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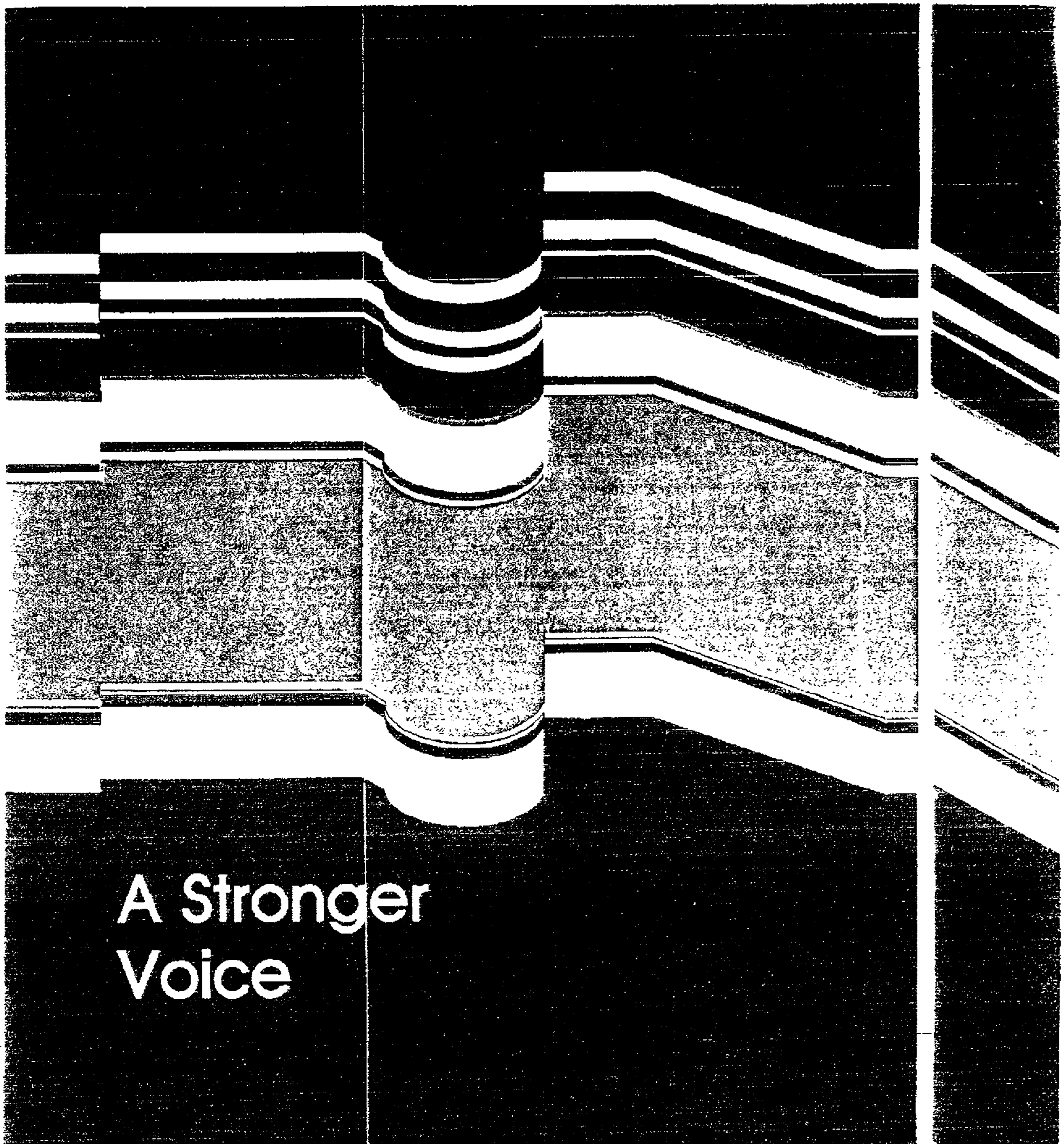

NATIONAL INSULATION CONTRACTORS ASSOCIATION

NICA

OUTLOOK

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Environmental Sciences Laboratory
MOUNT SINAI SCHOOL OF MEDICINE
of The City University of New York

