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Ms. Cynthia Weaver
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U.S. Dept. of Labor - OSHA - TS
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RECEIVED MAR 2 1 2003

Re: Regulatory Opinion
Asbestos Regulations [29CFR1910.26 (G) (vi)]

Dear Ms. Weaver:

In the course of our business we have been asked to look at the application of 29CFR 1910.26 (g)(vi) to gaskets and packings containing more than 1% asbestos and have "Asbestos fibers... modified by a bonding agent, coating, binder or other material...".

I conducted a search of the scientific literature and have conducted a study of gaskets and packings which was published in the November 2002 American Industrial Hygiene Association Journal. My article, a copy of which is attached, also critiques other literature on the subject.

My study correlates well with other competently conducted, published and unpublished studies of gaskets and packings. The range of concentrations on a 8-hour time weighted average (TWA) for the ten tests of five activities documented total fiber release under worst case scenarios as follows:

Test Cycle Description	8-hr TWA SAMPLING DATA ANALYSIS		
	Sample Type	Maximum (Total f/cc)	Minimum (Total f/cc)
Industrial #1 - Flat blade scraping	Personal	0.035	0.028
Industrial #2 - Hand wire brushing	Personal	0.007	0.005
Industrial #3 - Power wire brushing	Personal	0.023	0.021
Industrial #4 - Making gaskets with a ball peen hammer	Personal	0.052	0.038
Industrial #5 - Stem packing removal and replacement	Personal	0.027	0.024
Maritime #6 - Flat blade scraping	Personal	0.019	0.014
Maritime #7 - Hand wire brushing	Personal	0.004	0.000
Maritime #8 - Power wire brushing	Personal	0.010	0.008
Maritime #9 - Making gaskets with a ball peen hammer	Personal	0.029	0.022
Maritime #10 - Stem packing removal and replacement	Personal	0.010	0.008

Given these findings, I would appreciate OSHA's opinion as to whether or not gaskets and packings require labeling per 29CFR1910.26 (g)(vi).

Sincerely,

Frederick W. Boelter, CIH, PE

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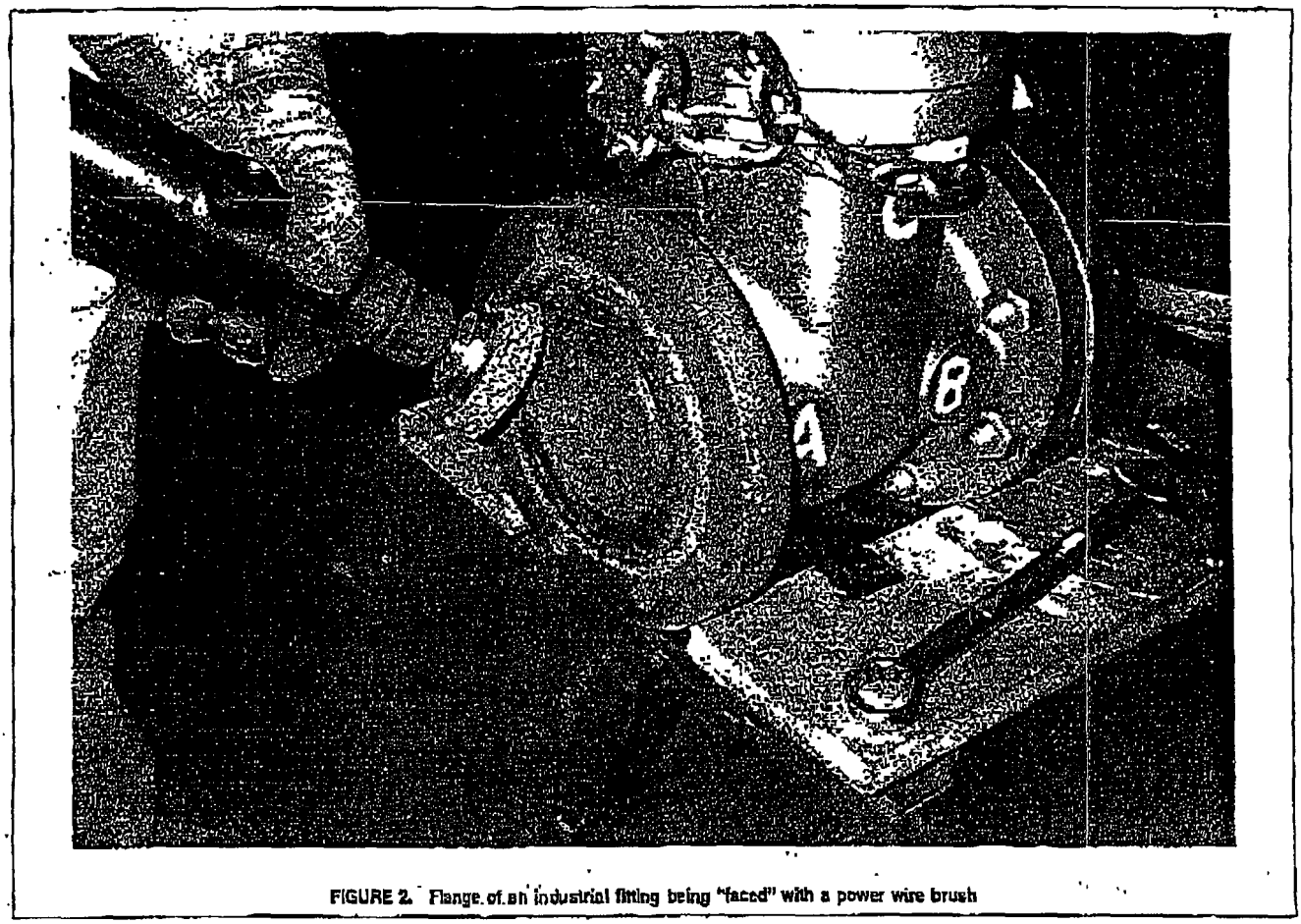


