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ENVIRONMENTAL EXPOSURES IN THE INSULATION TRADE

J. LeROY BALZER
Tacbershaw-Cooper Associates

J. LeRoy Balzer has written many papers dealing with hygiene and the asbestos worker. His publications include "The Work Environment of The Insulating Worker" and "Evaluation and Control of Asbestos Exposures in the Insulating Trade." He is connected with the University of California in the field of Industrial Hygiene and Environmental Health Sciences. Dr. Balzer has made field studies of major construction work sites and his main research interests are in occupational health and safety in industry. He is presently associated with Tabershaw-Cooper Associates.

* * *

Insulators, a small but important segment of the construction industry, are exposed to a number of special hazards above and beyond those which are ordinarily present in construction. Exposure to asbestos is the major concern because the asbestos minerals are known to cause human disease, primarily a disabling pneumoconiosis, "asbestosis". Evidence has also accumulated that individuals who work with asbestos are more prone to cancer of the lungs, of the chest, and of the abdominal cavity. However, reports on occupational disease in construction workers generally, and this is true of insulators as well, do not include quantitative data on types and degree of work exposures to environmental hazards. This information is difficult to obtain because of the changing and mobile jobs which are characteristic of construction.

Nevertheless, it is becoming important to obtain exposure data on all people in the construction trades and especially in asbestos workers.

The information is beginning to accumulate; the insulating craft is a stable one because of the high rage rate and the rigid apprentice testing and training program. Men who qualify and pass through the apprentice school tend to stay in the trade for their working life. While considerable shifting from contractor to contractor occurs, the union remains a stable base around which information can be gathered. Furthermore, most of the insulators have at some time or other worked for one or more of the major contractors and a complete work history can be obtained which includes the variety of material which a worker used on a job.

Some insulators prefer to work in heavy construction or on the waterfront, but all learn to do the major jobs of their craft and can work at any job assigned by their union dispatcher. The major types of work in which men are engaged can be classified as: (1) commercial building, involving the insulation of pipe and duct systems in office buildings, apartments, shopping centers, etc.; (2) heavy industrial buildings, which involves the insulation of turbines, boilers, pipes, duct systems, and processing equipment in power plants and factories; and (3) marine construction and repair, which involves insulating turbines, boilers, pipes and duct systems in ships, both naval and private.

The volume and nature of the fibrous materials and the approximate time spent in applying them are of paramount importance in reconstructing the work-a-day environment of insulators. The types of material with which they come in contact are quite varied and may be broken down as follows:

1. Materials containing asbestos—
   - 100% Amosite blankets
   - 95% Amosite—5% filler
   - 10-15% Mixed amosite and chrysotile—85% magnesia
   - 10-15% Amosite—85% calcium silicates
   - 10-15% Mixed amosite and chrysotile—85% Calccined diatomaceous silica
   - 100% Chrysotile asbestos shorts for finishing (mud)
   - 50% Asbestos shorts and 50% cement for finishing (mud)

Materials containing fibrous glass—
- Monoblock—compressed glass and resin binder
- Rolls—batts and blankets
- Prefabricates — pipe and duct covering, air duct systems
- Mineral wool
- High temperature insulation
- Finishing materials (muds)
- Mineral wool and cement
- Specialty materials

3. Plastics—
   - Polystyrenes — prefabricated product, powdered
   - Polyurethanes—foam in places, prefabricated products
4. Cork—
   - 100% cork blocks
5. Glass flakes—
   - Foam glass
6. Adhesives—
   - Epoxy and solvent; asphalt base and solvent
   - Wheat paste
   - Silicones
   - Magnesia
   - Portland cement

The following table estimates the percentage of the use of fibrous glass and asbestos-containing materials by the major types of construction:

TABLE I

Percentage of Fibrous Glass and Asbestos-Containing Materials Used in the Major Types of Construction

Types of Construction	Fibrous Insulation Materials		
	Total	Fibrous Glass	Asbestos
Commercial building	100%	70%	30%
Heavy industrial building	100%	30%	70%
Marine construction and repair	100%	20%	80%

It can be seen that fibrous asbestos and glass materials account for 90% of the materials applied. The greatest potential hazard is from these two materials.

Asbestos:

Asbestos is a commercial term applied to a group of fibrous silicates. They include chrysotile and the amphibole minerals — amosite, crocidolite, anthophyllite, tremolite, and actinolite. Chrysotile (hydrous magnesium silicates) is the most important commercial asbestos mineral, presently accounting for about 90% of the world's asbestos production. It occurs only in serpentine (hydrous magnesium silicate minerals) rock formations. In the United States insulation industry, chrysotile (Canadian) and amosite (South African)

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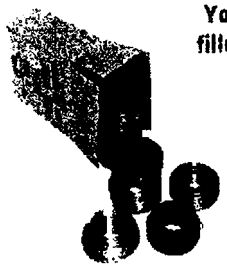
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are most often used in manufacturing insulation materials.