INSULATION HYGIENE PROGRESS REPORTS

FROM THE INSULATION INDUSTRY HYGIENE RESEARCH PROGRAM

Irving J. Selikoff, M.D., Program Director

Vol. 6 No. 1 Spring 1975

The Asbestos Exposure of Insulation Workmen

ASBESTOS STANDARD TO BE REVIEWED

On December 7, 1971 an Asbestos Standard was promulgated that prohibited workmen's eight-hour average asbestos exposures to exceed 5 fibers per milliliter (f/ml) of air. A milliliter is about a thimbleful of air and only fibers longer than five microns (about 1/25,000 of an inch) are to be counted. This level is mandated to go to 2 f/ml during June, 1976

Last year, the U.S. Court of Appeals ordered portions of the current U.S. standard to be reviewed by the Department of Labor. Of interest to insulators, the court specifically stated that in those industries where a dust level of 2 f/ml was feasible, it should be implemented before 1976.

Because of this pending review of the standard, a summary of all research on the asbestos exposure of insulation workers has been prepared for submission to the Dept. of Labor by the Insulation Industry Hygiene Research Program. Because of the importance of achieving a safe U.S. Asbestos Standard and the interest of asbestos workers in this goal, we are publishing the full report in this issue.

Extensive information has been developed on the mortality experience of insulation workers. It would, thus, be of considerable value to have quantitative information on the asbestos dust levels to which these workers were exposed. Because of the long lapse period between exposure and clinical appearance of disease, the dust estimates of greatest concern are those of 20, 30, 40 or more years ago.

While historical data are scant and fragmentary, insulation work practices have changed relatively little, prior to 1970, either in the U.S. or abroad. Thus, measurements taken prior to 1970 will also provide data of use in assessing earlier exposure.

United States Data

The only early work of note is the 1945 study of Fleischer and his colleagues[1] who reported asbestos dust levels during insulation application in four U.S. shipyards. In this study, dust levels were assessed using a konimeter (an instrument widely used at the time but no longer employed), and both total dust levels and fiber levels were recorded. This study gains importance in that one of the yards studied by Fleischer was resurveyed during 1965 and 1966 by personnel of the Department of Industrial Hygiene, Harvard School of Public Health[2,3] and a comparison of levels is possible.

During 1964, additional data were published by Marr[4] on exposure levels at the Long Beach Naval Shipyard (Local 20, IAHFIAW). However, detailed numerical data on dust concentrations are only given for particles. If fibers were present, but the count revealed less than 1 million particles per cubic foot (mppcf), they were reported only as a trace. Thus, no average fiber concentrations can be derived from this study. (Continued on page 2

TABLE I

Shipyard asbestos fiber concentrations by Konimeter count—1945, 1965-66

Yard	A fiber conc. MPPCF	A f/ml	B fiber conc MPPCF	B f/ml	C (1945) fiber conc MPPCF	C (1945) f/ml	C (1965-66) fiber conc. MPPCF	C (1965-66) f/ml	D fiber conc MPPCF	D f/ml
Shop Activity										
No. of men exposed (1945)	84		50		51		—		8	
Layout and cutting	0.35	12.4	0.23	8.1	2.2	78	1.76	62	0.63	22
Sewing and fabrication	0.03	1.1	0.1	3.5	0.62	22	0.27	9.5	0.03	1.1
General room air	0.08	2.8	0.01	0.4	0.8	28	0.3	10.6	0.02	0.7
The following shop activities were done at infrequent intervals and involved only one or, at most, two men:										
Band saw cutting	0.12	4.2	3.0	106	6.19	218	0.7	24.7	—	—
Mixing cement	0.2	7.0	1.7	60	3.1	109	0.23	8.1	0.01	0.4
Scrap grinding	0.47	16.6	—	—	..	—	—	—	—	—
Aboard Ship										
No. of men exposed (1945)	467		700		123		—		160	
Avg. exposure, all activities	0.02	0.7	2.8	98	1.1	39	0.17	5.0	0.03	1.1
Time-Weighted Average Exposure (All fibers visible)		1.1		90		35				1.1

Average Exposures Low

1945 Results Available

Table 1 lists the fiber exposure data obtained from over 200 dust counts by Fleischer in 1945 and also those obtained by Murphy[3] during 1965 and 1966. Using data supplied on the number of individuals engaged in the various work activities, a time-weighted (actually man-weighted) average asbestos exposure is calculated.

