Is Fiberglass Insulation Safe?

by Peter du Pont

Do mineral fiber insulations cause lung cancer in humans? The question has yet to be conclusively answered. In the meantime, workers installing fiberglass and mineral wool insulations should take precautions to minimize their exposure.

Each year millions of bags of insulation are blown into attics across the U.S. Much of this insulation is made of glass or mineral fibers that are used because of their superior thermal properties. During the past several years, studies of the long-term health of workers in plants that manufacture glass and mineral fibers have suggested that exposure to these fibers in the air might cause lung cancer.

Do mineral fiber insulations (fiberglass, rock wool, or mineral wool) cause lung cancer? At what risk are workers who install these insulations in attics and walls? What steps can workers take to protect themselves? These are urgent questions for weatherization professionals.

The cases made by both sides of the fiberglass and lung cancer controversy are based on many contradictory scientific studies. This article summarizes the evidence for linking mineral fiber insulations and lung cancer. (Several other references that deal with these issues in more detail are listed at the end.) It then focuses on the potential risks to installers and recommends precautions that these workers should take.

What are MMMF?

Man-made mineral fibers, or MMMF, are synthetic fibers that are glassy in nature. This family of fibers includes familiar insulation products such as rock wool, mineral wool, and slag wool (see glossary). The fibrous glass used in today's common insulation products was developed in the 1930s for use in home panel filters and home insulation. Fiberglass used for insulation has an average fiber diameter of less than 8 microns and usually less than 3 microns. (A micron is one millionth of a meter, or 1/25,000th of an inch.) Mineral wool fibers have a roughly similar fiber diameter.

This family of fibers is used mainly in commercial and residential insulation, acoustical control products, air ducts, pipe insulation, air filters, roof insulation, and insulation for a wide variety of equipment.

What are the Health Effects?

Evaluating the health effects of MMMF insulations is a particularly sensitive issue because of the manner in which the tragic effects of asbestos became known. During the 1940s, '50s and '60s, asbestos was used extensively as insulation in ships, offices, factories, and homes. Some manufacturers were aware of the health effects but suppressed the evidence. During the 1970s, the government restricted its use—but only after studies had shown conclusively that thousands of workers exposed to asbestos during the 1940s and 1950s were dying of lung cancer.

Some scientists believe that glass fibers cause lung cancer in a manner similar to asbestos because the two types of fibers have some similarities. Both consist of very fine particles that can be inhaled into the lung. But scientists do not know the exact molecular mechanism by which asbestos causes cancer. "We believe it is the fibrosity of the mineral," says David Groth of the National Institute for Occupation Safety and Health (NIOSH). "In fact, much of the recent concern about the link between glass fiber insulations and lung cancer lies in the similarity between the shapes and sizes of asbestos and glass fibers."

Glossary

Carcinogenic: Having the ability to cause cancer. Short-term tests using special bacteria can be used to indicate whether a substance causes genetic mutations, and therefore *might* cause cancer. Carcinogencity is determined in tests of laboratory animals and/or studies of disease patterns in human populations.

Epidemiology: The study of factors determining the frequency and distribution of diseases in human populations.

Fibrous Glass: This is supplied in two basic forms: wool type fibers or textile fibers. Wool type glass fibers (glass wool) are produced by spinning or blowing molten glass.

Mineral Wool: This is made from molten slag, rock, or glass (or selected combination of these ingredients) by blowing, drawing or otherwise fabricating it into fine fibers. It is the most common building insulation in the U.S.

Slag Wool: This is spun from slag—the vitreous mass that is left as a residue by the melting of metallic ore.

