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DATE: 1995

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° ALSO ADMITTED PENNSYLVANIA BAR

April 7, 1997

Barry Castleman, Sc.D.
2412 Pickwick Road
Baltimore, MD 21207-6631

Re: Welding Rod Defendants

Dear Dr. Castleman:

Pursuant to our telephone conversation of this morning, I am enclosing copies of Dr. Nicholson's and Dr. Dement's affidavits and deposition testimony regarding welding rod exposure, as well as Dr. Dement's study dated March 14, 1995 regarding welding rods.

If you have any questions please feel free to contact me.

Sincerely,



Vincent J. X. Hedrick, II

VJH\pra

Enclosure

Welder studios

copy for

**EVALUATION OF ASBESTOS-CONTAINING WELDING RODS
FOR ASBESTOS FIBER RELEASE**

John M. Dement, Ph.D., CIH

Lori Todd, Ph.D., CIH

Courtney Smith

March 14, 1995

Duke University Medical Center
Department of Community & Family Medicine
Division of Occupational & Environmental Medicine
2200 W. Main Street, Suite 700, Box 2914
Durham, North Carolina 27710

WELDING ROD ABRASION TEST

Background

A test of asbestos-containing welding rods was performed under controlled conditions to determine if asbestos fibers are released into the air from handling and abrasion. Welding rod samples were first tested for asbestos and non-asbestos fiber content by having a bulk sample of the rod coating analyzed by Transmission Electron Microscopy (TEM) and Polarized Light Microscopy (PLM). Welding rods found to be positive for asbestos content were selected and subjected to the abrasion test. In addition, one set of welding rods found not to contain asbestos was tested as a negative control of the experimental procedure. Testing involved bumping and rubbing two identical welding rods together in a small chamber for approximately 15 minutes while air samples were collected inside the chamber. Background air samples were obtained between each test.

Abrasion Test Design

Asbestos fiber release was tested using a customized Plexiglas glove box fitted with high efficiency particulate air (HEPA) filters. (See Appendix C, Figure 1.) The glove box is air tight except for access ports and filtered air intake and exhaust ports. Prior to each simulation, the glove box was thoroughly washed, and the air inside the glove box purged for 25 minutes using a high volume exhaust system. All air entering and leaving the glove box was HEPA filtered. Purging of the glove box was performed to reduce ambient particulate levels.

For each set of experiments, all necessary materials were placed inside the glove box in sealed plastic bags. This included two sets of air filters (one for the background air sample and one for the test sample), the welding rods to be tested, and clean-up materials. The air sampling pump was calibrated with a "Giliblator" air flow calibrating device before and after all sampling using an identical calibration filter (marked for calibration only) so as not to contaminate the sampling filter with ambient air. Flow rates of approximately 12 liters per minute were used for all samples. To confirm that the air inside the glove box was free of asbestos fibers, a background air sample was collected for 20 minutes before testing each set of welding rods.

Just prior to the initiation of the welding rod experiment, the air sampling pump was turned on. The two identical welding rods to be tested were then removed from the plastic bag and were bumped and rubbed against each other for approximately 15 minutes. After the rods had been bumped together for 15 minutes a small mixing fan was turned on for 5 minutes and then turned off. The mixing fan was used in order to enhance air mixing within the glove box. Air sampling was performed for a total of 30 minutes. The glove box was cleaned, purged with HEPA filtered air, and re cleaned before being used for testing the next set of rods.

All air samples were obtained using 25 mm diameter sampling cassettes fitted with mixed cellulose ester filters. Samples were analyzed for asbestos using Transmission Electron Microscopy (TEM), 40 CFR 753 Subpart E, Appendix A, and Phase Contrast Microscopy (PCM), NIOSH 7400.

Welding Rods Tested

The welding rods subjected to the abrasion experiment were two Hobart 6010 (batch 109), two Westinghouse 6011 (batch 107), and two partially burned asbestos containing received from Dr. James Millette of MVA. Analytical data for the rods tested are given in Appendix A. The Westinghouse 6011 (batch 107) rods were found not to contain asbestos and were tested between the tests of rods containing asbestos. This was done as an overall control of the testing, chamber clean-up and analytical procedures.

Sample Preparation and Analysis

Samples were prepared using the above protocol for the abrasion test. The flow rates and total sampling time for each filter cassette are outlined below in Table 1. (Cassettes 1 and 2 were used only for calibration and were not analyzed.)

Table 1: Sample Preparation Data

ID #	Description	Start Flow, Lpm	End Flow, Lpm	Average Flow, Lpm	Sampling time, min	Total air volume, Liters
3	Background	12.29	11.29	11.79	20.0	235.8
4	Hobart 6010 (<i>batch 109</i>)	11.29	10.39	10.84	30.0	325.2
5	Background	12.05	12.51	12.28	20.0	245.6
6	Westinghouse 6011 (<i>batch 107, non-asbestos</i>)	12.63	12.49	12.56	30.0	376.8
7	Background	12.44	12.27	12.36	20.0	247.1
8	Used for calibration only					
9	Partially burned rods (received from Dr. Millette)	12.27	12.84	12.56	30.0	376.7
10	Field blank - ambient air					

The used filter cassettes were covered with duct tape (to prevent their coming apart), numbered, and placed in individual sample bags. They were sent via Federal Express to Materials Analytical Services in Atlanta and were analyzed there by the methods mentioned under "Abrasion Test Design."

Results

Specifics of the laboratory analyses and results are included in Appendix B. For each set of asbestos containing rods tested, the phase contrast data for the test detected fiber concentrations in excess of background. The abrasion test using the non-asbestos rod found no asbestos fibers or structures by TEM thus confirming that the chamber was free of contamination. Highest TEM concentrations were observed for the partially used rods with a concentration of asbestos structures by TEM of 1.231 structures/cc. The partially used welding rods were much more friable than the unused rods and generated significantly more airborne asbestos fibers.

Fiber identification by TEM demonstrated that the fibers generated by the abrasion tests were chrysotile. Filter blanks and chamber background samples collected prior to each experiment did not detect the presence of chrysotile nor did the test conducted with non-asbestos containing welding rods. Therefore, the fiber concentrations measured are the result of fibers released from the welding rods. Electron micrographs of typical asbestos structures observed in this sample are shown in Appendix B.

APPENDIX A

WELDING ROD COATING ASBESTOS ANALYSIS RESULTS

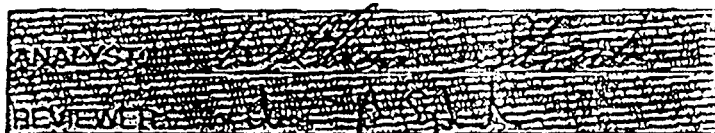
**MATERIALS ANALYTICAL SERVICES INC.
PRESENCE OR ABSENCE ANALYSIS**

CLIENT: UNC

MAS JOB #: M 11811-5

DATE: 9-28-94

SAMPLE ID: 006



109 Hobart 6010

VERIFICATION OF ASBESTOS IDENTIFICATION

TYPE OF ASBESTOS	MORPHOLOGY	SELECTED AREA ELECTRON DIFFRACTION	EDS PRINT OUT
CHRYSTILE	✓	✓	
AMOSITE			
TREMOLITE			
ACTINOLITE			
ANTHOPHYLLITE			
CROCIDOLITE			

SAMPLE ANALYSIS

GRID # SQUARE #	ESTIMATED NUMBER OF STRUCTURES
1-1	10
2	7
3	5
4	12
5	14
2-1	9
2	10
3	11
4	10
5	7

NO ASBESTOS DETECTED:



COMMENTS:

MATERIALS ANALYTICAL SERVICES, INC.
BULK ASBESTOS ANALYSIS

Project # - Spl #: M12224-03

Date: 1/31/85

Project Name: WELDING ROD COATING SAMPLES

Analyst: Paul Hess

Sample Identification: UNC Dept. ESE Sample # Todd-0107 #107 Westinghouse 6011

Gross Visual Description: Gray cream, fibrous, moderately bound

OPTICAL DATA FOR ASBESTOS IDENTIFICATION

Morphology	_____	_____	_____
Pleochroism	_____	_____	_____
Refractive Index <u>//L</u>	_____	_____	_____
Sign of Elongation	_____	_____	_____
Extinction	_____	_____	_____
Birefringence	_____	_____	_____
Melt	_____	_____	_____
Fiber Name	_____	_____	_____

ASBESTOS MINERALS:

Est. Vol. %

Chrysotile	_____	<u>NAO</u>
Amosite	_____	_____
Crocidolite	_____	_____
Tremolite/Actinolite	_____	_____
Anthophyllite	_____	_____

OTHER FIBROUS COMPONENTS:

Mineral/Rock wool	_____
Fibrous glass	_____
Cellulose	<u>35</u>
Synthetic	_____
Talc	<u>03</u>

NON FIBROUS COMPONENTS:

Vermiculite	_____
Wollastonite	<u>X</u>
Mineral Grains	<u>X</u>

BINDERS:

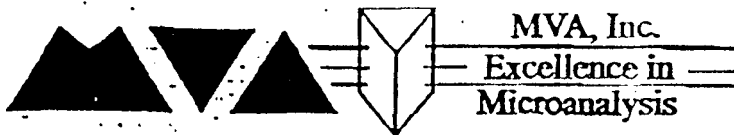
X

Fine grained aggregate observed

EFFERVESCENCE: weak to moderate

COMMENTS:

NAO = No Asbestos Observed, X = Materials detected, Sample ashed



06 December 1994

John Dement, Ph.D.
Duke University Medical Center
PO Box 2914
2200 W. Main Suite 700
Durham, NC 27710

Re: Welding Rod
MVA Project No. 1094

Dear John:

Enclosed please find three welding rods which were partially burned in our controlled experiment. They contain approximately two percent of chrysotile asbestos by weight. Please call if you have any questions.

Sincerely,

James R. Millette, Ph.D.
Executive Director

JRM/aw

Enclosure

MVA, Inc.
5500 Oakbrook Parkway, Suite 200
Norcross, Georgia 30093
(404) 662-8509

PLM ASBESTOS ANALYSIS**MVA #:** 0685**Client:** Ness, Motley, Loadholt, Richardson
& Poole**Sample ID #:** D2917**Client Sample ID #:** 129**Macroscopic Description:** White welding rod**Asbestos Minerals:**

Chrysotile	~ 2%
Amosite	---
Crocidolite	---
Anthophyllite Asbestos	---
Tremolite/Actinolite Asbestos	---

Total Asbestos	~ 2%
-----------------------	-------------

Fillers/Binders/Pigment %	~ 78%
----------------------------------	--------------

Fillers/Binders/Pigment Identified:

Mica/Vermiculite	---	Perlite/Pumice	---
Synthetic Foam	---	Carbonate	---
Gypsum	---	Pigment	---
Other	---		

Comments:**Analyst:** Bill Turner**Date:** 12/27/93

APPENDIX B

LABORATORY DATA FOR WELDING ROD ABRASION TESTS



MATERIALS
ANALYTICAL
SERVICES ■

March 9, 1995

Ms. Courtney Smith
Duke University Medical Center
Division of Occupational & Environmental Medicine
Box 2914
Durham, NC 27710

Dear Ms. Smith:

We have completed our analysis for the eight air samples that we received on March 4, 1995.

Our results for the analysis are enclosed. Please do not hesitate to give me a call after you have had a chance to review the data.

Sincerely,

William E. Longo, Ph.D.
President

WEL/mac



MATERIALS ANALYTICAL SERVICES

Project: Duke University Medical Center

MAS No: M-12592

Date: March 9, 1995

Phase Contrast Microscopy

<u>Client #</u>	<u>Structures/cc</u>
3	0.003
4	0.252
5	< 0.014
6	0.075
7	< 0.014
8	N/A (Blank)
9	0.032
10	N/A (Field Blank)

Transmission Electron Microscopy

<u>Client #</u>	<u>Structures/cc</u>
3	< 0.013
4	0.010
5	< 0.013
6	< 0.008
7	< 0.013
8	N/A (Blank)
9	1.231
10	N/A (Field Blank)

MATERIALS ANALYTICAL SERVICES

AIR SAMPLE ANALYSIS

ANALYST :

Johnson

ANALYTICAL PROTOCOL : Level II

REVIEWER :

M. M. M.

SAMPLE DATA

Client : Duke Univ. Medi Center

Sample ID : 3

Sample Volume, cc : 236000

Filter Type : MCE 25mm

Filter Pore Size, um : NG

Effective Filter Area, mm² : 385

ANALYSIS PARAMETERS

MAS Sample Number : M12592-1

Date Analyzed : 3-6-95

Microscope Number : 5

Accelerating Voltage : 100 KV

Indicated Mag : 20 KX

Screen Mag : 15.3 KX

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag : yes

Number of Openings / Grids Counted : 1012

Percent Loading : 1%

Grid Opening Size (um) : 1) 110 x 112

Average Grid Opening Area, mm² : 0.012210

2) 109 x 111

Area of Filter Analyzed, mm² : 0.122

ASBESTOS STRUCTURE DATA

≤ 5.0 um

> 5.0 um

Total

Number of Chrysotile Asbestos Structures Counted : 0

0

0

Number of Amphibole Asbestos Structures Counted : 0

0

0

Number of Asbestos Structures Counted : 0

0

0

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc > 5.0um :

BAS

Chrysotile Asbestos Concentration Str/cc :

BAS

Asbestos Concentration Str/cc ≤ 5.0um :

BAS

Amphibole Asbestos Concentration Str/cc :

BAS

Analytical Sensitivity Str/mm² :

812

Analytical Sensitivity Str/cc :

0.013

Total Asbestos Concentration Str/mm² :

1345

Total Asbestos Concentration Str/cc :

BAS

BAS = Below Analytical Sensitivity

Included form provides formulae for calculating results.