FIGURE 2. Flange of an industrial fitting being "faced" with a power wire brush

asbestos-containing and elastomeric (i.e., flexible) were used in the study. During each cycle event this was determined visually when the flange was actually opened, as shown in Figure 3. Gaskets that were not elastomeric (i.e., spiral wound metal) were rejected, and another fitting was selected for that event cycle. The necessity to reject a fitting occurred only three times in the course of the 48 event cycles when a gasket was being removed. All of the gasket and packing material removed was fibrous. All materials were retained and tested to verify asbestos content. When old gasket material was determined to contain asbestos, content ranged from 40 to 80% chrysotile. There were no crocidolite gaskets encountered.

The gasket-making sampling and event cycles were conducted identically to the methods used in the gasket removal and flange "facing" tests except that a new gasket was made. A fitting was selected that had been "faced" in a previous gasket removal test. New 1/16" thick Garlock 900 gasketing, which contains 60 to 80% chrysotile asbestos, was obtained and used for the event cycles. The 16 new gaskets were made using a ball-peen hammer, as shown in Figure 4.

The packing removal and replacement sampling and event cycles were conducted identically to the methods used in the gasket removal and flange "facing" tests except the valve stem packing was being removed and replaced. Removal and replacement of the stem packing for a particular fitting occurred during the same cycle (Garlock Sealing Technologies, Palmyra, N.Y.). A valve was selected and the old packing was removed (see Figure 5) and the stems were repacked with new asbestos-containing packing material. The old packing material was all fibrous, and when it contained asbestos, it varied from 40 to 80% chrysotile. The "new" asbestos-containing packing material used for the event cycles was from unused new old stock (NOS). This material was Garlock style 733, which is a graphite impregnated 80% chrysotile square braided packing. The 16 valves were packed using new valve packing tools purchased from a catalog.

Personal samples were collected using OSHA monitoring methods in accordance with good industrial hygiene practice.[21] Personal samples were collected from the breathing zones of the two individuals performing the work for the duration of the 8-hour test cycle. Samples were collected and analyzed by PCM following OSHA ID-160, which is essentially the same as NIOSH method 7400, A Rules.[7] To eliminate variability, analysis was performed by the same analyst at the same laboratory accredited for PCM analysis by the American Industrial Hygiene Association. Personal air samplers were started at the beginning of the 8-hour test cycle and were stopped only during the lunch break.

