Report of Results: MVA0154
Manchester, New Hampshire

Prepared for:

Faraci, Guadagnino, Lange & Johns
Suite 300, Times Square Building
45 Exchange Street
Rochester, New York 14614

Prepared by:

Millette, Vander Wood & Associates, Inc.
5500 Oakbrook Parkway, Suite 200
Norcross, Georgia 30093

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Report of Results: MVA Project No. 0154
Manchester, NH

MEASUREMENT OF AIRBORNE ASBESTOS CONCENTRATIONS DURING THE REMOVAL OF VALVE PACKING

INTRODUCTION

Most piping systems use valves to regulate the flow of fluids or gases within them. The valves, especially in industrial facilities, may contain asbestos packing material which acts as a seal to prevent fluid or gas leakage as the valve is turned. At various time intervals the valves must be repaired or maintained by removing the packing and replacing it with new packing. In some large steam plants it is common practice to collect a number of valves together and perform the removal and repacking of these valves at one time, and this effort may involve several workers and take several days to complete. The purpose of this study was to document the airborne levels of asbestos, if any, during valve packing removal activity.

ASBESTOS PACKING MATERIAL

According to the U.S. Environmental Protection Agency (EPA), asbestos packing means an asbestos-containing product intended for use as a mechanical seal in circumstances involving rotary, reciprocating, and helical motions, and which are intended to restrict fluid or gas leakage between moving and stationary surfaces (1).

The graphite impregnated packing material which has the appearance of shiny stiff rope is the type most commonly used in valves. Compression packings are manufactured from various forms of fibers, such as vegetable, animal, mineral (asbestos), or synthetic combined with binders and lubricants. The types of construction include twisted or braided (2). Packings are not considered friable asbestos-containing materials (ACM) because they are not easily crumbled into fine or dusty material by hand pressure. However, EPA states that products such as packing may release asbestos dust if cut or torn (3).

STUDY TEAM

The on-site research team consisted of James R. Millette, Ph.D., of Millette, Vander Wood & Associates, Inc. (MVA), Michael D. Mount, OHST, of Azimuth, Inc., and Robert Yantz, a retired steam plant maintenance worker.

STUDY SITE

The study was conducted in an unused steam power plant in Manchester, New Hampshire. The study team conducted the valve packing removal tests after an asbestos abatement contractor had prepared a double containment area around two valves attached to the main power plant turbine. Prior to the studies, the abatement contractor prepared the valves by removing all pipe insulation from the valve area and thoroughly cleaning each valve. In a separate area of the plant the abatement contractor also prepared a third valve which had been disconnected from the steam plant piping system by similarly removing all the pipe insulation and cleaning the valve thoroughly. This valve was later moved into the containment for packing removal. The containment barriers in the area consisted of layers of 6-mil polyethylene plastic sheets on a wooden frame and two layers of 6-mil polyethylene plastic on the floor. A containment area (5 ft by 7 ft) around the valves was completely contained within a larger containment area (7 1/2 ft by 11 ft). The study area had two High Efficiency Particle Absolute (HEPA) air filtration devices (AFD) used to clean the air of particulates including asbestos. The inner area AFD was turned off during each phase of testing. The outer area AFD operated throughout the tests. A diagram of the area is shown in Appendix A.

PERSONAL PROTECTION

All personnel inside the study area were protected by air purifying respirators and complete head and body coverings. The decontamination system consisted of a hallway outside the testing area, a shower room, and a clean room. The decontamination system was used each time a person exited the study area and the overall containment area.