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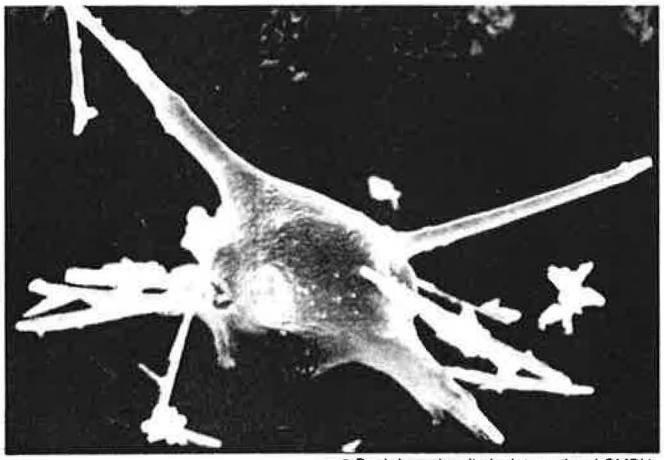
HEALTH

How Fiber Size Affects the Health Risk

Three main factors determine whether a material will cause cancer: the material's physical properties, its chemical properties, and the dose actually received.

Fibrous materials such as asbestos and fiberglass threaten human health not because of their chemical composition but because of their fibrous physical nature. It is widely accepted that fibrous forms of a given class of chemicals present a greater cancer risk than do non-fibrous forms. Thus, chrysotile, the most common type of asbestos, is a carcinogen, while its cousin, non-fibrous talc, is not.

Health specialists are concerned that a significant portion of MMMF fibers are small enough to bypass the body's natural defenses and to be inhaled into the lungs.



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Asbestos fibers being "swallowed" by a macrophage, an important defense in the body's immune system. Environmental pollutants like asbestos and silica silica can overwhelm them. Some scientists believe that glass fibers cause cancer in a manner similar to asbestos.

Fibers with diameters greater than 3 microns are not easily respirable; that is, they usually are trapped before reaching the alveoli in the lungs. Chrysotile fibers (which make up 95% or more of the asbestos fibers in use) have an average diameter of about 0.015 microns. Glass insulation fibers typically have a diameter of about 1 micron.

There is cause for alarm, however, because some recently developed glass insulation products have fibers approaching the size of asbestos. These smaller fibers have a better insulating value than the larger fibers, but it appears that these insulation gains may be made at the expense of health considerations.

One company, Certainteed Corporation, has steadily developed loose-fill fiberglass products with smaller diameter fibers. The pinnacle of this progression, called Insul-Safe III, has fibers that are in the same size range as asbestos. One study conducted at three different insurance company laboratories found that 80 percent of the Insul-Safe III samples had "a median diameter between 0.6 and 0.9 microns."[1]

Indeed, the decrease in fiber diameter is real cause for concern, because the narrower fibers are more carcinogenic as well as more respirable. "The fibrous mineral is going to be much more carcinogenic than the non-fibrous mineral of the same composition," says Groth of NIOSH. "On a fiber-to-fiber basis, fibers of the same dimensions are probably equally carcinogenic."

Are MMMFs going to be the next asbestos? Probably not, but studies presented at a World Health Organization conference in 1986 suggest that MMMFs deserve further scrutiny.[2] This conclusion is based on studies of the effects of MMMFs on laboratory animals and on large-scale health studies of workers in the fiberglass and rock wool manufacturing industries.

MMMFs Cause Cancer in Animals

Animal studies are conducted to determine whether a substance has the ability to cause tumors in animals such as mice and rats, and therefore, by extrapolation, in humans. In these studies, scientists use large doses of a chemical to get an observable cancer rate in a group of rats—typically 25 to 100 animals—in order to estimate what the cancer incidence would be at lower chemical concentrations. (At the doses to which humans are typically exposed, scientists would have to use thousands of rats to detect an increase in cancer incidence!)

MMMFs enter the body through the airways and lungs. The two main methods used to administer MMMFs to the lab animals have been by implantation (physical insertion of the fibers into lung tissue) and by inhalation. According to Groth of NIOSH, numerous studies have concluded that mineral and glass wool fibers can cause lung cancer in rats when implanted directly into their lungs. But Groth cautions that "the extrapolation of these studies to develop a risk estimate in humans is extremely difficult if not impossible."

Several long-term animal inhalation studies have also been performed using dust preparations of glass wool, rock wool, or slag wool. While these have produced little evidence of chronic respiratory effects or lung cancer, this does not mean that they won't do so in humans.[3] Rats, unlike humans, breathe only through their noses. Groth suggests that a portion of the fibers used in these studies never reached the lung tissue of the animals. Thus, Groth reasons, these findings do not prove that fiberglass cannot cause lung cancer in humans. As a result, scientists have turned to large-scale studies of workers to try to determine the health risk to humans.