To determine the general room air concentration, the isolation chamber was subdivided into 3600 modules of 1 ft^2 each, and each module was assigned a discrete consecutive number for purposes of identification. For each cycle a random number generator was used to select 8 of the modules for sampling. A sample cassette was located in the center of the randomly selected module for the duration of the cycle, and samples were collected and analyzed

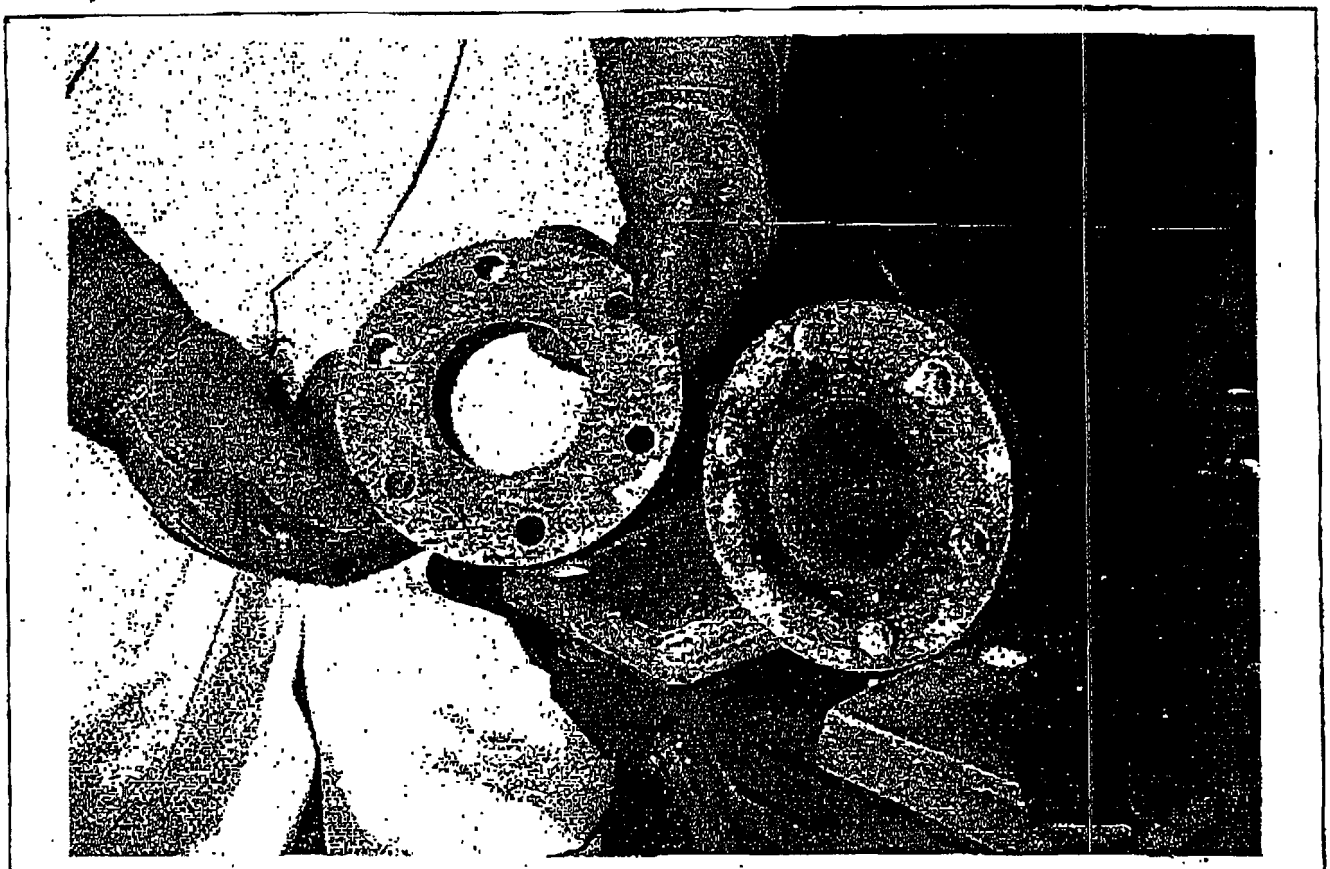


FIGURE 3. After opening the flange, the gasket was first verified as an elastomeric style.

following NIOSH method 7400, A Rules. General room air samplers were started at the beginning and were run during the entire 8-hour test cycle.

Prior to each test cycle the room was verified to be "clean" following "aggressive air" clearance monitoring protocols using a leaf blower and fans. The room cleanliness was verified as <70 s/mm² by collecting five air samples inside the chamber and analyzing them according to EPA AHERA, Appendix A, Post-Abatement Clearance TEM protocol.[12] To eliminate variability, analysis was performed by the same analyst at the same laboratory accredited for TEM analysis by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP).