EXPERIMENTAL PROCEDURES

The study was conducted on August 27, 1991, and consisted of collection of air samples before and during a valve packing removal activity to compare the airborne asbestos fiber levels. The activity was replicated three times. Prior to starting each part of the study, four area air samples were collected to determine the background level of asbestos in the air of the study area. The sampling cassettes were located on the walls at the breathing zone, five feet from the floor. A total volume of 720 to 840 liters of air passed through each cassette at a flow rate of 15 liters per minute. Two area air samples were collected during the valve packing removal in the same locations as the background air samples. The person doing the packing

removal (Mr. Yantz) was fitted with two personal air sampling devices. These personal air samples were collected at a rate of about 2 - 3.5 liters per minute. The person observing and taking photographs (Dr. Millette) also wore two personal air sampling cassettes. These air samples were collected at a rate of 2 - 3.5 liters per minute. Following packing removal from a valve attached to the power turbine, the area was cleaned and another valve found disconnected from the piping system was moved to the containment. The air filtration unit was turned on for a period of approximately 2 hours to reduce the number of airborne fibers in the study area. Prior to the second test a new set of background samples was collected. After the second test the area was cleaned and the air filtration unit again allowed to cleanse the air.

The first two valve packing removal activities consisted of opening a valve and reaching in with a variety of tools to pull out the old packing. The third test utilized the same valve that had been opened in the second test. More packing was removed. Mr. Yantz brought his own tools and performed the removal of packing in the same way that he had in his previous years of work with industrial valves. Pieces of the removed packing were placed in plastic bags and stored for analysis. Each packing removal activity occurred for approximately 30 minutes.

Three sampling locations were established outside the study area to monitor the airborne fiber levels during the packing removal. Two samplers were positioned in the outer containment area and one was placed outside the entrance the decontamination system. These samples were analyzed to make sure that fibers were not escaping the contained study area.

ANALYTICAL METHODS

All samples were analyzed by phase contrast microscopy (PCM) following the method currently required under Occupational Safety and Health Administration (OSHA) regulations. This method, developed by the National Institute of Occupational Safety and Health (NIOSH) is called the NIOSH 7400 method. The analyst followed the "A" counting rules which are currently specified by OSHA for asbestos monitoring. The phase contrast microscope enhances the analyst's ability to see fibers over other types of light microscopes but the technique does not involve an identification step which specifically determines that the fibers counted are all asbestos. Therefore, in addition, some of the samples were analyzed by transmission electron microscopy (TEM) following the NIOSH 7402 preparation method. The TEM analysis procedure identifies asbestos fibers on the basis of morphology, crystal structure, and x-ray elemental analysis. Only asbestos fibers longer than 5 um were counted.

Samples of the packing material removed from the valves were analyzed for asbestos type by polarized light microscopy (PLM) techniques. Samples of the packing material were also examined by scanning electron microscopy (SEM) to determine whether or not the chrysotile fibers were encapsulated.

The friability test to determine whether or not an asbestos-containing material potentially will release asbestos is a field test in which an attempt is made to crumble the ACM by hand. If the material can be crumbled by hand, it is considered friable. The U. S. Environmental Protection Agency (EPA) distinguishes friable from non-friable ACM in their regulations on handling asbestos products. Friable ACM is considered more of a potential hazard than non-friable material.

RESULTS

The results of the PCM analyses of the air samples collected in the study area are shown in Table I. Prior to the first test, the background air samples showed that the air contained less than 0.006 fibers/cc. During the actual removal activity, one personal sample collected on Mr. Yantz, the person doing the packing removal, showed that his exposure was about 0.2 fibers/cc. The personal samples on Dr. Millette, who was observing the removal operation ranged from 0.1 to 0.2 fibers/cc.

Prior to the second test, three of the four background air samples were less than 0.006 fiber/cc. One background sample was 0.009 fibers/cc. The personal samples on Mr. Yantz during the packing removal showed levels of over 1 fiber/cc in the air. The personal samples on Dr. Millette ranged from about 0.6 to 0.9 fibers/cc.

Prior to the third test, all background air samples showed the airborne fiber concentration to be less than 0.007 fiber/cc. The personal samples on Mr. Yantz during the packing removal ranged from about 0.4 to 0.7 fibers/cc. The personal samples on Dr. Millette ranged from 0.2 to 0.3. The area samples collected in the vicinity of the packing removal activity were elevated over the background levels in all three tests. The air samples collected outside the double containment at the door to the decontamination unit were less than detection limits.