Studying Workers' Health Records

Are there serious health effects among workers with high exposures? Scientists have examined the health records of the thousands of workers in factories that manufacture MMMF products. These individuals were exposed to glass and mineral wool fibers over long periods of time. Four of these studies, including two major studies of literally thousands of workers, show a *possible* link between MMMF exposure and lung cancer (see table 1).

Enterline and Marsh examined the health records and exposure of almost 17,000 workers at 17 U.S. plants—11

Study	Production	# of subjects	Length of employment (in years)	Assoc. with chronic resp. diseases	Assoc. with lung cancer
Enterline & Henderson	glass wool	416 (retired)	—	No	No
Bayliss et al.	1 glass-wool plant	1,448	>5	Possible	No
Morgan et al.	glass wool	4,339	>10	No	Possible
Shannon et al.	glass wool and rock wool	2,576	—	Possible	Possible
Enterline and March	17 glass-wool/ continuous filament/ rock-wool/slag-wool plants	16,730	11 (average)	Possible	Possible
Saracci et al.	13 glass-wool/rock-wool/ continuous filament plants	25,468	5 (average)	No	Possible
Robinson et al.	1 rock-wool/slag-wool plant	596	>1	Possible	No

Table 1. Data from mortality studies of workers producing man-made mineral fibers (MMMF). (Source: reference 4) The table summarizes studies that have evaluated the health records of thousands of workers in the mineral fiber production industry. **Key to Table:** *Study:* lists the author(s) of the study. *Production:* lists the number and type of production plants that were included in the study. *Assoc. with chronic resp. diseases:* indicates whether the authors found an association between employment at the production facility and an increased incidence of respiratory disease, compared to a reference population. *Assoc. with lung cancer:* indicates whether the authors found an association between employment at the production facility and an increased incidence of lung cancer, compared to a reference population.

glass-fiber factories and 6 glass-wool factories. In both types of factories, there were a slightly higher number of deaths from "non-malignant respiratory disease" than expected. Workers in both types of plants who were followed at least 30 years from first exposure had a significantly higher than expected death rate from lung cancer.

The second large study included 25,000 workers at 13 plants in seven European countries. As in the U.S. study, workers were followed for more than 30 years since their first exposure. The study did not show a significantly higher overall mortality rate for workers in the study. However, there was a slight increase in the rate of lung cancer. In contrast, similar studies comparing the health of smokers and non-smokers show huge increases in the rate of lung cancer among smokers.

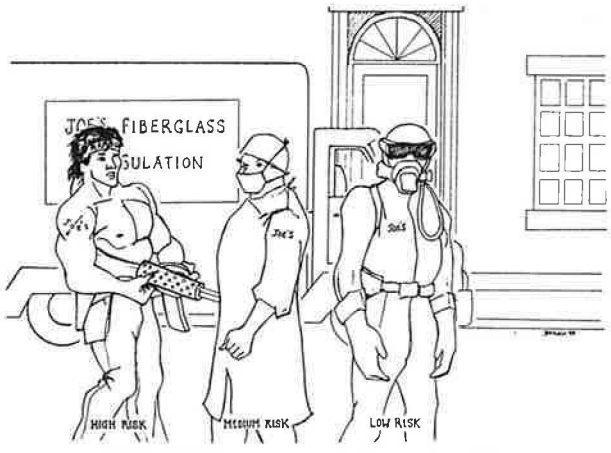
A summary of the studies concluded that "from the examination of the two major studies in the producer industry, the possibility that some excess of lung cancer may be causally related to man-made mineral fibers could not be ruled out of the range of reasonable interpretations."[4] The same report concludes that "... MMMF, as present in the environmental conditions of the early slag wool/rock wool production [before the development of procedures to control the level of dust fibers], may have played a role in the causation of lung cancer."

What Levels are Installers Exposed to?