A detailed analysis of the results, however, presents difficulties. In each yard, a worker's average exposure was dominated by insulation activities aboard ship. For such activities, the average asbestos dust levels reported in the different shipyards varied by nearly one hundred times.

It should be recognized that these fiber counts represent all fibers enumerated in the field of view of a konimeter. These would include fibers perhaps as short as 1.5 microns. Supplementary data[5] on the size distribution of amosite aerosols in shipyards suggest that this overestimates the number of fibers longer than five microns by a factor of two.

Taking this factor into account, the average of the eight-hour concentrations of fibers longer than five microns in the four U.S. shipyards studied by Fleischer in 1945 would be from 15 to 20 fibers per milliliter (f/ml). It must be emphasized, however, that such averages are highly subjective and depend strongly upon the vagaries of the particular work practices selected for sampling and conditions present at that time.

Similar considerations would yield a value of 4 f/ml for the shipyard survey by Murphy in 1965-66.

New Techniques Used

The first research that quantified asbestos insulation exposures using membrane filter techniques was that of Balzer and Cooper published in 1968[6] and extended in a report at the Dresden Conference on the Biological Effects of Asbestos in 1969.[7]

Their initial publication, however, enumerated fiber concentrations in marine and commercial insulation work in terms of all visible fibers, including those shorter than five microns. The later subsequent publication also provided data on fiber concentrations longer than five microns. Table 2 summarizes these results.

Using the information provided on dust concentrations and the percentage of time a worker is engaged in a particular practice, a time-weighted average of 2.7 f/ml was obtained for exposures during asbestos insulation work in light and heavy construction, and 6.6 f/ml in marine construction and repair.

Cooper and Balzer noted that at the time of their study, approximately 55% of the work time of insulation workers was spent using materials other than asbestos. Thus, eight-hour time-weighted average exposures for asbestos workers during 1968 in the western United States would have averaged less than 1.5 f/ml in light and heavy construction. Moreover, it is noteworthy that Cooper and Balzer state their samples were "deliberately taken under conditions where the highest dust concentrations representative of a particular job were being developed."

Union Cooperation Obtained

The environmental evaluation of insulation work that was undertaken by the Mount Sinai School of Medicine under the auspices of the Insulation Industry Hygiene Research Program[5] revealed asbestos air concentrations somewhat higher than those measured by Balzer and Cooper. Again using information supplied by union members and from observation of work practices, estimates were made of the percentage of time workmen were engaged in various activities in commercial and industrial construction.

The information on measured asbestos air concentrations obtained during these work activities is shown in Table 3. They were used as indicated to arrive at the estimated time-weighted average exposure of about 5 f/ml for insulators *when working with asbestos.*

On the average, in the eastern United

Insulation Hygiene Progress Reports

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from the

Insulation Industry Hygiene Research Program

Editor: W. J. Nicholson, Ph.D., Published at the Environmental Sciences Laboratory (Irving J. Selikoff, M.D., Director), Mount Sinai School of Medicine of the City University of New York, N.Y. 10029

PURPOSES OF THE INSULATION INDUSTRY HYGIENE RESEARCH PROGRAM

1. To develop improved methods for minimizing exposure of insulation workers to dusts and fumes encountered in their work.

2. To disseminate knowledge of these improved methods of dust control wherever they may be applied advantageously and to offer cooperation, advice and assistance toward their universal adoption.

TABLE II

Asbestos fiber concentrations by membrane filter techniques

Job Classification	Percentage of work with asbestos	Light and Heavy Industrial Fibers/cc mean		Marine Construction and Repair Fibers/cc mean	
		All Lengths	Length $> 5\mu$	All Lengths	Length $> 5\mu$
Prefabrication	10%	10.1	6.6	30.4	20.0
Application	40%	12.4	8.0	24.8	16.8
Mixing	5%	2.4	1.6	10.6	7.1
Finishing	30%	2.7	1.8	1.8	1.2
Tearing Out	10%	12.8	8.4	31.5	20.2
General	5%	0.8	.5	.2	0.1
Time-Weighted Average Exposure		4.1	2.7	9.9	6.6

IIHRP Results Reported

States during the 1960's, over half of the work activities of these men were with materials other than asbestos. Thus, the over eight-hour time-weighted average asbestos exposure was approximately 3 f/ml.