The TEM analyses results are shown in Table II. Chrysotile asbestos fibers were identified as the primary fiber in the air samples collected during the packing removal. Chrysotile asbestos was the type of asbestos found by polarized light microscopy in the packing material removed. All asbestos fibers longer than 5 μm were counted and recorded during the TEM

analysis. However, fibers thinner than about 0.25 µm would not be resolved by the PCM method which uses a light microscope. Therefore, two asbestos concentrations are listed. One of all asbestos fibers greater than 5 µm and one including only those over 5 µm in length and also over 0.25 µm in width. The second value is considered a PCM equivalent count because the fibers counted in the TEM would be equivalent to what would be seen by the PCM. Because of the greater resolving power of the electron microscope the fibers longer than 5 µm but thinner than 0.25 µm can be counted in the TEM analysis.

The used packing, removed from the valve, was friable. When examined under the scanning electron microscope, the sample of used packing was found to contain chrysotile fibers which were uncoated with any binder material.

CONCLUSIONS

The data show that airborne levels of asbestos fibers can be over the OSHA excursion limit (30 minute sample) of 1 fiber per cc during the removal of asbestos-containing packing material from valves using methods routinely employed by maintenance workers. Airborne levels of asbestos are significantly increased over background levels in the vicinity of the packing removal during the removal activity.

REFERENCES

1. Federal Register, July 12, 1989, 54(132):29509.
2. Nelson, C. A., Millwrights and Mechanics Guide, McMillian Pub. Co., London, (1986), p. 236.
3. U.S. EPA, Asbestos Waste Management Guidance, EPA/530-SW-85-007, p. 146.

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TABLE I

PHASE CONTRAST ANALYSIS (PCM)

FIRST TEST

SAMPLE # DATE	TIME SAMPLE TYPE	SAMPLE DESCRIPTION	RATE (LPM) VOLUME (L)	FIBERS FIELDS	CONC IN FIBERS/CC
10 27 Aug 91	807-901 Background	Southwest Corner of Containment, Inside Building; Inside Work Area	15.00 810	8.0 100	< 0.006
11 27 Aug 91	805-901 Background	Center of Containment, Inside Building; Inside Work Area	15.00 840	8.5 100	< 0.006
12 27 Aug 91	805-901 Background	East Wall of Containment, Inside Building; Inside Work Area	15.00 840	11.0 100	< 0.006
13 27 Aug 91	805-901 Background	Northeast Corner of Containment, Inside Building; Inside Work Area	15.00 840	11.5 100	< 0.006
14 27 Aug 91	1050-1115 Personal	Bob Yantz, Right Side, Inside Building; Inside Work Area	2.00 50	22.0 100	0.184
15 27 Aug 91	0-0 Personal	Bob Yantz, Left Side, Inside Building; Inside Work Area VOID - PUMP FAILED	0.00 0	0.0 100	
16 27 Aug 91	1050-1115 Personal	Jim Millette, Left Side Inside Building; Inside Work Area	3.50 87.5	23.5 100	0.114
17 27 Aug 91	1050-1115 Personal	Jim Millette, Right Side Inside Building; Inside Work Area	2.00 50	26.0 100	0.223
18 27 Aug 91	0-0 Area	Southwest Corner of Containment, Inside Building; Inside Work Area VOID - FILTER DAMAGED	0.00 0	0.0 100	
19 27 Aug 91	1050-1116 Area	Northeast Corner of Containment, Inside Building; Inside Work Area	15.00 390	54.00 100	0.064

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TABLE I

PHASE CONTRAST ANALYSIS (PCM)