MAS JOB NUMBER: 824 3388 M 12592-1

PAGE #

111

[illegible]

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE:

C = CHRYSOTILE
AM = AMOSITE
CR = CROCIDOLITE
AC = ACTINOLITE
TR = TREMOLITE
AN = ANTHOPHYLLITE
N = NON ASBESTOS

STRUCTURE :

F = FIBER
B = BUNDLE
C = CLUSTER
M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
MORPH = MORPHOLOGY
SAED = SELECTED AREA ELECTRON DIFFRACTION
EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN

MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST:

M. Melton

ANALYTICAL PROTOCOL: Level II

REVIEWER:

J. Harro

SAMPLE DATA

Client: Duke Univ. Med. Center

Sample ID: 4

Sample Volume, cc: 325000

Filter Type: MCE 25mm

Filter Pore Size, μm : N6

Effective Filter Area, mm^2 : 385

ANALYSIS PARAMETERS

MAS Sample Number: M 12592-2

Date Analyzed: 3-6-95

Microscope Number: 2

Accelerating Voltage: 100 K

Indicated Mag: 25 K

Screen Mag: 20 K

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: 7-8

Number of Openings / Grids Counted: 10, 2

Percent Loading: 2%

Grid Opening Size (μm): 1) 110 x 110

Average Grid Opening Area, mm^2 : 0.011882

2) 107 x 109

Area of Filter Analyzed, mm^2 : 0.12

ASBESTOS STRUCTURE DATA

$\leq 5.0 \mu\text{m}$

$> 5.0 \mu\text{m}$

Total

Number of Chrysotile Asbestos Structures Counted: _____

Number of Amphibole Asbestos Structures Counted: _____

Number of Asbestos Structures Counted: _____

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc $> 5.0 \mu\text{m}$:

0.010

Chrysotile Asbestos Concentration Str/cc:

0.090

Asbestos Concentration Str/cc $\leq 5.0 \mu\text{m}$:

0.080

Amphibole Asbestos Concentration Str/cc:

BAS

Analytical Sensitivity Str/ mm^2 :

8.4

Analytical Sensitivity Str/cc:

0.010

Total Asbestos Concentration Str/ mm^2 :

175.7

Total Asbestos Concentration Str/cc:

0.090

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

M/2592-2

111

KEYS TO ABBREVIATIONS USED ABOVE:

OTHERS:

NSD = NO STRUCTURES DETECTED
MORPH = MORPHOLOGY
SAED = SELECTED AREA ELECTRON DIFFRACTION
EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN

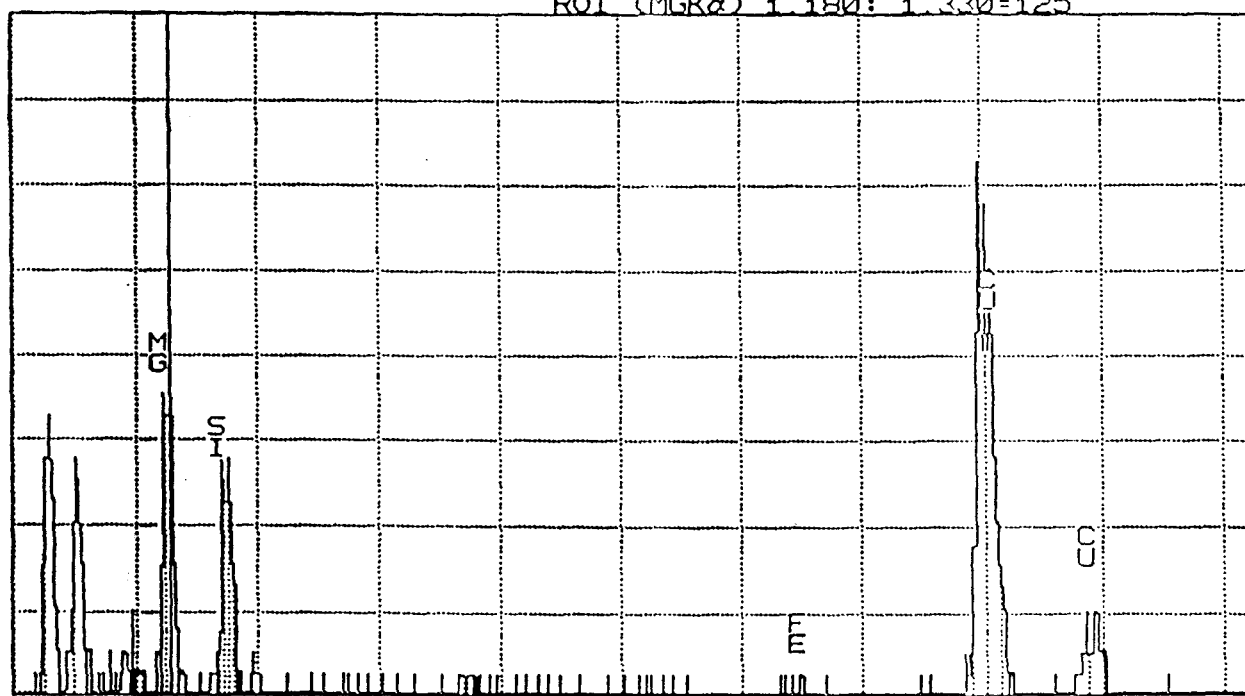
MATERIALS ANALYTICAL SERVICES

MON 06-MAR-95 10:31

Cursor: 1.290keV = 8

ROI (SIK α) 1.660: 1.810=112

ROI (MGK α) 1.180: 1.330=125



0.000

VFS = 32

10.240

42

M12592-2 , CHRYSOTILE

MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST:

Harmay

ANALYTICAL PROTOCOL: Level II

REVIEWER:

M. M. M.

SAMPLE DATA

Client: Duke Univ. Medi Center

Sample ID: 5

Sample Volume, cc: 246000

Filter Type: MCE 25mm

Filter Pore Size, um: NG

Effective Filter Area, mm²: 385

ANALYSIS PARAMETERS

MAS Sample Number: M12592-3

Date Analyzed: 3-6-95

Microscope Number: 5

Accelerating Voltage: 100

Indicated Mag: 20

Screen Mag: 15.3

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: 44

Number of Openings / Grids Counted: 1012

Percent Loading: 1%

Grid Opening Size (um): 1) 111 x 109

Average Grid Opening Area, mm²: 0.1012322

2) 112 x 112

Area of Filter Analyzed, mm²: 0.123

ASBESTOS STRUCTURE DATA

	$\leq 5.0 \mu m$	$> 5.0 \mu m$	Total
Number of Chrysotile Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Amphibole Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc $> 5.0 \mu m$:

BAS

Chrysotile Asbestos Concentration Str/cc:

BAS

Asbestos Concentration Str/cc $\leq 5.0 \mu m$:

BAS

Amphibole Asbestos Concentration Str/cc:

BAS

Analytical Sensitivity Str/mm²:

8.1

Analytical Sensitivity Str/cc:

0.013

Total Asbestos Concentration Str/mm²:

BAS

Total Asbestos Concentration Str/cc:

BAS

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

Nov 23 88

M 12592-3

PAGE #

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[illegible]

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE :

C = CHRYSOTILE
AM = AMOSITE
CR = CROCIDOLITE
AC = ACTINOLITE
TR = TREMOLITE
AN = ANTHOPHYLLITE
N = NON ASBESTOS

STRUCTURE :

F = FIBER
B = BUNDLE
C = CLUSTER
M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
MORPH = MORPHOLOGY
SAED = SELECTED AREA ELECTRON DIFFRACTION
EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN

MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST:

Hannan

ANALYTICAL PROTOCOL: Level II

REVIEWER:

M. M. [Signature]

SAMPLE DATA

Client: Duke Univ. Medi Center

Sample ID: 6

Sample Volume, cc: 377000

Filter Type: MCE 25mm

Filter Pore Size, μm : NG

Effective Filter Area, mm^2 : 385

ANALYSIS PARAMETERS

MAS Sample Number: M12592-4

Date Analyzed: 3-6-95

Microscope Number: 5

Accelerating Voltage: 100 V

Indicated Mag: 20 X

Screen Mag: 1513 X

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: yes

Number of Openings / Grids Counted: 1012

Percent Loading: 5%

Grid Opening Size (μm): 1) 110 x 111

Average Grid Opening Area, mm^2 : 0.1012155

2) 110 x 110

Area of Filter Analyzed, mm^2 : 0.122

ASBESTOS STRUCTURE DATA

	$\leq 5.0 \mu\text{m}$	$> 5.0 \mu\text{m}$	Total
Number of Chrysotile Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Amphibole Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc $> 5.0 \mu\text{m}$:

BAS

Chrysotile Asbestos Concentration Str/cc:

BAS

Asbestos Concentration Str/cc $\leq 5.0 \mu\text{m}$:

BAS

Amphibole Asbestos Concentration Str/cc:

BAS

Analytical Sensitivity Str/ mm^2 :

812

Analytical Sensitivity Str/cc:

0.008

Total Asbestos Concentration Str/ mm^2 :

BAS

Total Asbestos Concentration Str/cc:

BAS

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

MAS JOB NUMBER: 321 37 58 M 12592-4

PAGE #

11

[illegible]

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE:

C = CHRYSOTILE
AM = AMOSITE
CR = CROCIDOLITE
AC = ACTINOLITE
TR = TREMOLITE
AN = ANTHOPHYLLITE
N = NON ASBESTOS

STRUCTURE :

F = FIBER
B = BUNDLE
C = CLUSTER
M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
MORPH = MORPHOLOGY
SAED = SELECTED AREA ELECTRON DIFFRACTION
EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN

MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST:

Hamm

ANALYTICAL PROTOCOL: Level II

REVIEWER:

M. M. M.

SAMPLE DATA

Client: Duke Univ. Med. Center

Sample ID: 7

Sample Volume, cc: 247000

Filter Type: MCE 25mm

Filter Pore Size, μm : NG

Effective Filter Area, mm^2 : 385

ANALYSIS PARAMETERS

MAS Sample Number: M12592-5

Date Analyzed: 3-6-95

Microscope Number: 5

Accelerating Voltage: 100

Indicated Mag: 20

Screen Mag: 1513

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: yes

Number of Openings / Grids Counted: 1012

Percent Loading: 2%

Grid Opening Size (μm): 1) 111 x 114

Average Grid Opening Area, mm^2 : 0.012377

2) 110 x 110

Area of Filter Analyzed, mm^2 : 0.124

ASBESTOS STRUCTURE DATA

	$\leq 5.0 \mu\text{m}$	$> 5.0 \mu\text{m}$	Total
Number of Chrysotile Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Amphibole Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>
Number of Asbestos Structures Counted:	<u>0</u>	<u>0</u>	<u>0</u>

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc $> 5.0 \mu\text{m}$:	<u>BAS</u>	Chrysotile Asbestos Concentration Str/cc:	<u>BAS</u>
Asbestos Concentration Str/cc $\leq 5.0 \mu\text{m}$:	<u>BAS</u>	Amphibole Asbestos Concentration Str/cc:	<u>BAS</u>

Analytical Sensitivity Str/ mm^2 :	<u>81/</u>	Analytical Sensitivity Str/cc:	<u>0.013</u>
Total Asbestos Concentration Str/ mm^2 :	<u>BAS</u>	Total Asbestos Concentration Str/cc:	<u>BAS</u>

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

Box 3388

PAGE #

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KEYS TO ABBREVIATIONS USED ABOVE:

OTHERS:

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EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN

MATERIALS ANALYTICAL SERVICES

AIR SAMPLE ANALYSIS

ANALYST:

Hannay

ANALYTICAL PROTOCOL: Level II

REVIEWER:

M. M. K.

SAMPLE DATA

Client: DUKE UNIV. MED. CENTER

Sample ID: 8 - ~~low~~ Blank

Sample Volume, cc: 0

Filter Type: MCE 25

Filter Pore Size, um: 10

Effective Filter Area, mm²: 385

ANALYSIS PARAMETERS

MAS Sample Number: M 12592-6

Date Analyzed: 3-7-95

Microscope Number: 5

Accelerating Voltage: 100 K

Indicated Mag: 20 K

Screen Mag: 1513 K

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: 94

Number of Openings / Grids Counted: 1012

Percent Loading: 2

Grid Opening Size (um): 1) 109 x 110

Average Grid Opening Area, mm²: 0.012045

2) 110 x 110

Area of Filter Analyzed, mm²: 0.120

ASBESTOS STRUCTURE DATA

≤ 5.0 um

> 5.0 um

Total

Number of Chrysotile Asbestos Structures Counted: 0

0

0

Number of Amphibole Asbestos Structures Counted: 0

0

0

Number of Asbestos Structures Counted: 0

0

0

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc > 5.0um:

NA

Chrysotile Asbestos Concentration Str/cc:

NA

Asbestos Concentration Str/cc ≤ 5.0um:

NA

Amphibole Asbestos Concentration Str/cc:

NA

Analytical Sensitivity Str/mm²:

8.3

Analytical Sensitivity Str/cc:

NA

Total Asbestos Concentration Str/mm²:

BAS

Total Asbestos Concentration Str/cc:

NA

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST:

REVIEWER:

ANALYTICAL PROTOCOL: Level II

SAMPLE DATA

Client: Duke Univ. Med. Center

Sample ID: 9

Sample Volume, cc: 377000

Filter Type: MCE 25mm

Filter Pore Size, um: NG

Effective Filter Area, mm²: 385

ANALYSIS PARAMETERS

MAS Sample Number: M 12592-7

Date Analyzed: 3-6-95

Microscope Number: 2

Accelerating Voltage: 100 K

Indicated Mag: 25 K

Screen Mag: 20 K

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag: ✓ 28

Number of Openings / Grids Counted: 712

Percent Loading: 10

Grid Opening Size (um): 1) 108 x 112

Average Grid Opening Area, mm²: 0.02208

2) 110 x 112

Area of Filter Analyzed, mm²: 0.085

ASBESTOS STRUCTURE DATA

≤ 5.0 um

> 5.0 um

Total

Number of Chrysotile Asbestos Structures Counted: 100

3

103

Number of Amphibole Asbestos Structures Counted: 0

0

0

Number of Asbestos Structures Counted: 100

3

103

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc > 5.0um: 0.036

Chrysotile Asbestos Concentration Str/cc: 1.231

Asbestos Concentration Str/cc ≤ 5.0um: 1.195

Amphibole Asbestos Concentration Str/cc: BAS

Analytical Sensitivity Str/mm²: 11.7

Analytical Sensitivity Str/cc: 0.012

Total Asbestos Concentration Str/mm²: 1205.3

Total Asbestos Concentration Str/cc: 1.231

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

STR #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EDS
1	C1-HY	C	M-F	0.6	0.1	—	—	Pu
2		C	M-F	0.5	0.01	—	M23201	—
3		C	B	2.0	0.15	—	—	
4		C	M-F	0.7	0.05	—	—	
5		C	M-F	1.3	0.05	—	—	
6	PH	C	M-B	1.4	0.15	—	—	
7		C	M-F	0.7	0.01	—	—	
8		C	M-F	1.6	0.05	—	—	
9		C	M-F	0.6	0.05	—	—	
10	G2	C	M-B	0.6	0.2	—	—	Pu
11		C	M-F	1.4	0.01	—	—	
12		C	M-F	1.3	0.1	—	—	
13		C	M-F	2.0	0.1	—	—	
14		C	M-B	8.5	0.6	—	—	
15		C	F	0.8	0.05	—	—	
16		C	F	1.6	0.01	—	—	
17		C	M-F	0.7	0.05	—	—	
18		C	M-F	2.2	0.1	—	—	
19		C	M-F	0.7	0.05	—	—	
20		C	M-B	1.7	0.2	—	—	Pu.
21		C	F	0.7	0.05	—	—	
22	-E1	C	M-F	2.8	0.2	—	—	
23		C	F	1.9	0.2	—	—	
24		C	M-F	1.0	0.05	—	—	
25		C	F	2.2	0.1	—	—	

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE:

C = CHRYSOTILE
 AM = AMOSITE
 CR = CROCIDOLITE
 AC = ACTINOLITE
 TR = TREMOLITE
 AN = ANTHOPHYLLITE
 N = NON ASBESTOS

STRUCTURE:

F = FIBER
 B = BUNDLE
 C = CLUSTER
 M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
 MORPH = MORPHOLOGY
 SAED = SELECTED AREA ELECTRON DIFFRACTION
 EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
 IR = INTERROW SPACING
 NP = NO PATTERN

STR. #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EDS
26	C1-E1	C	B	5.7	0.5	—	—	
27	cont.	C	M-F	1.4	0.05	—	—	
28	C2	C	M-F	1.5	0.03	—	—	
29		C	F	1.3	0.05	—	—	
30		C	M-F	1.0	0.55	—	—	pr
31		C	M-B	24.0	1.5	—	—	
32		C	F	1.0	0.1	—	—	
33		C	M-F	1.9	0.1	—	—	
34		C	B	1.7	0.25	—	—	
35		C	M-F	1.6	0.1	—	—	
36		C	M-F	0.7	0.1	—	—	
37	D1 -E8	C	F	0.8	0.1	—	—	
38		C	F	1.2	0.05	—	—	
39		C	B	1.9	0.2	—	—	
40		C	B	1.7	0.2	—	—	pr
41		C	F	3.0	0.05	—	—	
42		C	F	0.9	0.1	—	—	
43		C	M-F	0.8	0.05	—	—	
44		C	M-B	1.3	0.3	—	—	
45		C	M-F	1.0	0.1	—	—	
46		C	M-F	0.6	0.05	—	—	
47		C	M-F	1.4	0.05	—	—	
48		C	M-F	1.6	0.05	—	—	
49	D1-I4	C	F	1.3	0.01	—	—	
50		C	F	1.7	0.1	—	—	pr
51		C	M-F	0.7	0.1	—	—	
52		C	M-F	2.8	0.1	—	—	
53		C	M-F	1.0	0.1	—	—	
54		C	M-F	0.3	0.05	—	—	
55		C	M-F	0.3	0.05	—	—	

STR #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EDS
56	D1-14	C	M-F	0.9	0.1	—	—	
57	Conte	C	M-F	0.7	0.05	—	—	
58		L	F	0.4	0.05	—	—	
59		C	B	2.4	0.4	—	—	
60		C	M-F	1.0	0.1	—	—	P.O
61		C	B	2.9	0.4	—	—	
62		C	F	3.7	0.05	—	—	
63	-F2	C	M-B	0.4	0.12	—	—	
64		C	M-F	1.5	0.15	—	—	
65		C	M-F	0.7	0.05	—	—	
66		C	M-F	0.6	0.1	—	—	
67		C	M-F	0.7	0.05	—	—	
68		C	M-F	0.6	0.05	—	—	
69		C	M-F	3.0	0.1	—	—	
70		C	M-F	1.0	0.05	—	—	P.
71		C	M-F	0.7	0.05	—	—	
72		C	M-B	2.5	0.15	—	—	
73		C	M-F	0.5	0.05	—	—	
74		C	M-F	0.4	0.01	—	—	
75		C	F	0.9	0.1	—	—	
76		C	M-B	2.0	0.5	—	—	
77		C	F	0.4	0.01	—	—	
78		C	M-F	0.7	0.01	—	—	
79		C	M-F	0.4	0.1	—	—	
80		C	M-B	0.6	0.08	—	—	P.
81		C	M-F	0.4	0.05	—	—	
82		C	M-F	0.8	0.05	—	—	
83		C	M-F	0.3	0.01	—	—	
84		C	B	2.3	0.5	—	—	
85	-D5	C	M-F	1.0	0.2	—	—	

