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**FIBER RELEASE STUDY  
INDUSTRIAL FITTINGS  
VALVE PACKING REMOVAL**

November 19, 1996  
BAI Project #1418A-4602



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FIBER RELEASE STUDY  
INDUSTRIAL FITTINGS  
VALVE PACKING REMOVAL

EXECUTIVE SUMMARY

Objectives

The purpose of the study was to determine the concentration of fibers in the air while packing material was removed from valves.

Background

The study was performed using intact valves from industrial fittings. The fittings had been in service many years and were obtained from a decommissioned power house.

The study was conducted in an isolation chamber to eliminate outside influences. The study was conducted at the rate of one (1) fitting per hour over an 8-hour period.

The study was conducted on October 2, 1996 by Mr. Fred Boelter. This report presents the results of the study described herein.

Sample Results

All samples measured concentrations of fibers in air well below the U.S. Department of Labor Occupational Safety and Health Administration (USDOL-OSHA) 8-hour Time-Weighted Average (TWA) Permissible Exposure Limit (PEL) of 0.1 fibers per cubic centimeter (f/cc). Sample results are presented in the accompanying tables.



## METHODOLOGY

### PCM Sampling Procedure

Samples were collected and analyzed following NIOSH Method 7400. Air was drawn through a 25mm, conductive cowl cassette with a 0.8 micron mixed cellulose ester (MCE) filter for collecting airborne particulate. The cassette was connected to a dedicated Gilian servo-drive pump. The pump was used to maintain a flow rate of two (2) liters per minute (lpm) for both personal and area room air samples.

A Brooks rotameter was used to calibrate the pumps prior to and post sample collection. The rotameter was calibrated against a primary standard.

The samples were sealed, labeled and shipped to the laboratory for analysis. Samples were signed by BEC, placed in a UPS shipping envelope, sealed, tracked by UPS, and arrived at the laboratory by next day air.

### Personal Samples

Personal samples were collected by attaching the cassette in the breathing zone of the individual performing the work for the duration of the test. The sampling pump was worn on the individual's belt.

### Average Room Air Samples

The isolation chamber was subdivided into 3,600 one cubic foot (1ft<sup>3</sup>) modules. For purposes of identification, each module was assigned a discrete, consecutive number.

To determine the average room air concentration, eight (8) of the modules were selected using a random number generator. A sample cassette was located in the center of the respective module for the duration of the test.

### Background Air Samples for TEM Analysis

Prior to conducting the test, the room was sampled to verify cleanliness. Five (5) samples were analyzed by transmission electron microscopy (TEM) following AHERA Protocol.

Just prior to collecting the samples, a "leaf blower" was utilized to aggressively disturb the isolation chamber's interior surfaces.

Air was drawn through a 25mm, conductive cowl cassette with a 0.8 micron mixed cellulose ester (MCE) filter for collecting airborne fibers. The cassette was connected to a dedicated Gast high volume pump. The pump was used to maintain a flow rate of 10 liters per minute (lpm).

A BGI rotameter was used to calibrate the pumps prior to and post sample collection. The rotameter was calibrated against a primary standard.



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The samples were sealed, labeled and shipped to the laboratory for analysis. Samples were signed by BEC, placed in a UPS shipping envelope, sealed, tracked by UPS, and arrived at the laboratory by next day air.

#### Background Air Samples for PCM Analysis

Simultaneous with collecting the five (5) samples for analysis by AHERA Protocol, three (3) additional air samples were collected in accordance with NIOSH 7400 for PCM analysis "on-site" in the BEC office. The same analytical procedures were followed in the BEC office as were used in the laboratory. An Olympus Model CH-2 phase contrast microscope was used for the BEC analyses.

#### Light Microscopy Analysis

Samples were analyzed in accordance with NIOSH Method 7400. Total fiber counts were determined by phase contrast microscopy (PCM) in accordance with the NIOSH Manual of Analytical Methods, Fourth Edition, dated 8/15/94, A Rules. Values for PCM analysis are provided in the Appendix A and Appendix B spreadsheets.

Only fibers longer than 5 microns which have a length to width ratio equal to or greater than 3:1 are counted. PCM analysis counts all fibers meeting the specified dimensions. The analysis is not specific for asbestos but is the method specified to be used in the OSHA regulations.

The PCM laboratory reports are presented in Appendix C.

#### Electron Microscopy Analysis

AHERA Protocol transmission electron microscopy (TEM) analysis was performed on all background samples to verify the cleanliness of the isolation chamber prior to beginning the test. The sample analysis was performed as described in the Federal Register Vol. 52, No. 210, the Asbestos Hazard Emergency Response Act (AHERA Protocol).

Small squares were cut from each filter, processed appropriately, placed onto 200 mesh copper screens (grids) and transferred to a modified Jaffe Wick Washer containing acetone solvent. After the appropriate processing time, the grids were examined with a JEOL 1200EX or 100CX TEM. Grid openings from each sample were scanned at 20,000 X.

When fibers or structures of various shapes were encountered, they were assessed for morphological characteristics and crystalline structure with selected area electron diffraction (SAED).

The TEM laboratory reports are presented in Appendix D.

#### Statistical Comparisons

Data was formatted in spreadsheets for analysis. Statistical functions were performed including maximum, average, minimum, standard deviation, and variance.



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The spreadsheets in Appendices A and B present the data and summarize the statistical analyses performed.