SECOND TEST

SAMPLE # DATE	TIME SAMPLE TYPE	SAMPLE DESCRIPTION	RATE (LPM) VOLUME (L)	FIBERS FIELDS	CONC IN FIBERS/CC
20 27 Aug 91	1305-1402 Background	Center of Containment, Inside Building; Inside Work Area	15.00 855	9.0 100	< 0.006
21 27 Aug 91	1305-1402 Background	Southwest Corner of Containment, Inside Building; Inside Work Area	15.00 855	19.5 100	0.009
22 27 Aug 91	1305-1402 Background	East Wall of Containment, Inside Building; Inside Work Area	15.00 855	10.0 100	< 0.006
23 27 Aug 91	1305-1402 Background	Northeast Corner of Containment, Inside Building; Inside Work Area	15.00 855	13.0 100	< 0.006
24 .. / Aug 91	1448-1519 Personal	Bob Yantz, Left Side, Inside Building; Inside Work Area	3.00 93	102.5 53	1.003
25 27 Aug 91	1448-1519 Personal	Bob Yantz, Right Side, Inside Building; Inside Work Area	2.00 62	100.5 61	1.278
26 27 Aug 91	1448-1519 Personal	Jim Millette, Right Side, Inside Building; Inside Work Area	2.00 62	100.5 85	0.910
27 27 Aug 91	1448-1519 Personal	Jim Millette, Left Side Inside Building; Inside Work Area	3.00 93	100.0 91	0.562
28 27 Aug 91	1446-1510 Area	Southwest Corner of Containment, Inside Building; Inside Work Area	7.50 180	109.5 67	0.436
29 27 Aug 91	1446-1511 Area	Northeast Corner of Containment, Inside Building; Inside Work Area	15.00 375	102.0 46	0.286
30 27 Aug 91	1044-1156 Area	Southwest Corner of Outer Containment, Inside Building; Outside Work Area	7.50 540	42.0 100	0.035
31 27 Aug 91	1044-1156 Area	Northeast Corner of Outer Containment, Inside Building; Outside Work Area	15.00 1080	71.0 100	0.031
32 27 Aug 91	1044-1156 Area	At Entrance to Decon, Inside Building, Outside Work Area	15.00 1080	14.0 100	0.005

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TABLE I

PHASE CONTRAST ANALYSIS (PCM)

THIRD TEST

SAMPLE # DATE	TIME SAMPLE TYPE	SAMPLE DESCRIPTION	RATE (LPM) VOLUME (L)	FIBERS FIELDS	CONC IN FIBERS/CC
33 28 Aug 91	736-824 Background	In Northeast Corner of Containment, Inside Building; Outside Work Area	15.00 720	9.0 100	< 0.007
34 28 Aug 91	736-824 Background	In Southwest Corner of Containment, Inside Building; Inside Work Area	15.00 720	4.0 100	< 0.007
35 28 Aug 91	736-824 Background	In Center of Containment, Inside Building; Inside Work Area	15.00 720	4.5 100	< 0.007
36 28 Aug 91	736-824 Background	On East Wall of Containment, Inside Building; Inside Work Area	15.00 720	5.5 100	< 0.007
37 28 Aug 91	849-922 Personal	Bob Yantz, Right Shoulder, Inside Building; Inside Work Area	2.00 66	62.6 100	0.440
38 28 Aug 91	849-922 Personal	Bob Yantz, Left Shoulder, Inside Building; Inside Work Area	3.00 99	106.0 72	0.713
39 28 Aug 91	847-926 Personal	Jim Millette, Left Shoulder, Inside Building; Inside Work Area	3.00 117	50.5 100	0.198
40 28 Aug 91	847-926 Personal	Jim Millette, Right Shoulder, Inside Building; Inside Work Area	2.00 78	56.5 100	0.335
41 28 Aug 91	845-920 Area	Northeast Corner of Containment, Inside Building; Inside Work Area	15.00 525	107.5 63	0.156
42 28 Aug 91	845-920 Area	Southwest Corner of Containment, Inside Building, Inside Work Area	7.50 262.5	85.5 100	0.154
43 28 Aug 91	845-920 Area	Northeast Corner of Outer Containment, Inside Building; Inside Work Area	15.00 525	41.0 100	0.035
44 28 Aug 91	845-920 Area	Southwest Corner of Outer Containment, Inside Building; Inside Work Area	7.50 262.5	41.0 100	0.071
45 28 Aug 91	850-909 Area	At Entrance to Decon, Inside Building; Outside Work Area	15.00 285	4.0 100	< 0.017