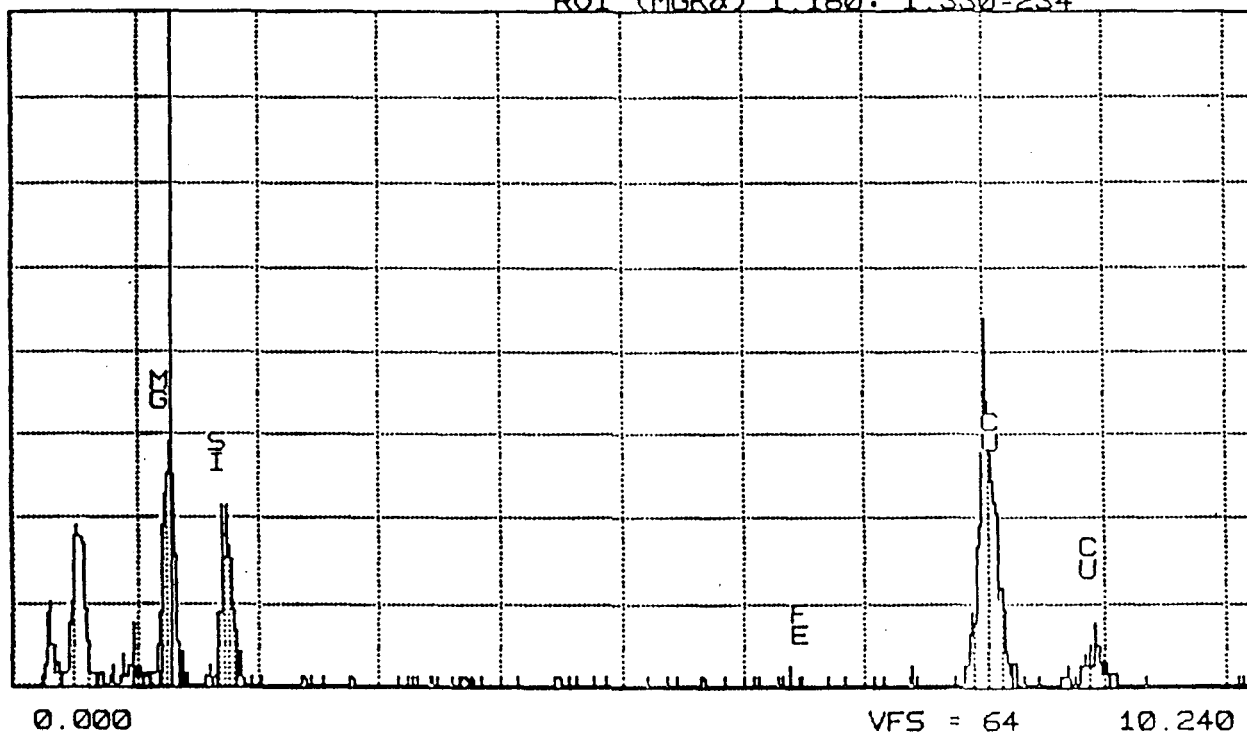
MATERIALS ANALYTICAL SERVICES

MON 06-MAR-95 13:22

Cursor: 1.280keV = 14

ROI (SIK α) 1.660: 1.810=169

ROI (MGK α) 1.180: 1.330=234



0.000

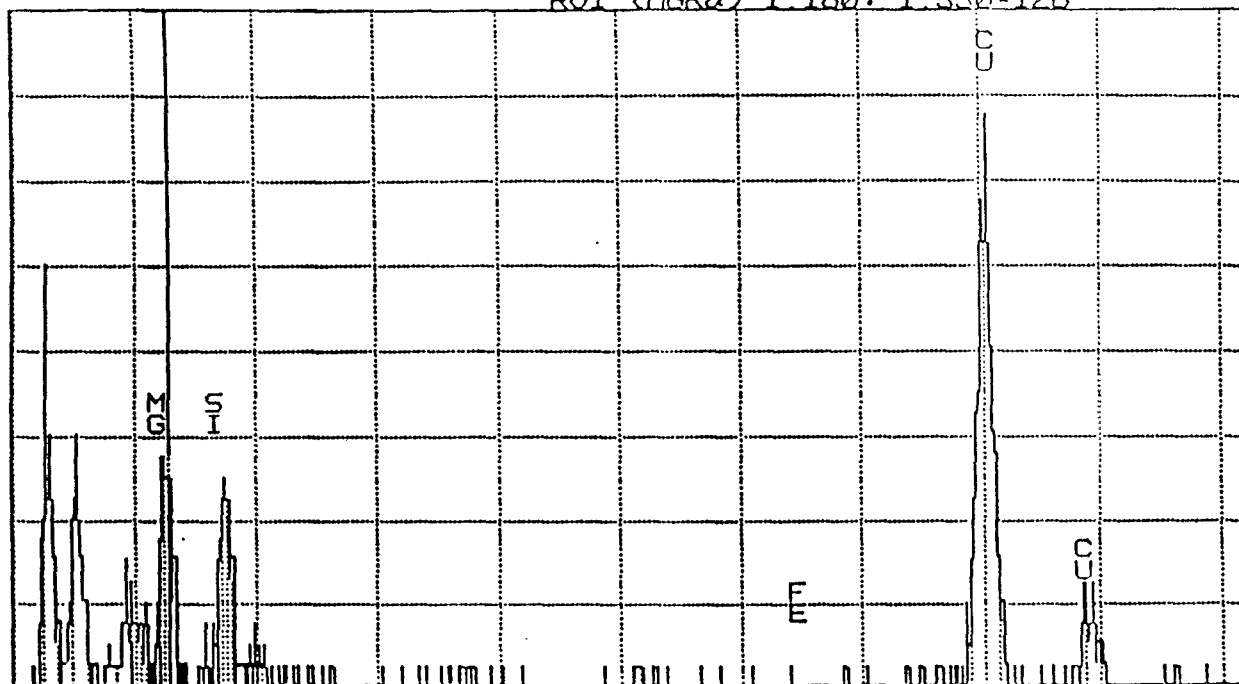
VFS = 64

10.240

21

M12592-7 , CHRYSOTILE

Cursor: 1.280keV = 14

ROI (SIK α) 1.660: 1.810=108ROI (MGK α) 1.180: 1.330=126

0.000

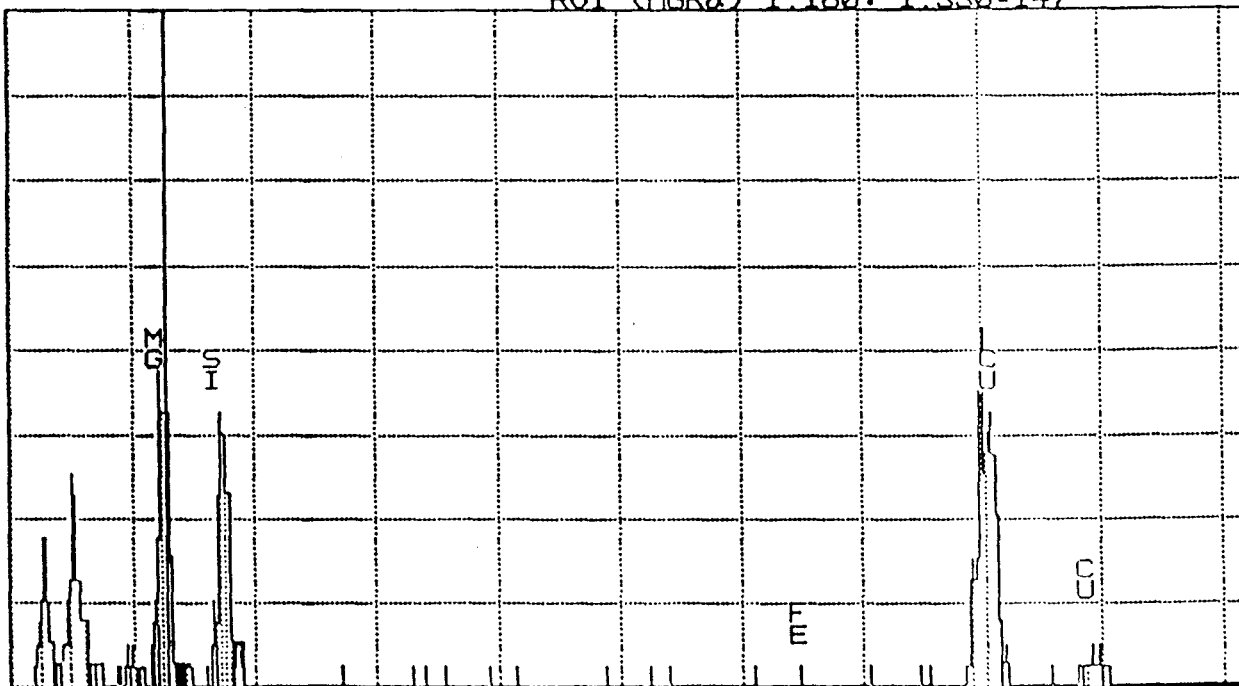
VFS = 32

10.240

21

M12592-7 , CHRYSOTILE

Cursor: 1.280keV = 15

ROI (SIK α) 1.660: 1.810=127ROI (MGK α) 1.180: 1.330=147

0.000

VFS = 32

10.240

34

M12592-7 , CHRYSOTILE

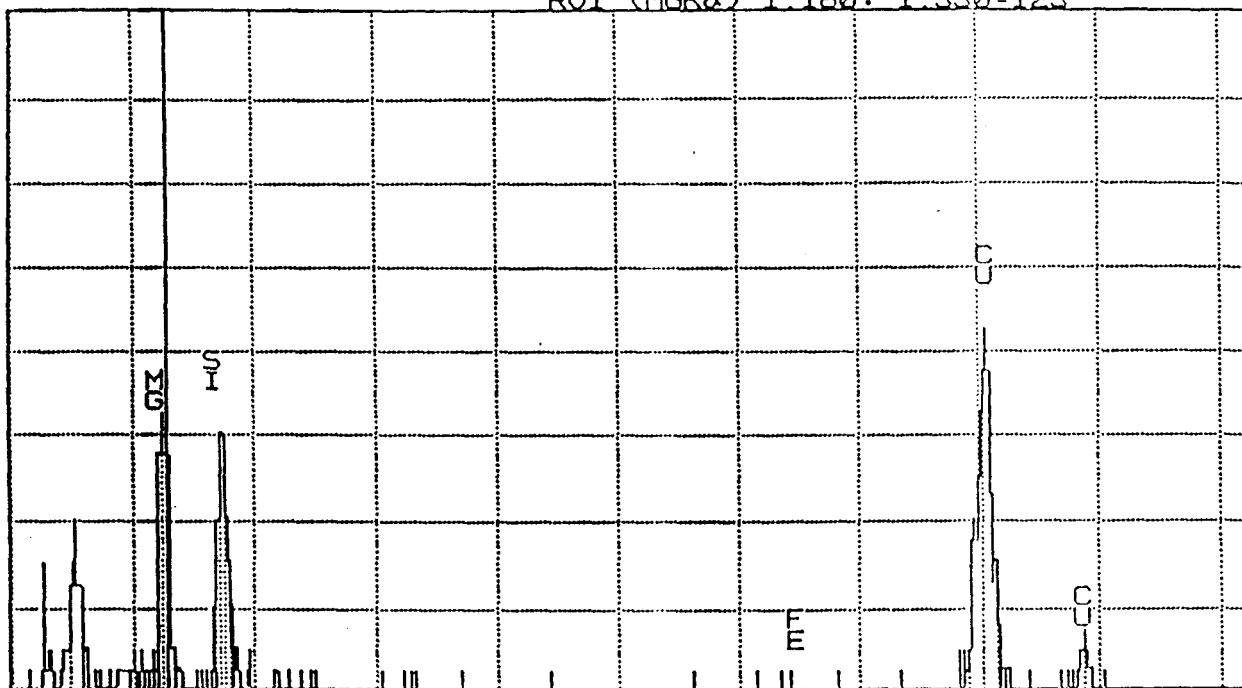
MATERIALS ANALYTICAL SERVICES

MON 06-MAR-95 14:27

Cursor: 1.280keV = 6

ROI (SIK α) 1.660: 1.810=120

ROI (MGK α) 1.180: 1.330=123



0.000

VFS = 32

10.240

14 M12592-7 , CHRYSOTILE

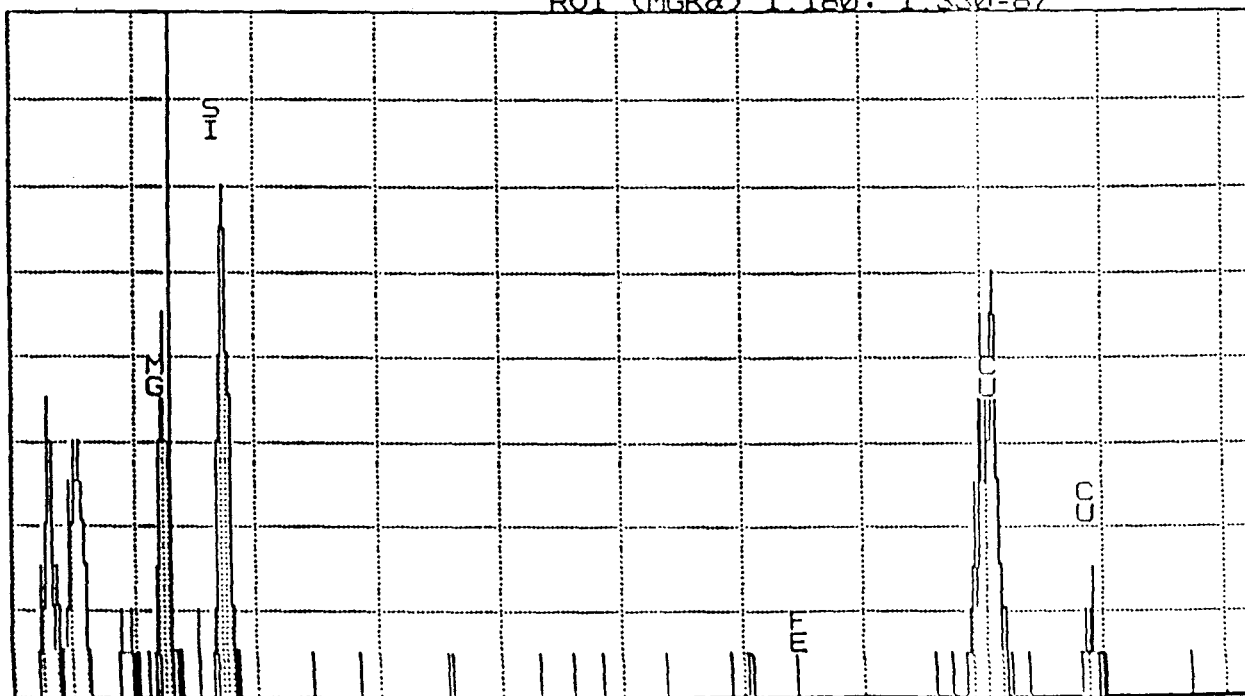
MATERIALS ANALYTICAL SERVICES

MON 06-MAR-95 15:34

Cursor: 1.300keV = 2

ROI (SIK α) 1.660: 1.810=117

ROI (MGK α) 1.180: 1.330=87



0.000

VFS = 16

10.240

15 M12592-7 , CHRYSOTILE

