Asbestos Exposure During Naval Vessel Overhaul

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A study among insulation workers in a shipyard has revealed several men on disability compensation and one death due to asbestosis. Exposures occur during the fabrication and installation of asbestos insulations and during removal of insulation for repairs or overhaul of ships. X-ray examinations are not adequate for control as cases usually take a minimum of seven years to develop.

Problem

THE LONG BEACH Naval Shipyard insulation shop has 60 to 80 employees working primarily aboard ship applying insulation containing asbestos to the steam power plants. Five employees, averaging 15 years exposure, have retired on disability compensation due to asbestosis. One employee, after 10 years employment as a pipecoverer and insulator, received disability compensation for seven years prior to his death in 1962. Extensive physical examinations and autopsy reports leave no doubt his death was due to asbestosis. He worked mostly on farms and in restaurants before his employment in the shipyard and denied any previous employment in a dusty trade.

Breathing asbestos fibers, usually over a period exceeding 10 years, causes this insidious industrial disease.[1,2,3] A non-productive cough and progressive shortness of breath that can lead to disability are the most striking symptoms.[4,5]

This report covers: (a) material used, (b) working environment, (c) fiber counts, (d) x-ray findings, (e) discussion, and (f) summary.

Material

Asbestos is a commercial name applied to several varieties of fibrous minerals. These varieties are two distinct mineral groups, serpentine and amphibole, that differ considerably in composition and physical properties.[6] Chrysotile, the fibrous form of serpentine, comes from Canada and constitutes about 95% of the total world production of asbestos. It is a magnesium silicate with iron, nickel, manganese, or aluminum often replacing part of the magnesium. The fibrous form of amphibole has four principal varieties, amosite, anthophyllite, tremolite, and crocidolite. These four are various silicates of iron, calcium, magnesium, and sodium.

The replacement of one element by another in varying proportions is a unique characteristic of asbestos causing a change in its physical properties. For example, machinery crushes chrysotile into fine soft silky-feeling fibers which are strong, flexible and can be woven into cloth. Amosite, which comes from South Africa, has long coarse fibers suitable for a blanket-type of insulation material. Amosite has been used in large quantities on naval ships since before World War II. Other than amosite, the amphibole mineral type of asbestos is weak and brittle.

Most authorities believe that all types of asbestos can cause asbestosis.[7] Medical science has not conducted sufficient research to determine the possible different effects of the mineral or which variety is the most hazardous.

Employees in the insulation trade also use fiberglass, magnesia, diatomaceous earth, and other inert substances that can complicate air sampling and the exposure hazard. Shipboard insulators use about ten different types of insulation material containing different varieties and a varying quantity of asbestos. Table I gives a list of material used in shipboard insulation and its composition. The table also shows the percentage of time the employee works with the material and his exposure in millions of particles per cubic foot.

TABLE I
Materials and Exposures in Shipboard Insulation Jobs

Material (Used aboard ship by pipecoverers and insulators)	Percentage of working time aboard ship (with each material)	Exposure Concentrations (length of exposure time varies from minutes to hours)		
		particle range in microns		fiber range in microns
		2-5	5-10	5-60
		mppcf	mppcf	mppcf
1. 100% Amosite asbestos blanket				
Installing	rarely		Installed damp	
Removing	3.0	1.4-3.0	1.6-2.0	0.5-8.0
2. 85% Magnesia and 15% amosite asbestos blocks and pipe sections				
Installing	38.0	1.4-6.0	0.1-0.4	0.1-1.8
Removing	1.5	0.8-10	0.7-2.0	tr.-1-2
3. Calcium silicate and 10% amosite asbestos blocks and pipe sections				
Installing	42.0	0.9-2.8	0.2-3.0	trace
Removing	2.0	0.4-1.7	0.4-0.9	trace
4. 100% Chrysotile asbestos filler and binder				
Installing	1.5	mixed as cement	and applied wet	
Removing	0.5	0.9-4.9	0.9-1.6	trace
5. 15% Chrysotile and 85% rock wool filler and binder				
Installing	1.5	mixed as cement	and applied wet	
Removing	0.5	0.8-4.7	0.7-1.7	trace
6. 80-95% Chrysotile asbestos cloth				
Installing	8.0	0.3-1.8	0.2-1.4	trace
Removing	0.5	0.2-1.9	0.5-2.0	trace
7. Fiberglass				
Installing	1.0			
Removing	rarely			

Working Environment

These employees, known as pipecoverers and insulators, face a potential exposure to asbestos fibers in the insulation shop and on board ship.