Laboratory Accreditation

The samples were shipped to and analyzed by R. J. Lee Group, Inc. in their Monroeville, Pennsylvania laboratory. R. J. Lee is accredited for TEM analysis by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP) as Lab #101208. R. J. Lee is also accredited for PCM analysis by the American Industrial Hygiene Association (AIHA) as Lab #8204.



## DISCUSSION OF FINDINGS

### Isolation Test Chamber

Testing was performed in the Boelter Environmental Consultants' (BEC's) Isolation Test Chamber. The chamber is 20 feet wide by 20 feet deep and is 9 feet in height. The chamber was constructed of 6 mil polyethylene sheeting to physically separate the activity being tested from outside of the chamber influences. The chamber is shown in Figure 1.

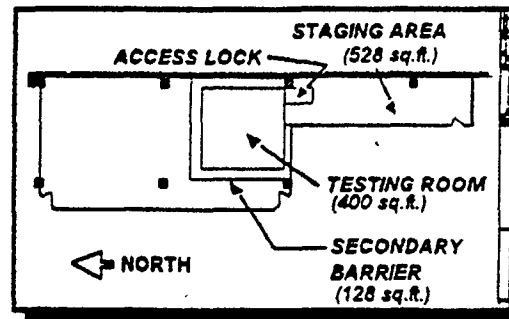


FIGURE 1 - BEC Isolation Test Chamber

The chamber was a static environment. During the test, there was no air movement into the chamber and there was no air movement out of the chamber. During cleaning, the room was ventilated with HEPA filtered air. Entry into the chamber was only through an access airlock.

### Background Sampling Results

Prior to conducting any tests, the isolation chamber was systematically cleaned. Following the cleaning, a series of background samples were analyzed from five (5) area sampling locations in accordance with AHERA protocol.

Background samples were collected under "aggressive" conditions with analysis by TEM in accordance with AHERA Protocol.

Results of the Pre-Test Background sampling are shown in the following table:

| STATISTICAL<br>FUNCTION<br>..... | Aggressive Air TEM (s/mm <sup>2</sup> ) |
|----------------------------------|-----------------------------------------|
|                                  | - Background -<br>.....                 |
| MAXIMUM                          | 33.5                                    |
| AVERAGE                          | 18.4                                    |
| MINIMUM                          | 8.4                                     |
| STAND. DEV                       | 12.3                                    |
| VARIANCE                         | 151.2                                   |
| COUNT                            | 5                                       |

The levels met the AHERA Clearance Criteria of an average of less than seventy structures per millimeter squared ( $<70$  s/mm<sup>2</sup>) for the 5 samples and the room was considered clean. Results are shown in the spreadsheet presented in Appendix B.

### Selection of Fittings

Eight (8) fittings were selected for the valve packing removal test. Fittings which were selected for the test were as shown in the following table:



| TABLE I - FITTINGS SELECTED |                   |                            |                              |                           |
|-----------------------------|-------------------|----------------------------|------------------------------|---------------------------|
| HOUR                        | FITTING<br>NUMBER | SHAFT<br>DIAMETER<br>(in.) | PACKING<br>DIAMETER<br>(in.) | PACKING<br>DEPTH<br>(in.) |
| 1                           | 7                 | 1                          | 1 3/4                        | 5/16                      |
| 2                           | 22                | 13/16                      | 1 7/16                       | 1 3/16                    |
| 3                           | 16                | 1                          | 1 11/16                      | 15/16                     |
| 4                           | 6                 | 7/8                        | 1 1/2                        | 13/16                     |
| 5                           | 1                 | 7/8                        | 1 5/16                       | 13/16                     |
| 6                           | 15                | 15/16                      | 1 3/4                        | 11/16                     |
| 7                           | 20                | 7/8                        | 1 1/4                        | 15/16                     |
| 8                           | 19                | 7/8                        | 1 1/2                        | 7/8                       |

All fittings were obtained by Mr. Boelter from a decommissioned power house.<sup>1</sup> All fittings were carefully cleaned prior to being used in the test.<sup>2</sup>

#### Valve Packing Removal Test Method

A work bench and hoist was placed in the center of the test chamber. The eight (8) fittings selected for the test (See Table I) were all placed in the isolation chamber.

Personal and average room air samplers were started prior to beginning the testing. The samplers were stopped after completion of the testing.

Testing started at about 8:00am and was concluded at about 5:00pm ("test cycle"). There was about a one hour break starting at about 12 noon. During the testing, no one left or entered the isolation chamber.

Each hour during the test cycle, one of the eight fittings was positioned in the center of the room on the work bench ("cycle event"). A typical setup for an event cycle is shown in Photo 1.

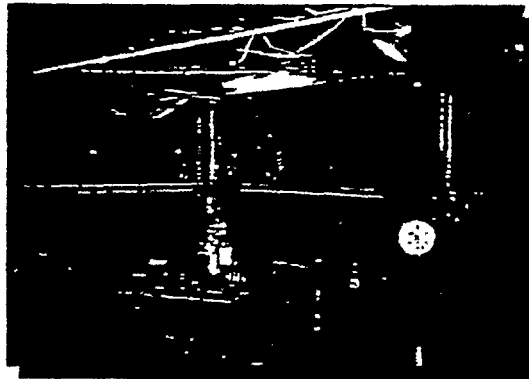


PHOTO 1 - Test setup for Valve Packing Removal and Replacement. Fitting is placed on the work bench.

Each of the eight cycle events were essentially the same. During the hourly cycle event, similar procedures were followed as described in Table II:

<sup>1</sup> The decommissioned power house was located in Peona, Illinois.

