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UNITED STATES MARITIME COMMISSION
REGIONAL CONSTRUCTION OFFICE
EAST COAST
[illegible] BUILDING, [illegible] STREET
PHILADELPHIA 2, PA.

21 September 1945

From: Dr. Philip Drinker
Chief Health Consultant
U. S. Maritime Commission

To: Bureau of Ships
Att: Admiral Mills

Reference (a) Letter from BuShips to [illegible] 26 February 1943 Section [illegible], [illegible], Subject: Industrial Health and Safety - Survey concerning Asbestosis

Enclosure (A) 2 copies of a Health Survey of Pipe Covering Operations in Constructing Naval Vessels

1. Enclosure (1) contains the results of the study authorized by the Bureau of Ships in Reference (b) and is forwarded for your consideration. As you will note from the data and conclusions, only 5 men out of 1076 showed any lung changes. All three had worked over twenty years at the trade. In our opinion this work as found in our Navy yards is most unlikely to cause ill health and we believe it would be well to publish a revision of this report in an appropriate medical journal.

2. We suggest, therefore, that you authorize us to revise the report with names and identity of shipyards deleted if you [illegible] submit it to you and to the Bureau of Medicine and Surgery for approval and then publish it appropriately.

3. We suggest also that copy of the enclosure, part (3), of the present report be given to your own Division of Insurance [illegible] Insurance division of the Maritime Commission. Both are concerned with possible damage suits from workers in shipyards.

9240389-A

[illegible]

cc: Capt. Barton, Bureau of Medicine and Surgery
Dr. Drury, Maritime Commission

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A HEALTH SURVEY OF PIPE COVERING OPERATIONS IN CONSTRUCTING NAVAL VESSELS

by

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An industrial health inspection of an important Navy Contract Yard, the Bath Iron Works [1] of Bath, Maine indicated that dustiness from miscellaneous pipe covering operations was considerable and a few of the employees had what appeared to be asbestosis. This is a well-known industrial disease caused by only one thing—prolonged breathing of asbestos dust. The clinical manifestations are shortness of breath and an unusual chest picture by x-ray. In industry the disease is often disabling, but it is much less frequent than silicosis, with which it very properly is classed.

It was not felt that experience in a single yard was enough to justify any general statements on working conditions in other yards, and certainly was no cause for alarm, but the results warranted check-ups elsewhere. Accordingly, at the direction of the Bureau of Ships [2] arrangements were made to examine by chest x-ray the pipe coverers in two Navy Yards, Boston and Brooklyn, and two contract yards, Bethlehem Fore River and New York Shipbuilding Corporation. Permission was obtained to use dust exposure data from the U. S. Navy Yard, Portsmouth, N. H. Examinations were made of the working conditions including dust counts of the air breathed and microscopic and chemical analysis of the dust itself.

We would point out that this procedure is the customary one in making dust surveys of occupational diseases—medical examination of the workers and a study of the nature and concentration of the contaminants in the air breathed. This report is a digest of our findings.

History of Amosite

Amosite, a magnesium iron silicate of variable composition, is the generic name for an asbestos fibre mined in Rhodesia, South Africa.

The obvious reasons for the wide use of amosite felt and pipe covering in naval work are its low thermal conductivity, light weight, strength and refractoriness. When the felt and pipe covering were first developed, we were still building vessels under the Washington Treaty of Limitations in Tonnage, and every pound saved meant that much more armor, guns or ammunition for a given displacement, to say nothing of more economic operation for the weight involved in insulation. Amosite pipe covering weighs about 14 pounds per cubic foot, with a temperature limit of 750°, as compared to magnesia with a weight of 16 pounds per cubic foot, with a temperature limit of 600°. High temperature amosite pipe covering weighs about 18 pounds per cubic foot as compared to 25 pounds per cubic foot for other high temperature insulations. Because of the lower conductivity and the higher temperature limit of the amosite type, less of it need be used in a combination covering than other types of insulations.