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TABLE II

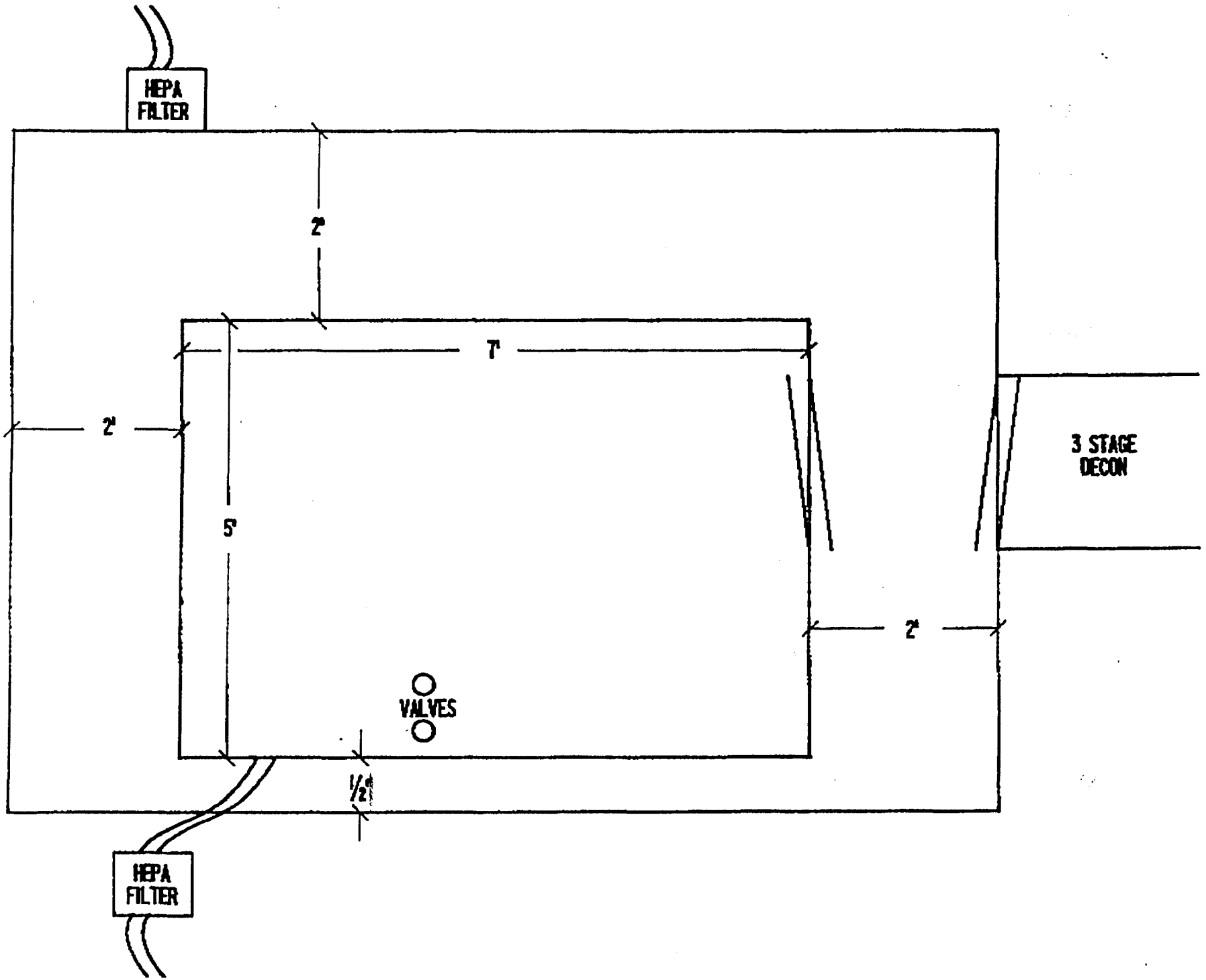
TEM ANALYSIS OF AIR SAMPLES
DURING PACKING REMOVAL
DIRECT PREPARATION

MVA #	Field I.D. #	Description	Asbestos Concentration (Fibers/cc) All >5µm	PCM Equiv*
B2178	24	Personal During Second Test	2.2	1.5
B2179	25	Personal During Second Test	4.2	2.6
B2180	37	Personal During Third Test	1.5	1.2
B2181	38	Personal During Third Test	2.1	1.5

* Phase Contrast Equivalent by Transmission Electron Microscopy Counting. Asbestos fibers must be >5µm in length and > .25 µm in width.