<sup>2</sup> The fittings were carefully blasted with glass beads to remove surface corrosion, rust, paint, insulation, etc. The gaskets were left intact. A light coat of clear lacquer was spray applied to the fitting after cleaning to prevent rusting. The edge of the flange was masked off during spraying to protect the gasket. If not removed, the surface corrosion, rust, paint, and insulation would have interfered with the analysis.



| TABLE II - TYPICAL HOURLY CYCLE EVENT |                                                |       |
|---------------------------------------|------------------------------------------------|-------|
| STEP                                  | ACTIVITY                                       | PHOTO |
| 1                                     | Place fitting on work bench                    | 1     |
| 2                                     | Removal of wheel                               | 2     |
| 3                                     | Remove bolts holding compression ring in place | 3     |
| 4                                     | Removal of valve packing material              | 4     |
| 5                                     | Cutting the valve packing material replacement | 5     |
| 6                                     | Replacing the valve packing material           | 6     |
| 7                                     | Replacement and packing of bolts               | 7     |

Thumbnail photographs depicting the various steps described in Table II follow below. Full size photographs are presented in Appendix E.



PHOTO 2 - Removing wheel. Fitting #1 is shown.



PHOTO 3 - Removing bolts. Fitting #22 is shown.



PHOTO 4 - Removing packing material. Fitting #16 is shown.



PHOTO 5 - Cutting packing material. Fitting #6 is shown.



PHOTO 6 - Replacing of packing. Fitting #1 is shown.



PHOTO 7 - Replacing bolts. Fitting #22 is shown.

#### Sampling Results During Test

Results of 8-Hour Time-Weighted Average Permissible Exposure Limit sampling are:

| STATISTICAL<br>FUNCTION | PCM Analysis by NIOSH 7400 (Total f/cc) |                      |
|-------------------------|-----------------------------------------|----------------------|
|                         | - Personal Samples -                    | - Average Room Air - |
| MAXIMUM                 | 0.027                                   | 0.031                |
| AVERAGE                 | 0.026                                   | 0.023                |
| MINIMUM                 | 0.024                                   | 0.018                |
| STAND DEV.              | 0.002                                   | 0.003                |
| VARIANCE                | 0.000                                   | 0.000                |
| COUNT                   | 2                                       | 8                    |



All sample results show the concentrations to be well below the current OSHA Permissible Exposure Limit of 0.1 f/cc as sampled over an 8-hour time-weighted average period of time. Refer also to Figure 2 for a graphical presentation of the air sample results.

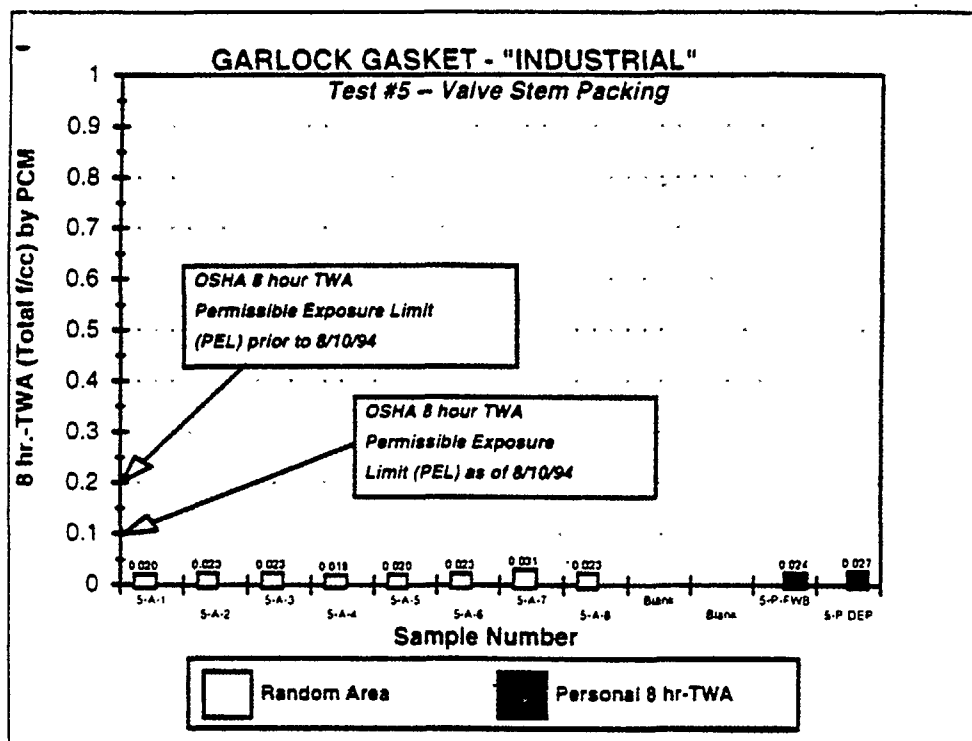
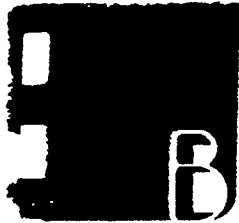


Figure 2 - Graphical presentation of the air sample results.

The Appendix A spreadsheets and charts present and depict the results of the testing in detail.



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### CONCLUSIONS

Packing material was removed from valves at the rate of one (1) per hour. Eight (8) room air samples and two (2) personal samples were collected during the processing.

All sample results show the airborne concentrations of fibers to be well below the current OSHA Permissible Exposure Limit of 0.1 f/cc as sampled over an 8-hour time-weighted average period of time.

