



EMSL Analytical, Inc.

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Edward Surbrugg
Tetra Tech
303 Irene Street
Helena, MT 59601
Phone: 406-442-5588

Customer ID: MAXI57
Customer PO: NA
Received: 6/17/2014 9:42
Date Sampled: 06/15/2014 07:00
EMSL Order: 041416997
Report Date: 07/03/14

Project: NDOT NOA / 10353259

ISO 10312
International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM -
Modified for PCMe Analysis

Customer Sample Number: BC-AA-01-00004
EMSL Sample Number: 041416997-0001
Minimum Level of analysis (chrysotile): CD
Minimum Level of analysis (amphibole): ADX
Magnification used for fiber counting: 10,000
Aspect ratio for fiber definition: 3:1
Min Length/ Width to be counted (um): >5 / 0.25-none
Area of collection filter (mm^2): 385
Result of Chi^2 Test: 50.00 Random
Air volume: 14400 Liters
Grid Opening Area: 0.0132 mm^2
Grid Openings Analyzed: 51
Analysis Date: 06/17/2014
Analyst: F. Craig

Analytical Sensitivity: 0.000040 Structure/cc Limit of Detection: 0.000119 Structure/cc

Table with 8 columns: Structure Class, Min ID Level, Primary Str., Total Str., Density Str/mm^2, Concentration (Str/cc), LCL (Str/cc), UCL (Str/cc). Rows include PCMe Structures (Chrys), PCMe Structures (Amph), PCMe Structures (NRA), Total PCMe Structures (Regulated), Total PCMe Structures (All), PCMe Fibers and Bundles (Chrys), PCMe Fibers and Bundles (Amph), PCMe Fibers and Bundles (NRA), Total PCMe Fibers and Bundles (Regulated), Total PCMe Fibers and Bundles (All), and Non Asbestos Mineral Structures.

Asbestiform Minerals Present: Actinolite
Explanation of Results
NRA = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.
PCMe structure (modified) = A fibrous structure of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 um with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.
PCMe Fiber or Bundle (modified) = A Fiber or Bundle of of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 microns with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.
Concentration (Reg) = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite
Concentration (all) = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles
Min ID Level = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.
NAM = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile
Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.

Comment: Sample collected on 0.8 um MCE filter.

Robyn Denton
Approved Signatory



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron Microscopy

Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0001	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-01-00004	Grid Box :	0414-TetraTech-04: U	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	50.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
U2	I3	None Detected								
U2	I5	None Detected								
U2	G9	None Detected								
U2	G7	None Detected								
U2	G5	None Detected								
U2	E1	None Detected								
U2	E3	None Detected								
U2	D2	None Detected								
U2	D4	None Detected								
U2	D6	None Detected								
U2	C9	MD11	0		13.8	3.56	ADX	Actinolite		
U2	C9	MF		0	13.8	0.72	ADX	Actinolite	010315D	
U2	C7	None Detected								
U2	C5	None Detected								
U2	C3	None Detected								
U2	B2	None Detected								
U2	B4	None Detected								
U2	B6	None Detected								
U2	B8	None Detected								
U2	A9	None Detected								
U2	A7	None Detected								
U2	A5	None Detected								
U2	A3	None Detected								
U2	J2	None Detected								
U2	J4	None Detected								
U2	J6	None Detected								
U2	J8	None Detected								
U3	J8	None Detected								
U3	J6	None Detected								
U3	J4	None Detected								
U3	J2	None Detected								
U3	I1	None Detected								
U3	I3	MD11	1		7.4	2.86	NAM	Non Asb. Mineral		
U3	I3	MF		1	5	1.2	NAM	Non Asb. Mineral		
U3	I5	None Detected								
U3	I7	None Detected								
U3	I9	None Detected								
U3	G9	None Detected								



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International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron Microscopy

Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0001	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-01-00004	Grid Box :	0414-TetraTech-04: U	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	50.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
U3	G7	None Detected								
U3	G5	None Detected								
U3	G3	None Detected								
U3	G1	None Detected								
U3	F4	MD11	2		31.2	26.4	ADX	Actinolite		
U3	F4	MF		2	6.2	1.68	ADX	Actinolite	010317D	
U3	F2	None Detected								
U3	E1	None Detected								
U3	E3	None Detected								
U3	E5	None Detected								
U3	E7	None Detected								
U3	D6	None Detected								
U3	D4	None Detected								
U3	D2	None Detected								
U3	C1	None Detected								
U3	C5	None Detected								



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct  
Transfer Transmission Electron Microscopy  
Structure Sketch Sheet for Direct Data Entry

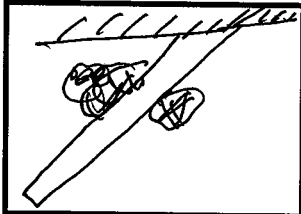
EMSL Order ID: 041416997-0001

Client: Tetra Tech

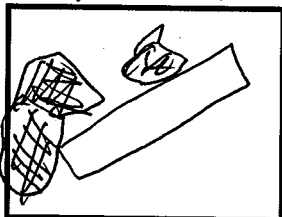
Client Sample: BC-AA-01-00004

Page 1 of 1

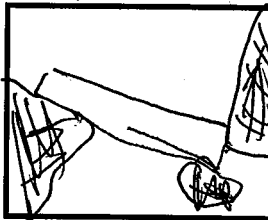
Primary Structure # 0



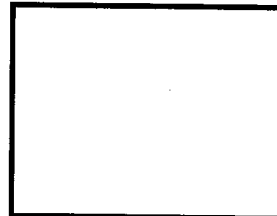
Primary Structure # 1



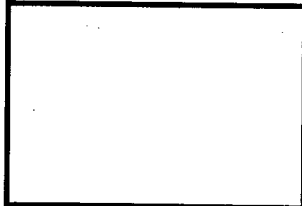
Primary Structure # 2



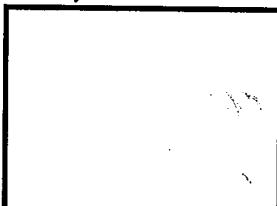
Primary Structure #



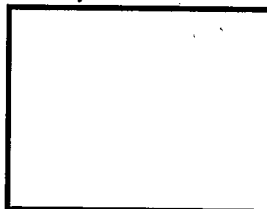
Primary Structure #



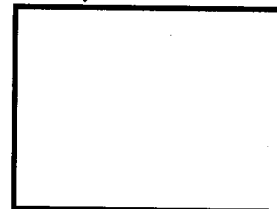
Primary Structure #



Primary Structure #



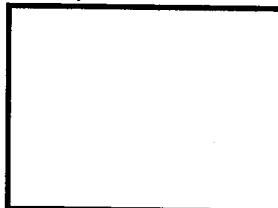
Primary Structure #



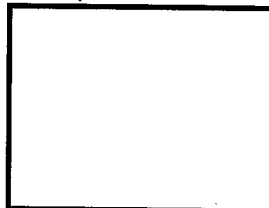
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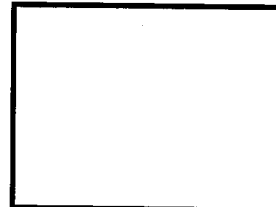
Primary Structure #



