THE ACTUAL CONTRIBUTION OF AIRBORNE ASBESTOS FIBERS FROM REMOVAL AND INSTALLATION OF ASBESTOS PACKING FROM VALVES

CARL A. MANGOLD

CERTIFIED INDUSTRIAL HYGIENIST

ENVIRONMENTAL CONTROL SCIENCES, INC.

BELLEVUE, WASHINGTON, 98008

AND

ROBERT L. GAY, PhD

CONSULTANT

2505 N.W. 83rd PLACE

PORTLAND, OREGON, 97229

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ABSTRACT

Asbestos packing in the form of round or square material of various sizes is fitted around the stem of steam and water valves. The packing is compressed with a gland nut to squeeze against the stem and form a seal. The stem can be turned to open or close the valve, yet the packing around the stem keeps a seal, thus preventing leaks. When valves are serviced, overhauled, or if leaks develop the valve packing is removed and new materials installed. This can be done in shops or with the valve in place.

When the asbestos packing was removed, and new materials were installed there would be a potential for the release of some asbestos fibers into the air at the point of work. The amounts of asbestos released to the breathing zone of the worker and surrounding work area was negligible because of the encapsulated nature of the packing, the small amount of packing involved, the short period of time required to process the material, and the infrequent nature of the changes. The valve packings are removed and reinstalled only when there is a requirement such as a leak, or a major valve overhaul.

Because the release potential from asbestos packing is so low, any other asbestos contamination in the area, such as piping insulation, would obscure any attempts at actual measurement of the contribution from the packings alone. And,

the measurements must reflect the 8 hour time-weighted average in order to compare to the Federal or State standards for asbestos exposure.

Several dozen medium sized (3 inch pipe diameter or larger) valves were obtained that still contained the old packings for examination. They were cleaned of any outer surface contamination for testing in a clean enclosure measuring 20 feet x 20 feet x 10 feet high with no ventilation. The old packing was removed from each of eight of the valves followed by replacement with new Garlock, Inc. valve packing using traditional methods.

Air samples were collected in the breathing zone of the operators, Carl A. Mangold, CIH, and Robert L. Gay, PhD who processed the valves. Environmental air samples were collected at points of the compass at 5 feet and 10 feet away from the operators to estimate by-stander exposures of persons who may be nearby when such packing changes occur. At each environmental sample station, a pair of samples were collected at head height (one for phase contrast microscopy [PCM], and one for transmission electron microscopy [TEM], during the continuous removal and installation processes at the center of the room.

The results showed that the PCM breathing zone concentration averaged .014 fibers/cc for Mr. Mangold, and .009 fibers/cc for Dr. Gay at the work bench which represents an 8 hour time weighted average exposure.

The average of the PCM concentrations at the 4 points of

the compass 5 feet from the work bench was .005 fibers/cc.

The average of the PCM concentrations at the 4 points of the compass 10 feet away was .004 fibers/cc.

The scanning transmission electron microscopy results for fibers greater than 5 micrometers in length at the points 5 feet from the work table was .008 fibers/cc, and at 10 feet away averaged .009 fibers/cc.

The results show remarkably good agreement, and are uniformly low even when old packing is removed from the valve stem, and new packing cut and inserted during the test for one valve after another involving eight valves.

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit defined in the Federal standard for asbestos (29 CFR 1926.58, 20 June 1986) is .2 fibers/cc, > 5 um in length, at a 3:1 aspect ratio using phase contract microscopy at 400X, for an 8 hour time-weighted average work day. A 1988 amendment (September 14, 1988) allows a peak exposure of 1 fiber/cc for any 30 minute period during a work day.

The Environmental Protection Agency (EPA) regulations for control of asbestos in schools (AHERA Regulations at 40 CFR, Part 763, October 1987) allows habitation of the buildings after an asbestos removal if the airborne concentrations do not exceed .01 fibers/cc.

The Environmental Protection Agency (EPA) regulations at 40 CFR, Part 61, Subpart M - National Emission Standards for Hazardous Air Pollutants; Asbestos NESHAP Revision (November 20, 1990) recognizes the low release potential of asbestos packing materials. Asbestos packing is listed as a Category I non-friable asbestos containing material that --- *"even when broken or damaged would not release significant amounts of asbestos fibers"*

Comparatively, the concentrations of asbestos fibers released and measured in the breathing zone of workers processing the valve packing, and for by-standers 5 and 10 feet way are not significant; they are many times less than the permissible exposure limits defined above and approach the natural ambient levels found in the environment.

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BACKGROUND:

Asbestos is one of the most plentiful, useful, and cheap industrial minerals used in the United States over the past 90 years. Because of its high thermal stability and resistance to corrosion it has appeared in more than 3,000 manufactured goods in the United States. Estimates are that at least 30,000,000 tons have been used in construction and manufacturing since the year 1900. This commercial use of asbestos has led to the exposure of millions of Americans at levels that may have a significant impact on their health. Large numbers of Americans are also exposed to asbestos in the non-occupational environment, where it occurs not only from industrial sources but naturally in the soil, air and water. Most environmental exposures occur in cities from industrial complexes, from soil high in asbestos content, in drinking, ground and surface waters, and in the air from those sources.

Therefore, most Americans receive some regular low level asbestos exposure throughout their lifetimes. In 1980, Dr. Andrew Churg (1) determined that most city dwellers retain a substantial amount of respirable asbestos fibers in their lungs in some state of residence and clearance. Dr. Churg documented that retained asbestos fibers can number in the millions of asbestos fibers just from living and working in the cities where low level exposure to airborne asbestos is commonplace.

The concerns about the role of asbestos in the

development of the lung disease: *Asbestosis*, began in the United States in the 1930's and progressed slowly as more was learned about the pathogenesis of the disease. Most of the attention was centered on disabled workers with obvious work-related exposure patterns involving exposure to raw asbestos fibers used commercially. There were three main commercial types of asbestos used: *Chrysotile; Amosite and Crocidolite.*

Few, if any, controls were followed so the time and intensity factors led to elevated dose levels that precipitated some degree of asbestosis among the workers. This continued until the 1960's when signs of asbestos-related cancers began to reshape thinking and action about the occupational exposures to asbestos. Today, the exposures of workers to asbestos has been markedly reduced through voluntary controls and legislation that led to the first Federal asbestos standards in 1972. For the first time standards with the force of law were uniformly administered throughout the United States through the Occupational Safety and Health Administration (OSHA). Since that time the permissible exposure levels of asbestos have been reduced through regulatory processes in the United States.

In 1964, Marr (2) concluded that asbestos-related disease was an important problem among insulators working in U.S. Naval shipyards. His assumptions were correct; however, the methods of assessment weakened the conclusions. In 1965, pioneer work was begun at Puget Sound Naval Shipyard

culminating in a conclusive report of exposure levels and medical findings by Mangold, Beckett and Bessmer (3,4). Most of the attention was directed at the products and operations that produced high level exposures to asbestos workers and associated trades, and because of the large volumes of asbestos products used annually in the shipyard. The conclusions were that the Threshold Limit Value (TLV) was still too high at 5 millions of particles per cubic foot (MPPCF), equivalent to about 50 fibers per cubic centimeter of air, and that intermittent peak exposures were far more important than previously recognized. Both of these conclusions have been corroborated by more recent literature.

About 1964, Selikoff (7) and a team of scientists published a protracted study of asbestos-related diseases which defined the latent effects of exposure and probable dose-response relationship based upon time and intensity of exposure. The model they used was based on high level exposures and was extrapolated to all lower levels of exposure. Other scientists such as J.E. Craighead, et.al (8), M.R. Becklake (9) and W.J. Nicholson (10) questioned the validity of the straight line model because of the uncertainty in latency factors and ill-defined responses to low level exposures. Dr. Nicholson (10) further observed that the long lapse time from exposure to the onset of asbestosis, or asbestos-related cancers, creates difficulties in attempting to establish the true dose-response relationship. He noted that the diseases detected in later

years were from exposures of decades past when few measurements of asbestos concentrations in the breathing zone of workers were made, exposures were high, and controls were few.

Since that time Dr. Churg (1) has described relatively high levels of asbestos fibers found in the lungs of city dwellers who were not occupationally exposed and died of causes not related to asbestos. This substantial exposure from man-made and natural sources averages about 160,000,000 fibers per whole lung. This suggests a sigmoid or "S" shaped dose-response curve indicating a lower no effect level at low levels of exposures. Otherwise, millions of Americans receiving such daily exposures to asbestos should show significant rates of asbestos-related disease. There is no epidemiological evidence that they do. Therefore, the assumptions that all levels of exposure have a proportionate risk (using the straight line model for dose response) is extreme and without proof because it is based upon extrapolation and assumption.

The Occupational Safety and Health Administration (OSHA) used those conservative assumptions in the 1972 Federal regulations governing the occupational exposure to asbestos (11) and in subsequent changes to those regulations. In addition, an assumption was made that all forms of asbestos *(Chrysotile, Amosite, Crocidolite, Actinolite, Anthophyllite, and Tremolite)* produce asbestos-related disease at the same level of exposure. More recent studies in 1988 by Dr. Churg

and others (12, 13) show that the potency of the various forms of asbestos are different related to the cancer producing effects. However, OSHA and the EPA treat the various forms alike. Other non-regulatory bodies such as the American Conference of Governmental Industrial Hygienists recommend different Threshold Limit Values for the various forms of asbestos.