The epidemiologic studies have suggested that exposure to MMMFs in industrial settings may have caused lung cancer. It is thought that work conditions during the early years of MMMF production, before the use of techniques to suppress levels of dust in the air, may explain the increase in lung cancers only among those workers exposed many years ago. Unfortunately, we do not know the levels to which workers in industry were exposed 20 or 30 years ago, but they were much higher than the levels in modern manufacturing facilities. With today's improved control techniques, workers in MMMF production plants are exposed to fewer than 0.5 fibers per cubic centimeter of air (fibers/cc), which is close to the legally permissible exposure limit for asbestos fibers (0.2 fibers/cc).[5]

A 1982 report by the World Health Organization described levels present in today's manufacturing plants. Table 2 summarizes the report's findings.

The current exposure level recommended for fiberglass workers by NIOSH is 3 fibers/cc. This is a time-weighted average exposure during a 40-hour week. The guideline was recommended by NIOSH in 1977 and has



Three different approaches to the risk posed by fiberglass insulation.

never been acted upon by the Occupational Safety and Health Administration (OSHA). The time-weighted average exposure to rock wool should not exceed 0.3 fibers/cc and peak exposure levels should not exceed 1.2 fibers/cc.

How much exposure occurs among contractors who blow in loose-fill insulation? The levels vary according to the job, but the only survey we are aware of indicates that they may exceed the NIOSH guidelines in many cases. The study was sponsored by the Thermal Insulation Manufacturer's Association (TIMA) and conducted by Dr. Nurtan Esmen at the Graduate School of Public Health at the U. of Pittsburgh. Esmen examined workers who install fibrous insulation materials including acoustical ceiling insulation, duct insulation, fiberglass and mineral wool attic insulation, aircraft insulation, and fibrous glass ducts.

MMMF	Concentration (fibers/cc) mean	range
U.S.A.	0.10	0.0024-0.78
United Kingdom	—	0.12-0.89
Europe		
rock wool	0.04	0.01-0.37
glass wool	0.02	0.01-0.45

Table 2. Levels of man-made mineral fibers at production facilities today. (Source: reference 6)

Esmen examined the total fiber concentrations and characteristics of 247 personal samples. Figure 1 shows the range of suspended total fiber concentrations for three categories of insulation. Respirable fiber concentrations ranged from 0.01 to 6.67 fibers/cc. The highest concentrations were experienced by attic insulators (both types) and then duct insulators.

One disturbing finding of this study is the relatively high fraction of respirable particles, because it indicates that most of the fibers can reach the lung tissue. Figure 2 shows the respirable fraction of fibers for the occupations included in Esmen's study. (To be respirable, a fiber must have a diameter of less than 3 microns.) Ninety-three percent of the fibers had a diameter of less than 3 microns.

Industry scientists contend that, although installer exposure may exceed the NIOSH guideline, the exposures are for short duration and do not represent a significant health risk. The Esmen study found that exposures are not so brief: installers spent between 15 and 61 percent of their working day in the attic.

No study has examined the link between lung cancer incidence and occupation as an insulation installer. One fact is clear, though. Workers installing loose-fill glass or mineral insulations should take precautions to minimize their exposure to insulation fibers. Their simplest and most effective protection is to wear a NIOSH-approved single-use dust/mist respirator. An ordinary dust mask gives essentially no protection against the tiny fibers that are of concern (see box on p. 10).