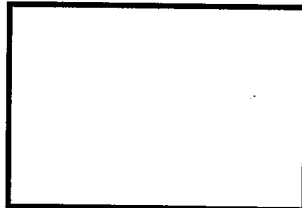
Primary Structure #



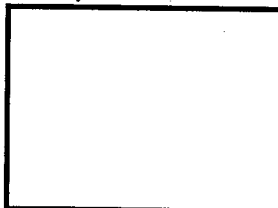
Primary Structure #



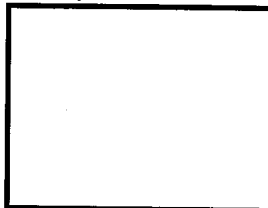
Primary Structure #



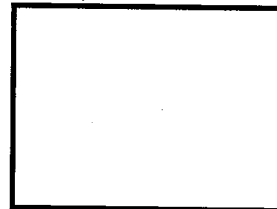
Primary Structure #



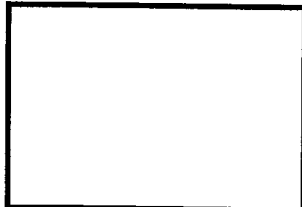
Primary Structure #



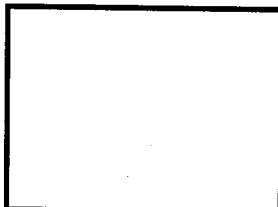
Primary Structure #



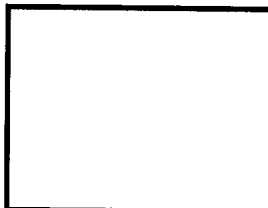
Structure #



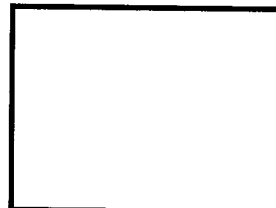
Structure #



Structure #



Structure #



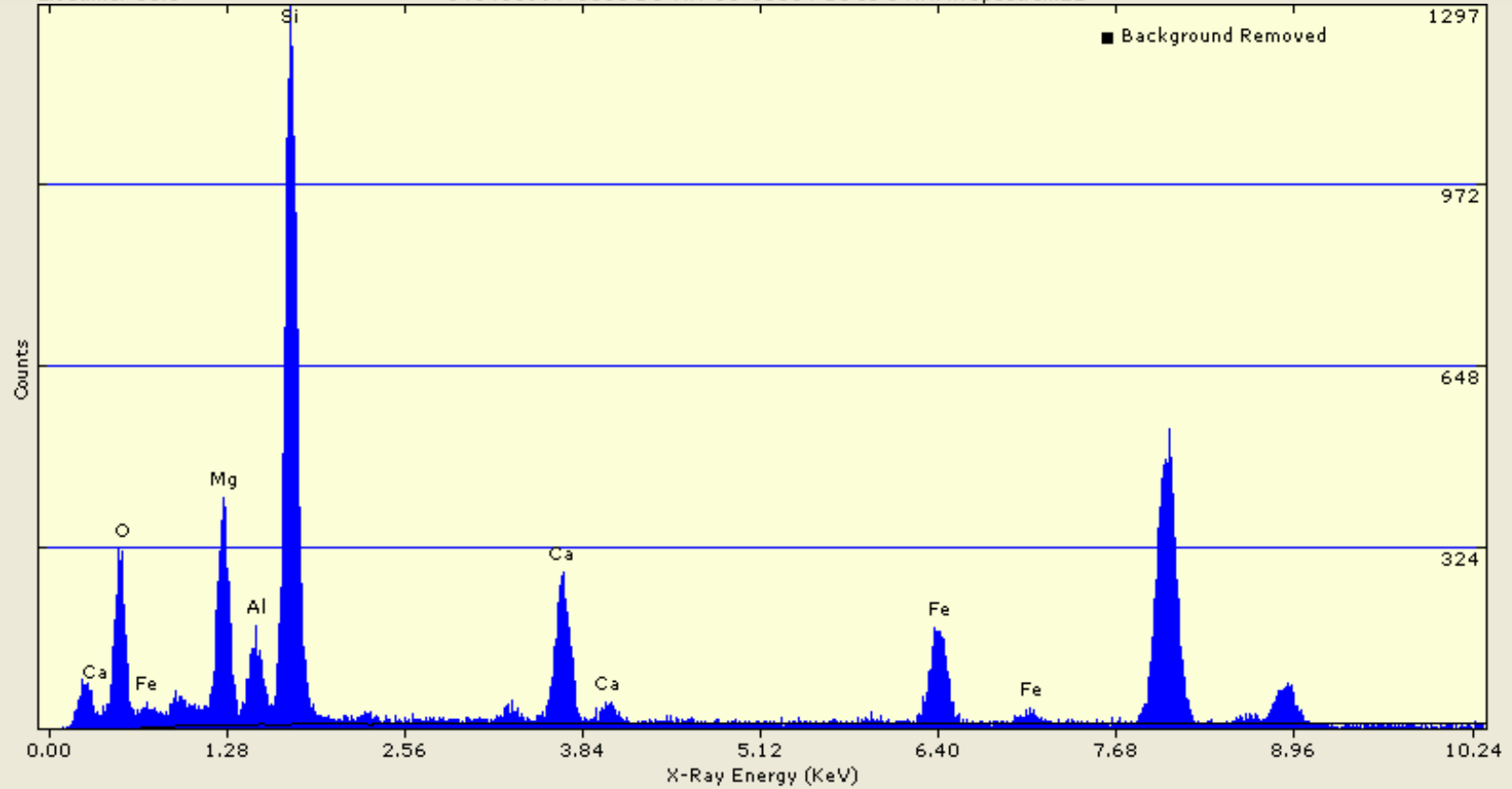
Analyst: FC

Date: 6/25/14

Scope: 04 01

Realtime: 74.5  
 Livetime: 56.8

041416997-0001 BC-AA-01-00004 U3 I3 1 NAM::Spectrum22



Quantitative Results for Spectrum22

Analysis: Thin Film Method: Standardless

Acquired 25-Jun-2014, 100.0 KeV @10 eV/channel

Element	Weight %	Std. Dev.	Atomic %	Oxide %	Cations	k-Ratio	Intensities	FWHM (eV)	ROI (net)
Oxygen	45.95	0.45	61.43	0.00	0.0000	0.0000	0.0	86.2	2419.79
Magnesium	9.55	0.09	8.40	15.84 (MgO)	3.1463	0.1690	2959.9	95.9	3079.18
Aluminum	3.54	0.04	2.81	6.69 (Al <sub>2</sub> O <sub>3</sub> )	1.0504	0.0631	1210.4	98.7	1386.75
Silicon	28.18	0.28	21.46	60.29 (SiO <sub>2</sub> )	8.0343	0.4649	10207.9	101.8	10614.57
Calcium	6.67	0.07	3.56	9.34 (CaO)	1.3330	0.0635	2508.8	122.5	2617.19
Iron	6.10	0.06	2.34	7.85 (FeO)	0.8751	0.0479	1822.8	146.4	2073.40
Total	100.00			100.00	14.4391				



## AMPHIBOLE SAED INDEXING FORM

EMSL Order Number:	041416997	Date:	Jun 25, 2014
Indexing of Image Number:	010317	Scope #:	04 - 01
Reference / Sample No:	0001-04-01	By:	F Craig
Preliminary ID:	ACTINOLITE		
Using Camera Constant of:	2.943e-003	1/A Pixels	
Determined from Reference:	AuCal-062414_10304		

Measured Inter-Row Spacing:	<b>63.98</b>	Pixels
Mean Distance between spots on Center row (d2):	<b>100.23</b>	Pixels
Mean Distance between spots on slant vector (d1):	<b>75.37</b>	Pixels

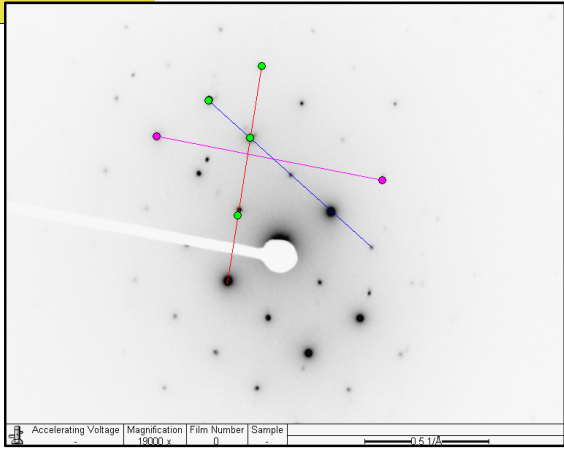
  

	Calculated	Ref	-5%	+5%
Inter-row Spacing (Angstroms):	5.311	<b>5.278</b>	5.014	5.542
d2 or hk0 (Camera K/zero row dist.):	3.390	<b>3.385</b>	3.216	3.554
d1 or hk1 (Camera K/slant vector dist.):	4.508	<b>4.482</b>	4.258	4.706
Ratio of hk0/hk1:	0.750	<b>0.755</b>	0.717	0.793
Angle of Slant Vector (Measured):	57.1	<b>57.000</b>	54.150	59.850

From SAED Reference Book, "unknown" diffraction pattern was found to be that of: **Actinolite** By: **F Craig**

Miller Indices hk0: ( **1 5 0** )  
 Miller Indices hkl: ( **0 2 1** )  
 With a Zone Axis of: [ **5 -1 2** ]

Preliminary Identification was:  CORRECT  
 INCORRECT



Percent accuracy to date: 100 %



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EMSL Order: 041416997
Report Date: 07/03/14

Project: NDOT NOA / 10353259

ISO 10312
International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM -
Modified for PCMe Analysis

Customer Sample Number: Field Blank 061514 Air volume: 0 Liters
EMSL Sample Number: 041416997-0002 Grid Opening Area: 0.0132 mm^2
Minimum Level of analysis (chrysotile): CD Grid Openings Analyzed: 10
Minimum Level of analysis (amphibole): ADX
Magnification used for fiber counting: 10,000
Aspect ratio for fiber definition: 3:1
Min Length/ Width to be counted (um): >5 / 0.25-none
Area of collection filter (mm^2): 385 Analysis Date: 06/17/2014
Result of Chi^2 Test: N/A N/A Analyst: F. Craig

Analytical Sensitivity: 7.575758 Structure/ mm^2 Limit of Detection: 22.651515 Structure/ mm^2

Table with 8 columns: Structure Class, Min ID Level, Primary Str., Total Str., Density Str/mm^2, Concentration Str/ mm^2, LCL Str/ mm^2, UCL Str/ mm^2. Rows include PCMe Structures (Chrys), PCMe Structures (Amph), PCMe Structures (NRA), Total PCMe Structures (Regulated), Total PCMe Structures (All), PCMe Fibers and Bundles (Chrys), PCMe Fibers and Bundles (Amph), PCMe Fibers and Bundles (NRA), Total PCMe Fibers and Bundles (Regulated), Total PCMe Fibers and Bundles (All), Non Asbestos Mineral Structures.

Asbestiform Minerals Present: None Detected

Explanation of Results

NRA = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.

PCMe structure (modified)= A fibrous structure of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 um with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

PCMe Fiber or Bundle (modified) = A Fiber or Bundle of of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 microns with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

Concentration (Reg) = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite

Concentration (all) = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles

Min ID Level = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.

NAM = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile

Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.

Comment: Sample collected on 0.8 um MCE filter.

Robyn Denton

Approved Signatory



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
**Microscopy**  
 Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0002	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	Field Blank 061514	Grid Box :	0414-TetraTech-04: O	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	N/A	Pore Size (micron):	0.8	Analysis Date:	06/25/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	1%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
O7	I4	None Detected								
O7	G2	None Detected								
O7	F6	None Detected								
O7	D5	None Detected								
O7	B3	None Detected								
O8	H8	None Detected								
O8	F9	None Detected								
O8	E7	None Detected								
O8	C5	None Detected								
O8	A6	None Detected								





**EMSL Analytical, Inc.**

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Edward Surbrugg  
 Tetra Tech  
 303 Irene Street  
 Helena, MT 59601  
 Phone: 406-442-5588

**Customer ID:** MAXI57  
**Customer PO:** NA  
**Received:** 6/17/2014 9:42  
**Date Sampled:** 06/15/2014 08:00  
**EMSL Order:** 041416997  
**Report Date:** 07/03/14

**Project: NDOT NOA / 10353259**

**ISO 10312**  
**International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM - Modified for PCMe Analysis**

Customer Sample Number:	BC-AA-03-00004	Air volume:	14400	Liters
EMSL Sample Number:	041416997-0003	Grid Opening Area:	0.0132	mm <sup>2</sup>
Minimum Level of analysis (chrysotile):	CD	Grid Openings Analyzed:	51	
Minimum Level of analysis (amphibole):	ADX			
Magnification used for fiber counting:	10,000			
Aspect ratio for fiber definition:	3:1			
Min Length/ Width to be counted (µm):	>5 / 0.25-none			
Area of collection filter (mm <sup>2</sup> ):	385	Analysis Date:	06/17/2014	
Result of Chi <sup>2</sup> Test:	47.00 Random	Analyst:	F. Craig	

<b>Analytical Sensitivity:</b>	<b>0.000040</b>	<b>Structure/cc</b>	<b>Limit of Detection:</b>	<b>0.000119</b>	<b>Structure/cc</b>
--------------------------------	-----------------	---------------------	----------------------------	-----------------	---------------------