Respectfully submitted,

**BOELTER ENVIRONMENTAL CONSULTANTS**

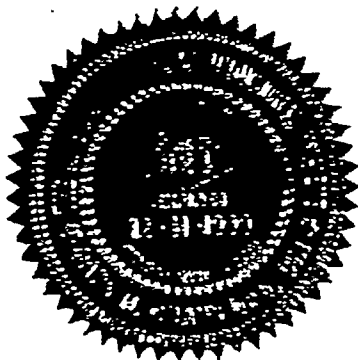
Frederick W. Boelter, CIH, PE, DEE, QEP

Reviewed by,

Gary N. Crawford, CIH

Enclosures

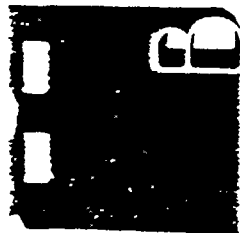
F:\APPS\WP5\EXPERT-W\1418XXXX\602\REPORTS\14184602.IVP





## **APPENDIX A**

**Compilation Spreadsheets and Graphs  
TESTING RESULTS**



# INDUSTRIAL FITTING TEST RESULTS

Collec Industries/Garlock Packing

BAI Project #1418A-4602

Privileged & Confidential  
Attorney Work Product

| TEST         | TEST DATE         | SAMPLE NUMBER | SAMPLE TYPE  | RANDOM AREA NUMBER | RANDOM AREA LOCATION | West | High | SAMPLE TIME | SAMPLE RATE | SAMPLE VOLUME | PCM RESULTS (Total floc) | - Personal TWA - | - Area @ 2 - |
|--------------|-------------------|---------------|--------------|--------------------|----------------------|------|------|-------------|-------------|---------------|--------------------------|------------------|--------------|
| Valve Packin | November 15, 1996 | 5-A-1         | RANDOM AREA  | 3081               | 18                   | 1    | 2    | 527         | 2           | 1054          | 0.020                    |                  | 0.020        |
| Valve Packin | November 15, 1996 | 5-A-2         | RANDOM AREA  | 501                | 3                    | 1    | 8    | 527         | 2           | 1054          | 0.023                    |                  | 0.023        |
| Valve Packin | November 15, 1996 | 5-A-3         | RANDOM AREA  | 3093               | 18                   | 13   | 2    | 527         | 2           | 1054          | 0.023                    |                  | 0.023        |
| Valve Packin | November 15, 1996 | 5-A-4         | RANDOM AREA  | 3520               | 20                   | 20   | 5    | 527         | 2           | 1054          | 0.016                    |                  | 0.016        |
| Valve Packin | November 15, 1996 | 5-A-5         | RANDOM AREA  | 2460               | 14                   | 20   | 6    | 527         | 2           | 1054          | 0.020                    |                  | 0.020        |
| Valve Packin | November 15, 1996 | 5-A-6         | RANDOM AREA  | 3070               | 18                   | 10   | 9    | 527         | 2           | 1054          | 0.023                    |                  | 0.023        |
| Valve Packin | November 15, 1996 | 5-A-7         | RANDOM AREA  | 1701               | 10                   | 1    | 5    | 527         | 2           | 1054          | 0.031                    |                  | 0.031        |
| Valve Packin | November 15, 1996 | 5-A-8         | RANDOM AREA  | 1340               | 8                    | 20   | 4    | 527         | 2           | 1054          | 0.023                    |                  | 0.023        |
| Valve Packin | November 15, 1996 | 5-A-9         | BLANK        |                    |                      |      |      | 0           | 0           | 0             |                          |                  |              |
| Valve Packin | November 15, 1996 | 5-A-10        | BLANK        |                    |                      |      |      | 0           | 0           | 0             |                          |                  |              |
| Valve Packin | November 15, 1996 | 5-P-FWB       | PERSONAL-TWA |                    |                      |      |      | 464         | 2           | 928           | 0.024                    |                  | 0.024        |
| Valve Packin | November 15, 1996 | 5-P-DEP       | PERSONAL-TWA |                    |                      |      |      | 464         | 2           | 928           | 0.027                    |                  | 0.027        |