Employees in the shop make pads shaped like small pillows for easy installation and removal from shipboard fittings, control valves, and pipe joints. A bolt of asbestos cloth is on a roller at the end of the layout and cutting table. Directly over the bolt a water spray system allows water to dampen the cloth as an employee draws it on the table. The employee measures and marks the material into appropriate sizes and cuts it with a rotary electric hand cutter. Another worker then stitches the cloth on a power sewing machine and passes it to another table where fiberglass is cut to size and stuffed into the opening. Finally, an employee closes the pad by sewing, trims it with a power cutter, and attaches rings to aid in the installation aboard ship. The cloth remains damp during the work process making dust control methods relatively easy in the shop. General exhaust ventilation operates continually, assisted by large doors and windows allowing for cross-ventilation.

Aboard ship pipecoverers and insulators perform a great variety of installations in most compartments, especially in the fire-rooms and engine-rooms. Several of these tasks are shown in Figures 1, 2 and 3. These men wire insulation block and insulation pipe sections in position around machinery and pipe. They make the surface smooth first by mudding with 85% magnesia plaster and then wrapping with asbestos cloth glued in position with a fire retarding waterproof adhesive. The amosite blanket, rarely used now, was generally used rather than preformed blocks and pipe sections until 1962. Employees apply rock wool mud to this amosite blanket followed by portland cement and

FIGURE 1. Removing insulation during overhaul.

asbestos cloth to form a smooth finish. They apply glass sheets to ventilation ducts and wrap it with fiberglass or asbestos cloth. These men wrap fiberglass around fittings, control valves, and pipe joints, then attach the pads from the shop into position.

During ship overhaul, repair, and remodernization, pipecoverers and insulators remove all the various types of insulation they have applied. As shown in Table I, this small portion of time spent in removing excessively dry insulation gives a high exposure to asbestos dust.

Adequate ventilation for pipecovers and insulators is rarely possible with our present ventilating system, which consists of 3,600 cfm exhaust fans with connections for four 5-inch flexible ducts. These portable exhaust fans are usually placed on the main deck and the ducts routed into the work area. The flow at each exhaust-duct entrance varies from 800 to 1500 lfm depending on the distance from the exhaust fan to the work process. This present exhaust system designed especially for welding and burning work is not adequate for our pipecoverers and insulators because their work processes and work positions vary.

Dust control by use of water during shipboard work appears to be practical only during application of amosite, a material seldom applied in our shipyard because of the excessive dust it causes during removal. The best protection for these employees is to avoid careless creation of dusty conditions by the use of damp material when possible, and the wearing of dust respirators constantly.

FIGURE 2. Applying filler and binder.

FIGURE 3. Sawing pipe sections.

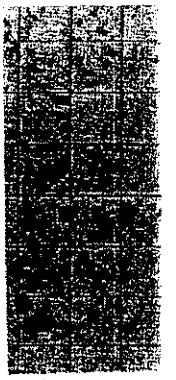

FIGURE 4 taken during i 20 microns.

Fiber Counts

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FIGURE 4. Photomicrograph of dust sample taken during insulation removal. Small squares are 20 microns.

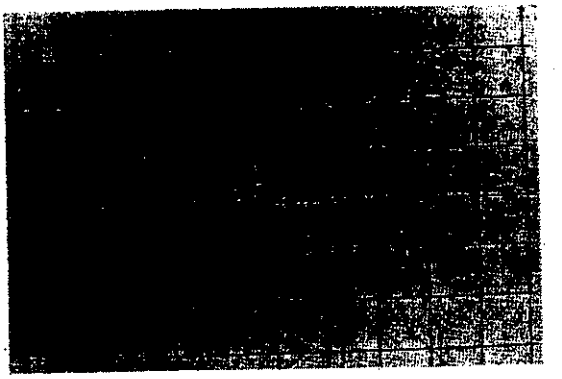

FIGURE 5. Photomicrograph of dust sample taken during application of insulation blocks.