2. ENVIRONMENTAL EXPOSURES:

The environmental exposure to the naturally occurring forms of asbestos in the United States is common, and can be elevated in some localities. *Chrysotile* is common to the ambient air in the environment especially near the mountainous regions of the United States. There are 22 states with major asbestos mineral outcroppings that contribute substantial amounts of asbestos to the air and water from the eroded soil. Many major cities, such as Seattle, Washington, use drinking water sources that contains 400,000 to 1,000,000 asbestos fibers per liter of water. The EPA's study on Ambient Water Quality Criteria for Asbestos in 1980 showed that the general population receives substantial exposures to asbestos from these natural sources.

Because the naturally occurring asbestos, mainly chrysotile, is so wide spread on the West and East coasts and along the border with Canada, millions of Americans receive daily substantial exposures to asbestos from birth. It is not uncommon to find airborne concentrations of

asbestos in communities at levels of about .002 fibers/cc of air, rising to occasional peaks of .02 fiber/cc or more.

The background levels of naturally occurring asbestos in air is so prevalent that the EPA properly took into account the ambient airborne asbestos background influence for clearance of school buildings following an asbestos removal project (14). It is not uncommon to find outside airborne concentrations of asbestos exceeding those inside the school buildings where asbestos minerals exist in high concentrations in the soil and water. The current EPA criteria for clearance of a school building after a removal project is .01 fibers/cc by transmission electron microscopy for total fibers. At that level, the EPA considers the building suitable for occupancy.

Doll and Peto (15), Weill and Hughes (16), and Hughes and Weill (17) all have made predictions of the risk of environmental exposures at those levels. Doll and Peto predict <u>one</u> excess death from environmental exposure in a year in the United Kingdom. Such a low level of risk at the known environmental levels of exposure in the United States and the United Kingdom accounts for the fact that the general populations do not demonstrate asbestos-related diseases at those levels.

3. VOLUME OF ASBESTOS USED IN SHIPYARDS:

The large volume of asbestos products used in U.S. Naval and commercial shipyards is important, especially in

the war years during the 1940's, 1950's, and 1960's. The Fleisher-Drinker report on Naval and contract shipyards published in 1946 shows that in these industrial communities about 100,000 to 500,000 pounds of asbestos products would be used each month for new ship construction alone (18). The report made no mention of the volume of asbestos removed prior to overhaul or renovation of vessels. The amount of asbestos materials used set the conditions for high levels of exposure to workers for the working conditions during that era. About 95% of the products by weight were amosite pads or blankets, loose amosite, magnesia block insulation, asbestos cements and asbestos cloth. Tons of the materials were loose, easily broken, crumbled, and handled directly by workers. The potential for high level exposure, especially peak expcsures is evident. Few effective control measures were in place at that time because the risk from high level exposures over many years was not recognized because of the long latency periods to develop asbestos-related diseases.

4. EXPOSURES OF THE CONSTRUCTION AND SHIPYARD TRADES:

There are several studies that attempted to define the occupational exposure of workers in the construction and shipyard trades in the 1960's. They constitute a cross section of the American experience at controlling high level occupational exposures in industry.

In 1970, Mangold, Beckett and Bessmer (3,4) published a report on asbestos exposures at Puget Sound Naval Shipyard

showing that 21% of the asbestos workers showed pulmonary abnormalities. They concluded that the current Threshold Limit Value (TLV) of 5 MFPCF was too high, that peak exposures were especially important, and that changes of work practices were required.

In 1968, W.C. Cooper and L. Baltzer (19) published a similar study of construction workers in the San Francisco Bay area. About 25% of the construction workers handling asbestos products and receiving high level exposure showed X-ray changes to the lungs. They also concluded that the TLV was too high and needed to be reduced.

In 1971, Gaensler, et.al. (20) published a study of exposures and medical findings in a private shipyard on the East coast. He concluded that exposures were too high and that the TLV should be reduced. He noted that conditions had not changed in about 20 years. A comparison of the asbestos exposures by job are contained in the report.

These three studies show that large volumes of asbestos were used during those periods and that high levels of exposure were commonplace for certain trades and workplaces. The asbestos exposure concentrations were probably hundreds to thousands of times greater than background levels, or environmental exposures. Such substantial exposures could probably account for most of the subsequent asbestos-related diseases following long latency periods.

5. CURRENT ALLOWABLE LEVELS OF EXPOSURE TO ASBESTOS:

In 1946, the American Conference of Governmental Industrial Hygienists (ACGIH) adopted a Threshold Limit Value (TLV) for asbestos of 5 Millions of Particles per Cubic Foot (MPPCF) of air samples for an 8 hour time-weighted average (TWA) workday (21). Years later, comparisons to the filter counting method showed 5 MPPCF was roughly equivalent to 50 fibers/cc. It remained as a recommendation until 1969, when it was reduced to 2 MPPCF or equivalent to 12 fibers/cc. The ACGIH still recommends different TLV's for the various forms of commercial asbestos; as follows.

A. Chrysotile:	2 fibers/cc, 8 hr TWA
B. Amosite:	.5 fibers/cc, 8 hr TWA
C. Crocidolite:	.2 fibers/cc, 8 hr TWA
D. Other Types	2 fibers/cc, 8 hr TWA

The current Occupational Safety and Health Administration (OSHA) Federal standard for occupational exposure to asbestos is .2 fibers/cc, >5 um in length, for all forms of asbestos used commercially. OSHA makes no distinction between the types of asbestos. The regulation specifies the use of air sampling and laboratory analyses by phase contract microscopy at 400 X magnification (11).

The EPA now regulates school clearances following an asbestos removal project to .01 fibers/cc as determined by phase contrast microscopy (PCM) or transmission electron microscopy (TEM), a precise method that measures all asbestos

fibers present (14).

It is apparent that there is a distinct difference between the control strategies adopted by the regulatory agencies and the independent recommendations offered by the ACGIH based upon specific studies and the toxicity of the various forms of asbestos.

6. EXPERIMENTAL DESIGN FOR ASBESTOS PACKING:

In many of the past articles on asbestos exposure the products used in low volumes and those that were encapsulated were not considered because of the small contribution to the overall exposure pattern (3,4) of those handling the products. Since many asbestos insulation products are used together or in conjunction with each other, the measurement of the contribution of a single product is difficult. In the case of products with a low release potential, the airborne asbestos fiber measurements will be dominated by the relatively high fiber release from the more friable products (3,4,19,20).

Asbestos packing is an encapsulated product containing asbestos and elastomers and is round or square in shape. The product is used to encircle the shaft of a valve and be compressed by a special compression nut to squeeze the packing; thus making a fluid tight seal (See Photograph at Enclosure # 6. The volume of valve packing used in industry, compared to other asbestos products is relatively small. It

is because of the special application (it is not used for insulation), and the infrequent need to replace it.

When a valve stem begins to leak steam, or fluids, the packing gland may need to be tightened to increase the compression seal, or the packing may need replacement. The packing can be installed while the valve is in place, or it may be replaced routinely when the valves are removed for reconditioning or overhaul.

The EPA published a revision to the *National Emission Standards for Hazardous Air Pollutants; Asbestos NESHAP Revision; Final Rule* at 40 CFR, Part 61, Subpart M on November 20, 1990 (22). Asbestos packing materials used for valves are specifically described and designated in Category I - Non-Friable Asbestos Containing Material which "even when broken or damaged, they would not release significant amounts of asbestos fibers". This is a recognition that encapsulated products do not release significant amounts of asbestos on handling or processing.

This report describes an experiment designed to determine the actual amount of asbestos released from the removal and installation of asbestos valve packing, in the absence of high environmental or other interfering sources of asbestos.

Two dozen medium sized valves (3 inch line or larger) were obtained from salvage yards, especially those where the history of origin was known such as the Seattle Steam Plant.

They were cleaned with warm soapy water to remove any residual asbestos materials clinging to the body of the valve. No packing nuts were removed or the packing in place altered in any way. The intent was to be able to remove the old packing materials in much the same way as a worker may remove it.

Garlock, Inc. brand asbestos braided packing material Styles 127 and 733 were obtained from the company, and the composition determined to be the same as that used more than thirty years ago in the late 1950's. The intent was to have a supply of various types of new asbestos braided packing materials, to replace that which would be removed during the testing, which was similar in composition to common valve packing produced by the Garlock, Inc for decades. The information is contained at Enclosure # 1.

A clean room was needed for the testing, to minimize contamination from any other sources of asbestos, and to accurately measure the low level release of chrysotile asbestos fibers expected from the handling of the old and new packing materials. Since the emissions were expected to be near the limit of detection of phase contrast microscopy, special precautions were taken to control potential asbestos contamination or other fibers that may interfere with the testing. A large facility was leased in Seattle, Washington and a clean enclosure was constructed inside in which the ambient and background airborne asbestos levels as measured

by electron microscopy was .002 fibers/cc for fibers greater than 5 micrometers in length, or .005 Structures/cc for all sizes of asbestos present. This background is sufficiently low to conduct the tests because:

1. the natural asbestos background in Seattle is near that level.

2. it is at or below the asbestos levels expected from the testing of the old and new valve packings.

Inside the building, an enclosure of polyethylene plastic was constructed that measured 20 feet by 20 feet and 10 feet high, or 4,000 cubic feet. This represents a small compartment or room much like is often found aboard ship or in some work places which may be occupied by a bystander to valve stem packing removal or installation. The ceiling, walls, and floor were covered with the polyethylene plastic and all the edges were sealed. The only entry was a specially designed flap door that would remain sealed during the testing. No ventilation was provided to the enclosure so that all fibers released during the testing would remain inside the enclosure.

A clean work bench was placed in the center of the enclosure and the valves placed beside the bench so that one valve after another could be processed by removal of the old packing and installation of the new.

