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THE ACTUAL OCCUPATIONAL EXPOSURE TO AIRBORNE ASBESTOS RELEASED BY GARLOCK SPIRAL WOUND, BRAIDED, AND ENCAPSULATED GASKETS

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ABSTRACT

Spiral wound, braided, or encapsulated asbestos materials manufactured by Garlock release negligible amounts of asbestos fibers during storage, handling, installation and removal.

This study commissioned by Garlock Inc. shows that when these gasket materials are handled and processed in a contamination-free environment the fibers released to the work atmosphere is 1/500th of the current allowable exposure of 2 fibers/cubic centimeter, greater than 5 um in diameter for an eight hour time-weighted average work day (7,8,9). The measured release of fibers is less than the levels of exposures experienced daily by city dwellers (23), and many times less than that experienced in downtown city streets on dry summer days (24).

The ambient release of asbestos fibers from other sources in industrial areas, asbestos-laden clothing, and general atmospheric pollution provide the major occupational exposure to workers, and far exceeds any contribution from these types of gasket materials. Therefore, the actual contribution of these Garlock asbestos gasket constitute a negligible exposure and risk to workers. The amount of fibers released is so low that it is easily obscured by other asbestos products, or contamination sources, and borders on the lower limit of detection by phase contrast microscopy.

DISCLAIMER

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I.

HISTORY

Asbestos is one of the most widely used industrial minerals appearing in more than 3,000 manufactured goods in the United States. About 3,000,000 tons have been used in construction and manufacturing since 1900. Millions of Americans are exposed occupationally, from enviromental levels near industries and in cities, and from soil and water high in asbestos content. Therefore, most Americans receive a regular low-level exposure to asbestos from a variety of sources in their lifetime.

Until about 1964 (1,2) when the real signs of asbestos-related cancers began to shape thinking about occupational exposures to asbestos, high level exposures to workers were allowed because standards were based on the etiology of asbestosis, not cancer. Many of those exposures were uncontrolled based on known work practices, and poor control programs.

Because of this little attention was given to products like asbestos gaskets that obviously produced only negligible contributions to the overall occupational exposure of workers. The pioneer work begun at Puget Sound Naval Shipyard (PSNS) in 1965 culminating in a conclusive report by Mangold, Beckett and Bessmer in 1970 (3,4) ignored low level exposure products or processes. Most of the attention was directed toward products

and operations producing high-level exposures to asbestos workers and associated trades.

When the high-level exposures occurred during uncontrolled work situations, or even at the allowable exposure level of 5,000,000 particles per cubic foot of air (50 fiber/cc) (4,5) which was the recommended threshhold limit valves at that time the contributions from encapsulated gaskets were negligible. Also, the extremely low-level contributions from gasket materials was obscured by high background contamination levels from other asbestos products.

Attention is now given to lower levels of asbestos exposure, and so it is informative to examine the actual contributions of each asbestos product.

In 1978, the Department of Navy evaluated asbestos exposures to workers storing, handling and processing asbestos gasket materials of all kinds in naval shipyards (6). The report concludes that even the simplest of general housekeeping controls or work practices are sufficient to maintain occupational exposures below the current federal standard of 2 fibers/cc greater than 5um in diameter for an eight-hour time-weighted average work day. In fact, many of the exposures were found to be less than .01 fibers/cc which is negligible.

II.

BACKGROUND

In 1976, the Federal Standard, 29 CFR 1910.1001 - Asbestos, limited the occupational exposure to 2 fibers/cc, greater than 5um in diameter as collected on a membrane filter at 2 liters per minute and counted by phase contrast microscopy at 400x for any eight-hour time-weighted average work day (7, 8, 9). The standard allows excursions of 10 fibers/cc for any 15-minute period during the same work day. Interpretations of paragraph (j) of the Federal Standard requires medical examination and serveillance of workers when the eight-hour TWA exposure reaches 0.1 f/cc (7).

Th current Federal Standard is a marked reduction over the threshold limit value (TLV) of 5 mppcf (50 fibers/cc) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) which existed from 1946 until 1969, when it was reduced to 2 mppcf. In 1972, the Federal Standard became 5 fibers/cc. reducing to 2 fibers/cc in 1976 (10). Thus, the current Federal Standard requires evaluation of exposures using personal samples and phase contrast microscopy that approaches the lower limit of detection of the analytical method, within reasonable statistical limits.

R. D. Zumwalde and J. M. Dement (11) observe that 0.1 fibers/cc, greater than 5 micrometers in diamter is the lower limit of detection that may be used with any reliability.

Therefore, rigorous procedures must be followed to avoid large errors and the effects of contamination when evaluating low-level contributions of products like encapsulated gasket materials.

III.