The development of amosite felt started in 1934 when a need existed to secure a thermal insulation lighter in weight and thermally more efficient than the materials (blocks and cement or asbestos blankets) which were then being used on destroyer turbines. The Navy approved the type developed by a manufacturer in September 1934. Originally amosite was used only for turbin

nsulation, but it proved so satisfactory that its field of application larged to include insulation of valves, fittings, flanges, etc. From the initial destroyer, it has been used on almost all the destroyers built since that time and on all other combat vessels built since before the War.

Pipe covering was a later development in late 1935 and early 1936. Due to the manufacturing problems involved, it took a longer time to evolve into a satisfactory shape, and its first use on naval vessels was in 1937. Since that time its use has spread markedly and it was used on the great majority of naval combat vessels built during the War.

Water-repellent amosite felt was developed during the early part of 1942, as a replacement for hair felt in the insulation of cold water lines to prevent sweating. Hair felt had the disadvantage of being combustible and as it was organic, when it became wet it moulded or rotted and could harbor vermin. At this time fires on board certain naval vessels convinced the Navy of the desirability of eliminating any combustible material from on board ship. Eventually a type was developed in strips of 60 foot lengths and of suitable width to enclose the circumference of the type and enclosed in an extremely light-weight muslin to provide handling ability and reduce the dust, which the water-repellent agent made more prominent than in other amosite products.

I. Description of Operations and Working Environment

Asbestosis results from breathing asbestos fibers of relatively long length, such as 15 to 75 microns. It is not caused by breathing chopped up asbestos fibers of one or two microns as has been very clearly demonstrated by Dr. L. U. Gardner (3) of the Saranac Laboratories. Therefore we are concerned with the presence in air of asbestos fibers which can be seen as such under low power of the ordinary microscope.

But the clinical picture can easily be complicated by the presence of diatomaceous earth, a form of amorphous silica, which can cause silicosis and is probably a more serious health risk than asbestos.

Another dust which may be present is magnesia, MgO, which is in very common use as a heat insulator and is harmless.

Therefore our analyses, Section IV, are done to indicate how much fibrous type of asbestos dust is present in the air breathed, how much silica is present (especially as diatomaceous earth), and how much of the harmless ingredients like iron oxide and carbonates.

There are frequent references in this report to the use of "approved respirators." The approval is given by the U. S. Bureau of Mines for industrial dust respirators which are intended to be worn under just such conditions as those we depict to protect the wearer against inhaling harmful quantities of dusts such as asbestos and silica. Respirators are never popular with workmen because if they are effective they always offer a slight resistance to breathing. But they do prevent dust inhalation and they can be and actually are used in preventing dust inhalation in many plants today. Both Navy and Maritime Commission have approved the use of dust respirators for special jobs in shipyards.

Pipe covering may be divided into seven different operations as follows:

1. Laying out and cutting
2. Band saw cutting
3. Sewing and preparation of boots and jackets
4. Cement mixing
5. Molding
6. Grinding
7. Installation on board ship

1. Laying out and cutting

Rolls of asbestos insulating felt are unwrapped and unrolled on a large layout table or on the floor of the shop. This material, with the exception of the type known as water repellant amosite, is then well wetted with a water spray. The material is marked into measured sections and cut with a rotary electric hand saw. The cut sections are rolled up and either used or stacked in the storeroom.

Usually one to three workers are employed at this operation. During the handling, unwrapping and unrolling of the asbestos, considerable dust arises but appears to settle readily. A very fine water spray should be used for wetting down the material as a high velocity spray will stir up dust. Once wetted the handling and cutting of the material gives rise to little visible dust. All of the yards wet down the asbestos as described above.

The Brooklyn Navy Yard has an elaborate exhaust system for the layout table. The entire top of this table is covered with small perforations through which the air is exhausted. This table is sufficiently large that no more than two-thirds of the top is ever covered with material and room air is thereby

exhausted through the other third. While no velocity or capacity measurements were made on this system, data presented later in the report indicate that this control measure had a marked effect in reducing the dust count.

2. Band saw cutting

A standard band saw such as is found in woodworking shops is used to cut asbestos insulation blocks and boards into desired shapes. This operation gives rise to large amounts of air-borne dust, most of which settles slowly. Normally there is only one worker on this operation at any one time.