A P P E N D I X A

Diagram of Study Site


HEPA FILTER
2'
7'
2'
5'
3 STAGE DECON
2'
VALVES
1/2"
HEPA FILTER

A P P E N D I X B

Transmission Electron Microscopy
PCM Equivalent Data Sheets

MVA PROJECT # :0154
LAB SAMPLE ID :B2178
CLNT SAMPLE ID:24
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 93
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/03/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
1	B3	1	F	6.82	0.11	C	
		2	F	7.27	0.11	C	
		3	F	9.55	0.23	C	
		4	F	9.55	0.34	C	
		5	F	5.68	0.23	C	
		6	F	9.09	0.26	C	
		7	F	5.23	0.68	C	
		8	F	15.91	1.14	C	
	E9	9	F	5.68	0.23	C	
		10	F	5.68	0.23	C	
		11	F	5.91	0.23	C	
	H8	12	F	15.23	1.82	C	
		13	F	15.91	0.91	C	
		14	F	7.95	0.23	C	
		15	F	9.09	0.23	C	
		16	F	6.82	0.45	C	
	I5	17	F	9.77	0.57	C	
		18	F	34.09	0.45	C	
		19	F	14.09	0.23	C	
		20	F	7.05	0.34	C	
	J2	21	F	5.68	0.23	C	
		22	F	11.36	0.23	C	
		23	F	35.23	2.27	C	Y
		24	F	7.73	0.80	C	
2	D6	25	F	5.68	0.34	C	
		26	F	6.82	1.14	C	
	F10	27	F	7.50	0.23	C	
		28	F	10.91	0.45	C	
		29	F	9.55	0.57	C	
		30	F	7.95	0.45	C	
		31	F	7.27	0.11	C	
	G6	32	F	7.27	0.34	C	
		33	F	5.68	0.91	C	
		34	F	20.45	0.45	C	
		35	F	11.36	0.11	C	
		36	F	25.00	0.34	C	
	F2	37	F	5.45	0.45	C	
		38	F	6.82	0.57	C	
	A1	39	F	7.95	0.45	C	
		40	F	13.64	1.59	C	

MVA PROJECT # :0154
LAB SAMPLE ID :B2178
CLNT SAMPLE ID:24
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 93
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/03/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
2	A1	41	F	9.55	0.45	C	
		42	F	6.14	0.68	C	
		43	F	8.41	0.57	C	

MVA PROJECT # :0154
LAB SAMPLE ID :B2179
CLNT SAMPLE ID:25
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 62
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/03/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
1	H7	1	F	9.55	0.11	C	
		2	F	19.32	0.34	C	
		3	F	35.23	1.14	C	
		4	F	6.14	0.45	C	
		5	F	11.36	0.45	C	
	I3	6	F	10.68	0.11	C	
		7	F	9.09	1.14	C	
		8	F	21.59	0.11	C	
		9	F	10.91	0.23	C	
		10	F	15.91	0.34	C	
	E1	11	F	15.91	0.91	A	Y
		12	F	17.05	0.68	C	
		13	F	7.27	0.34	C	
		14	F	8.41	0.45	C	
	B5	15	F	6.36	0.11	C	
		16	F	9.09	0.11	C	
		17	F	6.14	0.11	C	
		18	F	6.82	0.11	C	
		19	F	5.45	0.91	C	
		20	F	20.45	0.34	C	
		21	F	17.05	0.45	C	
		22	F	15.45	0.80	C	
	D9	23	F	8.41	0.57	C	
		24	F	8.86	0.23	C	
		25	F	13.64	0.45	C	
		26	F	7.50	0.23	C	
		27	F	40.91	2.27	C	Y
		28	F	11.36	0.68	C	
2	C5	29	F	17.05	0.91	C	
		30	F	5.00	0.80	C	
		31	F	7.95	0.23	C	
		32	F	5.68	1.14	C	
		33	F	12.50	0.23	C	
		34	F	12.50	0.23	C	
		35	F	23.86	0.57	C	
		36	F	5.68	0.23	C	
	B9	37	F	7.05	0.68	C	
		38	F	15.91	0.45	C	
		39	F	21.59	1.59	C	
		40	F	7.50	0.23	C	