In the research that led to these data, it was reported that peak exposures could be extremely high. It was not uncommon, for example, for two to five-minute concentrations of asbestos to range between 50 f/ml and 100 f/ml during the mixing of cement. This mixing, however, would consume only a few minutes time and be done perhaps once an hour. Thus, exposures measured over that hour, including the mixing, would seldom average over 5 f/ml.

Peak High, Average Low

Similar experiences were subsequently reported by Cooper[8] at Lyon who stated that, "Peak concentrations may be high for brief periods, while time-weighted averages are often deceptively low."

In a continuation of the work of the Department of Industrial Hygiene of Harvard University in assessing asbestos exposure in Naval Shipyards, Ferris *et al*[9] reported on the results obtained by J. Lynch and W. Burgess from 81 shipyard asbestos air samples taken during 1969. Using fiber counting techniques they determined a mean asbestos concentration of 0.3 f/ml in land fabrication shops and 2.9 f/ml in shipboard installation work.

3 f/ml Exposure

Three research programs in the United States point to the conclusion that the time-weighted average exposure of insulators between 1965 and 1969 was *less than 3 fibers longer than five microns per milliliter.*

We have direct information on asbestos fiber concentrations, measured using the currently prescribed analysis procedures. during recent years only. Insulation materials have changed from earlier years. Fibrous glass has found extensive use while work with cork is seldom seen today. Moreover, changes in the asbestos composition of insulation products have taken place. Pipe covering and insulation block may have had twice the asbestos content in past years as exists today.

During this period, however, work practices were virtually identical to those of past years and during the period of those measurements, few controls of significance were in use.

Insulators Still Exposed to Asbestos

While much of new insulation material contains no asbestos, pipe-coverers may still be exposed to high asbestos concentrations during removal and demolition. In such work, safe procedures and personal protective equipment must be used. Thus, obtaining an effective and safe Asbestos Standard remains of paramount importance.

Thus, dust concentrations measured under these conditions have relevance for the estimate of levels of past years.

Considering the possible doubling of asbestos content of insulation materials and considering that workers may have used asbestos materials more often in the past than now, the data from these three studies would suggest that the upper limit on insulator's exposures in the United States during past years would be about 10 f/ml.

British Data

At the Devonport Naval Dockyard in Plymouth, England, extensive measurements of asbestos dust concentrations during the application and removal of insulation aboard ship have been reported by Harries.[10] These are listed in Table 4. During the application of insulation material, fiber concentrations from 2.1 to 22.4 f/ml were found, not unlike those found in U.S. studies.

However, during the removal of pipe and machinery insulation, mean dust concentration in various compartments ranged from 88 to 257 f/ml, and in the removal of sprayed crocidolite asbestos, fiber concentrations ranged from 20 to 500 f/ml, with short-term breathing zone samples showing concentrations exceeding 1000 f/ml. Moreover, the spread of asbestos from the site of removal can be extensive. Concentrations of 30 f/ml were found at hatchway openings to decks from the area of crocidolite stripping.

High Dust During Ripout

Additionally, short-term fiber concentrations measured during the variety of specific application and removal techniques are reported. High levels, exceeding 200 f/ml, occurred while mixing asbestos cement. The cleaning of debris (155 f/ml) and the sawing (55 f/ml), fitting (43 f/ml), or removing (52 f/ml) of calcium silicate sections also produced high dust concentrations.

A subsequent publication by Harries[11] of long-term area sampling in var-

TABLE III

Asbestos concentrations during various work practices

Type of Work	Measured Fiber Concentration (f/ml) (greater than 5 microns)	Percentage of Time Practice Occurs When Asbestos is Used	Column One times Column Two
Mixing and Applying Cement and Cloth Covering to Insulation Material			
Good Ventilation	2.5	17.5	44
Poor Ventilation	4.6	17.5	81
Cutting and Applying Insulation Block or Sections of Pipe Covering			
Good Ventilation	5.2	20	104
Poor Ventilation	11.5	20	230
Pre-Fabrication work including Cutting Materials for later use	7.6	10	76
			535

Time-weighted average = 535/85 = 6.3 f/ml

The above practices, which occupy 85% of the work time in asbestos insulation work, give rise to a time-weighted average exposure of 6.3 f/ml. As the majority of the other activities of insulation work (supervision, collection of materials, movement and installation of equipment, etc.) are relatively clean, the overall exposure may be lower. (In the U.S., sweeping and dusty cleanup are done by members of the Laborers Union.)