Inasmuch as this is a very dusty operation, the band saw should be enclosed in a room by itself and should be equipped with adequate local exhaust ventilation both above and below the saw table. Because of the mechanical difficulties in locating this exhaust properly, some of the dust will escape into the air and the operator should therefore wear an approved dust respirator.

3. Sewing and preparation of boots and jackets

In this operation jacket covers for valves and pipe joints are fabricated. The work consists of cutting asbestos cloth with shears, padding the jackets with amosite or other insulating material, and sewing with wire or asbestos cord. These operations give rise to only slight amounts of visible dust and exhaust ventilation and respiratory protection are neither required nor used. There is usually a large number of workers doing this operation in one large room.

4. Cement mixing

For protection and to give a neat appearance the insulation on boilers is usually covered with cement containing a high percentage of asbestos fibers. In mixing, the proper amount of water is added to the dry asbestos cement and thoroughly agitated with a hoe. Occasionally small amounts of asbestos cement are mixed in a pail with a trowel. Considerable dust is raised when the asbestos

cement is dumped into the mixing trough and during the early stages of mixing. Ordinarily this process is done in a separate room and only one operator is exposed. The dustiness of this operation warrants the use of exhaust ventilation or respiratory protection or both, although neither is generally used.

Petrographic analyses of asbestos cement indicate that the amount of diatomaceous earth may be as high as 87% by count.

5. Molding

Molding is the process of building up asbestos insulation to fit odd shapes of boilerwork and piping. A form is made to the exact shape of the machinery to be insulated. Block insulation is laid on, adjoining sections glued together, exposed surfaces sealed with asbestos cement and the whole mold covered with asbestos cloth. When dry, the molded insulation can be lifted off the form and is ready to be installed on board ship. This operation is usually done in the shop next to the sawing operation. Very little dust is produced from this operation and no special ventilation or respiratory protection is required.

6. Grinding

Several shipyards reclaim their scrap pieces of prefabricated sections of asbestos insulation by grinding up this material and using it in the asbestos cement, all of which contributes considerable dustiness. Normally this job is done at infrequent intervals and only one or two men are exposed, but the operation should be isolated, general room exhaust supplied and approved dust respirator worn by the operator.

7. Installation of pipe covering on board ship

There are a number of operations involved in pipe covering on board ship. Amosite felt is wrapped and pounded tightly around large pipes and joints and fastened firmly in place with wire or asbestos cord. Pipes and boilers are

covered with prefabricated sections, which necessitates some hand sawing to fit the sections. Ready mixed cement is applied to fill in spaces and give a smoother finish. Some insulation is wrapped with glass cloth or asbestos cloth for greater strength. The only operations that produce much dust are the wrapping and pounding of amosite and the sawing of sections.

Nearly all of the compartments on board ship are involved in this work, although most of it is concentrated in the machinery spaces. Usually the greater number of pipe coverers work on board ship and relatively few men in the shop. The spacing of workers ranges from one or two men doing a small job in a living space to as many as twenty or thirty men working on ten or more jobs in the engine room. Temporary exhaust ventilation is seldom used on board ship for pipe covering and very few of the workers wear respirators.

Because of the varied nature of pipe covering operations in ship compartments, general exhaust ventilation is to be preferred. If the compartment is large, such as the main engine room, five air changes per hour are needed. In small compartments, such as living spaces, ten to fifteen air changes per hour are required.

II. Materials Used

A. Amount

A tremendous amount of asbestos insulation is used on modern naval ships. To give a general idea of the increase in asbestos pipe covering operations on major naval ships in recent years, Table I was compiled. The table starts with 1932 since high percentage asbestos insulation came into use at that time. The table covers only new construction although several yards did considerable repair work which included pipe covering. Since the dates given in the table are those of commissioning, the pipe covering work preceded these dates by one or two years. The listings for 1943 and 1944 are probably not complete and some of the listings for these years were estimated from the dates of launching. The information in this table was taken from "The Ships and Aircraft of the U. S. Fleet" by James C. Fahey. (5)

In Table 2 is given a summary of the amounts of asbestos insulation materials used in each of the shipyards during an average month.