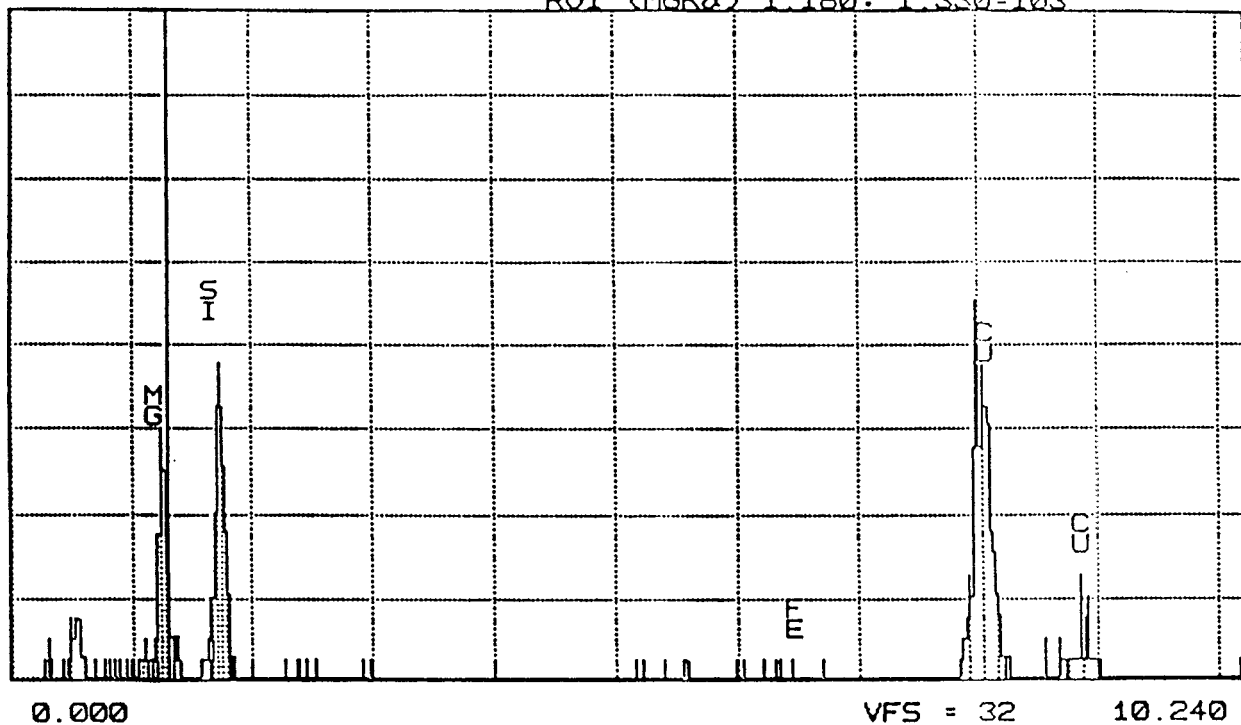
MATERIALS ANALYTICAL SERVICES

TUE 07-MAR-95 14:16

Cursor: 1.310keV = 6

ROI (SIK α) 1.660: 1.810=128

ROI (MGK α) 1.180: 1.330=103



21 M12592-7 , CHRYSOTILE

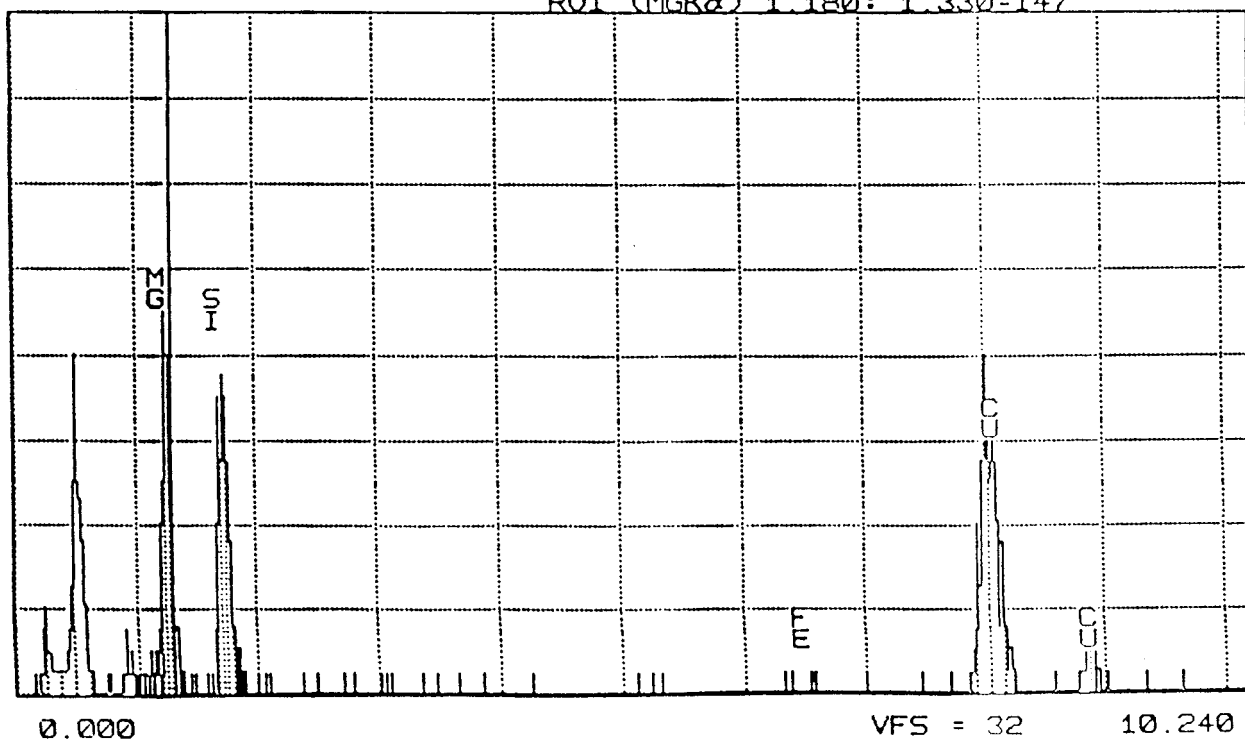
MATERIALS ANALYTICAL SERVICES

TUE 07-MAR-95 14:31

Cursor: 1.310keV = 6

ROI (SIK α) 1.660: 1.810=150

ROI (MGK α) 1.180: 1.330=147



12 M12592-7 , CHRYSOTILE

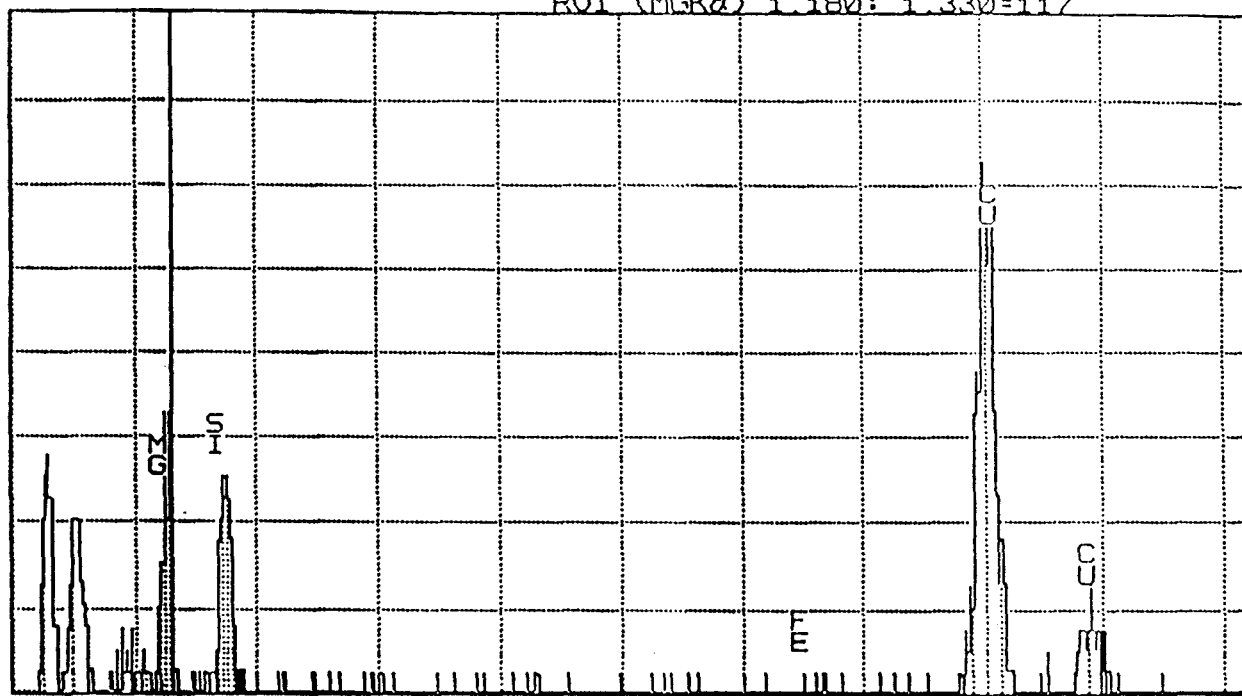
MATERIALS ANALYTICAL SERVICES

TUE 07-MAR-95 14:37

Cursor: 1.310keV = 7

ROI (SIK α) 1.660: 1.810=114

ROI (MGK α) 1.180: 1.330=117



0.000

VFS = 32

10.240

26

M12592-7 , CHRYSOTILE

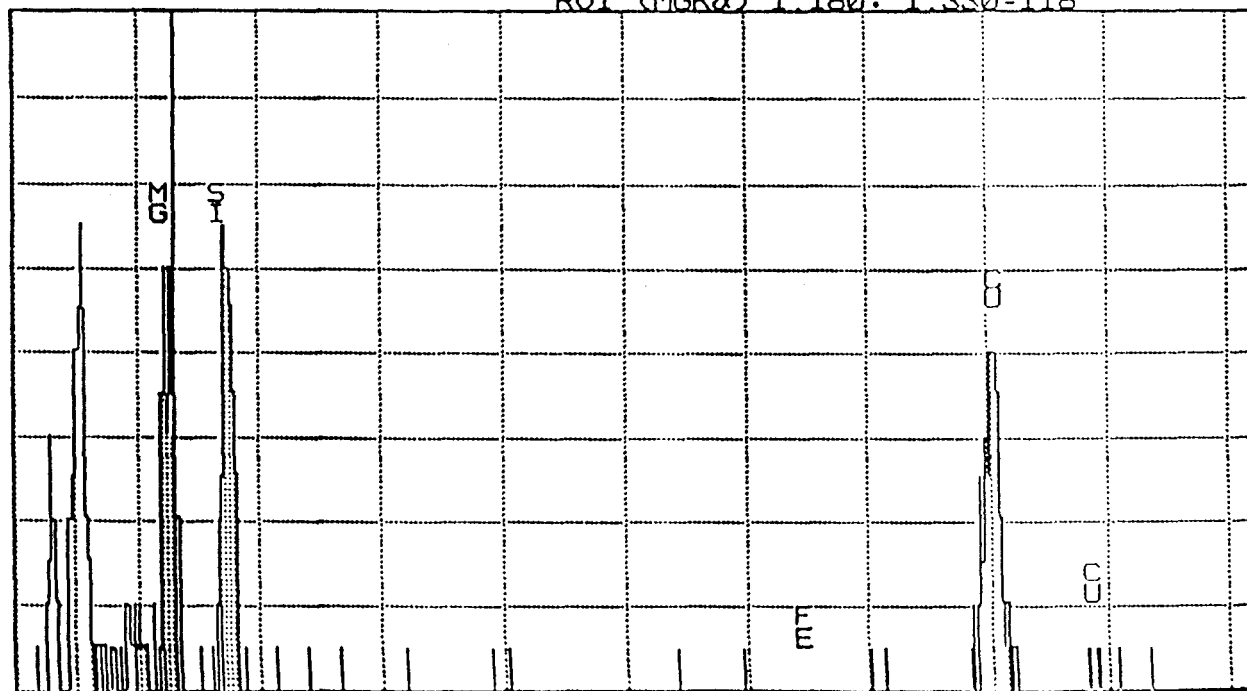
MATERIALS ANALYTICAL SERVICES

TUE 07-MAR-95 14:43

Cursor: 1.310keV = 2

ROI (SIK α) 1.660: 1.810=124

ROI (MGK α) 1.180: 1.330=118



0.000

VFS = 16

10.240

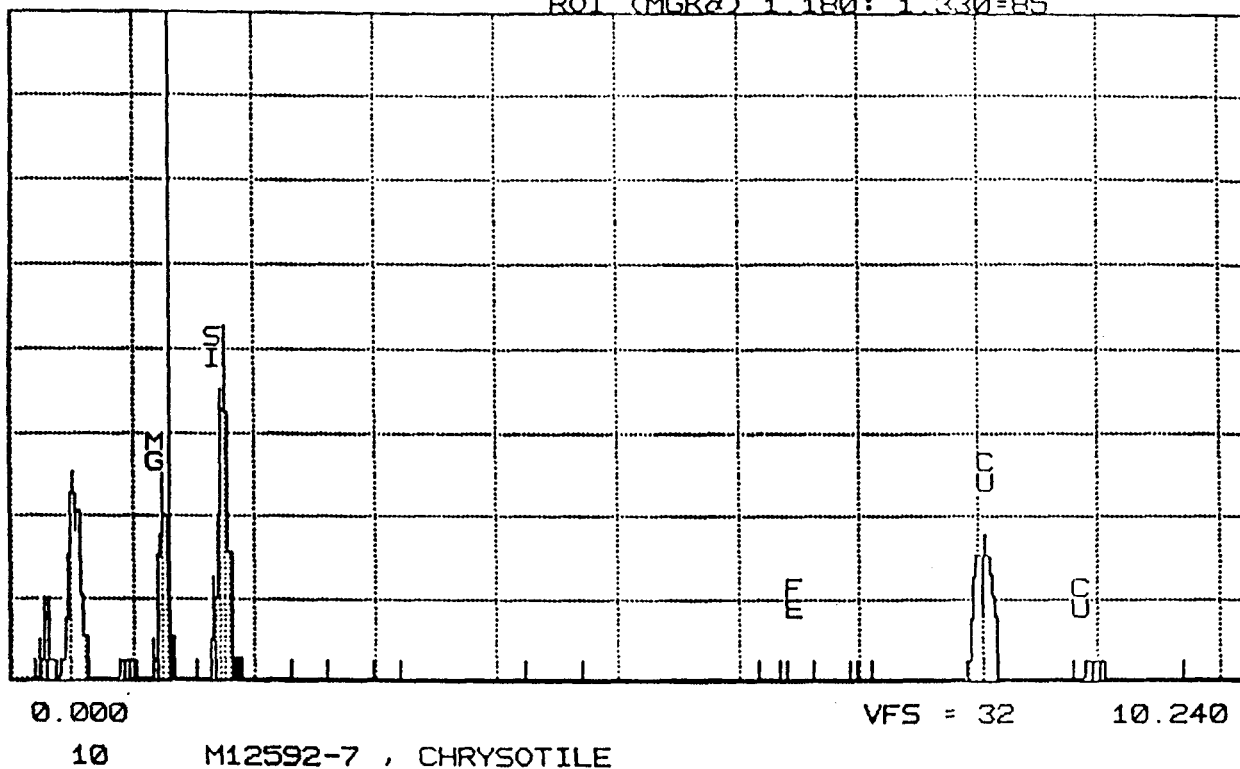
9

M12592-7 , CHRYSOTILE

TUE 07-MAR-95 14:52

Cursor: 1.310KeV = 3

ROI (SIK α) 1.660: 1.810=143

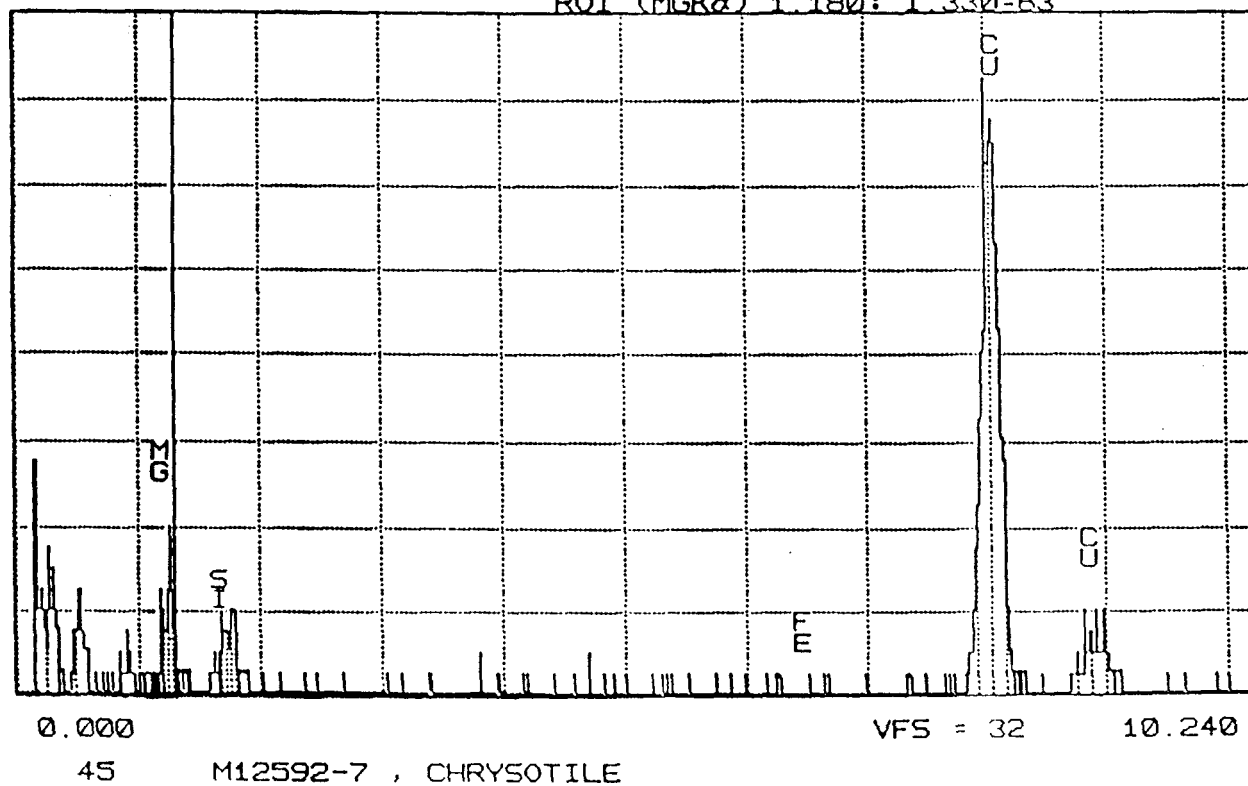
$$\text{ROI (MGK}\alpha) \text{ } 1.180: 1.330=85$$