MVA PROJECT # :0154
LAB SAMPLE ID :B2179
CLNT SAMPLE ID:25
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 62
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/03/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
2	B9	41	F	19.32	0.57	C	
	F10	42	F	5.68	0.23	A	Y
		43	F	8.41	1.36	C	
		44	F	30.68	0.45	C	
		45	F	12.50	0.11	C	
	J7	46	F	38.64	0.23	C	
		47	F	22.50	0.11	C	
		48	F	18.86	1.59	C	
		49	F	17.27	0.11	C	
	H2	50	F	6.14	0.34	C	
	H7	51	F	7.50	0.34	C	
		52	F	5.91	0.45	C	
		53	F	7.73	0.11	C	
		54	F	13.64	0.57	C	
		55	F	23.41	0.45	C	

MVA PROJECT # :0154
LAB SAMPLE ID :B2180
CLNT SAMPLE ID: 37
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 66
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/4/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
1	C1	1	F	15.23	0.45	C	Y
		2	F	23.86	0.57	C	
		3	F	51.14	1.14	C	
		4	F	7.95	0.45	C	
		5	F	17.05	0.45	C	
		6	F	5.91	0.23	C	
		7	F	5.91	0.45	C	
	A7	NSD*					
	E10	8	F	13.64	0.11	C	
		9	F	11.82	1.82	C	
	I9	10	F	27.27	0.57	C	
		11	F	46.59	0.45	C	
		12	F	7.95	0.45	C	
		13	F	42.05	0.68	C	
	J6	14	F	6.14	0.57	C	
2	H2	15	F	6.82	0.45	C	
	B3	16	F	25.68	0.23	C	
	E9	17	F	7.95	0.23	C	
	G8	18	F	24.09	1.93	A	Y
		19	F	5.68	0.45	C	
		20	F	14.77	0.34	C	
	F4	21	F	8.64	0.57	C	

* No Asbestos Structures Detected

MVA PROJECT # :0154
LAB SAMPLE ID :B2181
CLNT SAMPLE ID: 38
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 99
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/4/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
1	B2	1	F	7.05	0.23	C	
		2	F	7.50	0.11	C	
		3	F	11.36	0.45	C	Y
	C6	4	F	11.82	0.80	C	
		5	F	6.82	0.34	C	
		6	F	15.23	1.14	C	
	G9	7	F	22.95	0.68	C	
		8	F	9.09	0.45	C	
		9	F	20.45	1.59	C	
		10	F	10.23	0.34	C	
		11	F	11.36	1.36	C	
	H5	12	F	10.23	0.57	C	
		13	F	17.05	2.27	C	
	F1	14	F	5.68	0.11	C	
		15	F	12.95	0.45	C	
		16	F	47.73	0.80	C	
		17	F	18.18	1.14	C	
		18	F	12.50	0.45	C	
		19	F	7.05	0.34	C	
2	A1	20	F	10.23	0.45	C	
		21	F	13.64	0.11	C	
		22	F	69.32	0.68	C	
		23	F	7.95	0.23	C	
		24	F	17.05	0.91	C	
		25	F	6.14	0.11	C	
	D6	26	F	6.82	0.80	C	
		27	F	5.68	0.57	C	
		28	F	5.45	0.68	C	
		29	F	7.95	0.45	C	
		30	F	26.14	0.57	C	
	G10	31	F	10.23	0.91	C	
		32	F	29.55	2.05	C	
		33	F	11.14	0.34	C	
	I4	34	F	5.68	0.11	C	
		35	F	6.14	0.34	C	
		36	F	19.77	0.23	C	
		37	F	12.50	0.11	C	
		38	F	6.14	0.11	C	
		39	F	6.14	0.11	C	
		40	F	7.50	0.45	C	

MVA PROJECT # :0154
LAB SAMPLE ID :B2181
CLNT SAMPLE ID: 38
INSTRUMENT ID :CM12
MAGNIFICATION : 4.4 K
ACC. VOLTAGE : 100 KV

GRID NUMBER :025G91
GRID OPENING (MM2):0.0082
OPENINGS ANALYZED : 10
AMT COLLECT (L) : 99
AMT PREPPED (L) :DIRECT
FILTER AREA (MM2) : 385

ANALYST:RKW
DATE :10/4/91
COMMENT:PCM EQUIVAL.