The manufacturers of asbestos insulating materials use varying amounts and types of asbestos fibers and may rename their product for distribution by another manufacturer or wholesaler. Contractors will also order specific types of asbestos insulation because of their thermal properties and not because of the type of asbestos fibers they contain. These practices on the part of manufacturers and contractors make it impossible to find a working population that has had a "pure" exposure to one type of asbestos fiber.

Of interest, in terms of human effect, is the unique physical characteristic of asbestos to subdivide longitudinally into fibrils of molecular diameter. The fibrils are too small to be counted with ordinary light microscopic techniques, making it difficult to assess the true fiber exposure; however, this future is the most important measure of the potential biological effect since only fibrils of certain sizes can be inhaled—above 4-5 microns in diameter they are nonrespirable and hence essentially harmless. Unfortunately, many asbestos fibers are below that diameter and find their way deep into the lung.

Fibrous Glass:

Fibrous glass consists of a mixture of silicon dioxide, oxides of aluminum, boron and other additives. In general, the fibers of most commercial insulating products have diameters between 3 and 15 microns.

The range of diameters of the fibers in microns of various samples of fibrous glass insulating materials were: acoustical materials—3 to 14 microns, building insulation—8 to 15 microns, duct insulation —4 to 11 microns, pipe covering—4 to 8 microns. The importance here is that the fibers above 5 microns in diameter are not considered respirable. The majority of the fibrous material is above that diameter.

Adhesives and Coatings:

Nineteen products, accounting for 90% of the adhesives applied, were found to contain the following solvents: aliphatic hydrocarbons (naphtha, hexane and other petroleum distillates), ketones, aromatic hydrocarbons (xylol and toluol), chlorinated hydrocarbons (methylene chloride, trichloroethylene, and perchloroethylene), and isopropyl alcohol. The solvents are in combination with a number of plastics, organic and rubber resins, and paraffins. Concentrations of these active ingredients in the products used by insulators ranged from 1% to 95% by weight. The alcohols and aromatic hydrocarbons are generally present in concentrations of less than 10% while the chlorinated and aliphatic hydrocarbons represent the bulk of solvents used. This is significant because the chlorinated and aliphatic hydrocarbons are the group with the greatest potential for human injury.

Other:

This group contains the remaining materials that the insulator uses. Foam glass materials are a mixture of glass chips (greater than 10 microns in diameter) expanded by hydrogen sulfide gas into block forms. This product, along with cork and rubber materials, is mainly used for refrigeration insulation. Polystyrenes are being used in an ever increasing amount, especially in the area of cryogenics. The use of polyurethanes is increasing and the lack of adequately trained personnel is a concern of many locals. Programs are being implemented to meet this need.

Environmental Survey

To obtain a "classical" time-weighted exposure for this trade for every one of these conditions is impossible; however, it is possible to present data that will indicate the variability of the insulator's exposures. In contrast to other occupational groups who generally stay in the same working environment, the insulator is in a continually changing environment; the work locations, materials used, positions at work, humidity, temperature, ventilation, noise levels, and other variables are in a state of flux. Environmental exposures to the insulator also result from the work of others around him, such as welders, painters, and fireproofers. In order to better describe the work environment, the jobs performed by the insulating worker have been divided into six areas:

1. *Prefabrication*—(10% of his time)—Materials are precut and shaped using hand or power saws.
2. *Application* — (40% of his time) — Materials are fitted, hammered, or carved, and attached to the surface by wiring or gluing.
3. *Finishing* — (30% of his time) — Materials are coated with asbestos-containing cements, resins, asbestos or cotton cloth, or petroleum based sealers.
4. *Tearing out* — (10% of his time) — Removal of old or unusable materials is done in the process of insulating or reinsulating.
5. *Mixing* — (5% of his time) — Mineral wool, asbestos, fibrous glass, and cements are mixed separately or in combination in buckets or troughs.
6. *General* — (5% of his time) — Old insulation is cleaned up, materials are transported.

Dust Exposures

Asbestos:

The environmental sampling for dust exposures has been limited to areas in which asbestos-containing materials were being applied. Results of sampling by a midget impinger are summarized in Table II. The data represents both breathing zone and general air samples. The standard method of counting was used and both fibers and grains were pooled in the total count.