INTRODUCTION

In order to determine the actual contribution of airborne asbestos fibers to the occupational exposure of workers from spiral wound and encapsulated gasket materials, Garlock Inc. commissioned a study that would require accurate and precise measurement in the absence of asbestos contamination from other products. Without such attention the results would be skewed upward from:

(1) General atmospheric pollution;

(2) Redispersion of fallen asbestos in work areas;

(3) Sources of asbestos dust from adjacent operations; and

(4) Contaminated work clothing.

The National Institute for Occupational Health (NIOSH), Revised Recommended Asbestos Standard of 1976 (13) shows that even under the most optimum conditions the lower limits of detection of the sampling and analytical method ranges from .04 fibers/cc for a 15-minute period to .001 fibers/cc for an eight-hour work day. Regardless of its limitations, phase contrast microscopy is the only reasonable technique available

for routine asbestos counting, and is the only method that relates to the Federal Standard (7, 10, 13, 14, 15, 16, 17). However, the system fails due to large random and systematic errors when attempts are made to report a net fiber count of one (1) fiber/100 Porton retical microscope fields. Therefore, there is no justification for sampling or considering periods less than the eight-hour time-weighted average because of the effects on the lower limit of detection, and because such values do not relate to the Federal Standard which is based on the eight-hour time-weighted average (13).

Consideration must be given to the environmental conditions and the rate of ventilation because tiny fibers of asbestos remain airborne indefinitely under conditions of turbulence (10, 12, 13, 14, 18). This is an important consideration in assessing the actual contribution of spiral wound, braided, or encapsulated gasket materials known to emit few fibers to the atmosphere.

IV.

EXPERIMENTAL DESIGN

In order to meet the technical requirements previously stated, an experimental design was developed to simulate the actual eight-hour time-weighted average exposures to the Garlock (Guardian spiral wound, Styles 733 and 5862 braided and Styles 10PZ10, and LOK Gard encapsulated) gasket materials.

An enclosure measuring 10'x10'x10' (1,000 cubic feet) was constructed of PVC plastic piping and .004 inch polyethylene plastic including the floor in which to conduct the evaluations. This type of enclosure was selected because it represents the smallest practical size of small work spaces, ships compartments, or tanks, voids, or machinery spaces where such gasket materials often were and are installed. Measuring the airborne release and the potential build-up of asbestos fibers provides practical representation of the most severe exposures expected from the use of these gasket materials.

Each type of gasket material was assembled and disassembled using valves, flanges and surfaces requiring their use. Each product was processed for eight hours on a separate day inside the sealed plastic enclosure.

A mechanic was dressed in plastic impregnated paper coveralls, head cover and booties specified for asbestos work, and which were changed each work day. The mechanic remained in the plastic enclosure for two four-hour periods separated by a one-half hour break. He was fitted with two personal samplers whose filters were positioned in the breathing zone on the left and right lapel. The cassettes holding the filters were extended from the clothing with a wire device (18) to minimize baffling effects known to cause higher collection rates, and uneven distribution of fibers on the filters (11, 13, 16, 19, 20). Each personal sampler was operated for two consecutive

four-hour periods to determine the eight-hour time-weighted average exposure.

Two other personal samplers were positioned at head height on opposite sides of the plastic enclosure and operated at four-hour consecutive periods each test day to measure the potential environmental build-up factors inside the enclosure for each of the three products tested.

This method of replication was selected because it includes but normalizes the analytical and sampling errors, while excluding the effects of contamination. The samples were collected on separate test days under separate conditions for each product to dispel any gross random or systematic error (21, 22).

Only one product type was processed each test day to assess the potential occupational exposure to any asbestos fibers released, and relate that concentration to the Federal Standard of 2 fibers/cc, greater than 5um in diameter on an eight-hour time-weighted average.

The filters were processed and counted by phase contrast microscopy at 400x according to current NIOSH methods (9) and as specified by the Federal Standard.

The lower limit of detection of the method was determined based on a minimum net count of one (1) fiber/100 Porton reticle microscope field for a four-hour sample period according to the following formula.

$$\text{Fibers/cc, greater than 5um in diameter} = \frac{\text{(Average net fiber count) (filter area)}}{\text{(microscope filed area) (Sample vol. in liters) (1,000)}}$$

$$.04 \text{ f/cc} = \frac{(.01)\ (855\ mm^2)}{(.0046 mm^2)\ (480)\ (1{,}000)}$$

For a four-hour sample

$$.04 \text{ f/cc} = \frac{1}{\text{minutes sampled}} = \frac{1}{240}$$

This lower limit of detection is established since there is no justification for attempting to determine net counts less than one (1) fiber/100 Porton reticle microscope fields (11, 13).

IV.