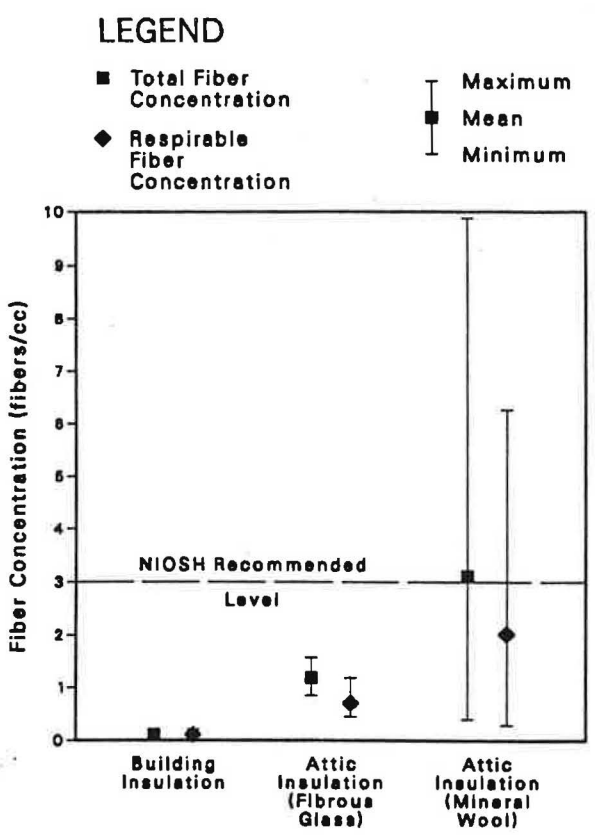


Figure 1. Fiber concentrations calculated from personal sampling data. The graph shows the mean and range of fiber concentrations (total and respirable fractions) for insulation workers. Respirable fibers have a diameter of less than 3 microns. The values in this table are time-weighted averages: that is, they represent the average concentration to which a worker would be exposed during a 40-hour week. (Source: reference 7)

Watch Out for that Hype

Advocates and detractors of fiberglass and mineral wool insulation interpret the test results differently. For years, industry has denied any potential link between MMMFs and lung cancer. Robert Doban, a senior vice-president at Owens-Corning, contends that "the truth of this all is that the fibers are safe. The overwhelming body of evidence doesn't show a connection between the fibers and disease." Nonetheless, the fiberglass industry now prints this message on its material safety data sheets:

> "Although inconclusive, some research supported by the industry indicates that manufacturing plant employees who were first employed more than 30 years ago in factories that manufactured glass wool and mineral wool have an increased rate of lung cancer as compared to certain other reference populations. Further study is planned to identify those factors associated with the reported increased rate."[8]

Proponents of the cellulose industry have used the asbestos comparison to make glass fibers sound worse than they may be. The most vocal of these, Richard Munson, founded an organization called Victims of Fiberglass. According to Munson, VOF has approximately 225 contributors. "The bulk of the contributions," says

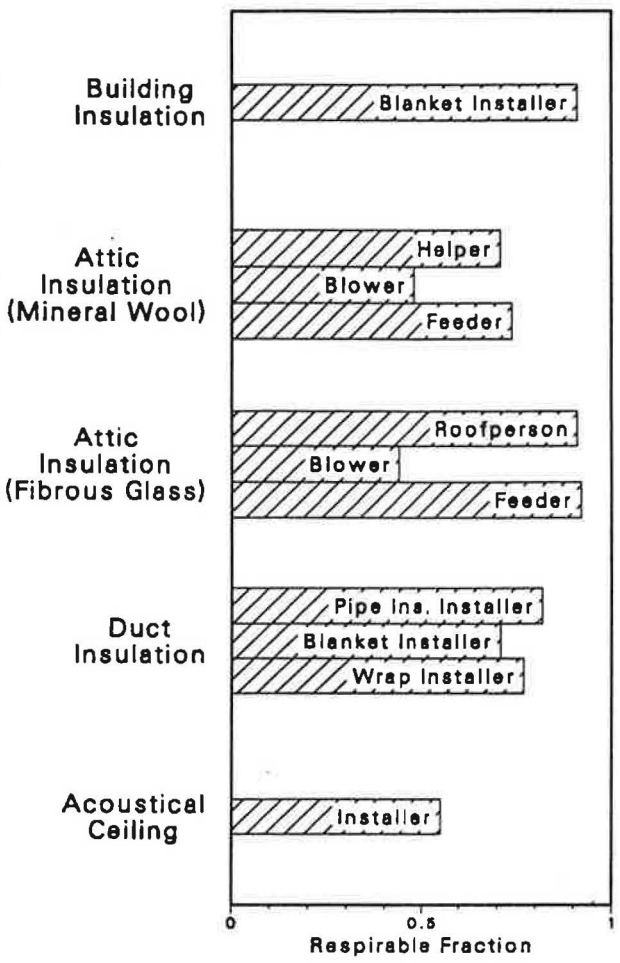


Figure 2. Fraction of total fiber concentration that is respirable (< 3 microns diameter). (Source: reference 7)

Munson, "come from insulation contractors and cellulose manufacturers." Munson is also president of Thermolite Corporation, a manufacturer of cellulose insulation. In addition, he founded a company called National Consumer Products Marketing, Inc., which serves as a cellulose trade association.