Continued On Page 13









TABLE II

Asbestos

Midget Impinger Counts by Job Classification MPPCF

	Mean	Range
Prefabrication	8.0	0.9-40
Application	3.5	0.9-9
Finishing	3.0	1.2-7
Tearing Out	5.5	2.2-10+
Mixing	9.0	3.0-20
General	1.2	0.5-3.5

We can see from the above table that the areas with the highest dust concentrations and exceeding the present Threshold Limit Value of 5 mppcf (proposed Threshold Limit Value—12 fibers per cubic centimeter) are prefabrication, tearing out, and mixing. However, these three areas account for less than 35% of the man's working time when applying asbestos materials.

The second set of samples were membrane filters taken by personal air samplers; and area samples were taken for periods ranging from 30 minutes to 2 hours. The fiber counts per cubic centimeter are given in Table III by job classification.

TABLE III

Fiber Concentration Based on Membrane Filter Samples by Job Classification

	fibers/cc Mean	Range
Prefabrication	10.0	0.1-30
Application	8.0	0.1-60
Finishing	2.0	0.1-20
Tearing Out	9.9	0.1-30
Mixing	2.4	0.5-30

Fibrous Glass:

Unlike the asbestos exposures, fibrous glass exposure is in two major areas: during application and in the general work environment. Measurements were taken on various jobs in which all types of products containing fibrous glass were used, i.e., wall board, duct wrap, pipe. Table IV presents this data by fiber concentration per cubic centimeter of air. Some gravimetric analyses were performed but this method of sampling was discontinued because of the inability to find a sampling device that would sample only the fibrous glass in construction dusts.

TABLE IV

Fibrous Glass Concentration—Fibers per Cubic Centimeter

	fibers/cc Mean	Range
Application	1.4	0.02-8
General Work Area	0.2	0.02-0.6

Solvent Exposures:

Measurements were made of aromatic hydrocarbons. At present no readings have approached the Threshold Limit Values for the solvents listed. However, since welders are often in the same working area, the chlorinated hydrocarbons are of concern because of the possible generation of the byproduct, phosgene, a highly toxic gas which is produced from the decomposition of the solvent in the high temperature electrical arc.

Temperature and Humidity:

Another condition that affects most of the workers at some time in their working life is extreme temperatures and humidity. In the commercial and heavy industrial building groups the humidity measurements ranged from 20% to 100% with temperature ranges of 32° to 110°F. The marine construction and repair group most often experience the most extreme conditions. The extremes measured on one of the jobs was 95% humidity and 95°F.

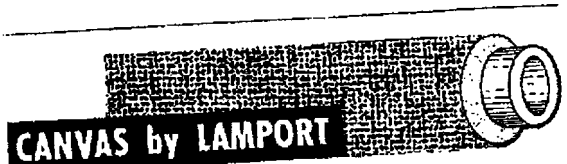
Noise:

Sound level measurements show, in general, few areas with sustained readings above 90 db. However, if chippers, caulkers, riveters, stud welders and grinders are working in the same area, readings above 100 db are not uncommon. High levels are also found in online refinery jobs. These measurements are of concern since permanent hearing loss can result from repeated exposures above 90 db.

Discussion

Asbestosis in the insulating worker can be prevented by instituting various work and engineering changes: total work enclosures, exhaust and forced air ventilation of dusty areas, personal respiratory protection, changes in work habits, and substitution of materials. All of these preventive measures cannot be adopted immediately and are all not applicable to every job. The industry must adopt some of these changes in order to reduce the environmental dust exposures and thereby extend the working life of the insulator.

Prefabrication of materials should be done in an open-end booth with exhaust fans and properly filtered exhaust, such as the spray paint booth. This will substantially reduce the operator's dust exposure. The mixing of muds should also be enclosed in a booth



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and an automatic mixer be utilized, thereby controlling dust levels that occur when these materials are mixed in open areas. This operation could also be done in central areas and trucked to the job since many of the materials do not dry out if they are kept tightly covered. For those small jobs and where cements are used, the material can be prepackaged in 5-15 lb. lots in plastic bags and mixed in the bags.

The use of local exhaust and forced air fans in the work area and on certain equipment, i.e., saws, will also reduce dust exposures. It is impractical on some jobs because few men work in one area long enough to justify the setting up of an elaborate ventilation system. However, when large boiler and generator jobs are in process, local exhaust or forced air fan systems should be used. This type of system could also be used to cool the men in areas of extreme temperature and humidity, such as in marine construction and repair.