When possible prior to selecting a particular fitting for study, the presence of asbestos in the gaskets was verified; however, this was not possible to determine for every fitting. Because it was important to maintain the integrity of the gasket to flange face, a small pinch of gasket material was removed from the flange face gap without opening the flange. After the gasket removal cycle was completed, the removed gasket material was reserved, and a larger bulk sample was collected and analyzed. In addition to the old removed gasket material, bulk samples of the new gasket material used in the cycles in which a ball-peen hammer was used to make gaskets were collected and analyzed. Bulk samples were analyzed by polarized light microscopy (PLM) following EPA AHERA, Appendix E.[11] Analysis was performed by a laboratory accredited for PLM analysis by NIST under NVLAP.

Sampling results were formatted in a database for analysis. Statistical functions were performed including maximum, mean, minimum, and standard deviation. Additionally, collateral information was recorded in the database related to variable factors such as type of gasket, composition of the gasket, percentage of gasket adhering to a flange surface, gasket surface area, and minutes elapsed for removal.

RESULTS

A database of some 20 factors was developed to record variables related to each of the eight fittings used in the six gasket removal testing cycles. These factors included, for example, type of material (full-face gasket, ring gasket, partial-face gasket, or packing), composition of the gasket when asbestos-containing (40 to 80% chrysotile); percentage of gasket adhering to a flange surface (0 to 100%); condition of gasket (poor to excellent); gasket surface area (6 to 60 in²); and minutes elapsed for removal (1 to 24 min).

A database of some five factors was developed to record variables related to each of the eight valves used in the two packing removal testing cycles. These factors included, for example, shaft outside diameter (0.56 to 1.625 inches), packing housing outside diameter (1.25 to 2.625 inches), packing depth (0.31 to 1.875 inches), and minutes elapsed for removal (5 to 26 min).



FIGURE 4. Punching bolt holes in a gasket made using a ball-peen hammer

Not surprisingly, a variety of gasket conditions were encountered, ranging from tightly adhered gaskets to loosely adhered gaskets. Of the 48 flanges, and therefore 96 flange faces, that were cleaned by either putty knife, hand wire brushing, or power wire brushing, only 1 flange face did not require any removal of residual gasket material. This happened to be related to a fitting during an industrial fitting putty knife test cycle. The other 95 flange faces had some material adhering to a flange face that required removal by the method being studied. Twenty-one flange faces were estimated to have 50% or more of the face covered with residual requiring removal.

Personal samples during the testing of "industrial fittings" ranged from 0.005 to 0.052 f/cc. The mean of the personal samples of the five "industrial" cycles was 0.026 f/cc. Standard deviations ranged from 0.001 to 0.008 f/cc. Table I shows the personal air sample results for the five test cycles in which industrial fittings were used.

Room air samples during the testing of industrial fittings ranged from 0.005 to 0.048 f/cc. The mean of the room air samples of the five industrial cycles was 0.023 f/cc. Standard deviations ranged from 0.001 to 0.006 f/cc. Table I shows the room air sample results for the five test cycles in which industrial fittings were used.

In test cycle 1, "industrial flat blade scraping," seven of the eight fittings used contained an asbestos gasket. The average of the personal samples was 0.031 f/cc, and the average of the area samples was 0.026 f/cc. In test cycle 2, "industrial hand wire brushing," eight of the eight fittings used contained an asbestos gasket. The average of the personal samples was 0.006 f/cc, and the average of the area samples was 0.008 f/cc. In test cycle 3, "industrial power wire brushing," five of the eight fittings used contained an asbestos gasket. The average of the personal samples was 0.022 f/cc, and the average of the area samples was 0.017 f/cc. In test cycle 4, "industrial making gaskets with a ball peen hammer," eight of the eight fittings used had an asbestos gasket made. The average of the personal samples was 0.045 f/cc, and the average of the area samples was 0.040 f/cc. In test cycle 5, "industrial stem packing removal and replacement," eight of the eight valves used contained asbestos packing, and all were replaced with asbestos stem packing. The average of the personal samples was 0.026 f/cc, and the average of the area samples was 0.023 f/cc.