Structure Class	Min ID Level	Primary Str.	Total Str.	Density Str/mm <sup>2</sup>	Concentration (Str/cc)	Poisson 95 % Confidence Interval	
						LCL (Str/cc)	UCL (Str/cc)
PCMe Structures (Chrys)	CD	0	-	0.00	0.000000	0.000000	0.000119
PCMe Structures (Amph)	ADX	4	-	5.94	0.000159	0.000043	0.000407
PCMe Structures (NRA)	ADX	0	-	0.00	0.000000	0.000000	0.000119
<b>Total PCMe Structures (Regulated)</b>	<b>CD/ADX</b>	<b>4</b>	<b>-</b>	<b>5.94</b>	<b>0.000159</b>	<b>0.000043</b>	<b>0.000407</b>
<b>Total PCMe Structures (All)</b>	<b>CD/ADX</b>	<b>4</b>	<b>-</b>	<b>5.94</b>	<b>0.000159</b>	<b>0.000043</b>	<b>0.000407</b>
PCMe Fibers and Bundles (Chrys)	CD	-	0	0.00	0.000000	0.000000	0.000119
PCMe Fibers and Bundles (Amph)	ADX	-	4	5.94	0.000159	0.000043	0.000407
PCMe Fibers and Bundles (NRA)	ADX	-	0	0.00	0.000000	0.000000	0.000119
<b>Total PCMe Fibers and Bundles (Regulated)</b>	<b>CD/ADX</b>	<b>-</b>	<b>4</b>	<b>5.94</b>	<b>0.000159</b>	<b>0.000043</b>	<b>0.000407</b>
<b>Total PCMe Fibers and Bundles (All)</b>	<b>CD/ADX</b>	<b>-</b>	<b>4</b>	<b>5.94</b>	<b>0.000159</b>	<b>0.000043</b>	<b>0.000407</b>
Non Asbestos Mineral Structures	NAM	0	0	-	-	-	-

**Asbestiform Minerals Present:** Actinolite

**Explanation of Results**

**NRA** = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.

**PCMe structure (modified)** = A fibrous structure of aspect ratio > 3:1, longer than 5 µm, and which has a diameter ≥ 0.25 µm with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

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**Concentration (Reg)** = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite

**Concentration (all)** = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles

**Min ID Level** = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.

**NAM** = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile

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Comment: Sample collected on 0.8 µm MCE filter.

*Robyn Denton*  
 Approved Signatory



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International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
Microscopy

Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0003	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-03-00004	Grid Box :	0414-TetraTech-04: P	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	47.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014 & 06/26/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
P2	I1	None Detected								
P2	I3	MD11	1		26.1	11.28	ADX	Actinolite		
P2	I3	MF		1	20.4	2.62	ADX	Actinolite	010311D	
P2	I5	None Detected								
P2	G7	None Detected								
P2	G5	None Detected								
P2	G3	None Detected								
P2	E3	None Detected								
P2	E7	None Detected								
P2	D6	None Detected								
P2	C5	None Detected								
P2	B4	None Detected								
P2	A3	None Detected								
P3	B2	None Detected								
P3	B4	None Detected								
P3	B6	MD11	2		6.7	6	ADX	Actinolite		
P3	B6	MF		2	6.7	2.04	ADX	Actinolite		
P3	D8	None Detected								
P3	D6	None Detected								
P3	D4	None Detected								
P3	F4	None Detected								
P3	F2	None Detected								
P3	H2	None Detected								
P3	I5	None Detected								
P2	H2	None Detected								
P2	H4	MD11	3		26.1	11.88	ADX	Actinolite		
P2	H4	MF		3	7.1	0.84	ADX	Actinolite		
P2	H6	None Detected								
P2	H8	None Detected								
P2	H10	None Detected								
P2	D8	None Detected								
P2	D4	None Detected								
P2	D2	None Detected								
P2	B2	None Detected								
P2	B6	None Detected								
P2	B8	None Detected								
P3	A3	None Detected								
P3	A5	None Detected								



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
Microscopy  
Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0003	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-03-00004	Grid Box :	0414-TetraTech-04: P	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	47.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014 & 06/26/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
P3	A7	None Detected								
P3	A9	None Detected								
P3	C9	None Detected								
P3	C7	None Detected								
P3	C5	None Detected								
P3	C3	None Detected								
P3	C1	None Detected								
P3	E1	None Detected								
P3	E3	None Detected								
P3	E5	None Detected								
P3	G1	None Detected								
P3	G3	None Detected								
P3	G5	MD11	4		7.1	3.56	ADX	Actinolite		
P3	G5	MF		4	5.7	0.72	ADX	Actinolite	010319D	
P3	I3	None Detected								
P3	I1	None Detected								
P3	J2	None Detected								



ISO 10312  
International Standard for the Determination of Asbestos Fibers-Direct  
Transfer Transmission Electron Microscopy  
Structure Sketch Sheet for Direct Data Entry

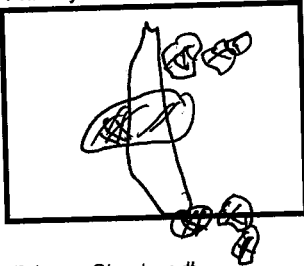
EMSL Order ID: 041416997-0003

Client: Tetra Tech

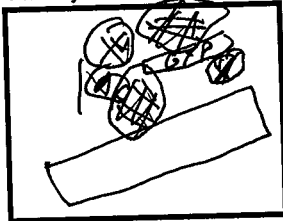
Client Sample: BC-AA-03-00004

Page 1 of 1

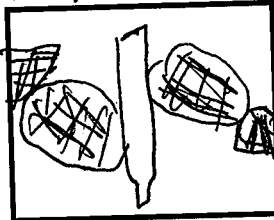
Primary Structure # 1



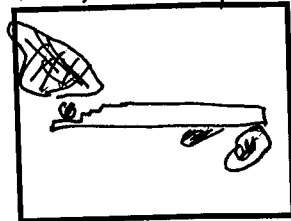
Primary Structure # 2



Primary Structure # 3



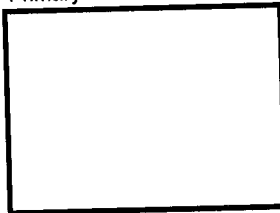
Primary Structure # 4



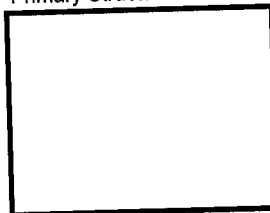
Primary Structure #



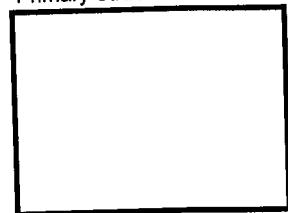
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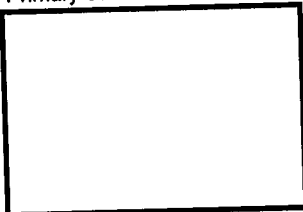
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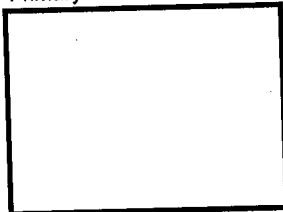
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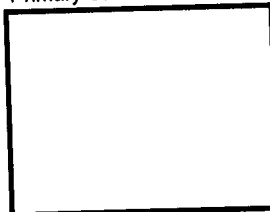
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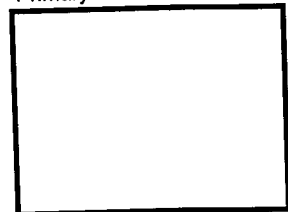
Primary Structure #