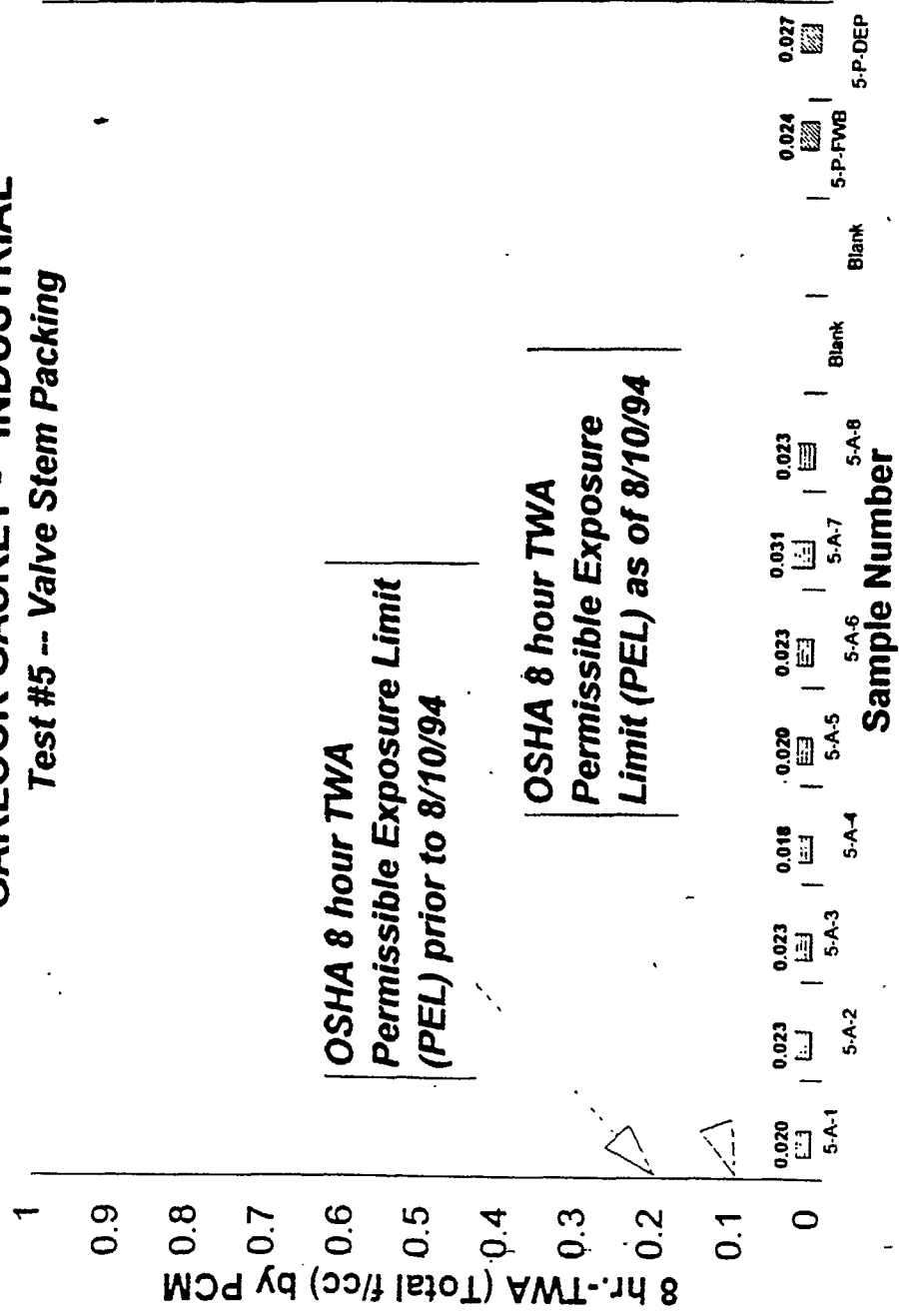
MAXIMUM  
AVERAGE  
MINIMUM  
STAND DEV  
VARIANCE  
COUNT

0.027  
0.026  
0.024  
0.002  
0.000  
2  
8

PERCENTAGE OF TESTS PASSED

# GARLOCK GASKET - "INDUSTRIAL"

Test #5 -- Valve Stem Packing



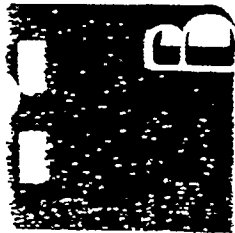
Random Area

Personal 8 hr-TWA



## **APPENDIX B**

**Compilation Spreadsheets and Graphs  
PRE-TEST BACKGROUND RESULTS**



# PRE-ACTIVITY BACKGROUND TESTING RESULTS

Collec Industries/Garlock Packing

BAI Project #1418A-4600

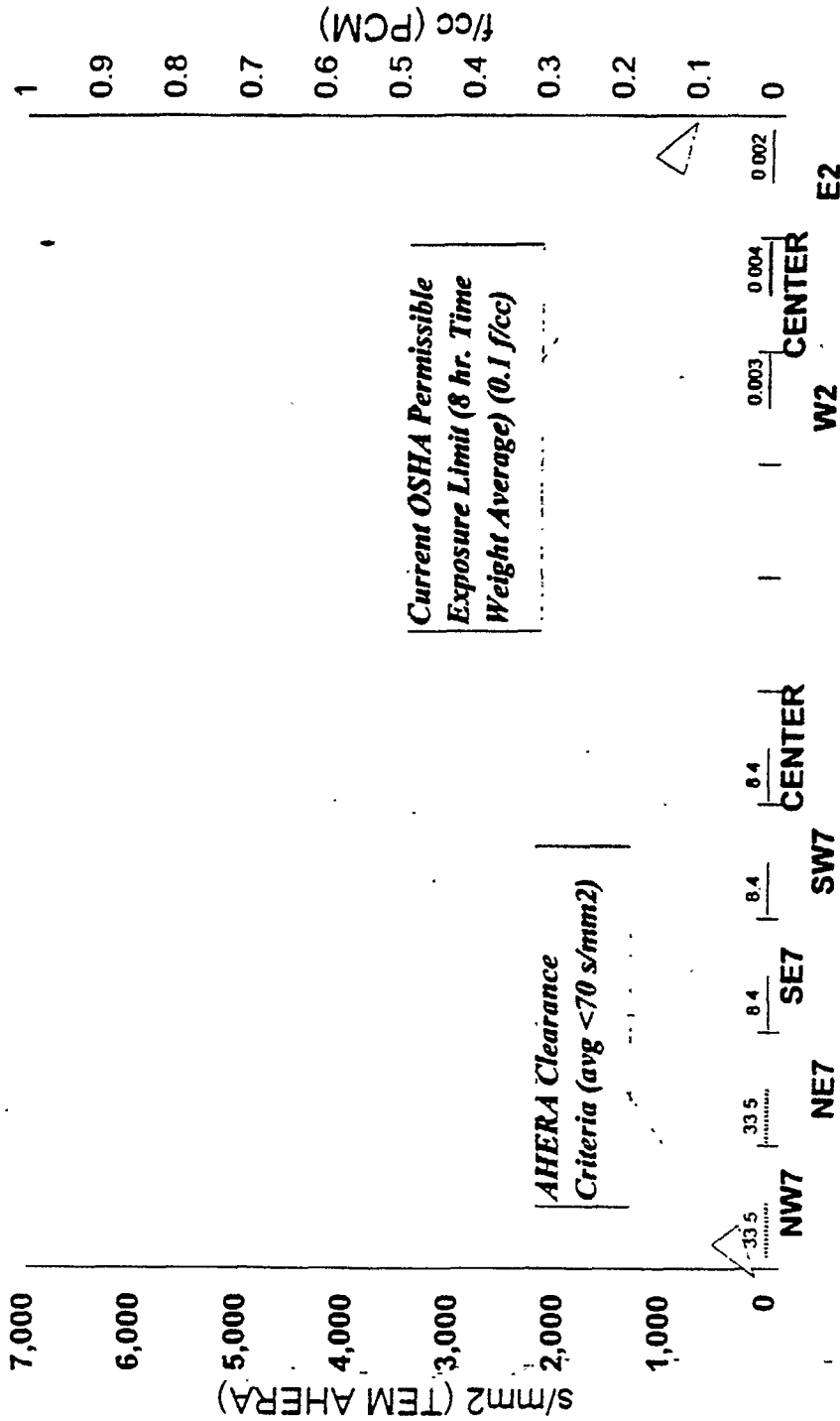
| TEST<br>NUMBER | TEST<br>DATE | SAMPLE<br>NUMBER | SAMPLE<br>TYPE | SAMPLE<br>LOCATION | SAMPLE<br>TIME | SAMPLE<br>RATE | SAMPLE<br>VOLUME | AGGRESSIVE AIR<br>TEM RESULTS (Total Asbestos s/mm2)<br>(avg <70 s/mm2) | LESS THAN LIMIT OF<br>ANALYTICAL SENSITIVITY<br>(<16.8 s/mm2) |
|----------------|--------------|------------------|----------------|--------------------|----------------|----------------|------------------|-------------------------------------------------------------------------|---------------------------------------------------------------|
|                | 5 14-Nov-96  | 5-B-1            | AREA           | NW7                | 130            | 10             | 1300             |                                                                         | 33.5                                                          |
|                | 5 14-Nov-96  | 5-B-2            | AREA           | NE7                | 130            | 10             | 1300             |                                                                         | 33.5                                                          |
|                | 5 14-Nov-96  | 5-B-3            | AREA           | SE7                | 130            | 10             | 1300             |                                                                         | 8.4                                                           |
|                | 5 14-Nov-96  | 5-B-4            | AREA           | SW7                | 130            | 10             | 1300             |                                                                         | 8.4                                                           |
|                | 5 14-Nov-96  | 5-B-5            | AREA           | CENTER             | 130            | 10             | 1300             |                                                                         | 8.4                                                           |
|                | 5 14-Nov-96  | 5-B-6            | BLANK          |                    |                |                |                  |                                                                         |                                                               |
|                | 5 14-Nov-96  | 5-B-7            | BLANK          |                    |                |                |                  |                                                                         |                                                               |

MAXIMUM  
AVERAGE  
MINIMUM  
STAND DEV  
VARIANCE  
COUNT

33.5  
18.4  
8.4  
12.3  
151.2  
5

# BACKGROUND TESTS - NOV 14, 1996

BAI Project 1418A-4600



**AHERA Clearance Criteria (avg <70 s/mm2)**

TEM AHERA (Aggressive) PCM 7400 (Aggressive)



## APPENDIX C

PCM Laboratory Reports