TUE 07-MAR-95 15:28

Cursor: 1.310keV = 1

ROI (SIK α) 1.660: 1.810=47

ROI (MGK α) 1.180: 1.330=63



MATERIALS ANALYTICAL SERVICES
AIR SAMPLE ANALYSIS

ANALYST :

Harrison

ANALYTICAL PROTOCOL : Level II

REVIEWER :

McMaster

SAMPLE DATA

Client : Duke Univ. Med. Center

Sample ID : 10 - Field Blank

Sample Volume, cc : 0

Filter Type : MCE 25mm

Filter Pore Size, μm : NG

Effective Filter Area, mm^2 : 385

ANALYSIS PARAMETERS

MAS Sample Number : M12592-8

Date Analyzed : 3-6-95

Microscope Number : 5

Accelerating Voltage : 100

Indicated Mag : 20

Screen Mag : 15.3

ANALYSIS RESULTS AND CALCULATION DATA

Grid Accepted, Low Mag : yes

Number of Openings / Grids Counted : 10 / 2

Percent Loading : 41 %

Grid Opening Size (μm) : 1) 110 x 110

Average Grid Opening Area, mm^2 : 0.012266

2) 111 x 112

Area of Filter Analyzed, mm^2 : 0.123

ASBESTOS STRUCTURE DATA

$\leq 5.0 \mu\text{m}$

$> 5.0 \mu\text{m}$

Total

Number of Chrysotile Asbestos Structures Counted : 0

0

0

Number of Amphibole Asbestos Structures Counted : 0

0

0

Number of Asbestos Structures Counted : 0

0

0

ASBESTOS CONCENTRATION DATA

Asbestos Concentration Str/cc $> 5.0 \mu\text{m}$:

NA

Chrysotile Asbestos Concentration Str/cc :

NA

Asbestos Concentration Str/cc $\leq 5.0 \mu\text{m}$:

NA

Amphibole Asbestos Concentration Str/cc :

NA

Analytical Sensitivity Str/ mm^2 :

8.2

Analytical Sensitivity Str/cc :

0.001

Total Asbestos Concentration Str/ mm^2 :

BAS

Total Asbestos Concentration Str/cc :

NA

BAS = Below Analytical Sensitivity
Included form provides formulae for calculating results.

PAGE #

M 12592-8

PAGE #

[illegible]

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE :

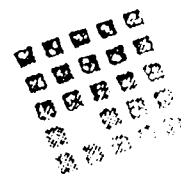
C = CHRYSOTILE
AM = AMOSITE
CR = CROCIDOLITE
AC = ACTINOLITE
TR = TREMOLITE
AN = ANTHOPHYLLITE
N = NON ASBESTOS

STRUCTURE :

F = FIBER
B = BUNDLE
C = CLUSTER
M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
MORPH = MORPHOLOGY
SAED = SELECTED AREA ELECTRON DIFFRACTION
EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
IR = INTERROW SPACING
NP = NO PATTERN



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-1

SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: QX

SAMPLE ID. 3

PUMP SER. # _____

CALIB. DATE _____

START _____ STOP _____ TIME _____

_____ Pump Flow Rate (L/Min) (FR)

_____ Sample Duration in Min. (T)

235.8l Sample Volume = FR X T (V)

8.5 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

7.0 Total Fibers Counted (FCB)
in Field Blank

100 Total Fields Counted (FLB)
in Field Blank

385mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS}{FLS} - \frac{FCB}{FLB}$$

GFA

$$E = \frac{1.9}{F/mm^2}$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER CC

$$C = \frac{(E)(AF)}{1000V}$$

$$C = \frac{0.003}{F/cc}$$

1	-	1	-	-	
1	-	-	-	-	10
1/2	-	-	-	-	
-	-	-	-	-	20
-	-	-	-	-	
-	-	-	-	-	30
-	-	-	-	-	
-	-	-	-	-	40
-	-	-	-	-	
1	-	-	-	-	50
-	-	-	-	-	
-	-	-	-	-	60
-	-	-	1	-	
-	-	-	-	-	70
-	-	-	-	-	
1	-	-	-	-	80
-	-	-	-	-	
-	-	1	-	-	90
-	-	-	1	-	
-	-	-	-	-	100
-	-	-	-	-	

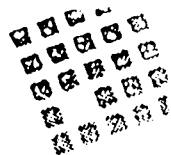
NOTES: _____



PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-2
SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: QOQ

$1\frac{1}{2}$	—	$2\frac{1}{2}$	1	2	
1	—	2	$1\frac{1}{2}$	$\frac{1}{2}$	10
5	—	$\frac{1}{2}$	2	4	
$10\frac{1}{2}$	—	1	4	$1\frac{1}{2}$	20
7	$2\frac{1}{2}$	—	3	2	
7	$1\frac{1}{2}$	$\frac{1}{2}$	—	—	30
$\frac{1}{2}$	1	—	—	$\frac{1}{2}$	
$1\frac{1}{2}$	$1\frac{1}{2}$	—	1	—	40
$5\frac{1}{2}$	—	$1\frac{1}{2}$	$1\frac{1}{2}$	4	
1	8	$\frac{1}{2}$	$\frac{1}{2}$	1	50
1	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	1	
—	—	3			60
					70
					80
					90
					100

NOTES:



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-3

SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: OO

SAMPLE ID. 5

—	—	—	1	—	
—	—	—	—	—	10
—	—	—	—	—	
—	—	—	—	—	20
—	—	—	—	—	
—	—	—	—	—	30
1	—	—	—	—	
—	—	1	—	—	40
—	—	—	—	—	
—	—	—	—	1	50
—	—	—	1/2	—	
—	—	—	—	—	60
—	—	—	—	—	
—	—	—	—	—	70
—	—	—	—	—	
—	—	—	—	—	80
—	—	—	—	—	
—	—	—	—	—	90
—	—	—	—	—	
—	—	—	—	—	100

PUMP SER. # _____

CALIB. DATE _____

START _____ STOP _____ TIME _____

_____ Pump Flow Rate (L/Min) (FR)

_____ Sample Duration in Min. (T)

245.68 Sample Volume = FR X T (V)

4.5 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

7.0 Total Fibers Counted (FCB)
in Field Blank

100 Total Fields Counted (FLB)
in Field Blank

385 mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS - FCB}{\frac{FLS}{FLB} \times GFA}$$

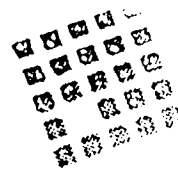
$$E = < 8.9 \text{ (L.O.D.) } F/mm^2$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER CC

$$C = \frac{(E)(AF)}{1000V}$$

$$C = < 0.014 \text{ (L.O.D.) } F/cc$$

NOTES: _____



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-4

SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: QO

—	1/2	—	—	2	
1	1	—	—	1/2	10
1	1 1/2	1 1/2	1 1/2	2 1/2	
1	1/2	—	—	—	20
1 1/2	1	—	—	1 1/2	
—	1	—	1	—	30
1	2	1	1	5	
—	—	1/2	—	—	40
1/2	—	—	1/2	—	
—	2	—	2	1	50
2	1	1	3	1	
1/2	—	—	—	1	60
—	—	1	—	—	
—	—	1	1 1/2	2	70
—	—	1	1	1	
—	—	2	—	—	80
—	—	1 1/2	1	2	
1	—	1	—	—	90
—	—	—	—	—	
—	—	1/2	1	—	100

SAMPLE ID. 6

PUMP SER. # _____

CALIB. DATE _____

START _____ STOP _____ TIME _____

_____ Pump Flow Rate (L/Min) (FR)

_____ Sample Duration in Min. (T)

376.8 l Sample Volume = FR X T (V)

65.0 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

7.0 Total Fibers Counted (FCB)
in Field Blank

100 Total Fields Counted (FLB)
in Field Blank

385 mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS - FCB}{FLS - FLB} \div GFA$$

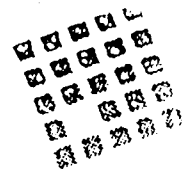
$$E = \frac{73.9}{F/mm^2}$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER CC

$$C = \frac{(E)(AF)}{1000V}$$

$$C = \frac{0.075}{F/cc}$$

NOTES: _____



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-5

SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: QD

SAMPLE ID. 7

—	—	—	—	—	
—	—	—	—	—	10
—	—	—	—	—	
—	—	—	—	—	20
—		—	—	—	
—		—	—	—	30
—	—	—	—	—	
—	—	—	—	—	40
—	—	—	—	—	
—	—	—	—	—	50
—	—	—		—	
—	—	—	—	—	60
—	—	—	—	—	
—	—	—	—		70
—	—	—	—	—	
—	—	—	—	—	80
—	—	—	—	—	
—	—	—		—	90
—	—	—	—	—	
—	—	—	—	—	100

PUMP SER. # _____

CALIB. DATE _____

START _____ STOP _____ TIME _____

_____ Pump Flow Rate (L/Min) (FR)

_____ Sample Duration in Min. (T)

247.18 Sample Volume = FR X T (V)

5.0 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

7.0 Total Fibers Counted (FCB)
in Field Blank

100 Total Fields Counted (FLB)
in Field Blank

385 mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS}{FLS} - \frac{FCB}{FLB}$$

$$E = \frac{GFA}{(L.O.D.)} F/mm^2$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER CC

$$C = \frac{(E)(AF)}{1000V}$$

$$C = \frac{(L.O.D.)}{F/cc}$$

NOTES: _____



SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: QA

100

3597 Parkway Lane • Suite 250
Norcross, Georgia 30092
(404) 448-3200 FAX (404) 368-8256



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-7

SAMPLE DATE: _____ ANALYSIS DATE: 3/6/95 ANALYST: COO

—	—				
—	—	—			10
—	—		—	—	
—		—			20
—	—	—	—	—	
—	—	2½	—	—	30
		—		—	
—	—	½	—	½	40
—	—	—	—	—	
	—	—	—		50
½	—	—		—	
	—	—	—	—	60
—	—	—		—	
—		½	—	½	70
—	—	—	½	—	
	—	—	—	—	80
—	—			—	
2	—	—	—	—	90
½		—	½	—	
	—	—	—	—	100

SAMPLE ID. 9

PUMP SER. # _____

CALIB. DATE _____

START _____ STOP _____ TIME _____

_____ Pump Flow Rate (L/Min) (FR)

_____ Sample Duration in Min. (T)

376.78 Sample Volume = FR X T (V)

31.5 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

7.0 Total Fibers Counted (FCB)
in Field Blank

100 Total Fields Counted (FLB)
in Field Blank

385 mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS - FCB}{\frac{FLS}{FLB} \times GFA}$$

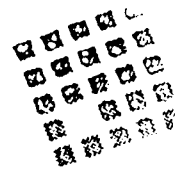
$$E = \frac{31.2}{F/mm^2}$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER cc

$$C = \frac{(E)(AF)}{1000V}$$

$$C = \frac{0.032}{F/cc}$$

NOTES: _____



MATERIALS
ANALYTICAL
SERVICES

PHASE CONTRAST MICROSCOPY AIRBORNE FIBER ANALYSIS

PROJECT NAME: Duke University - Medical Ctr. SAMPLE NUMBER: M12592-8

SAMPLE DATE: ANALYSIS DATE: 3/6/95 ANALYST:

—		—	—	—	
—	—	—	—	—	10
—	—	—	—	—	
—	—	1/2	—	—	20
—	—	—	—	—	
—	—	—	—		30
—	—	1/2	—	—	
—	—	—	—	—	40
—	—	—	—	—	
—	—	—	—	—	50
—	—	—		—	
—	—	—	—	—	60
—	—	—	—		
—	—	—	—	—	70
—	—	—	—	—	
—	—		—	—	80
—	—	—	—	—	
—	—	—	—		90
—	—	—	—	—	
—	—	—	—	—	100

SAMPLE ID. 10
Field Blank

PUMP SER. #

CALIB. DATE

START STOP TIME

 Pump Flow Rate (L/Min) (FR)

 Sample Duration in Min. (T)

 Sample Volume = FR X T (V)

7.0 Total Fibers Counted (FCS)
in Sample

100 Total Fields Counted (FLS)
in Sample

 Total Fibers Counted (FCB)
in Field Blank

 Total Fields Counted (FLB)
in Field Blank

385 mm² Area of 25 mm Filter (AF)

.00785 Graticule Field Area (GFA)
in sq. mm

CALCULATION OF FIBER DENSITY (E)

$$E = \frac{FCS}{FLS} - \frac{FCB}{FLB}$$

GFA

$$E = \frac{8.9}{F/mm^2}$$

CALCULATION OF FIBER CONCENTRATION (C)
IN FIBERS PER CC

$$C = \frac{(E)(AF)}{1000V}$$

$$C = \frac{N/A}{F/cc}$$

NOTES: Field Blank

MATERIALS ANALYTICAL SERVICES, INC.
3597 PARKWAY LANE, SUITE 250
NORCROSS, GEORGIA 30092
(404) 448-3200

CHAIN-OF-CUSTODY

Page 1 of 1

Client: DUKE UNIV.MED CTR

MAS Job #: M12592

Contact: COURTNEY SMITH

Date Recd: 03/04/95

Phone No: 1 (919)-286-3232

Client P.O.: UNKNOWN

TYPE OF ANALYSIS

Type : AIR

Requested T.A.T.: 72 Hours

Method: TEM & PCM

Due Date: 03/07/95

Sample Number(s):

1) 3	0
2) 4	0
3) 5	0
4) 6	0
5) 7	0
6) 8	0
7) 9	0
8) 10	0

Samples Relinquished By: Fedex

Samples Received By: S FITZGERALD SR Time: 08:08

Condition of Samples: OK

Client Docs: 3 = 2 COC + Cover

Init File Rev: _____

Sample Prep By: [Signature] Date: 04 MAR 95

Sample Analysis: Harman / Mike Lee Date: 3-6-95, 3-7-95

Report(s) Sent By: _____ Date: _____

Sample(s) Ret. By: _____ Date: _____



DUKE UNIVERSITY MEDICAL CENTER

Occupational Health Service

2 March 1995

Mr. Bill Egeland
MAS
3597 Parkway Lane, Suite 250
Norcross, GA 30092

Dear Mr. Egeland:

Enclosed please find the asbestos filter samples we discussed and two copies of a chain of custody form. The chain of custody form indicates the requested analyses and the billing information. We request expedited analyses of these samples (three days turnaround). Please FAX results to us as soon as they are available (FAX number: 919-286-1021). Once the analysis is completed please keep a copy of the chain of custody form and send one back to Dr. John Dement with the analytical results.