Personal samples during the testing of "maritime fittings" ranged from 0.000 to 0.029 f/cc. The mean of the personal samples of the five maritime cycles was 0.013 f/cc. Standard deviations ranged from 0.001 to 0.003 f/cc. Table I shows the personal air sample results for the five test cycles in which maritime fittings were used.

Room air samples during the testing of maritime fittings ranged from 0.001 to 0.025 f/cc. The mean of the room air samples of the five maritime cycles was 0.012 f/cc. Standard deviations ranged from 0.001 to 0.003 f/cc. Table I shows the room air sample results for the five test cycles in which maritime fittings were used.

In test cycle 6, "maritime flat blade scraping," eight of the



FIGURE 5. Digging out the stem packing after a hook did not work.

eight fittings used contained an asbestos gasket. The average of the personal samples was 0.017 f/cc, and the average of the area samples was 0.017 f/cc. In test cycle 7, "maritime hand wire brushing," four of the eight fittings used contained an asbestos gasket. The average of the personal samples was 0.002 f/cc, and the average of the area samples was 0.002 f/cc. In test cycle 8, "maritime power wire brushing," eight of the eight fittings used contained an asbestos gasket. The average of the personal samples was 0.009 f/cc, and the average of the area samples was 0.011 f/cc. In test cycle 9, "maritime making gaskets with a ball peen hammer," eight of the eight fittings used had an asbestos gasket made. The average of the personal samples was 0.026 f/cc, and the average of the area samples was 0.021 f/cc. In test cycle 10, "maritime stem packing removal and replacement," six of the eight valves used contained asbestos packing, and all were replaced with asbestos stem packing. The average of the personal samples was 0.009 f/cc, and the average of the area samples was 0.008 f/cc.

In summary, all 48 gaskets removed were elastomeric and fibrous, and 40 of them were determined to be asbestos-containing. All 16 of the gaskets made using a ball-peen hammer were made from asbestos-containing sheet stock. All 16 packings that were removed were impregnated and fibrous, and 14 of them were determined to be asbestos-containing. All 16 of the packings that were replaced were from NOS asbestos-containing packing.

DISCUSSION

The air sampling results from both the five industrial test cycles and the five maritime test cycles were not significantly different

TABLE I. Ten Test Cycle Sampling Results

Test Cycle Description	Sample Type	Sampling Data Analysis: No. Samples	Maximum (f/cc)	Mean (f/cc)	Minimum (f/cc)	Standard Deviation
Industrial #1—Flat blade scraping	personal	2	0.035		0.028	
	room air	8	0.034	0.026	0.020	0.004
Industrial #2—Hand wire brushing	personal	2	0.007		0.005	
	room air	8	0.010	0.008	0.005	0.002
Industrial #3—Power wire brushing	personal	2	0.023		0.021	
	room air	8	0.020	0.017	0.015	0.001
Industrial #4—Making gaskets with a ball-peen hammer	personal	2	0.052		0.038	
	room air	8	0.048	0.040	0.030	0.006
Industrial #5—Stem packing removal and replacement	personal	2	0.027		0.024	
	room air	8	0.031	0.023	0.018	0.003
Maritime #6—Flat blade scraping	personal	2	0.019		0.014	
	room air	8	0.020	0.017	0.014	0.002
Maritime #7—Hand wire brushing	personal	2	0.004		0.000	
	room air	8	0.004	0.002	0.001	0.001
Maritime #8—Power wire brushing	personal	2	0.010		0.008	
	room air	8	0.014	0.011	0.008	0.002
Maritime #9—Making gaskets with a ball-peen hammer	personal	2	0.029		0.022	
	room air	8	0.025	0.021	0.017	0.003
Maritime #10—Stem packing removal and replacement	personal	2	0.010		0.008	
	room air	8	0.011	0.008	0.004	0.002
Sample totals	personal	20				
	room air	80				

from each other. This was true for the personal samples as well as for the room air samples. Sample results for the 10 test cycles are shown in Table I.

The results of the 80 area samples and 20 personal samples indicate that no single sample ever exceeded the 8-hour TWA PEL of 0.1 f/cc and that only 1 personal sample (at 0.052 f/cc) ever exceeded half of this value. An upper confidence limit of all the personal samples was calculated to be 0.069 f/cc.[22] Therefore, based on these findings, it is unlikely that exposures would ever approach the PEL while these types of activities were performed, even when they were performed dry.