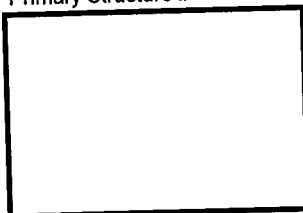
Primary Structure #



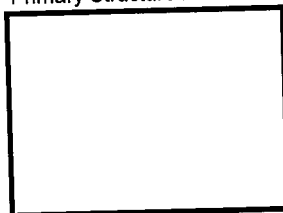
Primary Structure #



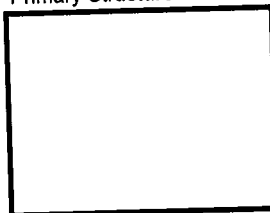
Primary Structure #



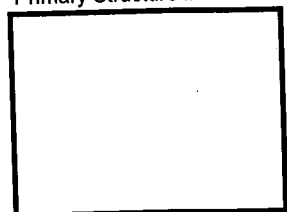
Primary Structure #



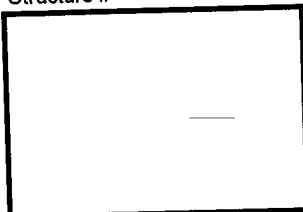
Primary Structure #



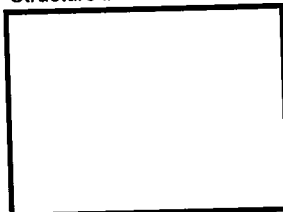
Primary Structure #



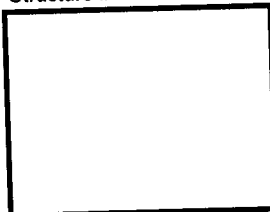
Structure #



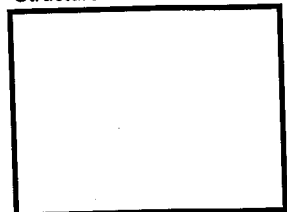
Structure #



Structure #



Structure #



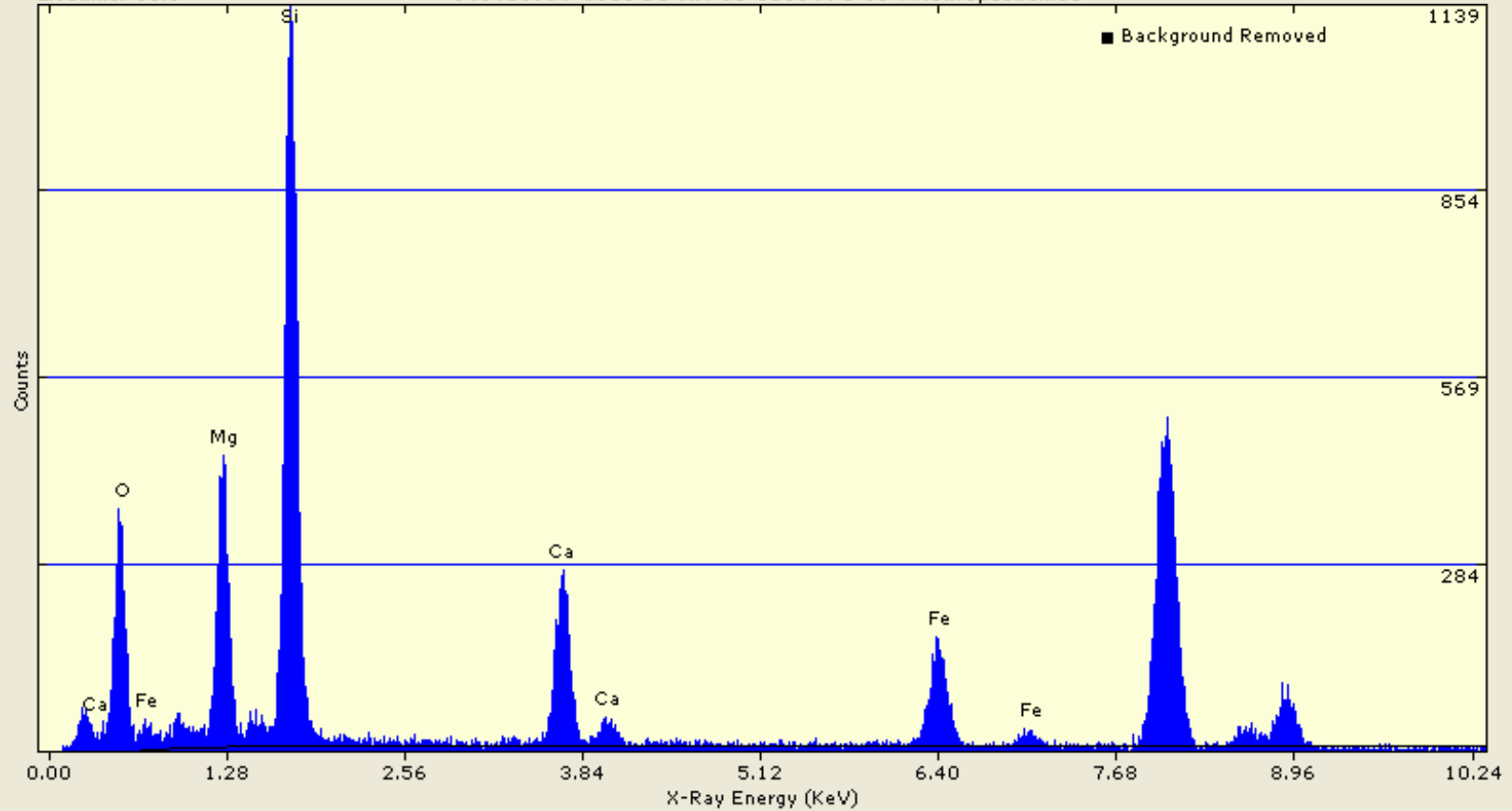
Analyst: Fe

Date: 6/26/14  
Fe  
6/26/14

Scope: 09 01

Realtime: 76.4  
 Livetime: 65.1

041416997-0003 BC-AA-03-00004 P3 G5 4 Act.: Spectrum35



Quantitative Results for Spectrum35  
 Analysis: Thin Film Method: Standardless  
 Acquired 26-Jun-2014, 100.0 KeV @10 eV/channel

Element	Weight %	Std. Dev.	Atomic %	Oxide %	Cations	k-Ratio	Intensities	FWHM (eV)	ROI (net)	
Oxygen	45.28	0.47	60.88	0.00	0.0000	0.0000	0.0	86.2	2735.10	
Magnesium	12.11	0.13	10.72	20.08	(MgO)	4.0482	0.2003	3367.9	95.9	3460.78
Silicon	28.41	0.30	21.76	60.79	(SiO2)	8.2210	0.4398	9237.2	101.8	9552.68
Calcium	7.73	0.08	4.15	10.82	(CaO)	1.5677	0.0679	2609.2	122.4	2680.13
Iron	6.47	0.07	2.49	8.32	(FeO)	0.9408	0.0459	1732.9	146.4	1836.72
Total	100.00			100.00		14.7776				



## AMPHIBOLE SAED INDEXING FORM

EMSL Order Number:	041416997	Date:	Jun 25, 2014
Indexing of Image Number:	010311	Scope #:	04 - 01
Reference / Sample No:	0003-04-01	By:	F Craig
Preliminary ID:	ACTINOLITE		
Using Camera Constant of:	2.943e-003	1/A Pixels	
Determined from Reference:	AuCal-062414_10304		

Measured Inter-Row Spacing:	63.77	Pixels
Mean Distance between spots on Center row (d2):	100.5	Pixels
Mean Distance between spots on slant vector (d1):	68.99	Pixels

	Calculated	Ref	-5%	+5%
Inter-row Spacing (Angstroms):	5.328	5.278	5.014	5.542
d2 or hk0 (Camera K/zero row dist.):	3.381	3.385	3.216	3.554
d1 or hk1 (Camera K/slant vector dist.):	4.925	4.931	4.684	5.178
Ratio of hk0/hk1:	0.686	0.686	0.652	0.720
Angle of Slant Vector (Measured):	69.0	69.320	65.854	72.786

From SAED Reference Book, "unknown" diffraction pattern was found to be that of: Actinolite By: F Craig

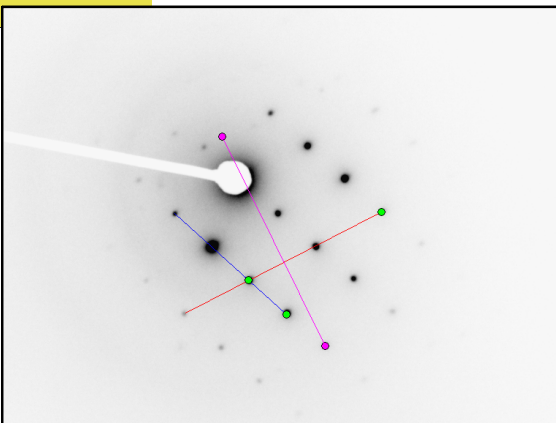
Miller Indice hk0: ( 1 -5 0 )

Miller Indice hkl: ( 1 -1 -1 )

With a Zone Axis of: [ 5 1 4 ]

Preliminary Identification was: X CORRECT

INCORRECT



Percent accuracy to date: 100 %



**EMSL Analytical, Inc.**

200 Route 130 North  
 Cinnaminson, NJ 08077  
 856-303-2500  
[www.EMSL.com](http://www.EMSL.com)

Edward Surbrugg  
 Tetra Tech  
 303 Irene Street  
 Helena, MT 59601  
 Phone: 406-442-5588

**Customer ID:** MAXI57  
**Customer PO:** NA  
**Received:** 6/17/2014 9:42  
**Date Sampled:** 06/15/2014 08:00  
**EMSL Order:** 041416997  
**Report Date:** 07/03/14

**Project: NDOT NOA / 10353259**

**ISO 13794**  
**International Standard for the Determination of Asbestos Fibers - Indirect Transfer TEM - Modified for PCMe Analysis**

Customer Sample Number:	BC-AA-04-00004	Air volume:	14400	Liters
EMSL Sample Number:	041416997-0004	Grid Opening Area:	0.0132	mm <sup>2</sup>
Minimum Level of analysis (chrysotile):	CD	Grid Openings Analyzed:	76	
Minimum Level of analysis (amphibole):	ADX	Percent of filter ashed:	50	%
Magnification used for fiber counting:	10,000	Suspension volume:	100	mL
Aspect ratio for fiber definition:	3:1	Volume Filtered:	25	mL
Min Length/ Width to be counted (µm):	>5 / 0.25-none	EFA of second filter:	364.9	mm <sup>2</sup>
Area of collection filter (mm <sup>2</sup> ):	385	Analysis Date:	06/17/2014	
Result of Chi <sup>2</sup> Test:	68.00 Random	Analyst:	F. Craig	

<b>Analytical Sensitivity:</b>	<b>0.000202</b>	<b>Structure/cc</b>	<b>Limit of Detection:</b>	<b>0.000604</b>	<b>Structure/cc</b>
--------------------------------	-----------------	---------------------	----------------------------	-----------------	---------------------

Structure Class	Min ID Level	Primary Str.	Total Str.	Density Str/mm <sup>2</sup>	Concentration (Str/cc)	Poisson 95 % Confidence Interval	
						LCL (Str/cc)	UCL (Str/cc)
PCMe Structures (Chrys)	CD	0	-	0.00	0.000000	0.000000	0.000604
PCMe Structures (Amph)	ADX	7	-	6.98	0.001415	0.000569	0.002915
PCMe Structures (NRA)	ADX	0	-	0.00	0.000000	0.000000	0.000604
<b>Total PCMe Structures (Regulated)</b>	<b>CD/ADX</b>	<b>7</b>	<b>-</b>	<b>6.98</b>	<b>0.001415</b>	<b>0.000569</b>	<b>0.002915</b>
<b>Total PCMe Structures (All)</b>	<b>CD/ADX</b>	<b>7</b>	<b>-</b>	<b>6.98</b>	<b>0.001415</b>	<b>0.000569</b>	<b>0.002915</b>
PCMe Fibers and Bundles (Chrys)	CD	-	0	0.00	0.000000	0.000000	0.000604
PCMe Fibers and Bundles (Amph)	ADX	-	7	6.98	0.001415	0.000569	0.002915
PCMe Fibers and Bundles (NRA)	ADX	-	0	0.00	0.000000	0.000000	0.000604
<b>Total PCMe Fibers and Bundles (Regulated)</b>	<b>CD/ADX</b>	<b>-</b>	<b>7</b>	<b>6.98</b>	<b>0.001415</b>	<b>0.000569</b>	<b>0.002915</b>
<b>Total PCMe Fibers and Bundles (All)</b>	<b>CD/ADX</b>	<b>-</b>	<b>7</b>	<b>6.98</b>	<b>0.001415</b>	<b>0.000569</b>	<b>0.002915</b>
Non Asbestos Mineral Structures	NAM	0	0	-	-	-	-

**Asbestiform Minerals Present:** Actinolite

**Explanation of Results**

**NRA** = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.

**PCMe structure (modified)**= A fibrous structure of aspect ratio > 3:1, longer than 5 µm, and which has a diameter ≥ 0.25 µm with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

**PCMe Fiber or Bundle (modified)** = A Fiber or Bundle of of aspect ratio > 3:1, longer than 5 µm, and which has a diameter ≥ 0.25 microns with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

**Concentration (Reg)** = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite

**Concentration (all)** = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles

**Min ID Level** = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.

**NAM** = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile

*Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.*

*Comment: Sample collected on 0.8 µm MCE filter. Analytical Sensitivity not met. . Stopping rule of 1.0 mm<sup>2</sup> evoked.*