Thank you very much for your help with obtaining the filters and with providing necessary information about the sampling.

Sincerely,

A handwritten signature in cursive script that reads "Courtney Smith".

Courtney Smith,
Research Associate

APPENDIX C

SKETCH OF GLOVE BOX USED FOR ABRASION TESTS

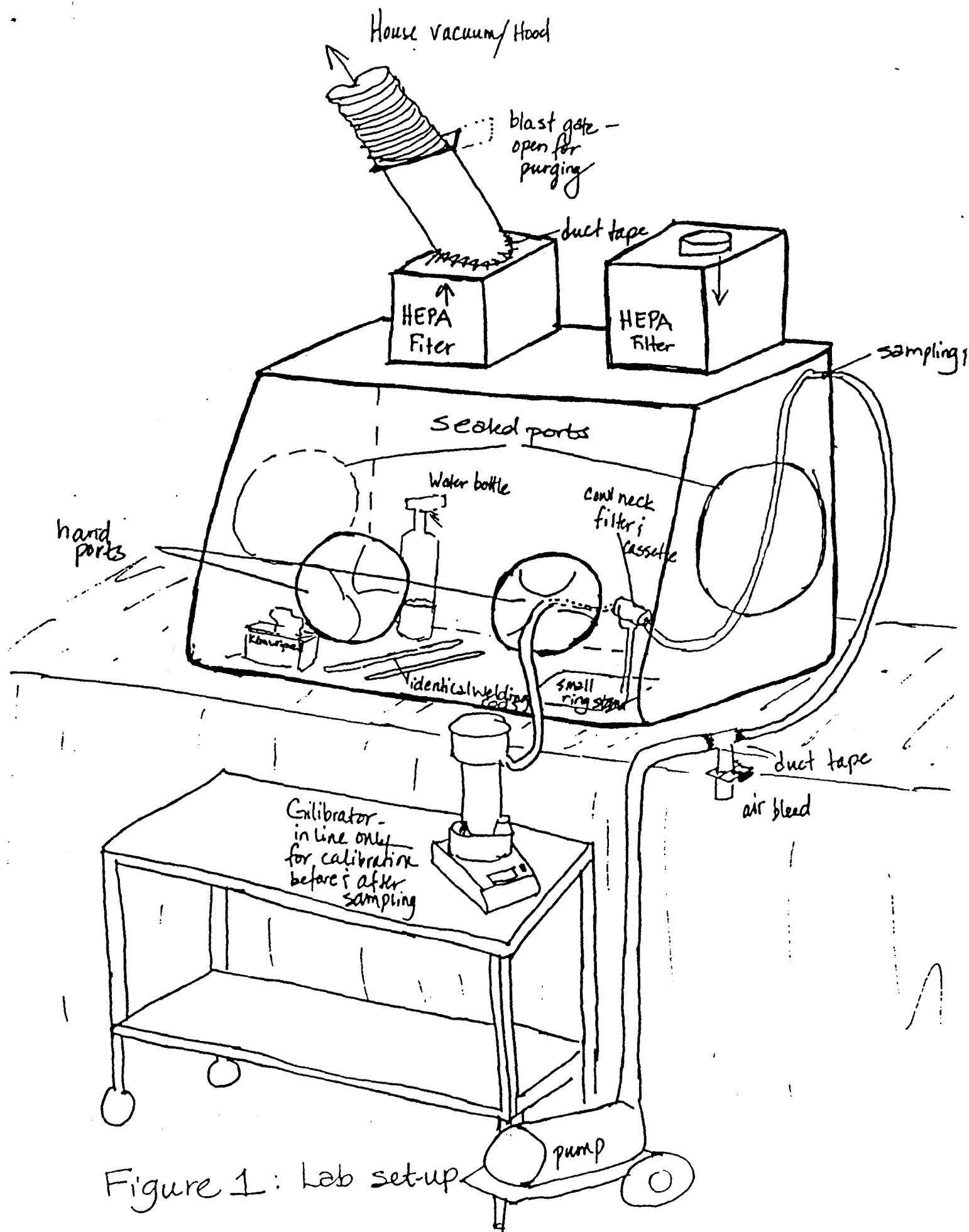


Figure 1: Lab set-up

EXHIBIT "E"

REPORT FROM DR. DEMENT DATED MARCH 29, 1995



DUKE UNIVERSITY MEDICAL CENTER

Occupational Health Service

COPY

March 29, 1995

Sheryl Moore Ingram
Ness, Motley, Loadholt, Richardson & Poole
151 Meeting Street, Suite 600
P.O. Box 1137
Charleston, South Carolina 29402

Re: Welding Rod Testing

Dear Sherry:

Enclosed are results of TEM studies of dusts which were collected during our study of used welding rods. During the bumping tests within the enclosure, the used rods were found to be friable resulting in visible dusts which accumulated on the bottom of the chamber. A sample of this dust was collected and submitted for TEM studies.

Results of the TEM studies confirmed the presence of chrysotile asbestos with the concentration ranging from 1.8 to 5.5%. The mean fiber length was 3.55 micrometers with a significant proportion longer than 5 micrometers.

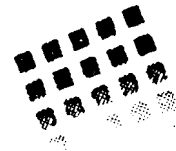
Please call if you have questions.

Sincerely;

A handwritten signature in black ink, appearing to read "John M. Dement".

John M. Dement, Ph.D., CIH
Associate Professor

Attachment



**MATERIALS
ANALYTICAL
SERVICES** ■

March 24, 1995

Dr. John Dement
Duke University Medical Center
2200 W. Main Street, Suite 700
Durham, NC 27710

RE: Welding Rod Residue/Powder

Dear Dr. Dement:

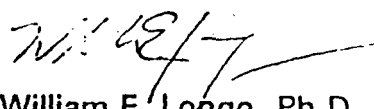
We have completed our asbestos fiber size distribution analysis for the welding rod material that we received from your group on March 13, 1995.

Our report is enclosed, but briefly our results are as follows:

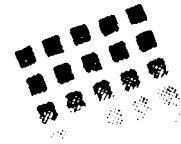
1. Weight of chrysotile in the sample was between 1.8 to 5.5% as determined by the Chatfield Method.
2. Size distribution:
Mean Fiber Length = 3.55 microns
Standard Deviation = 4.26

After you have had a chance to review the report and have any questions, please do not hesitate to give me a call.

Sincerely,


William E. Longo, Ph.D.
President

WEL/mac



**MATERIALS
ANALYTICAL
SERVICES** ■

WELDING ROD RESIDUE ANALYSIS

Submitted to:

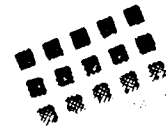
JOHN M. DEMENT, PH.D. CIH

DUKE UNIVERSITY MEDICAL CENTER

March 24, 1995

By:

William E. Longo, Ph.D.



MICROANALYSIS PROJECT REPORT

CLIENT: Dr. John Dement

DATE: March 24, 1995

INSTITUTION: Duke University Medical Center

MAS NO: M12664

PROJECT: Welding Rod Analysis

SUMMARY: *The object of this study was to determine the weight percent range of chrysotile in the welding rod residue and determine the chrysotile fiber size distribution in the material.*

Our results show that the chrysotile weight percent range was found to range from 1.8 to 5.5%. Also, the mean chrysotile fiber length calculated from 200 measured structures was 3.55 microns.

DESCRIPTION OF SAMPLE PREPARATION AND ANALYSIS:

Weight Analysis: The welding rod residue was analyzed by the Chatfield method to determine the weight percent of asbestos present. This analysis was performed as follows, 0.1029g of the residue was placed in a muffle furnace and heated to 480°C for 12 hours. The sample was removed from the furnace and allowed to cool to room temperature and reweighed. Sample weight after ashing was 0.0962 grams. The remaining residue was placed into 100 ml of 3% HCl in a 150ml Erlenmeyer flask. The solution was allowed to stir for 30 minutes and filtered through a pre-weighed 0.22 μ m polycarbonate (PC) filter. The PC filter was dried in a desiccator for 24 hours at room temperature and weighed. The sample weight after the acid dissolution was 0.0377g. After weighing, the remaining residue was suspended in alcohol and drop mounted onto a TEM grid and placed in a JEOL 1200X transmission electron microscope. The sample was scanned by TEM at a screen magnification of 20,000X. A visual estimation was made of the percent of chrysotile present versus the amount of non-asbestos particulates. These results were compared to the percent loss during both muffle furnace and acid dissolution analysis.

Fiber Size Distribution: Approximately 10 mg of welding rod residue was placed in a 25ml glass vial with 15ml of alcohol. The sample was capped and shaken by hand. A 2ml sample was removed from the suspension and filtered through a 0.22 μ m PC filter. The filter was allowed to dry and prepared for TEM analysis using a direct preparation technique. The prepared sample grid was placed in a JEOL 1200 EX TEM and examined at a screen magnification of 20,000X. For the fiber size distribution, the first 200 chrysotile structures were measured for both their length and width. This data is shown in the enclosed TEM count sheets.



FLOOR TILE ANALYSIS BY
CHATFIELD METHOD

Sample #: 112164-01

Analyst: W.F. BARNETT

Vial #

Date 3/21/94

MUFFLE FURNACE ASHING RESULTS

Vial weight (A)	<u>10.3042g</u>
Vial weight plus sample weight (B)	<u>13.4271g</u>
Original sample weight (B-A)	<u>0.1029g (W1)</u>
Weight of vial and sample after ashing (C)	<u>13.4204g</u>
Sample weight after ashing (C-A)	<u>0.0962g (W2)</u>

Muffle Furnace Ashing Results After Acid Dissolution

Polycarbonate filter weight (D)	<u>0.0135g</u>
Filter plus dry sample weight (E)	<u>0.0532g</u>
Sample weight after acid dissolution (E-D)	<u>0.0377g (W3)</u>