Personal samplers were worn by both personnel at the bench during the packing operations. These sampled the

airborne asbestos fibers in the breathing zone for subsequent analysis by phase contrast microscopy, as defined in the OSHA asbestos standard (11).

Sampler stations were also located 5 and 10 feet away from the work bench, at head height, in the North, South, East and West directions to simulate the exposure of a bystander. Each sample station had a cassette for phase contrast microscopy and one for scanning electron microscopy. Air was drawn through the special filters in the cassettes by electrically operated high volume air samplers. The volumes of air sampled at each station were measured by recording the flow rates (Liters per Minute) with a Class A rotometer and recording the amount of time the samples were collected. All sample cassettes were taken from the same Lot number from the box provided by the manufacturer. Enclosure # 2 shows the location of the samplers to record by-stander exposure in the plastic enclosure.

Personal samples were collected in the breathing zone of each of the two operators who remained in the room during the entire processing event. Eight samples were collected at the environmental stations; four at 5 feet and 4 at 10 feet from the bench. Blanks were collected for quality assurance of the data. All were analyzed by phase contrast microscopy (PCM).

Eight other samples were collected at the environmental stations for analysis by scanning transmission electron microscopy (STEM) for comparison to the PCM results.

Personnel wore disposable plastic impregnated protective clothing (TYVEC) to control the potential release of non-asbestos fibers from street clothing and dust from shoes which could interfere with the low level measurements.

Eight valves were processed one by one on the bench by the two operators over a continuous 4.4 to 4.5 hour period. The valves were disassembled, and the old packing removed. Then new packing was measured, cut and installed in the valve. This process was continued for more than four hours to develop enough data to make calculations for 8 hour time-weighted average exposures. Following the testing, the sample cassettes were removed and delivered to HAZTOX, Inc., Seattle, Washington, a NVLP certified asbestos analytical laboratory. At HAZTOX, Inc. all PCM samples were analyzed according to Appendix A of the Federal Asbestos Standard (NIOSH) 7400 A. In addition all PCM samples were counted by two different analysts and the results reported separately.

The results were then averaged for both the personal and by-stander exposures. The results of the two analyses are found at Enclosure # 3.

The sample cassettes for the scanning electron microscopy (STEM) were sent to ESSTEK, Inc., Wheatridge (Denver), Colorado, a qualified laboratory for analysis of

asbestos samples by electron microscopy. The letter of transmission and the results of the analyses are at Enclosure # 4. ESSTEK's laboratory qualifications are listed as Enclosure # 5.

The electron microscopy results were compared to, and corroborated, the phase contrast microscopy results. Only the phase contrast microscopy results can be compared to the permissible exposure limits found in the Federal asbestos standard.

The PCM analysis may count non-asbestos fibers that may be present. But the STEM method is highly specific. It can determine all types of structures and fibers present, identify the type of fiber, has a very low limit of detection, and can be arranged to provide data similar to the PCM method for direct comparison. The EPA published two volumes that uses such comparative methodologies. They are the *Superfund Method for Determination of Asbestos in Ambient Air: Part 1 -Method, and Part 2 - Technical Background* (See ref 23).

In this study, PCM and STEM samples collected at each by-stander sample location at the same time and filtered about the same volume of air so they could be compared in the data analysis. This provided two separate determinations for two specific methods at the same sample location to give a high degree of confidence that each result was comparative and reflected conditions in the test enclosure.

7. RESULTS AND CONCLUSIONS:

The removal of old asbestos packing from valves and installing new packing material of the same type used 30 years ago typifies the operations described by pipe fitters, machinists, maintenance mechanics and other tradesmen about how the valve packing was removed and replaced.

This test of asbestos release from old and new valve packing was conducted in a clean unventilated enclosure, in order to minimize the interference from natural or extraneous asbestos fibers or other types of fibrous dusts. This also represented a closed work space such as a ship's compartment, boiler room, or other work locations.

Because the airborne asbestos concentrations released are so low, background asbestos levels inside the enclosure must be at or below the expected release levels. The background levels sampled before the operations began were .002 fibers/cc by Scanning transmission Electron Microscopy comparable to the PCM data, and .005 Structures/cc for all sizes of asbestos present.

Analyses of the breathing zone samples of the two operators at the bench averaged .014 fibers/cc for Mr. Mangold, and .009 fibers/cc for Dr. Gay. These concentrations represent the occupational exposure of workers removing the packing from old valves, and replacing it with new packing in an enclosed, unventilated work space. The 4 to 4.5 hour test period was sufficient to represent an 8 hour time-weighted average exposure at that work rate.

The PCM data were compared to the current Permissible Exposure Limit (PEL) in the Federal standard for an eight hour time-weighted average asbestos exposure of .2 fibers/cc, >5 um in length, with a 3:1 aspect ratio, as determined by phase contrast microscopy at 400X. The OSHA regulation embraces the National Institute for Occupational Health (NIOSH) method # 7400, revision # 3 in the Appendix A of the standard.

The personal exposure patterns of the workers removing or installing asbestos containing valve packing were 14 to 22 times less than the OSHA PEL of .2 fibers/cc, 8 hr TWA.

The PCM samples 5 feet away from the bench averaged .005 fibers/cc for all four sample stations at the North, South, East and West locations. This represents a bystander exposure 5 feet from two workers removing and installing packing on an average of 2 valves per hour.

The PCM samples at 10 feet away at the four points averaged .004 fibers/cc.

These values are 40 to 50 times less than the Federal standard.

The Scanning Transmission Electron Microscopy (STEM) used to corroborate the by-stander PCM results for fibers greater than 5 um in length as defined in the standard averaged .008 fibers/cc at 5 feet at the four points, and .009 fibers/cc at 10 feet at the four points. The values

validate the range of concentrations collected by PCM and compared to the Federal standard. It is not uncommon for the STEM data to be higher than the PCM data because of the precise analysis offered by electron microscopy. However, it may only be used as a comparison since there is no occupational health standard using electron microscopy.

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10. ENCLOSURES:

1. GARLOCK, INC. PACKING MATERIALS.

2. SKETCH OF ENCLOSURE AND PLACEMENT OF SAMPLERS

3. PHASE CONTRAST MICROSCOPY (PCM) RESULTS.

4. SCANNING TRANSMISSION ELECTRON MICROSCOPY RESULTS.

5. ESSTEK, INC. LABORATORY QUALIFICATIONS.

6. PHOTOGRAPH OF PACKING IN A SPLIT VALVE.

GARLOCK, INC, PALMYRA, NEW YORK

BRAIDED ASBESTOS PACKING FOR VALVE STEMS

STYLE # 127 (1)		3/16"
		1/4"
		3/8"
STYLE # 733 (2)		3/16"
		1/4"
		3/8"

(1) Style # 127 has been made without significant change since the 1950's. Also, known as Style # 5901 to comply with U.S. Government specifications. Good for applications for valve stems to 4000 psi and 1200°F.

(2) Style # 733 has been made without significant change since the late 1940's. It is good for valve stems and rotary shafts for low and medium pressure applicatio up to 500°F.

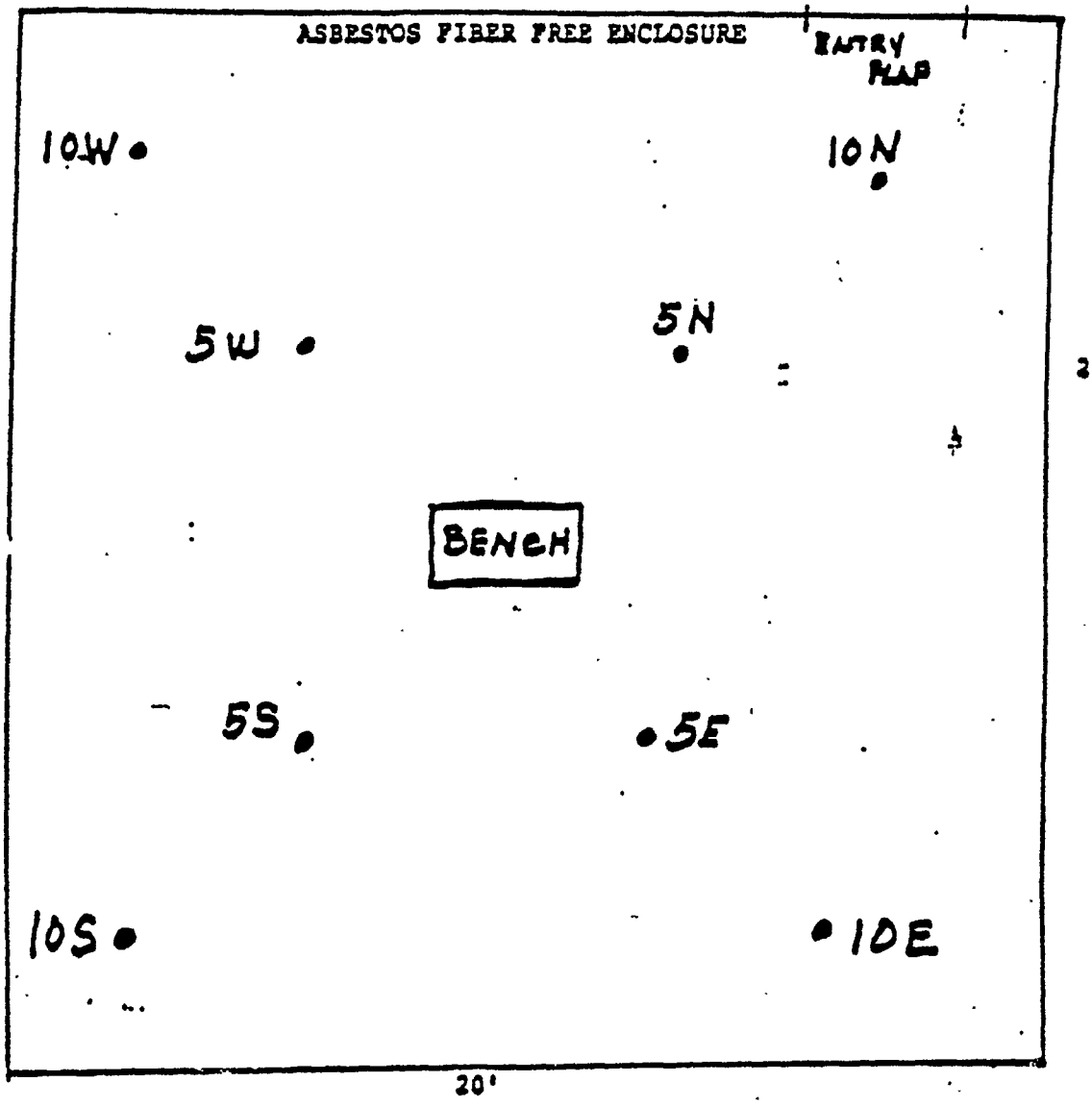
(3) The outer surfaces are coated with a graphite powder for lubrication of the surfaces against the valve stem and prevent sticking. It levels the surface and provides greater sealing contact.