TABLE I

YEAR	BOSTON NAVY YARD	BROOKLYN NAVY YARD	PORTSMOUTH NAVY YARD	NEW YORK SHIPBUILDING	BETHLEHEM FORE RIVER
			1 Submarine	1 Cruiser H	
1933			1 "		1 Cruiser H
1934		1 Cruiser H		1 " H	1 Destroyer
1935	2 Destroyers	2 Destroyers	2 "		
1936	2 "		1 "	3 Destroyers	1 Cruiser H 4 Destroyers
1937	2 "	1 Cruiser L	6 "	1 "	1 Cruiser H 2 Destroyers
1938		1 "	1 "	3 Cruisers L	
1939		1 "			
1940	6 Destroyers		2 "		1 Carrier 2 Destroyers
1941	2 "	1 Battleship	3 "		
1942	8 "		8 "	1 Battleship 4 Cruisers L	1 Battleship 2 Cruisers L 6 Destroyers
1943	3 " 25 Destroyer Escorts	1 "	3 "	3 Carriers L 1 Cruiser L	3 Carriers 4 Cruisers H 1 Cruiser L 12 Destroyer Escorts
1944	6 Destroyers	1 " 2 Carriers	3 "	1 Carrier L 2 Cruisers H	1 Carrier 1 Cruiser H 2 Cruisers L

H denotes Heavy L denotes Light

TABLE 2. SUMMARY OF MATERIALS USED AT EACH YARD PER MONTH

	New York Ship	Fore River	Brooklyn	Portsmouth	Boston
Amosite	40,000 sq. ft.	6,325 sq. ft.	50,000 sq. ft.	2,000 sq. ft.	58,200 sq. ft.
Amosite (water-repellent)	-	3,300 sq. ft.	15,000 sq. ft.	-	-
Prefabricated Sections (molded and block)	1,750 sq. ft. 18,800 linear ft.	15,700 linear ft.	1,200 sq. ft. 115,000 linear ft.	250 sq. ft.	600 sq. ft. 89,900 linear ft.
Asbestos cloth	34,700 sq. ft.	40,000 sq. ft.	106,600 sq. ft.	-	76,500 sq. ft.
Metallic Twine Asbestos Yarn	-	-	150 lb.	-	-
Asbestos paper	4,000 sq. ft.	5,500 sq. ft.	5,500 sq. ft.	-	-
Asbestos board	150 sq. ft.	-	6,000 sq. ft.	-	2,700 linear ft
Asbestos cement	57,500 lb.	38,500 lb.	15,000 lb.	120 lb.	34,400 lb.

B. Composition of Materials Used

According to Navy Specification 32 F 3, the rovings of asbestos insulating felt (amosite) shall contain not less than 95% asbestos fibre of the following composition:

Silica (SiO_2) percent minimum.....47.5

Iron oxide (Fe_2O_3) percent maximum.....45.0

Magnesium oxide (MgO) percent minimum....6.0

Typical analysis of the two types of asbestos fibres in general use are tabulated below:

	Chrysotile	Amosite
Silica (SiO_2)	39.05%	50.24%
Magnesia (MgO)	40.07%	3.96%
Alumina (Al_2O_3)	3.67%	
Ferric oxide (Fe_2O_3)	2.41%	7.80%
Ferrous oxide (FeO)		32.00%
Sodium oxide (Na_2O)		2.12%
Combined water (H_2O)	14.43%	3.00%

Therefore amosite alone will not comply with Navy Specifications because of the low magnesia content and must be mixed with chrysotile asbestos to equal or exceed the 6.0% minimum value for magnesia. On the other hand, chrysotile cannot be used alone because of its silica content which is below the minimum 47.5% specified by the Navy. The two types of asbestos fibres must be mixed together in the proper proportions to satisfy the values set

for magnesia and silica. The amounts of these materials used to form this mixture therefore would be 6 - 43% chrysotile asbestos and 94 - 57% amosite asbestos.