GRID	INDEX	STR#	STRU TYPE	LENGTH (um)	WIDTH (um)	SAED	EDS
2	I4	41	F	11.36	0.23	C	
	F2	42	F	5.91	0.45	C	
		43	F	52.27	1.82	C	
		44	F	18.18	0.11	C	
		45	F	11.36	0.80	C	

Notes on TEM Air Analysis Sheets

Explanation of Headings:

MVA PROJECT #	- Number assigned by MVA to the project
LAB SAMPLE ID	- Code assigned to each sample logged into the laboratory
CLNT SAMPLE ID	- Client identification, usually a field number
INSTRUMENT ID	- Electron microscope used. CM12 is a TEM model produced by Philips.
MAGNIFICATION	- Actual magnification at the microscope screen. 19.4 K is 19,400 times.
ACC. VOLTAGE	- Accelerating voltage of the TEM
GRID NUMBER	- Box grid was placed in for analysis
GRID OPENING (MM2)	- Average area of a grid opening in square millimeters
OPENINGS ANALYZED	- Number of grid openings examined
AMT COLLECT (L)	- Volume of air for the air sample collected in liters
AMT PREPPED (L)	- For direct preps, the volume prepared is the same as collected. For indirect preps the equivalent volume prepared from a portion of the air sample. A dilution factor can be calculated by dividing amount prepped by amount collected.
FILTER AREA (MM2)	- Area of the final filter used in the preparation process in square millimeters
GRID	- Number of grids analyzed, usually two grids are analyzed per sample
INDEX	- Grid opening location
STR#	- Number of structures counted
STRU TYPE	- F=fiber, B=bundle, Cl=cluster, M=matrix
LENGTH (um)	- Length of structure in micrometers
WIDTH (um)	- Width of structure in micrometers
SAED	- Selected Area Electron Diffraction Pattern C=chrysotile, A=amphibole
EDS	- Energy Dispersive X-ray Spectroscopy Y=yes, spectrum consistent with C or A

Calculation of Asbestos Structures per Cubic Centimeter:

$$\text{Str/cc} = \frac{(\#\text{STR} \times \text{FILTER AREA})}{(\text{OPENINGS ANALYZED} \times \text{GRID OPENING} \times \text{AMT PREPPED} \times \text{AMT COLLECT})}$$

A P P E N D I X C

Polarized Light Microscopy Analysis of Packing Removed from Valve During Third Test

Millette, Vander Wood & Associates, Inc.
5500 Oakbrook Parkway, Suite 200
Norcross, Georgia 30093
(404) 662-8509

PLM ASBESTOS ANALYSIS

MVA #: 0154 Client: Faraci, Guadagnino, Lange & Johns

Sample ID: B1992 Client Sample ID: J082791-7

Macroscopic Description: B1992 is a white fibrous woven material with a black flaky coating.

Asbestos Minerals:		Other Fibers:	
Chrysotile	~85%	Glass Fibers	
Amosite		Cellulose	
Crocidolite		Synthetic Fibers	
Anthophyllite Asbestos		Other	
Tremolite/Actinolite Asbestos			
Total Asbestos	~85%		

Fillers/Binders/Pigment % ~15%

Fillers/Binders/Pigment Identified (*):

Mica/Vermiculite		Perlite/Pumice	
Synthetic Foam		Carbonate	
Gypsum		Pigment	
Carbon and iron oxides	* * *		

Comments: Labeled "3rd Valve, 2nd Exp."

Analyst: Maureen C. Bottrell Date: 09/04/91