# Test Report

## Total Fiber Concentrations

### PCM Air Analysis

### Project AOH611606

| Sample Number | Client Sample Number | Analyzed Area (sq. mm) | Volume (Liters) | Fibers | Fields | Concentration (fibers/sq. mm) | Concentration (fibers/cc) | 95% Upper Confidence Interval† | Limit of Quantification‡ | Analyst | Analysis Date |
|---------------|----------------------|------------------------|-----------------|--------|--------|-------------------------------|---------------------------|--------------------------------|--------------------------|---------|---------------|
| 0565399BHPC   | 5-A-1                | 0.785                  | 1054            | 43     | 100    | 54.7771                       | 0.0200                    | 0.0283                         | 0.0026                   | RFW     | 11/19/96      |
| 0565400BHPC   | 5-A-2                | 0.785                  | 1054            | 50     | 100    | 63.6943                       | 0.0233                    | 0.0326                         | 0.0026                   | RFW     | 11/19/96      |
| 0565401BHPC   | 5-A-3                | 0.785                  | 1054            | 49.5   | 100    | 63.0573                       | 0.0230                    | 0.0323                         | 0.0026                   | RFW     | 11/19/96      |
| 0565402BHPC   | 5-A-4                | 0.785                  | 1054            | 39.5   | 100    | 50.3185                       | 0.0184                    | 0.0261                         | 0.0026                   | RFW     | 11/19/96      |
| 0565403BHPC   | 5-A-5                | 0.785                  | 1054            | 43.5   | 100    | 55.4140                       | 0.0202                    | 0.0286                         | 0.0026                   | RFW     | 11/19/96      |
| 0565404BHPC   | 5-A-6                | 0.785                  | 1054            | 48.5   | 100    | 61.7834                       | 0.0226                    | 0.0317                         | 0.0026                   | RFW     | 11/19/96      |
| 0565405BHPC   | 5-A-7                | 0.785                  | 1054            | 65.5   | 100    | 83.4395                       | 0.0305                    | 0.0422                         | 0.0026                   | RFW     | 11/19/96      |
| 0565406BHPC   | 5-A-8                | 0.785                  | 1054            | 49     | 100    | 62.4204                       | 0.0228                    | 0.0320                         | 0.0026                   | RFW     | 11/19/96      |
| 0565407BHPC   | 5-A-9                | 0.785                  | Blank           | 2      | 100    | <7.0064*                      | §                         | §                              | §                        | RFW     | 11/19/96      |
| 0565408BHPC   | 5-A-10               | 0.785                  | Blank           | 0      | 100    | <7.0064*                      | §                         | §                              | §                        | RFW     | 11/19/96      |
| 0565409BHPC   | 5-P-FWB              | 0.785                  | 928             | 45     | 100    | 57.3248                       | 0.0238                    | 0.0335                         | 0.0029                   | RFW     | 11/19/96      |
| 0565410BHPC   | 5-P-DEP              | 0.785                  | 928             | 51.5   | 100    | 65.6051                       | 0.0272                    | 0.0381                         | 0.0029                   | RFW     | 11/19/96      |