Those two fibres differ mainly in their physical characteristics. Chrysotile is capable of being readily separated into very fine fibres with a soft silky feel, whereas amosite is harsher and requires more manipulation to fiberize it. One authority has stated that the chrysotile has the finest individual fibres, and amosite the coarsest. Because of this difference we may suspect a decided decrease in the number of respirable fibres (below 300 microns in length and 5 microns in diameter) whenever amosite is used in preference to chrysotile asbestos.

III. Pipe Covering Facilities at Individual Shipyards

A. U. S. Navy Yard, Brooklyn, N. Y.

There are 50 men working in the shop and 700 men on board ship. The shop is divided into four main rooms: Layout, Sewing, Cement, and Storage and Band saw combined. With the exception of the Cement Room, the doors between these rooms are normally left open.

The work in the Sewing Room consists mostly of fabricating and sewing valve boots and jackets. All the cement used on board ship is mixed in the Cement Room. There is no exhaust ventilation for either the Sewing or Cement Room. The bandsaw is equipped with a flexible exhaust tube above the table and an exhaust around the blade below the saw table. The layout table is equipped with exhaust ventilation as described above. There is no exhaust ventilation supplied on board ship for pipe covering and no workers were found wearing respirators.

B. U. S. Navy Yard, Boston, Mass.

There are 84 men working in the shop and 467 men on board ship. The shop is divided into two rooms, one of which is primarily for storage and occasional grinding and band saw cutting operations. The only mechanical exhaust ventilation in the shop is provided for the grinding, mixing and band saw cutting operations and is inadequate. In the other room layout, cutting and sewing are done with a small amount of space for storage. Cross draft ventilation is provided by open windows on both sides of the room.

Work on board ship is not supplied with exhaust ventilation.

No asbestos workers were found wearing respirators.

C. U. S. Navy Yard, Portsmouth, N. H.

There are 5 men in the shop and 35 men working on board ship. The shop consists of one large layout room with two smaller cubicles, one for sewing and one for cutting and issue, separated from the main layout room by chicken wire partitions. A small exhaust hood is used in the layout room to exhaust cork cementing operations only. All other ventilation is natural draft. There is a small room in another building where band saw operations are done. The band saw operator is the only worker wearing a respirator. Most of the asbestos insulation is kept in a stock room in a third building.

D. Bethlehem Steel Co., Fore River Yard, Quincy, Mass.

There are 8 men in the shop and 160 men working on board ship. Pipe covering operations are done in two shops. In the main one, boots and jackets for pipe valves and connections are fabricated and surplus material is stored. In the smaller shop, layout and cutting of amosite, water repellent amosite and fire felt is done. There is no exhaust ventilation in either shop nor for the pipe covering operation on board ship. All the asbestos cement is mixed in a compartment on board ship. The only worker who wears an approved dust respirator is the man who cuts the two types of amosite. There is no band saw cutting of asbestos in this yard.

E. New York Shipbuilding Corp., Camden, N. J.

There are 51 men working in the shop and 123 on board ship. Layout, cutting and cement mixing are done at one end of the shop. Dust respirators are occasionally worn during these procedures. At the other end of the shop

the fabrication of boots, jackets and molds are done. A small amount of such fabrication is done on board ship.

Material is cut with a band saw in a separate room and the operator wears an approved dust respirator. The dust from this saw is exhausted through a slot under the table which catches only a part of the dust given off above the table.

There is no exhaust ventilation in the shop, other than for the band saw, and none for the pipe covering operations on board ship. All floors, walls and rafters of the shop are cleaned at frequent intervals with an industrial vacuum cleaner. Most pipe covering on board ship is applied in the evening during the second shift.

IV. Analyses of Settled Dust and Dust Counts

There are no established figures for permissible or safe dustiness in pipe covering operations. Dreessen et al [4] in their comprehensive study of asbestosis in the asbestos textile industry suggest 5 million particles of total dust as a threshold for that industry. We should like to point out that the asbestos textile and asbestos pipe covering industries differ widely in their hazards of dust exposure. In textile plants workers usually continue at specific jobs with fairly constant dust exposures for some years, whereas the pipe coverer may rotate between shop and ship and from small to large ship compartments with a wide variation in dust exposure.