*Robyn Denton*  
 Approved Signatory



# ISO 13794

International Standard for the Determination of Asbestos Fibers-Indirect Transfer Transmission Electron  
Microscopy  
Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0004	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-04-00004	Grid Box :	0414-TetraTech-05: S	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	68.00-Random	Pore Size (micron):	0.8	Analysis Date:	07/02/2014 & 07/03/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	10%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
S1	I1	None Detected								
S1	I3	None Detected								
S1	I5	None Detected								
S1	I7	None Detected								
S1	I9	F	1	1	19.7	1.92	ADX	Actinolite	010344D	
S1	H10	None Detected								
S1	H8	None Detected								
S1	H6	None Detected								
S1	H4	None Detected								
S1	H2	None Detected								
S1	G1	None Detected								
S1	G3	None Detected								
S1	G5	MD11	2		60.4	8.13	ADX	Actinolite		
S1	G5	MF		2	58	2.38	ADX	Actinolite		
S1	G7	None Detected								
S1	G9	None Detected								
S1	F10	None Detected								
S1	F8	MD11	3		10.7	3.56	ADX	Actinolite		
S1	F8	MF		3	10	3.33	ADX	Actinolite		
S1	F6	None Detected								
S1	F4	F	4	4	5.1	0.72	ADX	Actinolite	010346D	
S1	F2	None Detected								
S1	E1	MD11	5		18.2	5.94	ADX	Actinolite		
S1	E1	MF		5	18.2	2.38	ADX	Actinolite		
S1	E3	None Detected								
S1	E5	None Detected								
S1	E7	None Detected								
S1	E9	None Detected								
S1	D10	None Detected								
S1	D8	None Detected								
S1	D6	None Detected								
S1	D4	F	6	6	9.7	1.68	ADX	Actinolite		
S1	D2	None Detected								
S1	C1	None Detected								
S1	C3	None Detected								
S1	C5	None Detected								
S1	C7	None Detected								
S1	C9	None Detected								





# ISO 13794

International Standard for the Determination of Asbestos Fibers-Indirect Transfer Transmission Electron  
Microscopy  
Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0004	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-04-00004	Grid Box :	0414-TetraTech-05: S	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	68.00-Random	Pore Size (micron):	0.8	Analysis Date:	07/02/2014 & 07/03/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	10%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
S1	B10	None Detected								
S1	B8	None Detected								
S1	B6	None Detected								
S1	B4	F	0	0	14.3	1.2	ADX	Actinolite		
S1	B2	None Detected								
S2	J2	None Detected								
S2	J4	None Detected								
S2	J6	F	7	7	7.1	0.84	ADX	Actinolite		
S2	J8	None Detected								
S2	J10	None Detected								
S2	I9	None Detected								
S2	I7	None Detected								
S2	I5	None Detected								
S2	I3	None Detected								
S2	I1	MC11	8	8	12.4	3.52	AX	Actinolite		
S2	H2	None Detected								
S2	H4	None Detected								
S2	H6	None Detected								
S2	H8	None Detected								
S2	H10	None Detected								
S2	G9	None Detected								
S2	G7	None Detected								
S2	G5	None Detected								
S2	G3	None Detected								
S2	G1	None Detected								
S2	F2	None Detected								
S2	F4	None Detected								
S2	F6	None Detected								
S2	F8	None Detected								
S2	F10	None Detected								
S2	E9	None Detected								
S2	E7	None Detected								
S2	E5	None Detected								
S2	E3	None Detected								
S2	E1	None Detected								
S2	D2	None Detected								
S2	D4	None Detected								
S2	D6	None Detected								
S2	D8	None Detected								
S2	D10	None Detected								



# ISO 13794

International Standard for the Determination of Asbestos Fibers-Indirect Transfer Transmission Electron  
Microscopy  
Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0004	GO area (mm <sup>2</sup> ):	0.0132	Mag.	10,000
Customer Sample:	BC-AA-04-00004	Grid Box :	0414-TetraTech-05: S	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	68.00-Random	Pore Size (micron):	0.8	Analysis Date:	07/02/2014 & 07/03/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	10%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
S2	C5	None Detected								



ISO 13794

International Standard for the Determination of Asbestos Fibers-Indirect  
Transfer Transmission Electron Microscopy  
Structure Sketch Sheet for Direct Data Entry

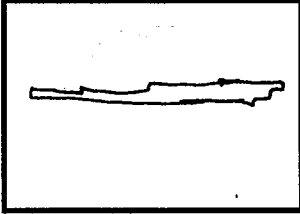
EMSL Order ID: 041416997-0004

Client: Tetra Tech

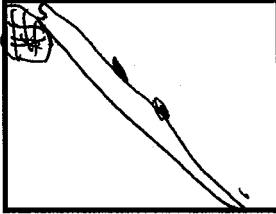
Client Sample: BC-AA-04-00004

Page 1 of 1

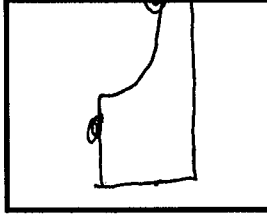
Primary Structure # 1



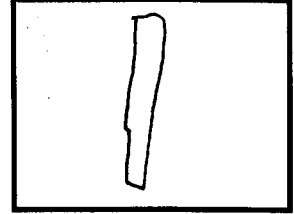
Primary Structure # 2



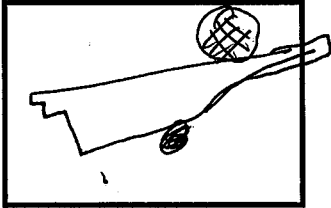
Primary Structure # 3



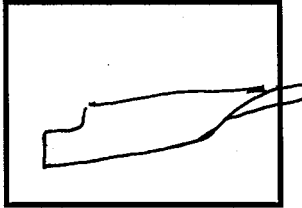
Primary Structure # 4



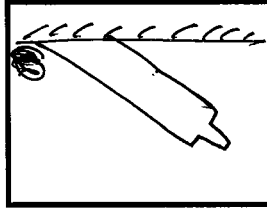
Primary Structure # 5



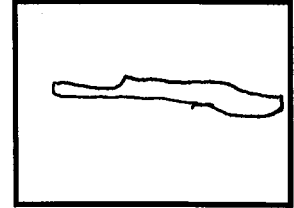
Primary Structure # 6



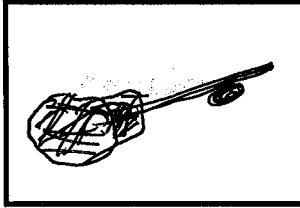
Primary Structure # 0



Primary Structure # 7



Primary Structure # 8



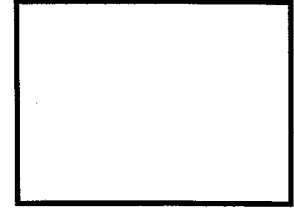
Primary Structure #



Primary Structure #



Primary Structure #



Primary Structure #



Primary Structure #



Primary Structure #



Primary Structure #



Structure #



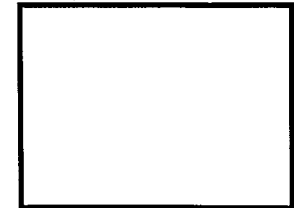
Structure #



Structure #



Structure #



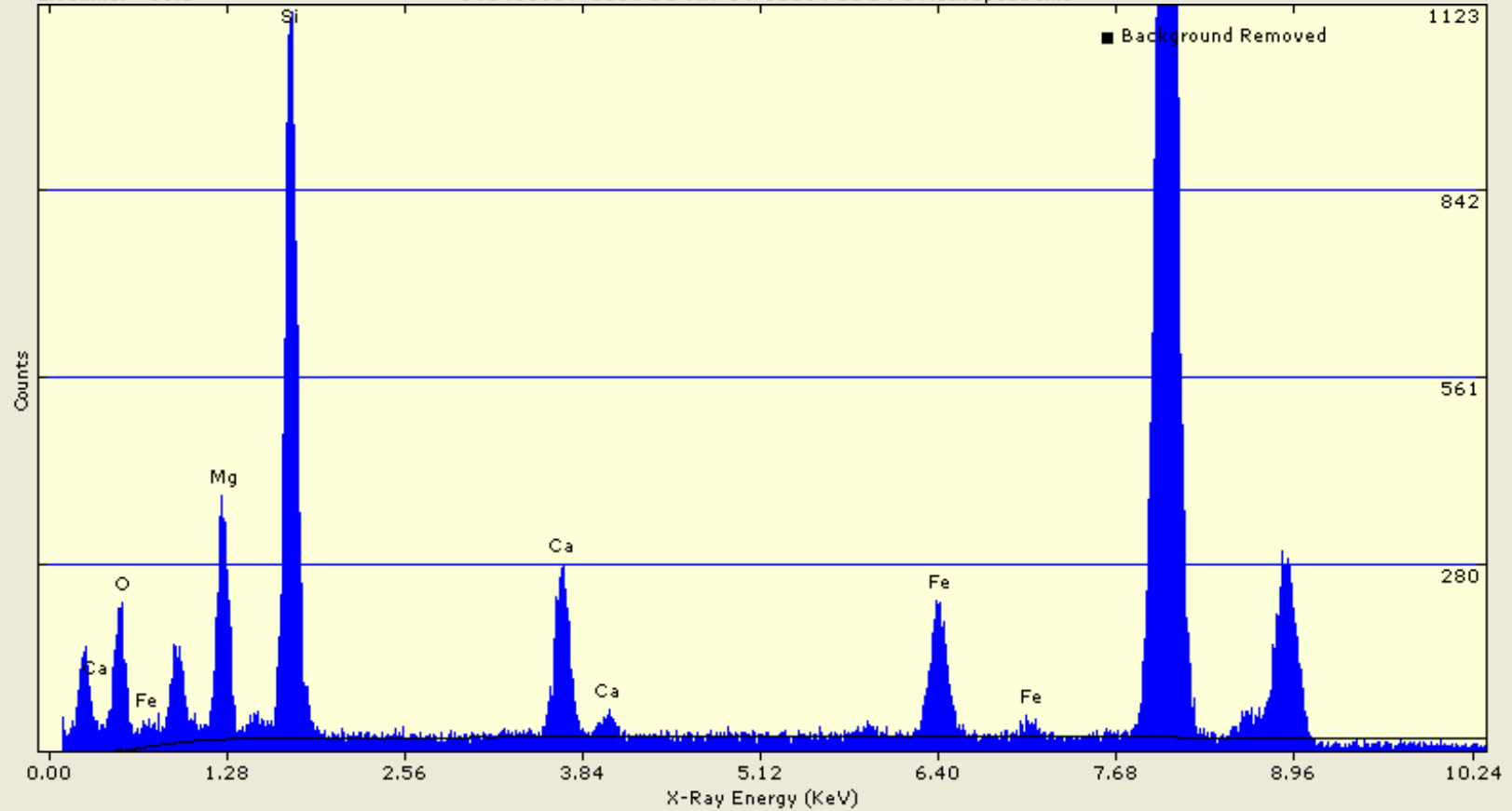
Analyst: FE

Date: 7/2/11

Scope: 04 01

Realtime: 100.0  
 Livetime: 59.1

041416997-0004 BC-AA-04-00004 S1 B4 0 Act: Spectrum9



Quantitative Results for Spectrum9  
 Analysis: Thin Film Method: Standardless  
 Acquired 02-Jul-2014, 100.0 KeV @10 eV/channel