ENCLOSURE(1)

3c

LOCATION OF SAMPLE STATIONS

IN THE



Enclosure Height = 10'

ENCLOSURE(2)

BLIND COUNT # 1

EMSL
Controlled Solutions

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.S.S., Inc.
3033 170th Pl. S.E.
Bellevue, WA 98008

REPORT #: 01-191273
REPORT DATE: 2-01-91

PAGE 1 of 3

PROJECT: Valve Packing, Garlock, Inc.

DATE RECEIVED: 1-30-91
PO #: None Given

CLIENT SAMPLE ID	ESS ID	SAMPLE DATE	SAMPLE VOL (L)	FIBER COUNT	FIELD COUNT	BLANK CNT /100 FLDS	FIBERS PER CC *	BKGRND MAT **
P-BLK-1	191273	1-29-91	0	2.0	100	N/A	BLANK	
P5E-3	191274	1-29-91	1219	49.0	100	1.00	0.019	M
P5N-1	191275	1-29-91	2582	35.0	100	1.00	0.006	H
P5E-2	191276	1-29-91	2803	20.0	100	1.00	0.003	H
P5S-3	191277	1-29-91	2470	29.0	100	1.00	0.006	H
P5W-4	191278	1-29-91	3550	26.0	100	1.00	0.003	H
P10N-5	191279	1-29-91	2767	16.0	100	1.00	0.003	H
P10E-6	191280	1-29-91	3484	12.5	100	1.00	0.002	H
P10S-7	191281	1-29-91	2527	25.0	100	1.00	0.005	M
P10W-8	191282	1-29-91	2594	28.5	100	1.00	0.005	M
PP-17	191283	1-29-91	450	6.0	100	1.00	< 0.011	L
PP-18	191284	1-29-91	540	10.0	100	1.00	< 0.009	L
PLAB #3-19	191285	1-29-91	0	0.0	100	N/A	BLANK	

SAMPLE LOCATIONS:

Sample #191273 was taken as a field blank.

SEATTLE DIVISION
12822 GATEWAY DR.
SEATTLE, WASHINGTON 98168

1-206-243-6573
FAX 206-244-3715

ENCLOSURE(3)A

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.H.S., Inc.
PROJECT: Valve Packing, Garlock, Inc.

SAMPLE LOCATIONS (continued):

Sample #191274 was a background sample.

Sample #191275 was by bystander, 5' north.

Sample #191276 was by bystander, 5', east.

Sample #191277 was by bystander, 5', south.

Sample #191278 was by bystander, 5' west.

Sample #191279 was by bystander, 10', north.

Sample #191280 was by bystander, 10', east.

Sample #191281 was by bystander, 10', south.

Sample #191282 was by bystander, 10' west.

Sample #191283 was a personal sample on Carl Mangold.

Sample #191284 was a personal sample on Bob Gay.

Sample #191285 was taken as a field blank.

The samples analyzed in this report were provided by third parties not subject to control by HAZTOX, Inc. or any of HAZTOX, Inc.'s affiliates. Consequently, the results presented represent microscopic examinations in HAZTOX, Inc. laboratory facilities and we make no representation as to sample collection techniques or procedures.

Analysis was performed using phase contrast microscopy under the guidelines of NIOSH method #7400-A.

* A minimum of ten fibers per 100 fields is needed for reliable quantification. Samples with less than 10 fibers per 100 fields are reported as less than (<) the quantification limit.

** Amounts of non-fibrous material are determined using charts for estimating composition from the Journal of Sedimentary Petrology (v. 25, pp. 229-234, 1955). Amounts reported reflect non-fibrous material density on sample filter only.

Legend: T = Trace (less than 1%), VL = Very Low (2-5%), L = Low (5-15%), M = Moderate (15-25%), H = High (25-40%), VH = Very High (greater than 40%).

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.H.S., Inc.
PROJECT: Valve Packing, Garlock, Inc.

REPORT #: 01-191273
PAGE 3 of 3

Microscope Field Area = 0.00785 mm²

Analyst(s) - WFG

Exposed Filter Area = 385.0 mm²

Rev. by: T. Ellis.

William Galloway

BLIND COUNT # 2

EMSL
Controlled Solutions

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.S.S., Inc.
3033 170th Pl. S.E.
Bellevue, WA 98008

REPORT #: 57-191273
REPORT DATE: 2-01-91

PAGE 1 of 3

PROJECT: Valve Packing, Garlock, Inc.

DATE RECEIVED: 1-30-91
PO #: None Given

CLIENT SAMPLE ID	ESS ID	SAMPLE DATE	SAMPLE VOL (L)	FIBER COUNT	FIELD COUNT	BLANK CNT /100 FLDS	FIBERS PER CC *	BKGRND MAT **
P-BLK-1	191273	1-29-91	0	1.5	100	N/A	BLANK	
P5E-3	191274	1-29-91	1219	38.0	100	0.75	0.015	M
P5N-1	191275	1-29-91	2582	26.0	100	0.75	0.005	H
P5E-2	191276	1-29-91	2803	15.0	100	0.75	0.002	H
P5S-3	191277	1-29-91	2470	30.0	100	0.75	0.006	H
P5W-4	191278	1-29-91	3550	29.0	100	0.75	0.004	H
P10N-5	191279	1-29-91	2767	22.0	100	0.75	0.004	M
P10E-6	191280	1-29-91	3484	13.0	100	0.75	0.002	M
P10S-7	191281	1-29-91	2527	19.0	100	0.75	0.004	M
P10W-8	191282	1-29-91	2594	26.0	100	0.75	0.005	M
PP-17	191283	1-29-91	450	15.0	100	0.75	0.016	M
PP-18	191284	1-29-91	540	11.0	100	0.75	0.009	M
FLAB #3-19	191285	1-29-91	0	0.0	100	N/A	BLANK	

SAMPLE LOCATIONS:

Sample #191273 was taken as a field blank.

SEATTLE DIVISION
12822 GATEWAY DR
SEATTLE, WASHINGTON 98168

1-206-243-6573
FAX 206-244-3715

ENCLOSURE(3)B

3

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.H.S., Inc.
PROJECT: Valve Packing, Garlock, Inc.

SAMPLE LOCATIONS (continued):

Sample #191274 was a background sample.

Sample #191275 was by bystander, 5', north.

Sample #191276 was by bystander, 5', east.

Sample #191277 was by bystander, 5', south.

Sample #191278 was by bystander, 5', west.

Sample #191279 was by bystander, 10', north.

Sample #191280 was by bystander, 10', east.

Sample #191281 was by bystander, 10', south.

Sample #191282 was by bystander, 10', west.

Sample #191283 was a personal sample on Carl Mangold.

Sample #191284 was a personal sample on Bob Gay.

Sample #191285 was taken as a field blank.

The samples analyzed in this report were provided by third parties not subject to control by HAZTOX, Inc. or any of HAZTOX, Inc.'s affiliates. Consequently, the results presented represent microscopic examinations in HAZTOX, Inc. laboratory facilities and we make no representation as to sample collection techniques or procedures.

Analysis was performed using phase contrast microscopy under the guidelines of NIOSH method #7400-A.

* A minimum of ten fibers per 100 fields is needed for reliable quantification. Samples with less than 10 fibers per 100 fields are reported as less than (<) the quantification limit.

** Amounts of non-fibrous material are determined using charts for estimating composition from the Journal of Sedimentary Petrology (v. 25, pp. 229-234, 1955). Amounts reported reflect non-fibrous material density on sample filter only.

Legend: T = Trace (less than 1%), VL = Very Low (2-5%), L = Low (5-15%), M = Moderate (15-25%), H = High (25-40%), VH = Very High (greater than 40%).

AIR SAMPLE ANALYSIS REPORT

CLIENT: E.H.S., Inc.
PROJECT: Valve Packing, Garlock, Inc..