In contrast to the textile worker, the pipe coverer's materials differ markedly in their asbestos content, ranging from 85% magnesia (10-15% asbestos) to amosite (95% asbestos). When asbestos cements contain large amounts of diatomaceous earth there is a resultant silicosis hazard as indicated above.

In general we feel that dust counts below 5 million particles per cubic foot by Konimeter indicate good dust control.

Our figures in Table 3 were determined by the Konimeter and not with the impinger instrument which is commonly used in studies of silicosis risks. We used the Konimeter because it is light, easily portable and takes records which can be kept indefinitely. As is indicated in Table 4, the dustiest operations are band saw cutting, cement mixing, and installation on board ship.

TABLE 3. ANALYSIS OF SETTLED DUST AND AIR SAMPLES

NOTE:
MPPCF = Million particles of dust per cubic foot of air.

OPERATION	Percent less than 10 microns by count	Asbestos (below 200 microns)	Percent less than 10 microns by count						Dust Counts (MPPCF)					
										Total Dust		Asbestos Dust		
Layout and Cutting	Percent less than 10 microns by count	Asbestos (below 200 microns)	Diatomaceous Earth	Serpentine	Other Fibres (Organic & glass)	Iron oxide (Opaque)	Carbonates and oxides	Others	Number of samples	Range of Counts	Average	Range of Counts	Average	Percent Asbestos (Range)
Boston	96	18	6	12	6	24	26	10	2	3.5 - 8.7	6.1	0.21 - 0.50	0.35	8.7 - 6.
Brooklyn	98	10	8	12	tr	40	18	12	7	1.6 - 6.8	4.2	0.01 - 0.54	0.23	0.6 - 7.
Portsmouth	98	9	tr	9	tr	38	28	16	84	0.9 - 10.7	7.1	0.06 - 4.0	2.3	7.5 - 6
Pore River	96	26	8	8	tr	72	31	10	5	6.5 - 18.5	10.9	0.06 - 1.18	0.65	1.4 - 3.
Sample from top of table	95	10	42	8	tr	18	14	10						
New York Ship.	95	30	5	10	tr	26	14	15	4	17.1 - 25.2	20.6	1.13 - 4.30	2.18	6.6 - 1
Cutting with Band saw														
Boston									2	11.0 - 19.2	15.1	0.10 - 0.14	0.12	0.7 - 0.
Brooklyn	98	9	7	8	tr	48	16	12	2	32.4 - 46.6	39.5	2.8 - 3.2	3.0	6.0 - 8.
Portsmouth	98	4	5	5	tr	8	51	24	24	1.2 - 30.0	13.1	0 - 2.5	1.1	0 - 4
New York Ship	98	9	63	2	tr	10	4	12	3	18.2 - 100 +	73 +	.9 - 12.8	6.19	4.3 - 1
Welding Operations														
New York Ship	98	8	66	3	tr	7	0	10						
Fore River	96	4	9	7	tr	48	10	12						

TABLE 3. (Sheet 2) ANALYSES OF SETTLED DUST AND AIR SAMPLES

NOTE:

= Million particles
st per cubic foot of

OPERATION	Percent less than 10 microns by count	Asbestos (below 200 microns	Percent less than 10 microns by count: Diatomaceous Earth	Serpentine	Other Fibres (Organic & glass)	Iron Oxide (Opaque)	Carbonates and oxides	Others	Number of Samples	Dust Counts (MPPCF): Total Dust Range of Counts	Total Dust Average	Asbestos Dust Range of Counts	Asbestos Dust Average	Percent Asbestos (Range)
A Area of Docks & Jackets														
klyn (Sewing asbestos cloth)	98	12	tr	9	tr	42	21	16	3	3.3-6.9	4.8	0.0-0.4	0.1	0-6.4
(Stuffing with Amosite)	98	8	8	11	tr	38	20	15	1	2.1	2.1	0	0	0
tsmouth	98	6	tr	5	tr	42	26	21	12	2.7-8.2	5.4	.2-.5	.35	6-7
e River	98	6	6	8	tr	38	28	14	5	3.9-10.9	6.0	0 -.05	.03	0-0.5
York Ship.	95	26	6	11	3	28	12	14	2	10.6-12.3	11.4	.46-.78	.62	3.7-7.4
ton									2	3.6-6.1	4.8	.01-.05	0.03	0.3-1.0
room														
tsmouth (Stockroom)	98	10	8	6	tr	31	27	19						
(Issue Room)	98	4	2	6	tr	45	28	15						
e River	95	15	8	7	tr	26	32	12						
t Mixing														
ton									16	6.4-90 f	31 f	0 - 0.52	0.2	0 - 0.7
klyn									2	87 - 100 f	94 f	1.6-1.7	1.7	1.4 - 2.5
e River (On board ship)									5	19.6-40.0	32	0 - .02	.01	0 - .001
York Ship.									2	33.8-43.7	41.3	1.6 - 4.7	3.1	4.7 - 10.0
Area Materials														
ton	98	8	20	16	1	19	23	12	10	3.4 - 109 f	50 f	0 - 1.8	.47	0 - 2.6

TABLE 3. (Sheet 3) ANALYSES OF SETTLED DUST AND AIR SAMPLES

NOTE:
MPCF = Million particles of dust per cubic foot of air.

OPERATION General Room	Percent less than 10 microns by count	Asbestos (below 200 microns)	Percent less than 10 Microns by count: Diatomaceous Earth	Serpentine	Other Fibres (Organic & glass)	Iron oxide (Opaque)	Carbonates and oxides	Others	Number of Samples	Dust Counts (MPCF): Total Dust Range of Counts	Total Dust Average	Asbestos Dust Range of Counts	Asbestos Dust Average	Percent Asbestos (Range)
Boston									149	0.2 - 24.6	10.0	0 - 1.4	0.08	.02 - 0.3
Brooklyn									2	1.6 - 3.3	2.4	0 - .01	.01	0 - 0.6
Portsmouth									14	0.8 - 7.7	2.0	.06 - .2	.14	6.2 - 7.5
Fore River									8	3.9 - 10.9	6.0	0 - .05	.02	0 - 0.5
New York Ship.									4	9.0 - 21.6	14.2	0.34-1.7	.8	3.8 - 7.9
Aboard Ship														
Boston									30	65 - 250	142	0 - 0.17	0.02	0 - 0.03
Brooklyn									11	64.4-102.0	128	1.36-5.21	2.8	1.1 - 3.7
Portsmouth									52	5.4 - 27.0	11.9	0-0.7	0.3	0 - 3.7
Fore River									16	8.0 - 22.1	11.0	0 - 0.21	0.05	0 - 1.0
New York Ship.									15	25.3-89.0	49.2	0.25-2.38	1.10	0.5 - 6.8

TABLE 4. COMPARISON OF DUSTINESS OF VARIOUS OPERATIONS IN EACH SHIPYARD

OPERATION	BOSTON		BROOKLYN		FORE RIVER		NEW YORK SHIP.		PORTSMOUTH	
	MPPCF		MPPCF		MPPCF		MPPCF		MPPCF	
	Total Dust	Asbestos Dust	Total Dust	Asbestos Dust	Total Dust	Asbestos Dust	Total Dust	Asbestos Dust	Total Dust	Asbestos Dust
ut and Cutting	6.1	0.35	4.2	0.23	10.0	0.83	20.6	2.18	7.1	2.3
Saw Cutting	15.1	0.12	30.6	3.0	--		73.0	6.19	13.1	1.1
ng and Fabrication	4.8	0.03	4.8	0.1	6.0	0.03	11.4	0.62	6.4	0.35
nt Mixing	31.0	0.2	84.0	1.7	32.0	0.01	41.3	3.1	--	
ding	50.0	0.47	--		--		--		--	
ral Room	10.0	0.08	2.4	0.01	6.0	0.02	14.2	0.8	3.0	0.14
hop Average	30.0	0.25	26.9	1.0	7.4	0.23	32.0	2.8	6.9	1.0
ip Average	142.0	0.02	128.0	2.0	11.0	0.03	45.2	1.1	11.9	0.3

NOTE: MPPCF = Million particles of dust per cubic foot of air.