Samples received on: Monday, November 18, 1996

† Analytical results based upon the volumes provided by Boelter Environmental Consultants

Prepared, Counted, and Calculated in accordance with NIOSH 7400. Fiber counts and concentrations are blank corrected.

\* Results Below Analytical Sensitivity

§ Sample is a Blank, or no volume was supplied. Calculation could not be done.

Authorized Signature

Robert F. Wellman, Microscopist

Tuesday, November 19, 1996

Date

RJ Lee Group, Inc.  
Headquarters

350 Hochberg Road  
Monroeville, PA 15146

Page: 1 of 1

Phone (412) 325-1776  
Fax (412) 733-1799



## APPENDIX D

TEM Laboratory Reports

# Test Report

## Total Asbestos Structure Concentration

### TEM AHERA Analysis

Project AT11611869

| RJ Lee Group<br>Sample Number | Client<br>Sample Number | Filter Area<br>(sq mm) | Volume†<br>(liters) | Area                 |            | Structures<br>Chr Amp | Analytical Sensitivity †<br>(S/sq. mm) | Concentration |          | Analysis Date |
|-------------------------------|-------------------------|------------------------|---------------------|----------------------|------------|-----------------------|----------------------------------------|---------------|----------|---------------|
|                               |                         |                        |                     | Analyzed<br>(sq. mm) | (S/sq. mm) |                       |                                        | (S/sq. mm)    | (S/cc)   |               |
| 0077168HT                     | 5-B-1                   | 385                    | 1300.00             | 0.0596               | 16.8       | 2 0                   | 0.0050                                 | 33.5          | 0.0099   | 11/20/96      |
| 0077169HT                     | 5-B-2                   | 385                    | 1300.00             | 0.0596               | 16.8       | 2 0                   | 0.0050                                 | 33.5          | 0.0099   | 11/20/96      |
| 0077170HT                     | 5-B-3                   | 385                    | 1300.00             | 0.0596               | 16.8       | 0 0                   | 0.0050                                 | 16.8*         | <0.0050* | 11/20/96      |
| 0077171HT                     | 5-B-4                   | 385                    | 1300.00             | 0.0596               | 16.8       | 0 0                   | 0.0050                                 | <16.8*        | <0.0050* | 11/20/96      |
| 0077172HT                     | 5-B-5                   | 385                    | 1300.00             | 0.0596               | 16.8       | 0 0                   | 0.0050                                 | <16.8*        | <0.0050* | 11/20/96      |
| 0077173HT                     | 5-B-6                   | 385                    | Blank               | N/A                  | -          | -                     | -                                      | -             | -        | -             |
| 0077174HT                     | 5-B-7                   | 385                    | Blank               | N/A                  | -          | -                     | -                                      | -             | -        | -             |

† Volumes provided by Buckler Environmental Consultants for Project 1418A-4600 were used to calculate analytical results and sensitivities.

† Analytical sensitivity is the calculated concentration based on one structure in the area analyzed.

Samples received on: Friday, November 15, 1996

Chr - Chrysotile, Amp - Amphibole

\* Results Less Than Analytical Sensitivity

N/A Sample not analyzed

Authorized Signature

Kimberly A. Allison, Manager-TEM Analysis

Date

Wednesday, November 20, 1996

RJ Lee Group, Inc.  
Headquarters

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Test Report Page: 1 of 1

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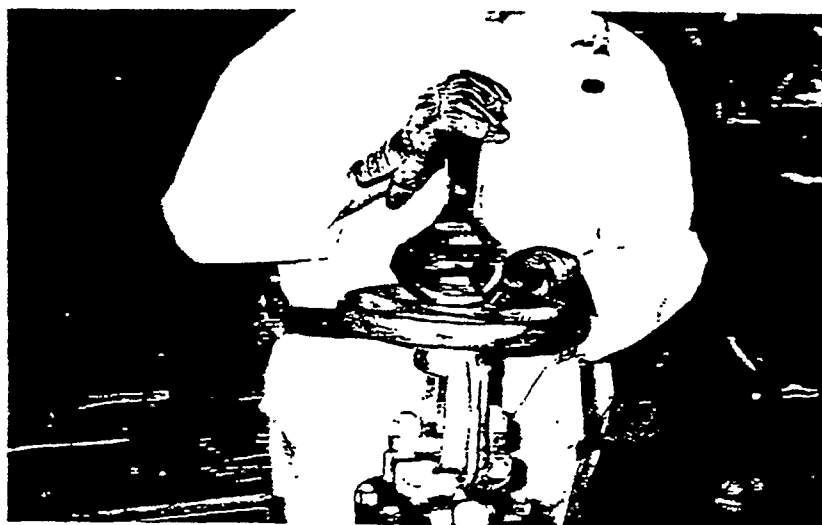