Munson has developed an impressive array of evidence to support his point—that glass fibers present a real lung cancer risk. However, he often goes beyond the evidence in public speeches. For example, he told an audience in Cleveland that "fiberglass cannot perform as presented and in fact is the most significant consumer fraud ever perpetrated in American history."[9]

Munson told *Home Energy* that "Owens-Corning's own tests show that fiberglass cannot perform within 30 percent of its rated value." He cited an article in *Energy Auditor & Retrofitter* ("How Effective is Insulation," Oct/Nov '84), which reported on tests that Owens-Corning conducted on fiberglass batt insulation. The article concluded that "measured R-values for fiberglass batt insulation were typically 30 percent less than predicted using a simple heat loss calculation." While the measured R-values were less than the nominal ratings, researchers attributed the difference to edge effects (thermal bridges that occur at wood joists), where the insulation itself was not to blame. Presumably, cellulose would suffer the same reduction in R-value. It is true that cellulose insulation is more effective than loose fiberglass or fiberglass batt insulation at reducing air leaks between heated and unheated spaces. This is because it is better at filling up cracks and holes, not because it is a better insulator.

Recommendations

Exposure to glass and mineral fiber insulations poses a risk, but that risk has not been well quantified. Cigarette smoking, for example, is a known health risk and is many, many times more dangerous. MMMFs may cause lung cancer in humans, although they are clearly much less hazardous than asbestos. This is because, under the same conditions of use, fewer airborne respirable particles are generated than with asbestos.

Homeowners are probably not at risk from insulation already installed in their attics. However, it is not clear whether these fibers can cause cancer in humans and whether the levels to which insulation installers are exposed entail a significant risk.

Workers installing or inspecting glass or mineral fiber insulations should take precautions to minimize their exposure. Because MMMFs irritate unprotected skin, workers should always wear protective clothing. In addition, workers installing loose-fill glass or mineral fiber insulations should use a high-efficiency dust/mist respirator approved by NIOSH (see box on page 10).

In addition, the manufacture of fibrous insulations with fiber sizes in the respirable size range appears to be a genuine hazard. Although smaller diameter fibers have a better insulating ability, they have become, in some cases,

Fiberglass Can Itch, Too

Fiberglass is a short-term irritant that should be handled carefully during installation, whether it be in batts, rolls, or loose-fill, pipe or duct insulation, or water heater blankets. Here are some ways to minimize skin irritation.

Wear loose clothing. Wear long-sleeved shirts and blouses, as well as long pants and a cap. This will prevent the fibers from coming into contact with and irritating the skin. Loose clothing also helps prevent the fibers from rubbing against the skin.

Prevent dust. Dust collection systems should be used whenever fibrous glass exposures may exceed either established particulate standards or recommended fiber standards. Operations such as blowing fiberglass have the potential for high exposures.

Protect your eyes. Safety glasses, goggles, or face shields should be worn whenever fiberglass materials are being applied in areas where loose fibers can get into the eyes.

Wear respirators. Use a respirator for protection against all nuisance dusts. Acceptable respirators are specifically designed for protection against nuisance dusts and are approved by NIOSH (see box on page 10).

Keep work areas clean. Avoid unnecessary handling of scrap materials by keeping waste disposal equipment as close to working areas as possible. Don't let debris pile up on the floor and other surfaces.

alarmingly similar in size and shape to asbestos. The insulating benefits that come from reduced fiber size need to be weighed against the potential adverse health effects. ■