V. Medical Findings

The incidence of asbestosis among pipe coverers as determined by chest x-ray is given in Table 5. The relation between years of exposure and percent asbestosis is included in Table 6.

Due to frequent turnover of shipyard workers and the length of time required to x-ray a large number of workers, the number x-rayed may not equal the number of pipe coverers. At New York Ship. x-rays were examined of men who have left the yard while at Brooklyn a few pipe coverers were not x-rayed. At Boston the 48 x-rayed out of 551 were all older men working in the shop.

Some of these pipe coverers have had pre-shipyard experience in the asbestos industry, but the tables are based solely on shipyard exposure. At New York Ship., for example, the Asbestos Shop estimated that about one-third of their pipe coverers had worked with asbestos before coming to the yard.

The one case of advanced asbestosis at New York Ship had worked in the asbestos industry for 23 years before coming to work in the yard. At Fore River the two cases of moderate asbestosis had worked 22 years and 30 years at pipe covering in their yard.

All of the x-ray films used in the above data were first read by roentgenologists of the Medical Department at the Navy Yards, by Dr. Locke at New York Ship., and by Drs. Fred Manley and J. E. Moriarity at Fore River. In addition all of these films were examined by one of the authors (W. E. F.). Dr. W. C. Dreessen, U.S.P.H.S. was kind enough to examine the three positive plates and he agreed on the diagnosis.

Since only three workers out of the 1074 x-rayed had asbestosis, and each of the three had been a pipe coverer for more than 20 years, it would appear that asbestos pipe covering is a relatively safe occupation. However it must be remembered that these men rotated among the various operations of pipe covering and were not continually exposed to high concentrations of asbestos dust as found in band saw cutting and cement mixing. The suggestions made in Section I relative to exhaust ventilation and respiratory protection are therefore of value despite this low incidence of asbestosis.

TABLE 5. INCIDENCE OF ASBESTOSIS AMONG PIPE COVERERS

SHIPYARD	Number of Pipe Coverers	Number X-rayed	Number of Cases of Asbestosis		
			Minimal	Moderate	Advanced
Boston	551	48	0	0	0
Brooklyn	760	642	0	0	0
Fore River	168	168	0	2	0
New York Ship	174	196	0	0	1
Totals	1653	1074	0	2	1

NOTE: X-rays from the Portsmouth Navy Yard were not available.

TABLE 6. RELATIONSHIP BETWEEN LENGTH OF EXPOSURE AND INCIDENCE OF ASBESTOSIS

SHIPYARD		Years in Pipe Covering Industry			
		0 - 2	2 - 5	5 - 10	10 Plus
Boston	(Exposed	24	13	8	3
	(Affected	0	0	0	0
	(Percentage	0%	0%	0%	0%
Brooklyn	(Exposed	225	435	87	22
	(Affected	0	0	0	0
	(Percentage	0%	0%	0%	0%
Fore River	(Exposed	26	118	5	9
	(Affected	0	0	0	2
	(Percentage	0%	0%	0%	22%
New York Ship	(Exposed	0	105	45	17
	(Affected	0	0	0	1
	(Percentage	0%	0%	0%	6%

VI. Summary and Conclusions

1. The data in Tables 3 and 4 indicate that band saw cutting, cement mixing and installation on board ship are the dustiest operations.

2. The above 3 operations should be equipped with exhaust ventilation to keep the total dust concentration low. Such dust control will greatly facilitate good housekeeping in pipe covering operations.

3. The incidence of asbestosis found was low - 0.29% (3 cases out of 1074 x-rayed). Since each of these 3 men had worked at asbestos pipe covering in shipyards for more than 20 years, it may be concluded that such pipe covering is not a dangerous occupation.

4. The excellent exhaust ventilation supplied to the layout and cutting table at Brooklyn decreased markedly the dustiness of this operation.

5. Since water repellent zonolite cannot be wetted, exhaust ventilation should be supplied during laying out and cutting of this material.

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