Fiber Counts

There are no established figures for a maximum allowable concentration of asbestos fibers in pipe covering operations or for short duration massive exposures. Because study in a textile mill in 1938 found no cases of asbestosis where the count by impinger light field was below 5 mppcf, this figure became the recommended maximum allowable concentration.[8] An asbestos operation in Canada has had no new cases of asbestosis in 15 years where the particle count is below 1 mppcf for dust below 10 microns.[9] One U. S. industry uses 5 mppcf below 10 microns and 1 mppcf above 10 microns as their MAC.[10]

Pathologists find fibers exceeding 400 microns in lungs during autopsy.[11] These long fibers do not settle in air as rapidly as spherical particles. They are less than one micron in thickness and their needle-like form allows them to stand on end and work down into the lungs.

The Saranac Laboratory experiments by animal exposure to asbestos indicated that asbestosis is a mechanical rather than a chemical action.[12] The researchers also considered fibers greater than 10 microns the most harmful. This is not in agreement with recent studies in South Africa where authorities consider fibers less than 5 microns the most harmful.[13]

Dust counts, taken with the Bausch and Lomb Dust Counter, appear in Table I. The low counts on sampling do not appear to give an adequate indication of the actual hazard. During sawing of blocks and pipe sections and removal of old insulation, the work environment appears extremely dusty. Respirator filters often clog after an hour's work removing insulation.

Fibers from 3 to 60 microns in length received special attention during this study (Figures 4 and 5). If fibers were present but count revealed less than one mppcf, they appear in Table I as a trace.

X-Ray Findings

It is common practice for industrial hygienists to use information from periodic physicals to assure themselves that exposure controls are adequate. X-ray examinations on new employees in asbestos are not of value for this assurance; on the contrary, this information can be extremely misleading as it usually takes a minimum of seven years exposure for cases of asbestosis to develop.[14,15,16] It also appears that some people are susceptible while others escape harm during the same exposure.[17]

A medical team surveyed five shipyards in 1945 to investigate the health hazard due to insulation work.[18] Only three cases of asbestosis appeared in 1074 x-ray examinations. These three employees had worked in asbestos material for more than 20 years. Insulation material and work methods have remained essentially the same since that study. The greatest change, starting right after the war, is the removal of insulation during overhaul and repair. Many of our employees

now have over 20 years in the insulation trade in contrast to the survey in 1945 where only 51 of the 1074 employees had over 10 years experience in insulation work.

Discussion

The world's consumption of asbestos has increased from 500,000 tons in 1942 to 2,400,000 tons in 1961.[20] Recent studies recognize asbestosis as a serious health hazard.[20,21,22]

Asbestos exposure during shipboard insulation differs from exposure in mining and manufacturing processes of this material. In these industries employees usually continue at one job with the same material and their exposure is relatively constant. This is not true for shipboard insulation where the pipecoverers and insulators work location, work position, and material constantly change. Under these conditions it is impossible to determine the exposure of the employee without spending hours in observation and sampling. Samples taken as in Table I are only bases for discussion concerning their exposure.

We do not know whether our cases of asbestosis came from massive exposure during removal of old insulation or from many years of exposure by susceptible individuals during all types of insulation work.

Summary

The Long Beach Naval Shipyard has several men on disability compensation and one death due to asbestosis. Many of these employees have more than 20 years' experience as pipecoverers and insulators working primarily aboard ship.

Asbestos exposure during ship overhaul and repair varies extensively giving an entirely different problem from exposure in mining and manufacturing operations. The maximum allowable concentration for pipe covering operations or for short duration massive exposures is unknown. There still remains a difference of opinion among medical authorities on a MAC and the effects of long-fiber and short-fiber asbestos. Chest x-ray examinations of employees exposed to asbestos can be misleading as it usually takes a minimum of seven years for cases of asbestosis to develop. Shipboard pipecovering and insulating during overhaul and repair is a hazardous trade. Employees in this trade should wear respirators when exposed to dry insulation material containing asbestos.

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