REPORT #: 57-19127
PAGE 3 of 3

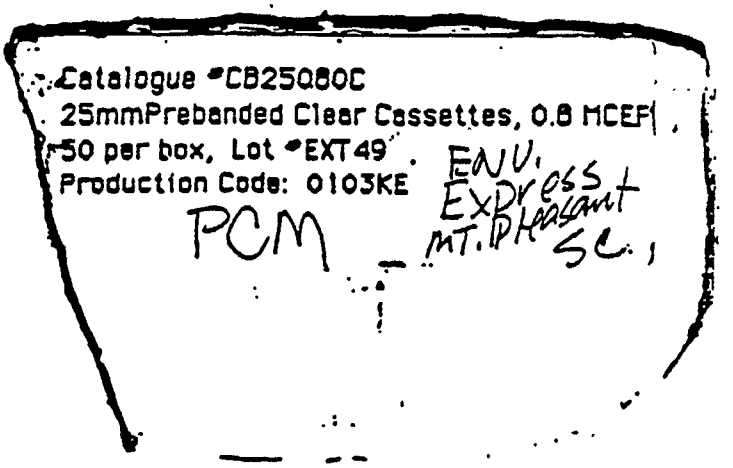
Microscope Field Area = 0.00785 mm²

Analyst(s) - TAF

Exposed Filter Area = 385.0 mm²

Rev. by: T. Fdes

Trevor Fernande



ENCLOSURE(3)C

ENVIRONMENTAL CONTROL SCIENCES, INC.
• Certified Industrial Hygienist
• Occupational Health Programs
• Asbestos Surveys
• Environmental Analytical Chemistry
• Toxic Chemical Control
• Waste Control Programs

February 1, 1991

Mr. Robert A. Woellner
Laboratory Director
ESSTEK, INC.
11435 West I-70 Frontage Road North
Wheat Ridge, Colorado, 80033

RE: VALVE PACKING RESEARCH
GARLOCK, INC.

Dear Bob,

Enclosed are eleven (11) samples offered for STEM analysis.

They are:

T5N-9	T10N-13	T5E-B (background prior to sampl
T5E-10	T10E-14	TBlank2 - a field blank
T5S-11	T10S-15	T-Lab-4 - a cassette selected from the lot - See lot data sheet
T5W-12	T10W-16	

Please see the field data sheet for descriptions. The PCM's were sent to HAZTOX in Seattle to split results for credibility. Please select the most appropriate STEM method, presumeably the NIOSH 7402 Method, 8/15/87 with revisions.

What I need is;

a. The total concentration of all types of asbestos present in all sizes countable. This gives the total asbestos fibers present. The numbers of chrysotile, amphiboles, and ambiguous too

b. The "Chrysotile" fiber (structure) size for 5 um length, and .25 um diameter to be able to compare to the PCM results.

c. The concentration of all Chrysotile fibers present for the 5 um length and .25 um diameter.

Please see the examples of the ESSTEK format done before for me. This will be acceptable, unless you have a better one. I need the data on each sample. My goal is to be able to compare the TEM results with the PCM results for strengthening the data and to define any other non-asbestos fibers that might interfere with the PCM; as it usually does.

3033 - 170th Place S.E. • Bellevue, Washington 98008 • (206) 747-9620 EIN 91-1415392

ENCLOSURE (1)

I expect to see few, if any, amphiboles present. If they are it was contamination on the valves tested that were taken from steam plants and ships.

There is no great hurry on the results. A week or so will be fine. However, this is a research project for a client. The utmost care in reporting is required since the data and results will be used in asbestos litigation cases.

If you have any qudstions or comments, please call me.

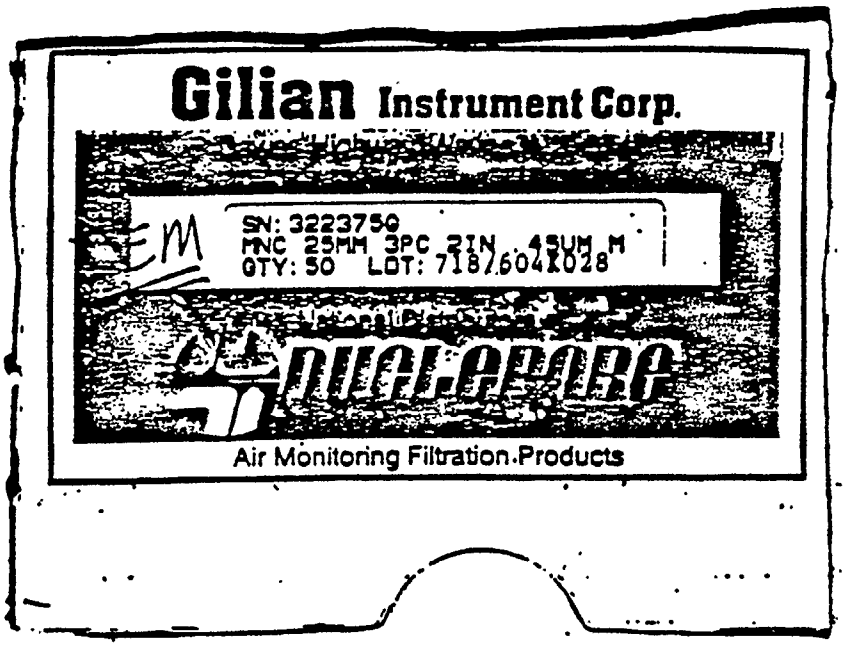
Sincerely,

Carl A. Mangold

CARL A. MANGOLD, CIH
INDUSTRIAL HYGIENE CONSULTANT
&
ANALYTICAL CHEMIST

President, ECS, Inc.

Encls: 11 samples.
Field sample sheets (3)
TEM Cassette Lot data
ESSTEK report format
ESSTEK Individual Sample Report format



ENCLOSURE(4)E

41

ESSTEK, Inc.

TEM ANALYSIS REPORT

Prepared For:

HAZTOX, Inc., Seattle Office

Project:

Valve Packing Research - Garlock Inc.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North
(303) 425-7038

ENCLOSURE(A)
40

ESSTEK, Inc.

CLIENT:	HAZTOX, Inc., Seattle Office 12822 Gateway Dr. Seattle, WA 98168
HAZTOX, Inc., Seattle Office REPRESENTATIVE:	Dick Sawyer
DESCRIPTION OF WORK:	Transmission Electron Microscopy (TEM) of air samples at Valve Packing Research - Garlock Inc.
ANALYST:	Dan Dolk

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North
(303) 425-7038

TRANSMISSION ELECTRON MICROSCOPY (TEM)

Analysis Methodology

TEM analyses were conducted using NIOSH Method 7402 methodology. Issued August 15, 1987.

NIOSH 7402 methodology involves first mounting sub-samples of the air sample filters (mixed cellulose ester) on slides, and plasma etching the MCE filters. The samples are then coated with a thin layer of carbon in a vaccume vaporator. Following coating, samples are mounted on 3mm TEM copper gride (200 Mesh) and are further processed in a Jaffe Wick washer or condensation washer.

Sample grids are scanned on the TEM at 10,000x and structures identified using the the following characteristics:

1) All particules less than 3um diameter with length to width ration of greater than 3:1 with parallel sides.

2) Record fibers diameter and length.

3) Record as Bundle, Cluster, Matrix, or Fiber.

4) Count fibers that are partially obscured by grid bars, log as 5um fiber if 2.5 mm is visible.

5) Determine asbestos fiber fraction shorter than 5um and thinner than 0.25um (these fibers undetected in PCM counting.)

Laboratory Equipment

The laboratory utilizes a Philips CM10 Transmission Electron Microscope. The TEM is equipped for electron diffraction and energy dispersive x-ray analysis. The TEM is located in our full service asbestos analysis laboratory near Denver, Colorado.

Laboratory Results

This report in no way implies product approval or endorsement by NIST. This report can be reproduced only in it's entirety. These results relate only to the samples as they were received by the laboratory. Sampling information is assumed to be correct as provided on the clients letter of transmittal.

In accordance with NIST regulation, ESSTEK, Inc. maintains a TEM laboratory average accuracy / precission record of greater than 90% true positives, and less than 10% false positives as calculated from the previous years quality assurance sample records.

ESSTEK, Inc.

TEM Asbestos Analysis Data Summary

Client:	HAZTOX, Inc., Seattle Office		
Job Location:	Valve Packing Research - Garlock Inc.		
Date of Analyses:	Feb 02-05 91		

Description Sample Number	Laboratory Number	Asbestos Fibers / mm2 > 5 um	Asbestos Fibers /cc > 5 um	Asbestos Fiber All Fibers > 5 um
T5N-9	TE601511	13.1	0.002	10%
T5E-10	TE601512	43.7	0.008	34%
T5S-11	TE601513	27.5	0.006	11%
T5W-12	TE601514	61.2	0.011	32%
T10N-13	TE601515	64.2	0.012	37%
T10E-14	TE601516	45.9	0.008	24%
T10S-15	TE601517	30.8	0.006	21%
T10W-16	TE601518	45.9	0.009	31%
TSE-B	TE601519	3.3	0.002	N/A

BDL = Below Detection Limit
Note: As per EPA protocol, any structure greater than 5.0 um long counted

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North, Wheat Ridge, CO. 80033
(303) 425-7038

ESSTEK, Inc.