Percent weight of organic material
 $\frac{(W1 - W2) \times 100}{W1} =$ 6.5%

Percent weight of dolomite/calcite
 $\frac{(W2 - W3) \times 100}{W1} =$ 36.9%

Estimated upper and lower percent
asbestos by TEM scan 5% lower 15% upper

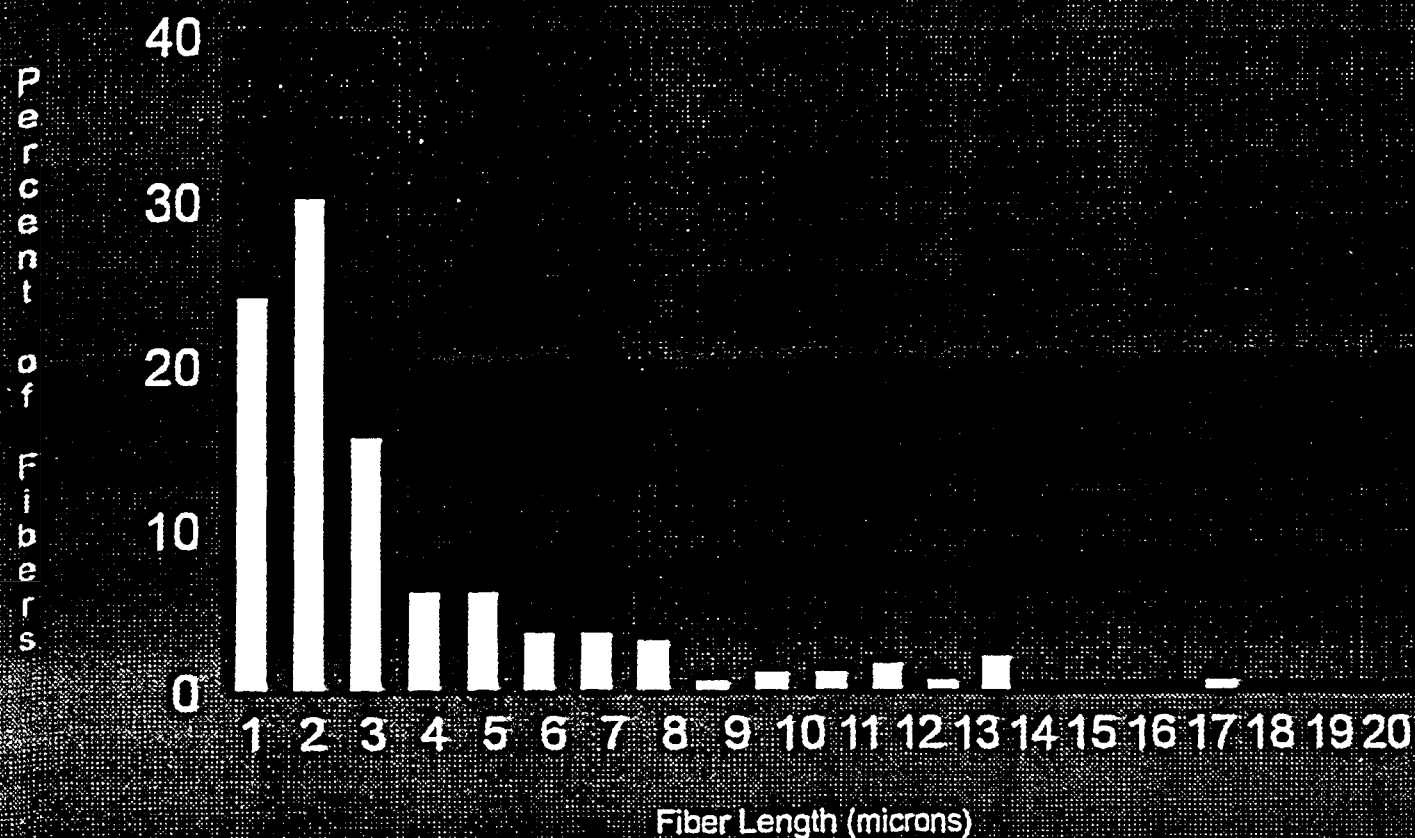
Percent weight of asbestos

$\frac{W3 \times 100}{W1}$ to $\frac{W3 \times 100}{W1}$

1.8% to 5.5%

ASBESTOS FIBER SIZE DISTRIBUTION

Duke University Medical Center



Box 1082

MAS JOB NUMBER:

M 12664-1

PAGE #

1

STR #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	E
1		C	F	2.4	0.1			
2		C	F	3.5	0.05			
3		C	F	2.0	0.05			
4		C	F	1.2	0.05			
5		C	F	2.5	0.1			
6		C	F	1.7	0.1			
7		C	F	16.0	0.05			
8		C	F	0.7	0.05			
9		C	F	2.2	0.1			
10		C	F	6.5	0.15			
11		C	F	1.0	0.1			
12		C	M-F	1.3	0.03			
13		C	F	3.7	0.01			
14		C	F	3.8	0.15			
15		C	F	4.5	0.1			
16		C	F	0.8	0.1			
17		C	F	1.4	0.1			
18		C	F	1.7	0.05			
19		C	F	0.4	0.01			
20		C	F	1.8	0.1			
21		C	F	1.8	0.1			
22		C	M-F	0.3	0.01			
23		C	F	2.6	0.1			
24		C	F	0.7	0.01			
25		C	F	0.6	0.05			

KEYS TO ABBREVIATIONS USED ABOVE:

TYPE:

C = CHRYSOTILE
 AM = AMOSITE
 CR = CROCIDOLITE
 AC = ACTINOLITE
 TR = TREMOLITE
 AN = ANTHOPHYLLITE
 N = NON ASBESTOS

STRUCTURE:

F = FIBER
 B = BUNDLE
 C = CLUSTER
 M = MATRIX

OTHERS:

NSD = NO STRUCTURES DETECTED
 MORPH = MORPHOLOGY
 SAED = SELECTED AREA ELECTRON DIFFRACTION
 EDS = ENERGY DISPERSIVE X-RAY SPECTROSCOPY
 IR = INTERROW SPACING
 NP = NO PATTERN

3.54

MAS JOB NUMBER:

M 12664-1

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STR. #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EC
26		C	F	1.7	0.05			
27		C	B	2.2	0.2			
28		C	F	1.6	0.05			
29		C	M-F	6.7	0.05			
30		C	M-F	13.0	0.05			
31		C	F	0.7	0.05			
32		C	F	1.7	0.05			
33		C	F	4.4	0.05			
34		C	F	3.0	0.1			
35		C	F	3.8	0.1			
36		C	F	3.0	0.1			
37		C	F	3.4	0.1			
38		C	F	7.6	0.1			
39		C	B	4.3	0.5			
40		C	F	0.8	0.05			
41		C	F	0.7	0.05			
42		C	F	0.3	0.01			
43		C	F	4.3	0.05			
44		C	F	4.6	0.05			
45		C	F	6.2	0.1			
46		C	F	8.6	0.1			
47		C	F	2.7	0.05			
48		C	F	1.4	0.04			
49		C	F	1.8	0.05			
50		C	F	5.7	0.05			
51		C	F	2.0	0.25			
52		C	F	0.6	0.05			
53		C	M-F	1.4	0.03			
54		C	F	5.4	0.1			
55		C	F	6.0	0.1			

STR #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EL
56		C	F	14.0	0.1			
57		C	F	5.3	0.1			
58		C	F	1.9	0.1			
59		C	F	1.3	0.05			
60		C	F	1.7	0.1			
61		C	F	1.8	0.1			
62		C	F	3.3	0.05			
63		C	F	1.6	0.05			
64		C	F	0.7	0.1			
65		C	F	1.7	0.05			
66		C	F	5.4	0.05			
67		C	F	3.0	0.05			
68		C	F	28.0	0.05			
69		C	F	0.7	0.05			
70		C	F	1.9	0.1			
71		C	F	0.8	0.1			
72		C	F	3.9	0.05			
73		C	F	1.6	0.05			
74		C	F	2.9	0.1			
75		C	F	1.6	0.1			
76		C	B	1.0	0.2			
77		C	F	8.0	0.05			
78		C	F	5.4	0.05			
79		C	F	2.0	0.05			
80		C	F	2.0	0.05			
81		C	n-F	4.3	0.1			
82		C	F	7.3	0.05			
83		C	F	0.7	0.1			
84		C	R	1.6	0.05			
85		C	B	1.3	0.2			

STR. #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	ET
86		C	F	1.3	0.05			
87		C	F	0.4	0.03			
88		C	B	1.8	0.2			
89		C	B	1.0	0.2			
90		C	B	1.4	0.2			
91		C	F	0.5	0.05			
92		C	F	0.5	0.05			
93		C	F	0.6	0.1			
94		C	F	0.6	0.05			
95		C	F	1.4	0.05			
96		C	F	0.9	0.05			
97		C	M-B	2.2	0.3			
98		C	F	5.0	0.05			
99		C	F	2.0	0.1			
100		C	M-F	6.8	0.1			
101		C	F	10.0	0.01			
102		C	F	11.0	0.15			
103		C	F	7.0	0.05			
104		C	F	1.0	0.05			
105		C	F	1.3	0.01			
106		C	F	3.5	0.05			
107		C	F	2.6	0.1			
108		C	F	5.2	0.05			
109		C	F	0.7	0.05			
110		C	F	1.0	0.05			
111		C	F	12.0	0.05			
112		C	F	1.0	0.05			
113		C	F	0.8	0.05			
114		C	F	2.9	0.01			
115		C	P	0.7	0.05			

MAS JOB NUMBER:

M 12264-1

PAGE #

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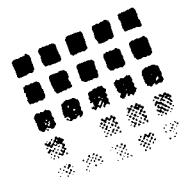
STR #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EDS
116	H6	C	F	3.3	0.02			
117		C	F	1.3	0.05			
118		C	F	1.0	0.05			
119		C	F	0.7	0.05			
120		C	F	0.9	0.05			
121		C	F	1.4	0.1			
122		C	F	12.0	0.05			
123		C	F	0.6	0.05			
124		C	F	1.3	0.1			
125		C	F	2.2	0.1			
126		C	F	2.3	0.1			
127		C	F	1.7	0.05			
128		C	F	0.9	0.1			
129		C	M-F	5.0	0.05			
130		C	B	1.6	0.3			
131		C	F	2.3	0.05			
132		C	F	1.4	0.05			
133		C	F	1.0	0.05			
134		C	F	4.4	0.05			
135		C	B	18.0	0.5			
136		C	F	8.0	0.05			
137		C	F	7.3	0.04			
138		C	B	1.0	0.4			
139		C	F	1.7	0.05			
140		C	B	1.9	0.2			
141		C	F	1.3	0.1			
142		C	F	1.8	0.05			
143		C	F	2.0	0.05			
144		C	F	13.7	0.05			
145		C	M-F	2.0	0.05			

STR. #	GRID # SQUARE #	TYPE	STRUCTURE	LENGTH MICRONS	WIDTH MICRONS	CONFIRMATION		
						MORPH.	SAED	EDS
146		C	B	1.7	0.3			
147		C	F	8.6	0.05			
148		C	F	2.4	0.05			
149		C	F	3.3	0.05			
150		C	F	2.0	0.05			
151		C	F	1.0	0.05			
152		C	B	1.4	0.15			
153		C	F	13.2	0.1			
154		C	F	1.0	0.05			
155		C	F	2.3	0.1			
156		C	M-F	1.0	0.03			
157		C	M-F	1.4	0.05			
158		C	F	3.0	0.05			
159		C	B	1.0	0.2			
160		C	F	7.0	0.05			
161		C	F	0.7	0.05			
162		C	M-B	1.4	0.15			
163		C	F	2.3	0.15			
164		C	F	14.0	0.05			
165		C	F	6.6	0.03			
166		C	F	1.8	0.05			
167		C	F	3.0	0.05			
168		C	M-B	18.0	0.3			
169		C	M-F	2.2	0.05			
170		C	F	1.1	0.05			
171		C	F	4.0	0.05			
172		C	F	1.6	0.15			
173		C	F	3.8	0.05			
174		C	F	1.8	0.05			
175		C	F	2.3	0.05			

M 12264-1

7

[illegible]



MATERIALS
ANALYTICAL
SERVICES

MAS CHAIN-OF-CUSTODY

Client: JOHN M. DEMENT, Ph.D., CIH

Mas Job #: M12664

Contact: JOHN M. DEMENT, Ph.D., CIH

Date Recd: 3/13/95

Phone #: (919) 286-1722

Client PO: WELDING ROD ANALYSIS

BULK SAMPLE ANALYSIS

SAMPLE NUMBER(S)

1) <u>MVA 0685 D2917A</u>	11) _____
2) _____	12) _____
3) _____	13) _____
4) _____	14) _____
5) _____	15) _____
6) _____	16) _____
7) _____	17) _____
8) _____	18) _____
9) _____	19) _____
10) _____	20) _____

Samples Relinquished By: COURTNEY SMITH

Samples Recd. By: _____

Time: 10:00 AM

Condition of Samples: OK

Client Docs: COC, COVER LETTER

Init File Rev: _____

Sample Prep by: _____ Date: _____

Sample Analysis: _____ Date: _____

Report(s) Sent: _____ Date: _____

Sample(s) Ret. By: _____ Date: _____

Raleigh Office:
616 Hutton Street • Suite 101
Raleigh, North Carolina 27606
(919) 829-7041 • FAX (919) 829-5518

Atlanta Office:
3597 Parkway Lane • Suite 250
Norcross, Georgia 30092
(404) 448-3200 • FAX (404) 368-82

SAMPLE ANALYSIS REQUEST & CHAIN OF CUSTODY

DATE: 10 March 1995

LABORATORY: MAS

LABORATORY CONTACT: Bill Longo/Bill Egeland

DUKE CONTACT: Dr. John M. Dement

INVOICE INFORMATION
John M. Dement, Ph.D., CIH
Duke University Medical Center
2200 W. Main St., Suite 700
Box 2914
Durham, N.C. 27710

DESCRIPTION OF ANALYSES REQUESTED:

Transmission electron microscopy analysis of bulk sample of powder from welding rod abrasion test. Determine size distribution for asbestos fibers; also determine the percentage of the total sample that is made up of asbestos fibers. TEM should use counting of all structures and structures > 5um. Please provide TEM photographs of typical fields. Also please return unused dust to us, possibly to be used as evidence. Please have Bill Longo contact John Dement prior to analysis. ((919) 286-1722x266.)

CHAIN OF CUSTODY

The following 1 sample(s) were in my possession and were transferred to Bill Egeland, MAS on 10 Mar 95, via the method checked:

☐ Hand Delivered
☒ Federal Express or Overnight Carrier
☐ U.S. Mail
☐ Other (Describe) _____

Signed: Courtney V. Smith

Printed Name: Courtney V. Smith

Sample ID #	Description
MVA 0685 D2917A	sample of powder residue from welding rod abrasion test (also includes partially burned, completely abraded rod).

I acknowledge the receipt of the above samples on behalf of MAS on 3-13-95.

Signed: Denise Mazzareo

Printed Name: Denise Mazzareo