FINDINGS

The asbestos fibers/cc, greater than 5um in diameter based on an eight-hour time-weighted average, and as collected in the breathing zone of the mechanic inside the plastic enclosure are shown in Table I. The environmental samples collected during the same periods reflect airborne dispersion of fibers released by the process and the absence of significant build-up factors inside the sealed enclosure. Each determination represents a four-hour sample period.

Table I shows the extremely low levels of asbestos fibers captured by duplicate samples during consecutive four-hour segments in the breathing zone, and the general atmosphere

inside the enclosure. This means that few fibers are released by the Garlock spiral wound, braided, and encapsulated cloth asbestos gasket materials.

The environmental samples did not exceed the lower limit of detection of the analytical method of .004 fibers/cc, greater than 5um in diameter.

TABLE I

ACTUAL OCCUPATIONAL EXPOSURE TO
SPIRALWOUND, BRAIDED, OR ENCAPSULATED
ASBESTOS GASKETS

GARLOCK GASKETS	BZ(1)	BZ(2)	ENV(3)	ENV(4)
Type I	.005(5)	.004	.004	.004
Guardian Spiral wound metal encased	.004	.004	.004	.004
Type II	.004	.005	.004	.004
Impregnated braided Styles 5862 and 733 1/2" strand	.005	.006	.004	.004
Type III	.005	.005	.004	.004
Tackified & aluminized asbestos cloth - Styles 10PZ10, asb-lock gard	.005	.005	.004	.004

$\bar{X} = .004\bar{7}$ $\bar{X} = .004\bar{0}$

(1)(2) Represents separate samples operating in the breathing zone of the mechanic assembling/dissembling gaskets in the 1,000 cubic foot sealed enclosure with no exhaust ventilation.

(3)(4) Represents environmental samples collected on opposite sides of the enclosure during asbestos gaskets processing.

(5) .004 fibers/cc greater than 5um in diameter is the lower limit of detection for a four-hour sample.

The careful attention to cleanliness and contamination elminates this potential contamination from other sources of airborne fibers. Therefore, the values reported reflect the actual contribution of the asbestos products to the occupational exposure of a user, exclusive of the sources of contamination. The values relate to conditions that may be found in small shops or ships' compartments by using a sealed 1,000 CF enclosure to conduct the tests.

The 1981 findings of Le Moine (23) show that the general population in cities like Seattle, Washington, with good weather clearance, and relatively low atmospheric inversion factors are exposed to airborne asbestos fibers ranging from .004 fibers/cc in city streets to .03 fibers/cc in nearby industrial areas. Mangold (24) found that such exposures may be elevated during summer or dry days when most downtown construction occurs and averages .02 fibers/cc.

This study shows that the actual use of these types of gasket materials as manufactured release few asbestos fibers to the atmosphere from storage, handling, assembly, or disassembly, and at levels well below those expected in city streets on dry summer days. A review by Churg and Warnock (25) conclude that city dwellers receive a significant exposure from the general environmental contamination as determined by examination of lungs of deceased not occupationally exposed. This implies a level of exposure at which there is a negligible risk.

J. E. Craghead, et al. (26), M. R. Becklake (27) and W. J. Nicholson, et al. (28), raise reasonable questions about the validity of the probable dose-response relationshp because of latency fctors, and the ill-defined responses to low-level exposure. W. J. Nicholson further observes that the long lapse time from exposure to the onset of asbestos or asbestos-related cancers creates significant difficulties in attempting to establish a dose-response relationship, since the disease incidence is from decades past when exposures were high, and controls few.

VI.

CONCLUSIONS

A study commissioned by Garlock Inc. was devised to determine the actual contribution of Garlock spiral wound, braided or encapsulated asbestos gasket materials to the occupational exposure of a user. The evaluation was conducted inside a sealed 1,000 cubic foot plastic enclosure to limit the effects of contamination and simulate work in small shops or in ships' compartments.

The results show that the eight-hour time-weighted average exposure to airborne asbestos fibers from these products do not exceed that expected in the city streets of Seattle (23).

The eight-hour time-weighted average asbestos exposure of .004 fibers/cc is 1/500th of the current allowable occupational

exposure of 2 fibers/cc, greater than 5um in diameter. Some of the values reported for the environmental samples may even be lower than the lower limit of detection of .004 fibers/cc.

Some epidemiological data suggest there may be a small risk to health as long as there are asbestos fibers existing naturally in soil, water, and atmospheric pollution. Nevertheless, occupational exposure of 5,000,000 particles per cubic foot (50 fibers/cc) has been established since 1946 to 1969, and defined as an index based on the theory that low-level exposures may be tolerated without incurring undue risk (29). Further reductions to 2 fibers/cc in 1976 continued this concept. By comparison, the actual release of airborne fibers of asbestos from these types of Garlock gaskets that are spiralwound, braided or encapsulated presents a negligible occupational risk to users.

VII.

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