All samples were analyzed by direct preparation in accordance with NIOSH 7400. Because it was assumed all detected fibers were asbestos, it was not necessary to subsequently analyze these samples by TEM utilizing NIOSH 7402. Had definitive fiber identification been performed, it would have been incorrect to use a TEM method other than NIOSH 7402, because methodologies such as EPA's AHERA or Yamate protocol, as well as ISO, have no relationship with the epidemiologically derived fibers per cubic centimeter exposure standards based on the PCM. It would further be incorrect to compare the TEM unit of "structures/cubic centimeter" against the 0.1 f/cc allowable limits that are to be determined by PCM.

Intuitively, one would expect greater variation based on type of activity or asbestos content. For example, it would be reasonable to expect the airborne fiber concentrations to be greater for power wire brushing (industrial, 0.022 f/cc; maritime, 0.009 f/cc) than they would be for flat blade scraping (industrial, 0.031 f/cc; maritime, 0.017 f/cc). One would also expect that an activity that was literally identical between the industrial (0.045 f/cc) and maritime (0.026 f/cc) test cycles, namely that of making a gasket with a ball-peen hammer, would yield more similar numbers results because it was the same hammer, same sheet material, similarly clean flange faces, and same people doing the work in a cleanroom.

The numerical results would appear to show some differences. But analysis of the database did not yield any significant correlation between the air sample results and the multitude of recorded variables, including whether the material contained asbestos. One reason was that few fibers were detected on the filters, so a variation of a few fibers counted made a significant difference in the reported value. Further, all fibers were being counted as asbestos whether they were or were not asbestos.

Also, the room air sample results were not significantly different from the personal air sample results for each of the test cycles. This was not surprising, because there was no ventilation in the room during testing, and over an 8-hour period it is reasonable to expect the personal samples would reflect the general air quality in a room with no ventilation.

The results of this carefully controlled study are consistent with other published studies in which the sampling and analytical methods are believed to have been properly followed for comparison against the OSHA 8-hour TWA allowable exposure. For example, the results for dry scraping and power sanding reported by Cheng et al. calculate as 0.03 and 0.07 f/cc on an 8-hour TWA, respectively. The results for production removal of hard-to-remove plate (sheet) gasketing reported by Spence et al. are shown to range between nondetection and 0.005 asbestos f/mL on an 8-hour TWA. Also, the results for installation and removal of sheet gaskets as reported by Liukonen et al. show averages ranging from 0.03 to 0.09 f/cc. All of these studies were conducted in actual workplace situations where there were other fiber influences.

CONCLUSIONS

This exposure assessment showed that the rate of fiber release for old and new elastomeric asbestos-containing gaskets and impregnated asbestos packing materials are insignificant even when the materials are manipulated dry. Although there is some quantified total fiber exposure during the activities typically performed by workers while using elastomeric asbestos-containing

gaskets and impregnated asbestos packing materials, all sample results showed the airborne concentrations of fibers to be well below the current OSHA PEL of 0.1 f/cc as sampled over an 8-hour TWA period. This is regardless of the activity being conducted and whether the activity was removal of an old elastomeric gasket or impregnated packing material or replacement with new elastomeric gasket or impregnated packing material.

The study methods controlled for potential interference that could impact analytical confidence at the very low fiber concentrations related to gasket and packing activities. The study methods also yield a high degree of confidence that the fiber concentrations reported are those resulting from the respective gasket or packing removal or replacement activity. Further, the results were obtained using tools and techniques as well as traditional worker methods with only dry materials, dry removal, and dry replacement techniques under conditions of no ventilation in a contained room. The results of this simulation, therefore, represent worst case conditions and are likely higher than those that would be experienced in actual working conditions out of doors or in ventilated spaces if interfering fiber sources could be eliminated from those settings.

These findings are useful for exposure assessments and dose reconstructions related to historical activities and to current activities in which dry methods are used.

ACKNOWLEDGMENTS

Thanks is extended to Central Illinois Light Co. for access to their decommissioned R.S. Wallace powerhouse, which allowed the opportunity to obtain intact industrial fittings for use in the study. And also, thanks to the U.S. Navy for the intact maritime fittings that came from either the decommissioned destroyers U.S.S. Davis, U.S.S. Ricketts, or U.S.S. King.

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