Endnotes

1. Lowry, W.T. "Particle Size Distribution Studies of Fibrous Glass." Prepared for Richard Munson, president National Consumer Products Marketing, Auburn, CA.
2. The Proceedings of the conference, "Biological Effects of Man-Made Mineral Fibers," are presented in a special issue of *Scandinavian Journal of Work and Environmental Health* Vol. 12: supplement 1, 1986. An arm of WHO, the International Agency for Research on Cancer (IARC), has concluded that glass wool, rock wool, and slag wool are "possibly carcinogenic to humans." IARC has five classifications regarding carcinogenicity: (1) sufficient evidence of human carcinogenicity; (2A) probably carcinogenic to humans; (2B) possibly carcinogenic to humans; (3) not classifiable as to human carcinogenicity; and (4) probably not carcinogenic.
3. Davis, J.M.G. "A Review of the Evidence for the Carcinogenicity of Man-Made Vitreous Fibers." *Scandinavian Journal of Work and Environmental Health.* Vol. 12 (suppl. 1): 12-17. 1986.
4. Saracci, R. "Ten Years of Epidemiologic Investigations on Man-Made Mineral Fibers and Health." *Scandinavian Journal of Work and Environmental Health* Vol. 12 (suppl. 1): 5-11. 1986.
5. Scientists reconstructed conditions of the production plants during the 1940s to estimate fiber levels and came up with levels of about 5 fibers/cc.
6. *Biological Effects of Man-Made Mineral Fibres.* Report on a WHO/IARC meeting, Copenhagen, Denmark, April 1982. World Health Organization.
7. Esman, N. et al., "Estimation of Employee Exposures to Total Suspended Particulate Matter and Airborne Fibers in Insulation Installation Operations." U. of Pittsburgh Graduate School of Public Health. March 1980.
8. Excerpted from an Owens-Corning Fiberglass Material Safety Data Sheet for fibrous glass. Manufacturers must prepare material safety data sheets for all potentially hazardous chemicals.
9. Stated at the "Blueprint for a Healthy House" conference, held October 15-16, 1987. The conference was sponsored by the The Housing Resource Center, a non-profit organization in Cleveland. Tapes for many of the conference sessions are available by writing Al Wasco at the HRC, 1820 W. 48th St., Cleveland, OH 44102. Tel: (216) 281-4663.

Further Reading

Below is a list of articles that have appeared in the popular and trade press on the lung cancer risk of exposure to fibrous insulations.

"Fiberglass Insulation and Lung Cancer." *Energy Design Update.* February 1987, p. 4.

Meier, B. "Health Studies Suggest Asbestos Substitutes Also Pose Cancer Risk." *Wall Street Journal.* Tuesday, May 12, 1987, p.1

Shabecoff, P. "Evidence Grows on Fiberglass Link to Cancer." *New York Times.* Sunday, March 15, 1987, p. 1.

Shaw, W. "New Research Rekindles Fiberglass Health Issue." *Roofing/Siding/Insulation (RSI).* May 1987, p. 64.

Shaw, W. "Science has Yet to Pin Down Fiberglass Risk." *Roofing/Siding/Insulation (RSI).* June 1987, p. 40.

Using the Right Respirator

Respirators that remove particles are generally called dust, mist or fume respirators. They all work by removing the particles from the air stream before it can be inhaled.

Respirators come in three basic configurations: quarter mask, half mask, and full facepiece. Quarter masks, which are not in common use any more, cover the mouth and nose. A half-mask seals more reliably than a quarter mask because it covers the chin as well. A full facepiece respirator covers the entire face and is generally used where there is exposure to higher pollutant concentrations.

Half-mask or full-face respirators should be used when installing fibrous insulations. It is especially important to wear a mask approved by the National Institute for Occupational Safety and Health (NIOSH). Make sure that the mask is labeled certified and that it has two headstraps. The single-strap, non-approved dust masks commonly sold in hardware stores should be avoided, because they do not effectively filter small particles.

Currently it is legal to use a NIOSH-approved disposable half mask for fiberglass exposures. Nonetheless, we recommend a respirator with a replaceable filter. To be consistent with the kind of protection called for during asbestos exposure, you should use a high-efficiency filter particulate (HEPA) respirator.

The "fit" of the respirator is extremely important. NIOSH-approved masks are form-fitting. Facial hair significantly and unpredictably reduces the mask's effective particle removal.

From left to right: A Pulmosan dust mask, circa 1920 (this quarter mask was the forerunner of the dust/mist respirators used today); a NIOSH-approved, single-use dust/mist respirator; a half-mask with replaceable high-efficiency particle filters.