothelioma** — There is no evidence of 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 commission was: *Such evidence as there is does not indicate any risk.*

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 at laboratories throughout the world. A significant percentage of this research is being sponsored, co-sponsored or otherwise aided by the world asbestos industry. Two of the largest non-governmental sources of funds for asbestos-health research are the Institute of Occupational and Environmental Health (IOEH) in Montreal, sponsored by the Quebec Asbestos Mining Association, and the Asbestos Research Council, sponsored by the British asbestos manufacturing industry. Individual companies acting independently are also conducting research into the problem.

Controlling the Hazard

When asbestos is mined, milled, or processed in manufacturing plants, its minute, dry fibers become air-borne like dust particles. Enclosure and local exhaust ventilation applied to equipment or operations are the principal means of preventing employee exposure to dangerously high concentrations. Dust respirators certified by National Institute of Occupational Safety and Health (NIOSH) are recommended for use by employees in some work operations.

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; innovative wetting and dampening methods that 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 enter the 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 air-borne 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;

- 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 any dust levels that might 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 the Occupational Safety and Health Administration are to be achieved.

Establishing Safe Dust Levels

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 TLV.

The American Conference of Governmental Industrial Hygienists (ACGIH) set the industry's first standard in 1938 by establishing a TLV 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 1961, 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 OSHA Administration, and it is the present accepted level. However, on



Specially-treated, lint-free asbestos textile material with "locked-in" fibers is pulled onto table for marking, cutting of patterns. (Photo: courtesy Raybestos-Manhattan).

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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.

Specifically, OSHA's current permissible level is five fibers per milliliter greater than five microns in length for an eight-hour time-weighted average air-borne concentration. This may be increased to 10 such fibers per milliliter for *no more than 15 minutes per hour*, up to five hours per eight-hour day. Such determination shall be by the membrane filter method at 400 to 450 times magnification (4 millimeter objective) phase contrast illumination. Imminent danger situations are generally not applicable. Any exposure greater than permissible levels for unprotected or improperly protected workers is considered a serious violation.²

How Is It Measured?

Asbestosis dust will be collected with a personal sampling pump. Fibers will be counted microscopically at 400-450 magnification using phase contrast illumination.

OSHA Regulations

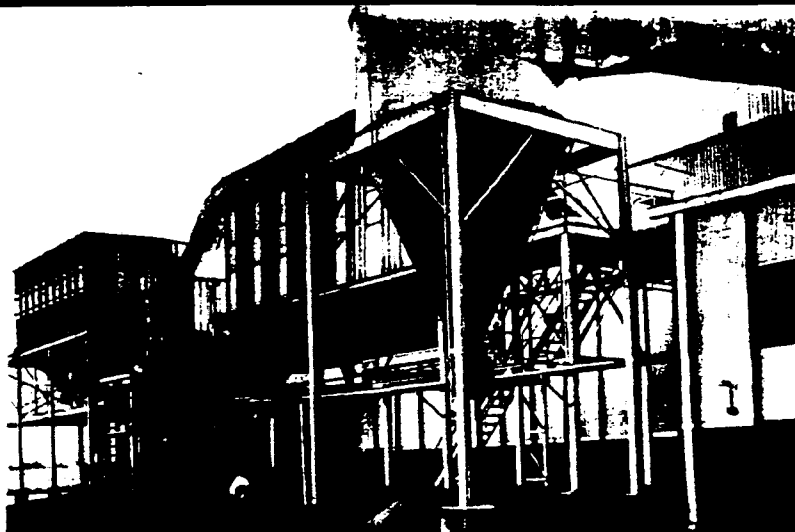
On July 7, 1972, OSHA Administration issued standards regulating asbestos dust exposures. These occupational standards deal with:

- Permissible concentrations of asbestos fibers;
- Methods of compliance;
- Warning signs and labeling of potentially dangerous products;
- Monitoring of dust levels;
- Medical examinations for employees;
- 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 standards can be summed up as follows:

1) The employer shall maintain a healthy workplace, making sure



Prime method of dust control is the bag house type collector, as shown here outside plant.

that no employee is exposed to concentrations of air-borne asbestos fiber in excess of established limits;

2) 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;

3) Engineering controls and the implementation of safe work practices are the only approved permanent methods of correction;

4) 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;

5) The use of respirators or shift rotation to achieve control is not permitted except during the time required to install engineering controls or implement safe work practices; in situations where such controls or practices are not technically feasible; and in emergencies;

6) 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;

7) Special protective clothing

change rooms, and separate clothes lockers shall be provided for employees in certain situations;

8) 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;

9) Warning signs shall be posted at entrances to areas where dust levels are in excess of the standard;

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

11) The employer shall provide yearly medical examinations for employees exposed to concentrations of asbestos dust, and pre-employment and termination medical exams also are required;

12) Upon request, an employee's medical record will be made available to his family physician.

*EDITOR'S NOTE: Manufacturers and processors of apparel made of asbestos-based textile fabrics are *not* required to identify such products with caution labels, because such asbestos is "locked" into the fabric through sealants or other sophisticated processes. Several such patented methods of locking-in the asbestos have been developed, thus minimizing or eliminating raveling.

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Other requirements included in the standard are:

- Where respirators are permitted, they must be selected from among types approved by the U.S. Bureau of Mines or certified by the National Institute for Occupational Safety and Health (NIOSH);

- 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;

- 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;

- Hand tools that may produce or release asbestos fibers in excess of the limits must be provided with local exhaust ventilation systems;

- External work surfaces must be kept free of excessive accumulations of asbestos fiber;

- Waste must be collected in sealed impermeable bags or other closed, impermeable containers.

The National Institute for Occupational Safety and Health (NIOSH) recently conducted environmental surveys in some 30 plants manufacturing asbestos cement pipe, fric-

tion materials, insulating materials, and textiles. In addition, workers in 12 plants were given medical examinations, including X-rays, and pulmonary function tests to show any indication of lung disease. Information was also recorded on each worker's occupational, smoking, and respiratory disease history.

On March 30, 1973, Environmental Protection Agency Administrator William D. Ruckelshaus set national emission standards for three hazardous air pollutants — asbestos, beryllium, and mercury.³

These three pollutants are the first to be designated as hazardous to health under the *Clean Air Act* amendments of 1970. The act defines hazardous air pollutants as those that "may cause, or contribute to, an increase in mortality, or an increase in serious irreversible or incapacitating reversible illness."

The "hazardous to health" designation requires EPA to set national emission standards for the affected air pollutants.

The new asbestos standards prohibit visible emissions from asbestos mills, selected manufacturing operations, and spray-on applications. The use of asbestos tailings for roadway surfacing generally is prohibited. Certain work practices are specified for the demolition of buildings in order to control asbestos emissions. These practices generally prohibit the dropping of asbestos debris from buildings and

require the wetting of asbestos materials before removal. The demolition standards apply to all structures except homes and apartment buildings with four units or less. — End.

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Gloves and mittens are a major item of protective equipment utilizing asbestos. Special treatment of asbestos fabric assures "locking-in" of fibers, preventing fraying and unraveling. Such treatment obviates any need to label the product as a possible health hazard. Asbestos material so treated meets OSHA standards as set forth in the *Federal Register*, Vol. 37, No. 110, dated June 7, 1972. (Photo: courtesy of Wheeler Protective Apparel, Inc.).

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