In a review of work activities in commercial and industrial construction, it was found that little removal of insulation was conducted and asbestos spray applications were very rarely undertaken by insulators. (Asbestos workers applied spray insulations only to powerhouse turbines.) It is estimated that less than two or three percent of nonmarine insulation work by members of the Asbestos Workers Union is in these continuously dusty operations. Even if average exposures here were 50 f/ml and the men wore no respirators, their overall average exposure would be increased only to 7 f/ml when working with asbestos.

Adequacy of Standard Questioned

ious circumstances indicated a mean concentration of 226 f/ml during the removal of spray; of 152 f/ml during the removal of pipe insulation; and of 8.9 f/ml during the application of pipe lagging.

As with the Mount Sinai research and the Balzer-Cooper study, short-term dust concentrations during specific insulation practices can be extremely high, while samples taken over long periods of time yield concentrations that are relatively low when compared with current and past asbestos standards.

Summary

Studies on asbestos concentrations from 1965 through 1971 by five different research groups in two countries are summarized in Table 5, along with estimates made of earlier insulation asbestos exposures. They indicate that recent average exposures of insulation workers to asbestos are from 3 to 9 f/ml when working with asbestos.

As asbestos workers in the United States in the period these measurements were taken used asbestos materials in their work less than 50% of the time, their eight-hour average exposure to asbestos was less than 3 f/ml. It is noteworthy that these exposures existed prior to the implementation of the current 5 f/ml standards in the U.S. As extensive substitution of non-asbestos materials has subsequently taken place in insulation work, current exposures are now considerably lower.

The estimate of from 10 to 15 f/ml obtained for past exposures in non-marine insulations work does not offer much confidence that 5 f/ml, or even 2 f/ml, is sufficient to protect asbestos workmen. Forty percent of insulators' deaths can be attributed to their past occupational exposure to asbestos at such levels. A standard set at two, or even five times lower, is unlikely to offer significant protection to asbestos workmen.

Asbestos Workers Have High Peak but Low Average Asbestos Exposures

The high peak exposures of asbestos workers measured by different groups can be deceptive. These often are of short term and may involve few men. Average exposures have universally been found to be low, usually less than current standards. This result leads to two conclusions: 1) Current standards may be inadequate to protect workers, and 2) Easily accomplished control of peak exposures can significantly reduce the long-term average exposures.

TABLE IV

Asbestos dust concentrations during the fabrication, application and removal of insulation materials

Location	General Atmosphere			Breathing Zone		
	No. of samples	Mean fibers/cm³	Range	No. of samples	Mean fibers/cm³	Range
Application of pipe and machinery insulation:						
Boiler rooms	17	22.4	1-61	14	15.8	0.1-68
Engine rooms	28	2.1	0.1-14	16	7.3	0.04-40
Accumulator room	5	16.5	2.5-46	17	9.6	1-47
Mattress fabrication:						
Old shop	12	12.7	0-126	15	1.5	0-7
New shop	11	16.3	2-83	25	3.7	0-17
Removal of pipe and machinery insulation:						
Boiler room	153	171	0.04-1062	20	97	25-220
Engine room	45	88	0.16-3021	25	91	2-490
Brick stowage space	13	257	9-592	—	—	—
Removal of asbestos acoustic panels.	6	413.5	30-684	6	131	48-271

TABLE V

Summary of average asbestos air concentrations during insulation work

Research Group	Average Fiber Concentration: Light and Heavy Construction	Average Fiber Concentration: Marine Work
Mount Sinai (IIHRP)	6.3	
Balzer-Cooper	2.7	6.6
Murphy, Harvard		8.0*
Burgess-Lynch		2.9
Harries		8.8
Estimates of early exposures		
Fleischer		15-20
Mount Sinai	10-15	

These concentrations were those measured or estimated for workers while using asbestos. Eight-hour average exposures, considering the use of other materials, would be as little as half the above values.

*Fiber count includes all visible fibers

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