Element	Weight %	Std. Dev.	Atomic %	Oxide %	Cations	k-Ratio	Intensities	FWHM (eV)	ROI (net)
Oxygen	45.13	1.40	61.17	0.00	0.0000	0.0000	0.0	86.2	1707.68
Magnesium	10.39	0.11	9.27	17.23 (MgO)	3.4857	0.1990	2784.7	95.9	2795.32
Silicon	28.92	0.30	22.33	61.87 (SiO2)	8.3958	0.5166	9038.2	101.7	9268.91
Calcium	7.81	0.08	4.23	10.93 (CaO)	1.5892	0.0817	2538.8	122.4	2652.73
Iron	7.75	0.08	3.01	9.97 (FeO)	1.1320	0.0694	2002.3	146.4	2370.57
Total	100.00			100.00	14.6027				



## AMPHIBOLE SAED INDEXING FORM

EMSL Order Number:	041416997	Date:	Jul 02, 2014
Indexing of Image Number:	010344	Scope #:	04 - 01
Reference / Sample No:	0004-04-01	By:	F Craig
Preliminary ID:	ACTINOLITE		
Using Camera Constant of:	2.968e-003	1/A Pixels	
Determined from Reference:	AuCal-070114_10341		

Measured Inter-Row Spacing:	66.4	Pixels
Mean Distance between spots on Center row (d2):	99.65	Pixels
Mean Distance between spots on slant vector (d1):	68.48	Pixels

	Calculated	Ref	-5%	+5%
Inter-row Spacing (Angstroms):	5.075	5.278	5.014	5.542
d2 or hk0 (Camera K/zero row dist.):	3.381	3.385	3.216	3.554
d1 or hk1 (Camera K/slant vector dist.):	4.920	4.931	4.684	5.178
Ratio of hk0/hk1:	0.687	0.686	0.652	0.720
Angle of Slant Vector (Measured):	81.3	80.860	76.817	84.903

From SAED Reference Book, "unknown" diffraction pattern was found to be that of: Actinolite By: F Craig

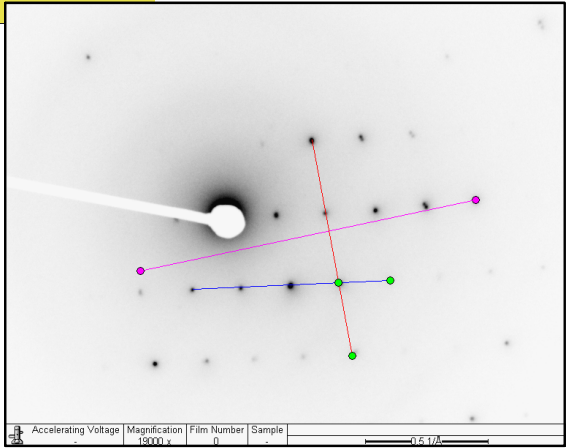
Miller Indices hk0: ( 1 5 0 )

Miller Indices hkl: ( -1 1 1 )

With a Zone Axis of: [ 5 -1 6 ]

Preliminary Identification was: X CORRECT

INCORRECT



Percent accuracy to date: 100 %



## AMPHIBOLE SAED INDEXING FORM

EMSL Order Number:	041416997	Date:	Jul 02, 2014
Indexing of Image Number:	010346	Scope #:	04 - 01
Reference / Sample No:	0004-04-01	By:	F Craig
Preliminary ID:	ACTINOLITE		
Using Camera Constant of:	2.968e-003	1/A Pixels	
Determined from Reference:	AuCal-070114_10341		

Measured Inter-Row Spacing:	63.87	Pixels
Mean Distance between spots on Center row (d2):	66.01	Pixels
Mean Distance between spots on slant vector (d1):	68.54	Pixels

	Calculated	Ref	-5%	+5%
Inter-row Spacing (Angstroms):	5.275	5.278	5.014	5.542
d2 or hk0 (Camera K/zero row dist.):	5.104	5.099	4.844	5.354
d1 or hk1 (Camera K/slant vector dist.):	4.916	4.931	4.684	5.178
Ratio of hk0/hk1:	1.038	1.034	0.982	1.086
Angle of Slant Vector (Measured):	67.4	67.810	64.419	71.201

From SAED Reference Book, "unknown" diffraction pattern was found to be that of: Actinolite By: F Craig

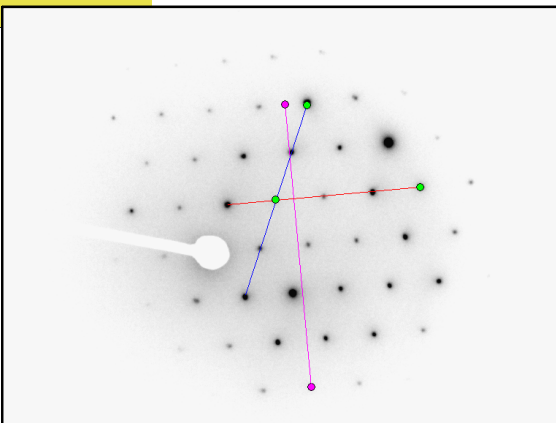
Miller Indices hk0: ( 1 -3 0 )

Miller Indices hkl: ( 1 -1 -1 )

With a Zone Axis of: [ 3 1 2 ]

Preliminary Identification was: X CORRECT

INCORRECT



Accelerating Voltage: 18000 x Magnification: 0 Film Number: 0 Sample: 0.517A

Percent accuracy to date: 100 %



EMSL Analytical, Inc.

200 Route 130 North
Cinnaminson, NJ 08077
856-303-2500
www.EMSL.com

Edward Surbrugg
Tetra Tech
303 Irene Street
Helena, MT 59601
Phone: 406-442-5588

Customer ID: MAXI57
Customer PO: NA
Received: 6/17/2014 9:42
Date Sampled: 06/15/2014 08:00
EMSL Order: 041416997
Report Date: 07/03/14

Project: NDOT NOA / 10353259

ISO 10312
International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM -
Modified for PCMe Analysis

Customer Sample Number: BC-AA-02-00004 Air volume: 14400 Liters
EMSL Sample Number: 041416997-0005 Grid Opening Area: 0.0132 mm^2
Minimum Level of analysis (chrysotile): CD Grid Openings Analyzed: 51
Minimum Level of analysis (amphibole): ADX
Magnification used for fiber counting: 10,000
Aspect ratio for fiber definition: 3:1
Min Length/ Width to be counted (um): >5 / 0.25-none
Area of collection filter (mm^2): 385 Analysis Date: 06/17/2014
Result of Chi^2 Test: 48.00 Random Analyst: P. Harrison

Analytical Sensitivity: 0.000040 Structure/cc Limit of Detection: 0.000119 Structure/cc

Table with 8 columns: Structure Class, Min ID Level, Primary Str., Total Str., Density Str/mm^2, Concentration (Str/cc), LCL (Str/cc), UCL (Str/cc). Rows include PCMe Structures (Chrys), PCMe Structures (Amph), PCMe Structures (NRA), Total PCMe Structures (Regulated), Total PCMe Structures (All), PCMe Fibers and Bundles (Chrys), PCMe Fibers and Bundles (Amph), PCMe Fibers and Bundles (NRA), Total PCMe Fibers and Bundles (Regulated), Total PCMe Fibers and Bundles (All), and Non Asbestos Mineral Structures.

Asbestiform Minerals Present: Actinolite
Explanation of Results
NRA = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.
PCMe structure (modified)= A fibrous structure of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 um with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.
PCMe Fiber or Bundle (modified) = A Fiber or Bundle of of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 microns with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.
Concentration (Reg) = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite
Concentration (all) = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles
Min ID Level = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.
NAM = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile
Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.

Comment: Sample collected on 0.8 um MCE filter.

Robyn Denton
Approved Signatory



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
Microscopy  
Bench Sheet Data

Client:	Tetra Tech			Scope:	JEOL-1200-EX (04-03)
EMSL Sample ID:	041416997-0005	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-02-00004	Grid Box :	0414-Tetra Tech-05: A	Analyst(s):	P. Harrison
Chi <sup>2</sup> Test for Uniformity:	48.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
A1	A2	None Detected								
A1	A4	None Detected								
A1	A8	None Detected								
A1	B9	None Detected								
A1	B5	None Detected								
A1	B3	None Detected								
A1	C2	None Detected								
A1	C4	F	1	1	12.9	1.7	ADX	Actinolite	4400	
A1	C6	F	2	2	5.7	0.8	ADX	Actinolite		
A1	C10	None Detected								
A1	D7	None Detected								
A1	E4	None Detected								
A1	E6	None Detected								
A1	E8	None Detected								
A1	F7	None Detected								
A1	G8	None Detected								
A1	G6	None Detected								
A1	G4	None Detected								
A1	G2	None Detected								
A1	H3	None Detected								
A1	H5	None Detected								
A1	H7	None Detected								
A1	H9	None Detected								
A1	I6	MD11	3		8	1.6	ADX	Actinolite		
A1	I6	MF		3	6.7	1.2	ADX	Actinolite		
A1	I4	None Detected								
A1	I2	None Detected								
A1	J5	None Detected								
A1	J7	None Detected								
A2	A8	None Detected								
A2	A6	None Detected								
A2	A4	None Detected								
A2	B5	None Detected								
A2	C8	None Detected								
A2	C6	None Detected								
A2	C4	None Detected								
A2	D5	None Detected								
A2	D7	None Detected								





# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron Microscopy

Bench Sheet Data

Client:	Tetra Tech			Scope:	JEOL-1200-EX (04-03)
EMSL Sample ID:	041416997-0005	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	BC-AA-02-00004	Grid Box :	0414-Tetra Tech-05: A	Analyst(s):	P. Harrison
Chi <sup>2</sup> Test for Uniformity:	48.00-Random	Pore Size (micron):	0.8	Analysis Date:	06/25/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	25%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
A2	D9	None Detected								
A2	E10	None Detected								
A2	E8	None Detected								
A2	E4	None Detected								
A2	F5	None Detected								
A2	F7	None Detected								
A2	F9	None Detected								
A2	G8	None Detected								
A2	G4	None Detected								
A2	H5	None Detected								
A2	H7	None Detected								
A2	H9	None Detected								
A2	I10	None Detected								
A2	I8	None Detected								



ISO 10312  
International Standard for the Determination of Asbestos Fibers-Direct  
Transfer Transmission Electron Microscopy  
Structure Sketch Sheet for Direct Data Entry

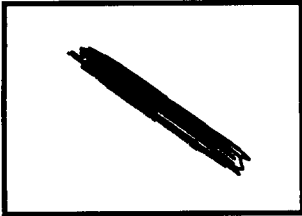
EMSL Order ID: 041416997-0005

Client: Tetra Tech

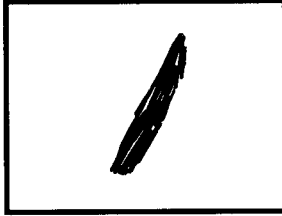
Client Sample: BC-AA-02-00004

Page 1 of     

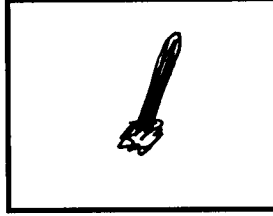
Primary Structure # 1



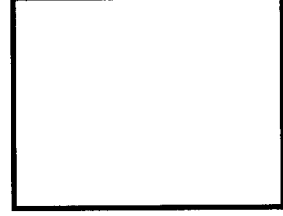
Primary Structure # 2



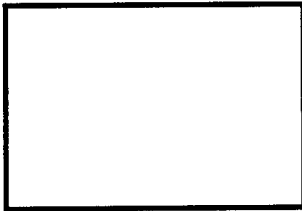
Primary Structure # 3



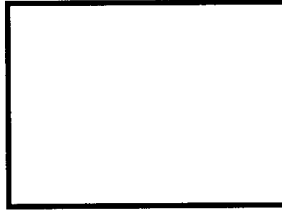
Primary Structure #



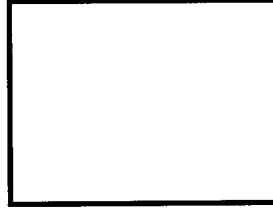
Primary Structure #



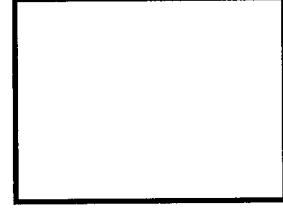
Primary Structure #



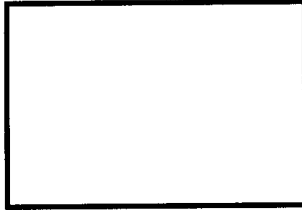
Primary Structure #



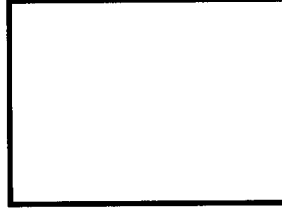
Primary Structure #



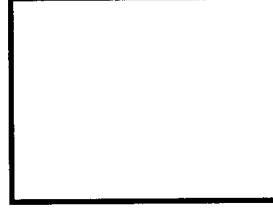
Primary Structure #



Primary Structure #



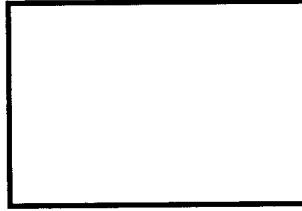
Primary Structure #



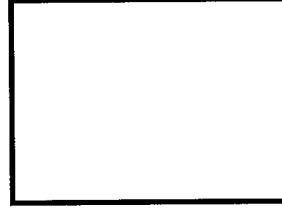
Primary Structure #



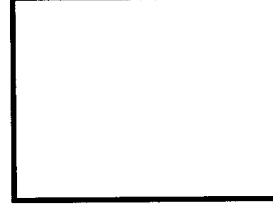
Primary Structure #



Primary Structure #



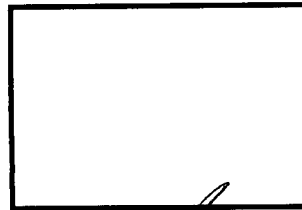
Primary Structure #



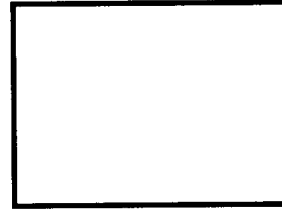
Primary Structure #



Structure #



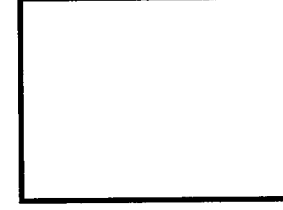
Structure #



Structure #



Structure #



Analyst: [Signature]

Date: 6/25/04

Scope: 04-03



# Energy Dispersive X-Ray Analysis

## Quantitative Spectra & Data

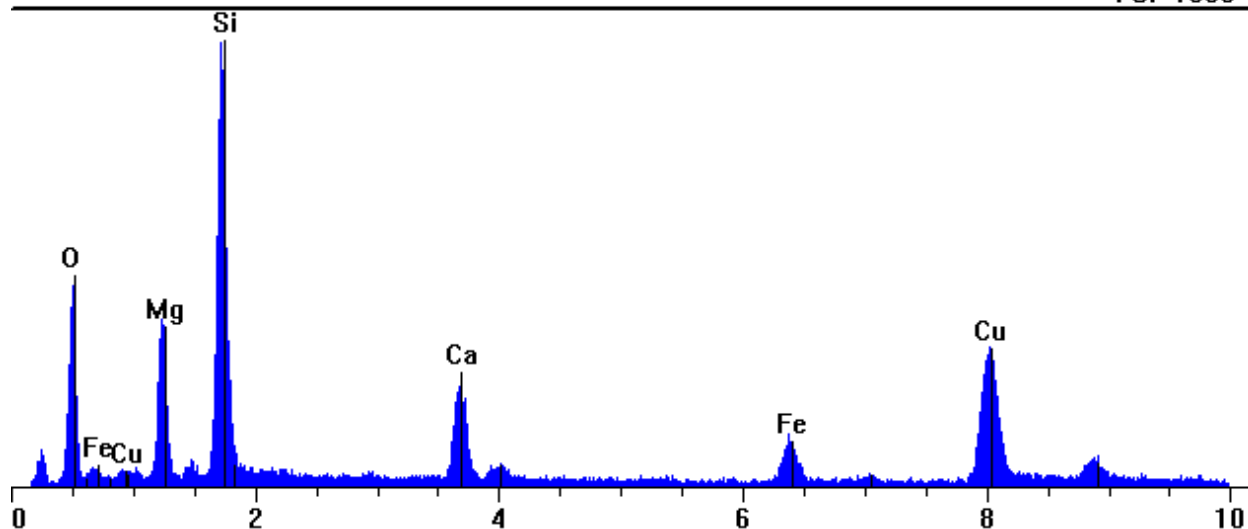
EMSL ANALYTICAL, INC.

File: L:\EDS Spe...Spectra\Scope 04-03\2014\041416997-0005 A1 C4 1 AC.pgt  
 Collected: June 25, 2014 08:21:46

Live Time: 9.97                      Count Rate: 13391                      Dead Time: 66.86 %  
 Beam Voltage: 20.00                  Beam Current: 2.00                      Takeoff Angle: 31.00  
 Thickness limit: 26801.96

■ 041416997-0005 A1 C4 1 AC.pgt

FS: 1600



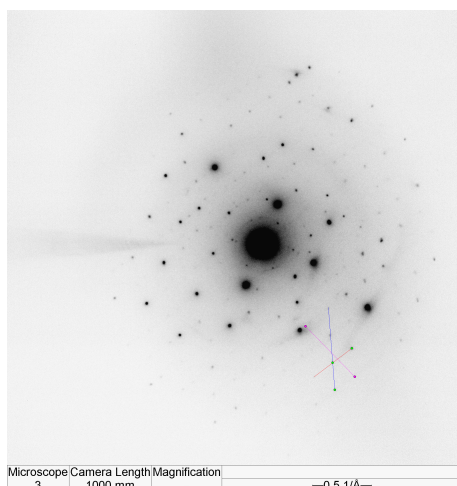
Element	Line	keV	CL Ratio	Wt%	At%	At Prop	Compound	Cmpd Wt%
Mg	KA1	1.254	1.4000	15.63	14.63	6.7	MgO	25.91
Si	KA1	1.740	1.0000	33.76	27.36	12.6	SiO	52.99
Ca	KA1	3.691	1.0500	10.62	6.03	2.8	CaO	14.87
Fe	KA1	6.403	0.9900	4.85	1.98	0.9	FeO	6.23
Cu	KA1	8.046	0.0000	0.00	0.00	0.0		
O	KA1	0.523	0.0000	35.14	50.00	23.0		
<b>Total</b>			<b>0.0000</b>	<b>100.00</b>	<b>100.00</b>	<b>46.0</b>	<b>Total</b>	<b>100.00</b>

Element	Line	Gross (cps)	BKG (cps)	Net (cps)	P:B Ratio
Mg	KA1	782.8	67.5	715.3	10.6
Si	KA1	2249.0	86.3	2162.7	25.1
Ca	KA1	734.4	86.1	648.3	7.5
Fe	KA1	376.5	62.9	313.6	5.0
Cu	KA1	1300.4	81.3	1219.1	15.0
O	KA1	750.6	27.5	723.0	26.3

# AMPHIBOLE SAED INDEXING FORM

<b>EMSL Order Number:</b>	<u>041416997</u>	<b>Date:</b>	<u>Jun 25, 2014</u>
<b>Image Number:</b>	<u>04400</u>		
<b>Reference / Sample Number:</b>	<u>0005</u>		
<b>Preliminary ID:</b>	<u>ACTINOLITE</u>		
<b>Camera Constant:</b>	<u>1.873e-003</u>	<b>1/A Pixels</b>	
<b>Calibration Reference:</b>	<u>062314-04-03-04397_C</u>		