The use of personal respiratory equipment is very important, but what is more important is the development of a mask that has a filter with a low resistance to air flow and a face piece that is easily fitted to the man. Most of the present masks do not fit properly and the filters, besides having a high resistance to flow, clog very quickly. This makes it necessary to change the filter frequently, or as is most often the case, the men simply remove the mask and continue to work. Another form of respiratory equipment is the supplied air respirator which should supply enough air to cool the man as well as meet his physiological needs. This requires elaborate hose and compressor systems and is not economically feasible or desirable. But it is suggested that personal air supplied respirators with their own power units be used in areas of high dust exposure such as prefabrication and tearing out. Appropriate respiratory protection should also be made available for use in areas where high solvent concentrations exist.

Changes in work practices such as the use of a water spray to wet down some materials before they are cut would substantially reduce the dust exposure. Industrial vacuum sweepers should be used for clean-up instead of brooms, thus reducing the dust level to the men and other crafts in the area. In addition, tearing out of old insulation could be done with local exhaust hoses connected to a vacuum sweeper. All these steps would reduce the present high levels of dust exposure at these various jobs. Mixing of muds in closed plastic bags has also been suggested and tried, but data on acceptability is presently not available.

Substitution of new materials is possible under certain conditions, but at present we do not know enough about the physiological effects of fibrous glass and ceramics to suggest the total change to these kinds of products. When proposing the substitution of new materials to replace asbestos, the engineers often have

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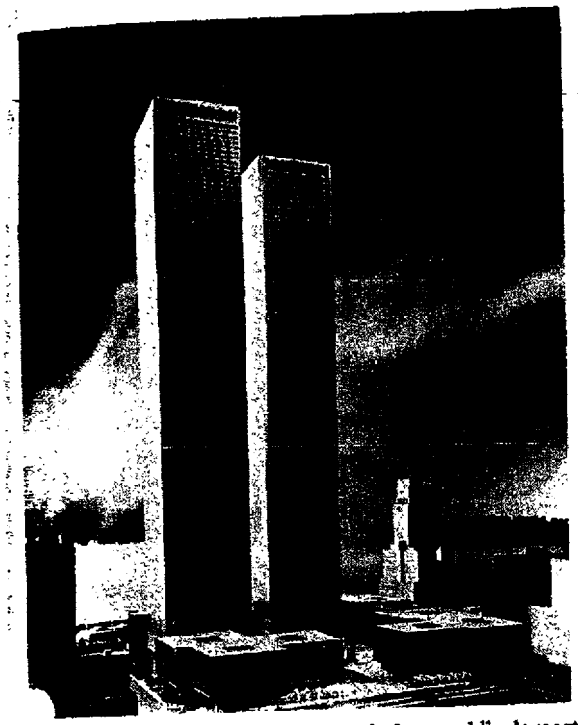
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World's Largest Single Insulating Project



Work is under way on one of the world's largest single insulating projects . . . protection for the heating, ventilating and air conditioning systems in the twin 110-story towers of the New York World Trade Center buildings.

Initial work is in a mammoth chilled water system. The project is expected to continue through most of 1971 when the entire 1600 million, six-building complex, including four low-rise buildings, is scheduled for completion.

PPG Industries will supply what may be more than 75 per cent of the pipe insulation and all the blanket insulation requirements. The nearly 50 miles of pipe and insulation would stretch two-and-a-half times the width of Long Island, and the blanket insulation would cover more than 30 football fields.

Because of the lower Manhattan site of the Trade Center, there are no parking or contractor storage facilities, thus getting steel, concrete, glass, aluminum and tons of other construction materials onto the site creates a major logistics problem. The 60-men engineering staff of the general contractor uses a computer to help schedule the unloading hoists for each contractor. This operation is so closely scheduled that when it's a contractor's turn to use the hoists, they must be there with all material and must finish on schedule.

After six years of planning, designing and the demolition of 13 city blocks, the center is beginning to take shape. In the midst of the 16-acre site, steel work for the first tower has reached 50 stories while the second stands at approximately 15 floors. There also will be two multi-level plaza buildings for trade exhibits, banks and other activities of international commerce, as well as a new U.S. Customs House, and a hotel and conference facilities—all surrounding a five-acre plaza.

The twin towers will be 100 feet taller than the Empire State Building. The entire complex will have 230 acres of rentable space, nine acres more than the Pentagon's total. The center's demand for electricity will equal that of a city the size of Schenectady, N.Y.

The labor and materials contract for heating, ventilating and air conditioning is valued at approximately $37 million. Facilities will include about 100,000 supply and return air conditioning outlets integrated architecturally with interior lighting fixtures. Some 24,000 under-the-window induction units will air condition peripheral zones of the buildings. The air conditioning system will circulate about eight million cubic feet of air per minute throughout the towers. Another example that insulation continues to pay for itself.

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