## APPENDIX E

Original Photographs

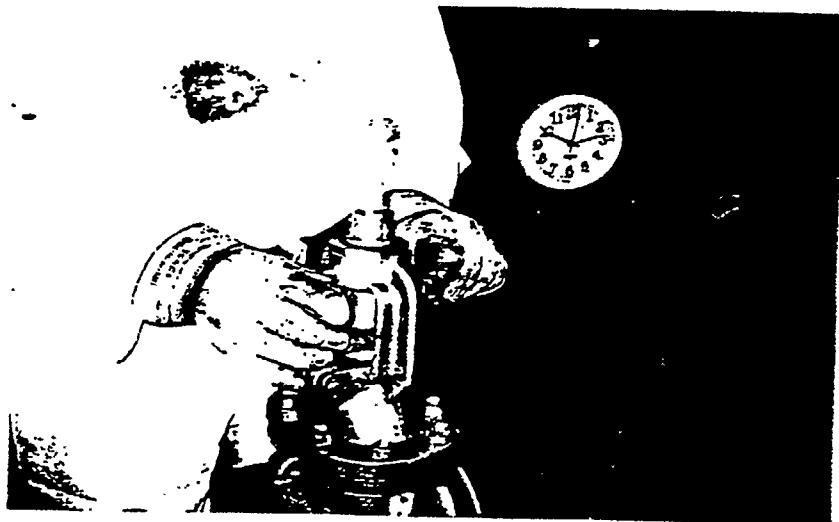


-Photo 1-  
Test setup for Valve Packing Removal and Replacement.  
Fitting placed on the work bench.

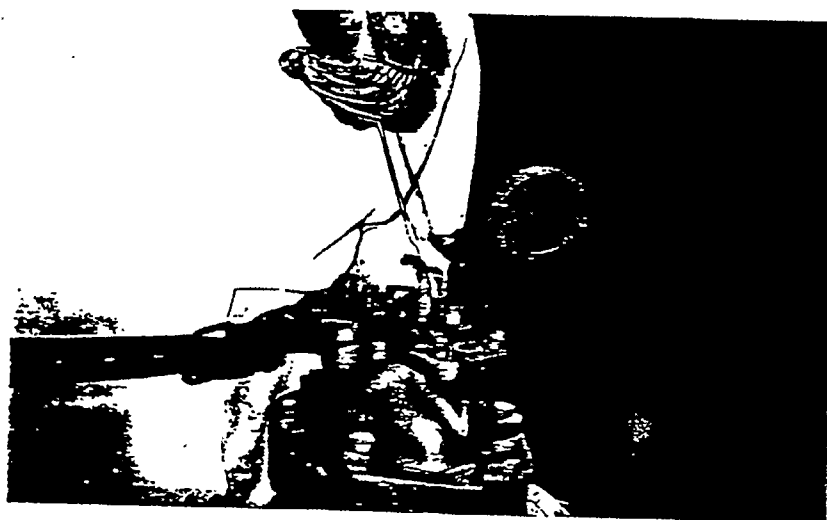


-Photo 2-  
Removing wheel. Fitting.#1 is shown.

CICOLTECPH-PHOTO 5P1



-Photo 3-  
Removing bolts. Fitting #22 is shown.



-Photo 4-  
Removing packing material. Fitting #16 is shown.

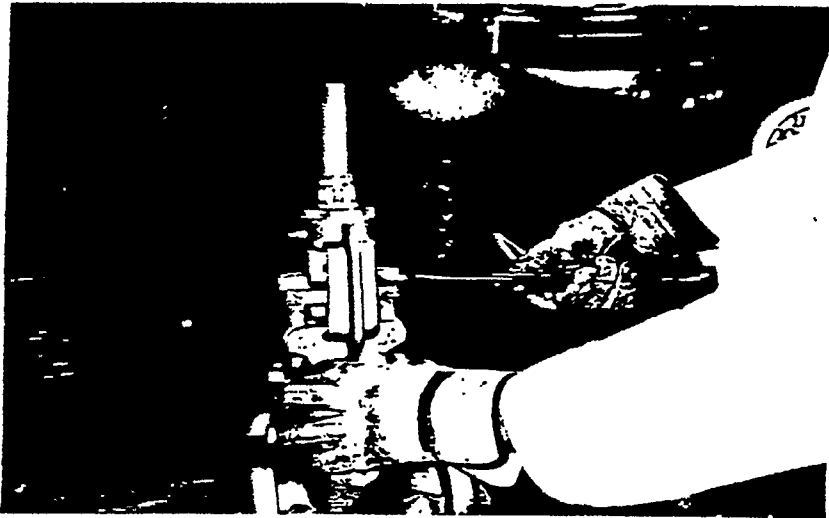
C:\COLTECPH-PHOTO 5P2



-Photo 5-  
Cutting packing material. Fitting #6 is shown.



-Photo 6-  
Replacing packing. Fitting #1 is shown.



-Photo 7-  
Replacing bolts. Fitting #22 is shown.

C:\COLTECPH\PHOTO 5P4