TEM Asbestos Analysis Data Summary

Client:	HAZTOX, Inc., Seattle Office		
Job Location:	Valve Packing Research - Garlock, Inc.		
Date of Analyses:	Feb 02-05 91		

Description Sample Number	Laboratory Number	Total Number Asbestos	Total Number Non-Asb.	All Asb. S/cc	All Asbestos All Fibers
T5N-9	TE601511	12	44	0.010	21%
T5E-10	TE601512	26	29	0.020	47%
T5S-11	TE601513	20	56	0.018	26%
T5W-12	TE601514	27	48	0.020	36%
T10N-13	TE601515	17	32	0.015	35%
T10E-14	TE601516	12	49	0.010	20%
T10S-15	TE601517	16	44	0.011	27%
T10W-16	TE601518	20	33	0.014	38%
TSE-B	TE601519	3	7	0.005	N/A
T-Blank-2	TE601520	NSD	NSD	N/A	N/A
T-Lab-4	TE601521	NSD	1	N/A	N/A

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long counted

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North, Wheat Ridge, CO. 80033
(303) 425-7038

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 5' North	Date Received:	Feb 02 91
Sample Number:	T5N-9	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601511	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2084.75 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	21
Area of Filter Sample Analyzed (mm2):	0.229

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	3	3.5 - 7.0	9	BDL	BDL	3	12
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	3	3.5 - 7.0	9	BDL	BDL	3	12
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	26	44

Number of Asbestos Structures / CC > 5um : 0.002

Number of Asbestos Structures / mm2 > 5um : 13.1

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 9

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert S. Wallace

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 5' East	Date Received:	Feb 02 91
Sample Number:	ISE-10	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601512	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2101.29 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	21
Area of Filter Sample Analyzed (mm2):	0.229

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	7	2.3 - 5.0	14	BDL	5	10	26
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	7	2.3 - 5.0	14	BDL	5	10	26
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	19	29

Number of Asbestos Structures / CC > 5um : 0.008

Number of Asbestos Structures / mm2 > 5um : 43.7

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 16

Comments:

BDL: = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert L. Walker

4E

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 5' South	Date Received:	Feb 02 91
Sample Number:	TSS-11	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE001513	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	1921.25 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	20
Area of Filter Sample Analyzed (mm2):	0.218

Structures Counted and Identified

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total > 5um	Total Structures
Chrysotile	4	1.5 - 3.5	12	1	3	6	20
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	4	1.5 - 3.5	12	1	3	6	20
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	47	56

Number of Asbestos Structures / CC > 5um : 0.006

Number of Asbestos Structures / mm2 > 5um : 27.5

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 14

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Walther

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 5' West	Date Received:	Feb 02 91
Sample Number:	T5W-12	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601514	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2244 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	21
Area of Filter Sample Analyzed (mm2):	0.229

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total > 5um	Total Structures
Chrysotile	13	3.0 - 11.0	11	1	2	14	27
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	13	3.0 - 11.0	11	1	2	14	27
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	30	48

Number of Asbestos Structures / CC > 5um : 0.011

Number of Asbestos Structures / mm2 > 5um : 61.2

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 13

Comments:

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wallner

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 10' North	Date Received:	Feb 02 91
Sample Number:	T10N-13	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601515	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2057.4 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	20
Area of Filter Sample Analyzed (mm2):	0.218

Structures Counted and Identified

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	6	3.0 - 10.5	11	BDL	BDL	14	17
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	6	3.0 - 10.5	11	BDL	BDL	14	17
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	24	32

Number of Asbestos Structures / CC > 5um : 0.012

Number of Asbestos Structures / mm2 > 5um : 64.2

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 3

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Walker

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 10' East	Date Received:	Feb 02 91
Sample Number:	T10E-14	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601516	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2211 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	20
Area of Filter Sample Analyzed (mm2):	0.218

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	2	1.0 - 5.0	7	2	1	10	12
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	2	1.0 - 5.0	7	2	1	10	12
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	32	49

Number of Asbestos Structures / CC > 5um : 0.008

Number of Asbestos Structures / mm2 > 5um : 45.9

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 2

Comments:

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wolther

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 10' South	Date Received:	Feb 02 91
Sample Number:	T10S-15	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601517	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	1921 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	27
Area of Filter Sample Analyzed (mm2):	0.294

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	5	2.0 - 12.0	9	BDL	2	9	16
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	5	2.0 - 12.0	9	BDL	2	9	16
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	33	44

Number of Asbestos Structures / CC > 5um : 0.006

Number of Asbestos Structures / mm2 > 5um : 30.6

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 7

Comments:

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wuelfer

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 10' West	Date Received:	Feb 02 91
Sample Number:	T10W-16	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601518	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	1944 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	25
Area of Filter Sample Analyzed (mm2):	0.283

Structures Counted and Identified

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	BDL	0.0	16	1	3	13	20
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	BDL	0.0	16	1	3	13	20
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	29	33

Number of Asbestos Structures / CC > 5um : 0.009

Number of Asbestos Structures / mm2 > 5um : 45.9

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 7

Comments:

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wallace

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Background Sample	Date Received:	Feb 02 91
Sample Number:	T5E-B	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601519	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	779 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	28
Area of Filter Sample Analyzed (mm2):	0.305

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	BDL	0.0	3	BDL	BDL	1	3
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophylite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	BDL	0.0	3	BDL	BDL	1	3
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	3	7

Number of Asbestos Structures / CC > 5um : 0.002

Number of Asbestos Structures / mm2 > 5um : 3.3

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures: 2

Comments:

BDL = Below Detection Limit

Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wallner

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Field Blank TEM	Date Received:	Feb 02 91
Sample Number:	T-Blank-2	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601520	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	N/A	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	29
Area of Filter Sample Analyzed (mm2):	0.316

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	BDL	0.0	BDL	BDL	BDL		BDL
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	BDL	0.0	BDL	BDL	BDL		BDL
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A		BDL

Number of Asbestos Structures / CC > 5um : N/A

Number of Asbestos Structures / mm2 > 5um : N/A

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures:

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:

Robert A. Wallace

ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Lot Blank	Date Received:	Feb 02 91
Sample Number:	#718/604K025	Date Analyzed:	Feb 02-05 91
Lab Sample Numb	TE601521	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	N/A	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	29
Area of Filter Sample Analyzed (mm2):	0.315

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length in Microns	Total Bundles	Total Clusters	Total Matrices	Total > 5um	Total Structures
Chrysotile	BDL	0.0	BDL	BDL	BDL		BDL
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	BDL	0.0	BDL	BDL	BDL		BDL
Total Non-Asbe	N/A	N/A	N/A	N/A	N/A	1	1

Number of Asbestos Structures / CC > 5um : N/A

Number of Asbestos Structures / mm2 > 5um : N/A

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

Asbestos < 5um micron structures:

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:
Robert A. Woellner

ESSTEK, Inc.

TEM ANALYSIS REPORT

Prepared For:

HAZTOX, Inc., Seattle Office

Project:

Valve Packing Research - Garlock Inc.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North
(303) 425-7038

ESSTEK, Inc.

CLIENT:	HAZTOX, Inc., Seattle Office 12822 Gateway Dr. Seattle, WA 98168
HAZTOX, Inc., Seattle Office REPRESENTATIVE:	Dick Sawyer
DESCRIPTION OF WORK:	Transmission Electron Microscopy (TEM) of air samples at Valve Packing Research - Garlock Inc.
ANALYST:	Dan Dolk

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. North
(303) 425-7038

TRANSMISSION ELECTRON MICROSCOPY (TEM)

Analysis Methodology

TEM analyses were conducted using NIOSH Method 7402 methodology. Issued August 15, 1987.

NIOSH 7402 methodology involves first mounting sub-samples of the air sample filters (mixed cellulose aster) on slides, and plasma etching the MCE filters. The samples are then coated with a thin layer of carbon in a vaccume vaporator. Following coating, samples are mounted on 3mm TEM copper grids (200 Mesh) and are further processed in a Jaffe Wick washer or condensation washer.

Sample grids are scanned on the TEM at 10,000x and structures identified using the the following characteristics:

1) All particules less than 3um diameter with length to width ratio of greater than 3:1 with parallel sides.

2) Record fibers diameter and length.

3) Record as Bundle, Cluster, Matrix, or Fiber.

4) Count fibers that are partially obscured by grid bars, log as 5um fiber if 2.5 mm is visible.

5) Determine asbestos fiber fraction shorter than 5um and thinner than 0.25um (these fibers undetected in PCM counting.)

Laboratory Equipment

The laboratory utilizes a Philips CM10 Transmission Electron Microscope. The TEM is equipped for electron diffraction and energy dispersive x-ray analysis. The TEM is located in our full service asbestos analysis laboratory near Denver, Colorado.

Laboratory Results

This report in no way implies product approval or endorsement by NIST. This report can be reproduced only in it's entirety. These results relate only to the samples as they were received by the laboratory. Sampling information is assumed to be correct as provided on the clients letter of transmittal.

In accordance with NIST regulation, ESSTEK, Inc. maintains a TEM laboratory average accuracy / precision record of greater than 90% true positives, and less than 10% false positives as calculated from the previous years quality assurance sample records.

ESSTEK, Inc.

TEM Asbestos Analysis Data Summary

Client:	HAZTOX, Inc., Seattle Office
Job Location:	Valve Packing Research - Garlock Inc.
Date of Analyses:	Feb 15 91

Description Sample Number	Laboratory Number	Asbestos Fibers / mm2 > 5 um	Asbestos Fibers /cc > 5 um	Asbestos Fiber All Fibers > 5 um
T5N-9	TE601511B	45.9	0.008	25%

Description Sample Number	Laboratory Number	Total Number Asbestos	Total Number Non-Asb.	All Asb. S/cc	All Asbestos All Fibers
T5N-9	TE601511B	19	41	0.016	32%

SDL = Sample Detection Limit

Note: As per EPA protocol, only structures greater than 0.3 um long counted

ESSTEK, Inc.
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ESSTEK, Inc.

TEM Asbestos Assessment Report

Sample Location:	Bystander - 5' North	Date Received:	Feb 15 91
Sample Number:	T5N-9	Date Analyzed:	Feb 15 91
Lab Sample Numb	TE601511B	Filter Type:	mixed cellulose
Sample Type:	Air	Filter Size (mm):	25
Volume Sampled:	2064.75 L	Analyst:	Dan Dolk

Analytical Sensitivity (s/cc):	N/A
Average Grid Opening Area (mm2):	0.0109
Number of Grid Openings Examined:	20
Area of Filter Sample Analyzed (mm2):	0.218

Structures Counted and Identified*

Fiber Description	Total Fibers	Fiber Length In Microns	Total Bundles	Total Clusters	Total Matrices	Total >5um	Total Structures
Chrysotile	4	2.0 - 5.0	6	2	7	10	19
Amosite	BDL	0.0	BDL	BDL	BDL		BDL
Actinolite	BDL	0.0	BDL	BDL	BDL		BDL
Anthophyllite	BDL	0.0	BDL	BDL	BDL		BDL
Crocidolite	BDL	0.0	BDL	BDL	BDL		BDL
Tremolite	BDL	0.0	BDL	BDL	BDL		BDL
Total Asbestos	4	2.0 - 5.0	6	2	7	10	19
Total Non-Asbe	38	2.0 - 24.0	2	N/A	1	30	41

Number of Asbestos Structures / CC > 5um : 0.008

Number of Asbestos Structures / mm2 > 5um : 45.9

Selected Area Diffraction:

Comments on Particulate Loading: N/A

Qualitative Description of Non-asbestos Particles: N/A

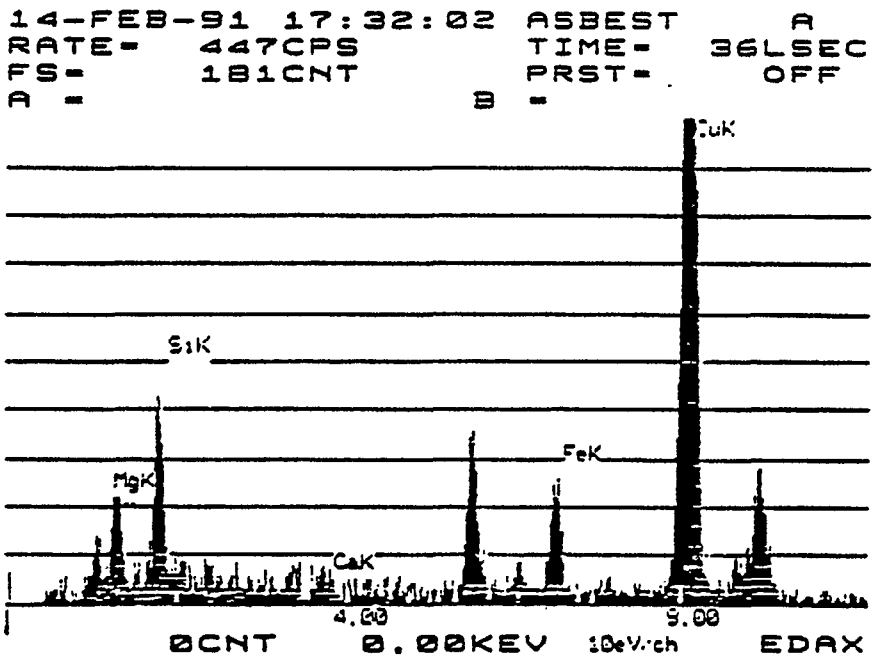
Asbestos < 5um micron structures: 9

Comments:

BDL = Below Detection Limit
Note: As per EPA protocol, only structures greater than 0.5 um long are counted.

ESSTEK, Inc.
11435 W. I-70 Frontage Rd. N., Wheat Ridge, CO 80033
(303) 425-7038

Reviewed and signed for the company by:


14-FEB-91 17:32:02 ASBEST A
RATE= 447CPS TIME= 36LSEC
FS= 181CNT PRST= OFF
A = B =
SiK
MgK
CaK
FeK
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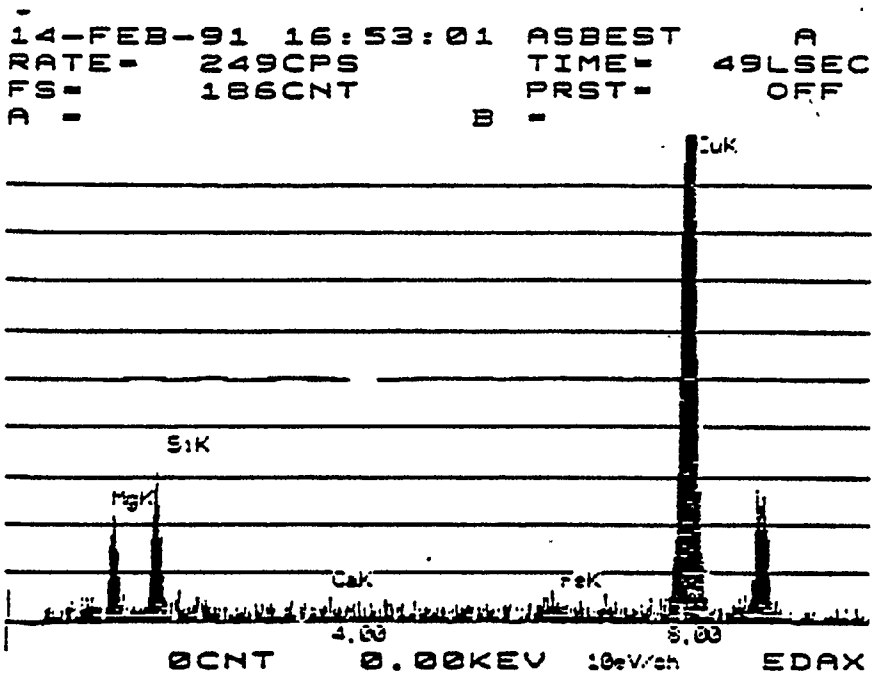
9.00
0CNT 0.00KEV 10eV/ch EDAX


14-FEB-91 16:53:01 ASBEST A
RATE= 249CPS TIME= 49LSEC
FS= 186CNT PRST= OFF
A = B =
CuK
SiK
MgK
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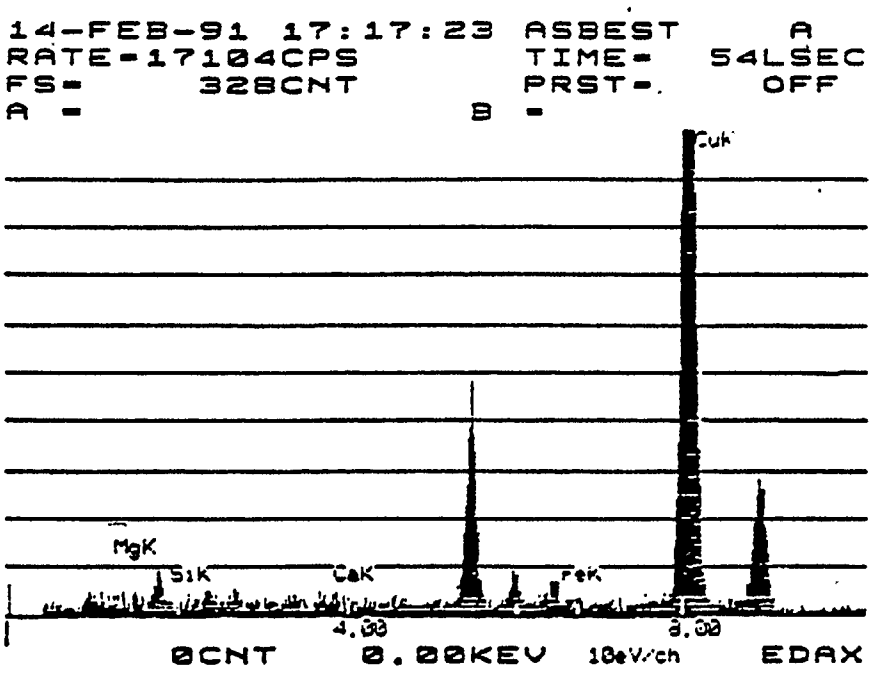
0CNT 0.00KEV 10eV/ch EDAX


14-FEB-91 17:17:23 ASBEST A
RATE=17104CPS TIME= 54LSEC
FS= 328CNT PRST=. OFF
A = B =
CuK
MgK
SiK
CaK
FeK
4.00
8.00
0CNT 0.00KEV 10eV/ch EDAX

EssTeK /HABTOX, Inc.

CORPORATE LICENSES AND ACCREDITATIONS

The following are the current corporate licenses and accreditations:

Boise Office:

NVLAP Accreditation from National Institute of Standards and Technology. Since May 1989	1368
EPA Bulk Asbestos Quality Assurance Program (RTI) Since April 1988	0285
EPA Interim Laboratory Accreditation for Laboratories that offer Analysis of Bulk Samples for Asbestos. Since June 1988	0285
AIHA Laboratory Accreditation Since June 1986	0303
PAT Participant Since June 1986	32903-001

Seattle Office:

NVLAP Accreditation from National Institute of Standards and Technology. Since May 1989	1631
AIHA Asbestos Analysts Registry Since April 1988	98168001
PAT Participant Since April 1988	98168001

ENCLOSURE 5
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Denver Office:

NVLAP Accreditation from
National Institute of Standards and Technology.

Bulk Since July 1989	1602
TEM Pending	1602-0D

AIHA Laboratory Accreditation

Since January 1989	378

AIHA Asbestos Analysts Registry

Since June 1988	80226001

PAT Participant

Since May 1988	80226-001

The Commonwealth of Massachusetts Certification for Analytical Services

Since July 1989	AA000068

The State of Vermont PLM, PCM, and TEM Analysis

Since September 1989	12299
	ID Code AAS-0289

Cleveland Office:

NVLAP Accreditation from
National Institute of Standards and Technology.

Since July 1989	1700

AIHA Asbestos Analysts Registry

Since March 1988	44130-001

PAT Participant

Since February 1988	44130-001

United States Department of Commerce
National Institute of Standards and Technology

NVLAP

Certificate of Accreditation

ESSTEK
WHEAT RIDGE, CO

is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations. Accreditation is awarded for specific services, listed on the Scope of Accreditation, for:

AIRBORNE ASBESTOS FIBER ANALYSIS

July 1, 1991
Effective until

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA •

Nancy M. Dahey
For the National Institute of Standards and Technology

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United States Department of Commerce
National Institute of Standards and Technology

NVLAP

Certificate of Accreditation

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ASBESTOS FIBER ANALYSIS

July 1, 1991
Effective until

DEPARTMENT OF COMMERCE • UNITED STATES OF AMERICA •

Nancy M. Dalton
For the National Institute of Standards and Technology

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AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

ESSTEK
Industrial Hygiene Laboratory
Wheat Ridge, Colorado

has fulfilled AIHA criteria for
Industrial Hygiene Laboratory Accreditation
since January 1, 1989

This accreditation shall be effective until
the 1st day of January, 1992
subject to continued compliance with
AIHA accreditation criteria.

Chairman
Laboratory Accreditation
Committee

President
American Industrial Hygiene
Association

#378
Accreditation Number

April 10, 1989
Date

PROFICIENCY ANALYTICAL TESTING PROGRAM
LABORATORY PERFORMANCE - ROUND 102

80226001 X X A X
GINA FESTI-GITANO

ESSTEK
11435 W 170 FRONTAGE ROAD N
WHEAT RIDGE, CO 80033

CONTAMINANT	SAMPLE	RND102 STATISTICAL SUMMARY REF. VALUE	PERFORMANCE LIMITS	NO. LABS	OUTLIERS HI	OUTLIERS LO	OUTLIERS TOT	LABORATORY RESULTS R102 DATA	PROF RATING	OUTLIER SUMMARY 99	100	101	102
LEAD (MG)	1	0.0842	0.0543-0.0741	380	9	18	27		-	-	-	-	-
	2	0.0288	0.0227-0.0310		16	18	34			-	-	-	-
	3	0.0843	0.0731-0.0955		9	23	32			-	-	-	-
	4	0.0483	0.0414-0.0552		13	17	30			-	-	-	-
CADMIUM (MG)	1	0.0090	0.0079-0.0101	386	18	24	42		-	-	-	-	-
	2	0.0117	0.0102-0.0133		13	18	31			-	-	-	-
	3	0.0182	0.0166-0.0217		14	17	31			-	-	-	-
	4	0.0118	0.0104-0.0134		14	16	30			-	-	-	-
ZINC (MG)	1	0.1071	0.0922-0.1220	382	16	21	37		-	-	-	-	-
	2	0.1297	0.1134-0.1458		21	24	45			-	-	-	-
	3	0.2186	0.1880-0.2491		13	17	30			-	-	-	-
	4	0.1751	0.1512-0.1990		15	14	29			-	-	-	-
SILICA (MG)	1	0.0702	0.0337-0.1484	109	0	4	4		-	-	-	-	-
	2	0.0778	0.0458-0.1321		3	7	10			-	-	-	-
	3	0.0534	0.0224-0.1276		1	5	6			-	-	-	-
	4	0.0842	0.0460-0.1542		0	7	7			-	-	-	-
ASBESTOS (F/MM2)	1	369.3	194.7- 599.5	1304	34	18	52	266.7	P				
	2	573.2	201.4-1135.2		10	10	20	492.4					
	3	783.1	435.7-1231.5		37	35	72	461.8					
	4	224.8	104.8- 390.1		103	7	110	-193					
SOLVENT (MG) 1	1	0.1908	0.1628-0.2189	382	29	17	46		-	-	-	-	-
	2	0.2445	0.2165-0.2726		34	21	55			-	-	-	-
	3	0.2894	0.2546-0.3242		30	23	53			-	-	-	-
	4	0.1477	0.1257-0.1696		26	23	49			-	-	-	-
SOLVENT (MG) 2	1	1.0888	0.9120-1.2657	382	26	19	45			-	-	-	-
	2	0.8029	0.6725-0.9333		21	16	37			-	-	-	-
	3	1.2488	1.0490-1.4501		15	17	32			-	-	-	-
	4	1.5362	1.2765-1.7959		15	17	32			-	-	-	-
SOLVENT (MG) 3	1	1.5987	1.3999-1.7975	382	21	25	46			-	-	-	-
	2	0.9020	0.7683-1.0357		18	15	33			-	-	-	-
	3	1.1526	1.0187-1.2864		28	16	44			-	-	-	-
	4	1.3808	1.2171-1.5446		31	22	53			-	-	-	-
		OVERALL:		1445					P				

BENZENE (BNZ)

O-XYLENE (OXY)

TOLUENE (TOL)

NOTES: -PROFICIENCY RATINGS: (P=PROFICIENT, NP = NUMBER OF TIMES NON-PROFICIENT, - = ANALYSIS NOT PERFORMED OR NOT RATED)
-OUTLIER SUMMARY: (BLANK=ANALYSIS ACCEPTABLE, - = ANALYSIS NOT RATED)
-ONLY ONE RATING IS GIVEN FOR ALL SOLVENT VALUES

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ASBESTOS ANALYSTS REGISTRY

JOE E.JENKINS
ESSTEK
11435 WEST I-70 FRONTAGE ROAD N
WHEAT RIDGE CO 80033

August 6, 1998

Report of performance for Round 14, Organization 86226661

ID	NAME (*=Aprvd)	RESULTS (f/cm^2) FOR THE CURRENT ROUND (R14)				OUTLIERS R14	R13	TOT	PERFORMANCE RATING
1468	*SCHAFER, STEVEN	A142 165	B142 188	C142 196	D142 388	0	0	0	ACCEPTABLE
1469	*CHRISTMER, MICHA	A142 357	B142 197	C142 315	D142 453	0	0	0	ACCEPTABLE
1478	*FESTI, GINA M.	A142 164	B142 168	C142 222	D142 335	0	0	0	ACCEPTABLE
1554	GADDIS, JOHN	A142 163	B142 125	C142 151 4Out	D142 214 4Out	2	0	2	ACCEPTABLE
1646	*JANZEN, JOHN	A142 357	B142 139	C142 232	D142 221	0	1	1	ACCEPTABLE
2415	*GITANO, ALAN	A142 144 4Out	B142 162	C142 255	D142 364	1	0	1	ACCEPTABLE
2414	*PINENTEL, D MILE	A142 322	B142 214	C142 266	D142 386	0	0	0	ACCEPTABLE
2418	*JENKINS, JOE E.	A142 172	B142 172	C142 255	D142 311	0	0	0	ACCEPTABLE
2426	*BOILER, ROBERT H	A142 252	B142 128	C142 322	D142 328	0	0	0	ACCEPTABLE
2425	*FISK, THOMAS E.	A142 144 4Out	B142 128	C142 191	D142 249	1	0	1	ACCEPTABLE
2424	*ROBINSON, COREY	A142 254	B142 161	C142 268	D142 277	0	0	0	ACCEPTABLE
2794	FERRELL, ED	A142 218	B142 283	C142 325	D142 421	0	0	0	ACCEPTABLE
1686	*HORTON, GREGORY	A142 124 4Out	B142 185	C142 318	D142 398	1	0	1	ACCEPTABLE

The determination of outliers for the above results are based on the following performance limits:

SAMPLE I.D.:	A141	B141	C141	D141	A142	B142	C142	D142	E142	F142	G142	H142
LOWER LIMIT:	187	75	283	98	153	183	178	217	335	381	388	142
REF. VALUE :	375	149	487	191	387	287	356	434	678	682	776	285
UPPER LIMIT:	749	299	813	382	614	414	711	869	1348	1284	1552	578

All results for the AAR program MUST be reported to AIHA, PO Box 8399, 345 White Pond Drive, Akron OH 44320-8998.(216/873-2442). ONLY SCAN FORMS WILL BE ACCEPTED NO PHOTOCOPIES OR FAXES.

THE AMERICAN BOARD OF INDUSTRIAL HYGIENE
INCORPORATED

AMERICAN BOARD OF INDUSTRIAL HYGIENE

Organized to improve the practice and educational standards of the profession of Industrial Hygiene.

This is to certify that

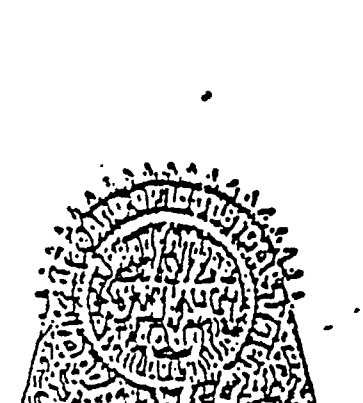
Donald G. Quilici

has met the requirements of this Board through his education, experience, and professional ability, and is hereby certified in the

COMPREHENSIVE PRACTICE

of

INDUSTRIAL HYGIENE



Date
May 12, 1974

Certificate Number
852

Chairman of the Board of Trustees

Secretary