	Measured	Reference	-5%	+5%
<b>Inter-row Spacing:</b> <input type="checkbox"/> <input type="checkbox"/>	<b>5.044</b>	5.278	<b>5.014</b>	<b>5.542</b>
<b>d2 or hk0 (Camera K/zero row dist.):</b>	<b>5.036</b>	5.099	<b>4.844</b>	<b>5.354</b>
<b>d1 or hkl (Camera K/slant vector dist.):</b>	<b>4.315</b>	4.482	<b>4.258</b>	<b>4.706</b>
<b>Ratio of hk0/hkl:</b>	<b>1.167</b>	1.138	<b>1.081</b>	<b>1.195</b>
<b>Vector Angle:</b>	<b>57.34</b>	57.320	<b>54.454</b>	<b>60.186</b>



From SAED Reference Book, "unknown" diffraction pattern was found to be that of: **ACTINOLITE**

With a Zone Axis of: [ **3-12** ]

Preliminary Identification was:

X

CORRECT

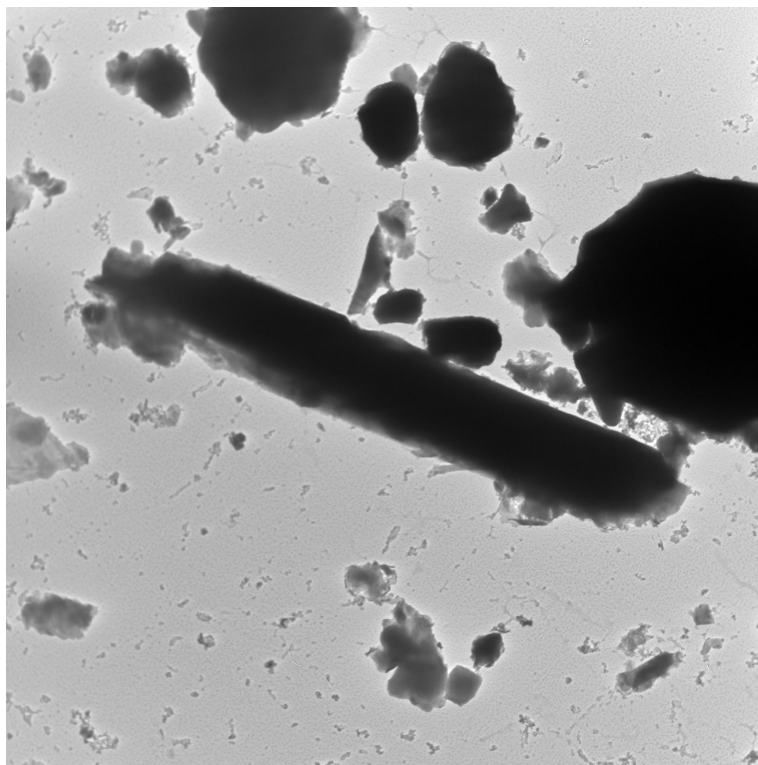
INCORRECT



EMSL ANALYTICAL, INC.

# EMSL Analytical, Inc.

## *Photomicrograph Report*



Microscope	Camera Length	Magnification	
3	-	10000 x	—2 $\mu$ m—

### *Micrograph Information*

<b>Sample ID:</b>	0005
<b>Order ID:</b>	041416997
<b>Image Number:</b>	04401
<b>Mineral Type:</b>	ACTINOLITE
<b>Date:</b>	6/25/2014
<b>Magnification:</b>	10000
<b>Microscope:</b>	3



**EMSL Analytical, Inc.**

200 Route 130 North  
 Cinnaminson, NJ 08077  
 856-303-2500  
[www.EMSL.com](http://www.EMSL.com)

Edward Surbrugg  
 Tetra Tech  
 303 Irene Street  
 Helena, MT 59601  
 Phone: 406-442-5588

**Customer ID:** MAXI57  
**Customer PO:** NA  
**Received:** 6/17/2014 9:42  
**Date Sampled:** 06/30/2014 08:00  
**EMSL Order:** 041416997  
**Report Date:** 07/03/14

**Project: NDOT NOA / 10353259**

**ISO 10312**  
**International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM - Modified for PCMe Analysis**

Customer Sample Number:	Ashing Blank	Air volume:	0	Liters
EMSL Sample Number:	041416997-0006	Grid Opening Area:	0.0132	mm <sup>2</sup>
Minimum Level of analysis (chrysotile):	CD	Grid Openings Analyzed:	10	
Minimum Level of analysis (amphibole):	ADX			
Magnification used for fiber counting:	10,000			
Aspect ratio for fiber definition:	3:1			
Min Length/ Width to be counted (µm):	>5 / 0.25-none			
Area of collection filter (mm <sup>2</sup> ):	385	Analysis Date:	06/30/2014	
Result of Chi <sup>2</sup> Test:	N/A N/A	Analyst:	F. Craig	

**Analytical Sensitivity:** 7.575758 Structure/ mm<sup>2</sup>      **Limit of Detection:** 22.651515 Structure/ mm<sup>2</sup>

Structure Class	Min ID Level	Primary Str.	Total Str.	Density Str/mm <sup>2</sup>	Concentration Str/ mm <sup>2</sup>	Poisson 95 % Confidence Interval	
						LCL Str/ mm <sup>2</sup>	UCL Str/ mm <sup>2</sup>
PCMe Structures (Chrys)	CD	0	-	0.00	NA	0.000000	22.651515
PCMe Structures (Amph)	ADX	0	-	0.00	NA	0.000000	22.651515
PCMe Structures (NRA)	ADX	0	-	0.00	NA	0.000000	22.651515
<b>Total PCMe Structures (Regulated)</b>	<b>CD/ADX</b>	<b>0</b>	<b>-</b>	<b>0.00</b>	<b>NA</b>	<b>0.000000</b>	<b>22.651515</b>
<b>Total PCMe Structures (All)</b>	<b>CD/ADX</b>	<b>0</b>	<b>-</b>	<b>0.00</b>	<b>NA</b>	<b>0.000000</b>	<b>22.651515</b>
PCMe Fibers and Bundles (Chrys)	CD	-	0	0.00	NA	0.000000	22.651515
PCMe Fibers and Bundles (Amph)	ADX	-	0	0.00	NA	0.000000	22.651515
PCMe Fibers and Bundles (NRA)	ADX	-	0	0.00	NA	0.000000	22.651515
<b>Total PCMe Fibers and Bundles (Regulated)</b>	<b>CD/ADX</b>	<b>-</b>	<b>0</b>	<b>0.00</b>	<b>NA</b>	<b>0.000000</b>	<b>22.651515</b>
<b>Total PCMe Fibers and Bundles (All)</b>	<b>CD/ADX</b>	<b>-</b>	<b>0</b>	<b>0.00</b>	<b>NA</b>	<b>0.000000</b>	<b>22.651515</b>
Non Asbestos Mineral Structures	NAM	0	0	-	-	-	-

**Asbestiform Minerals Present:** *None Detected*

**Explanation of Results**

**NRA** = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.

**PCMe structure (modified)**= A fibrous structure of aspect ratio > 3:1, longer than 5 µm, and which has a diameter ≥ 0.25 µm with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

**PCMe Fiber or Bundle (modified)** = A Fiber or Bundle of aspect ratio > 3:1, longer than 5 µm, and which has a diameter ≥ 0.25 microns with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

**Concentration (Reg)** = include all federally regulated asbestos types. Currently Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite

**Concentration (all)** = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles

**Min ID Level** = the minimum level of analysis that must have been met to be included in the reportable structure count. If any fibrous structure did not meet the minimum ID level, it would not be included in the concentration.

**NAM** = Non Asbestos Mineral. A mineral fiber that has been rejected from being either Amphibole or Chrysotile

*Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.*

*Robyn Denton*  
 Approved Signatory



# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
**Microscopy**  
 Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	Ashing Blank	Grid Box :	0414-TetraTech-05: R	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	N/A	Pore Size (micron):	0.8	Analysis Date:	07/01/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	1%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
R1	B7	None Detected								
R1	D10	None Detected								
R1	E5	None Detected								
R1	G7	None Detected								
R1	I6	None Detected								
R2	B3	None Detected								
R2	E4	None Detected								
R2	C6	None Detected								
R2	G3	None Detected								
R2	I2	None Detected								



EMSL Analytical, Inc.

200 Route 130 North
Cinnaminson, NJ 08077
856-303-2500
www.EMSL.com

Edward Surbrugg
Tetra Tech
303 Irene Street
Helena, MT 59601
Phone: 406-442-5588

Customer ID: MAXI57
Customer PO: NA
Received: 6/17/2014 9:42
Date Sampled: 06/30/2014 08:00
EMSL Order: 041416997
Report Date: 07/03/14

Project: NDOT NOA / 10353259

ISO 10312
International Standard for the Determination of Asbestos Fibers - Direct Transfer TEM -
Modified for PCMe Analysis

Customer Sample Number: Filtration Blank Air volume: 0 Liters
EMSL Sample Number: 041416997-0007 Grid Opening Area: 0.0132 mm^2
Minimum Level of analysis (chrysotile): CD Grid Openings Analyzed: 10
Minimum Level of analysis (amphibole): ADX
Magnification used for fiber counting: 10,000
Aspect ratio for fiber definition: 3:1
Min Length/ Width to be counted (um): >5 / 0.25-none
Area of collection filter (mm^2): 385 Analysis Date: 06/30/2014
Result of Chi^2 Test: N/A N/A Analyst: F. Craig

Analytical Sensitivity: 7.575758 Structure/ mm^2 Limit of Detection: 22.651515 Structure/ mm^2

Table with 8 columns: Structure Class, Min ID Level, Primary Str., Total Str., Density Str/mm^2, Concentration Str/ mm^2, LCL Str/ mm^2, UCL Str/ mm^2. Rows include PCMe Structures (Chrys), PCMe Structures (Amph), PCMe Structures (NRA), Total PCMe Structures (Regulated), Total PCMe Structures (All), PCMe Fibers and Bundles (Chrys), PCMe Fibers and Bundles (Amph), PCMe Fibers and Bundles (NRA), Total PCMe Fibers and Bundles (Regulated), Total PCMe Fibers and Bundles (All), Non Asbestos Mineral Structures.

Asbestiform Minerals Present: None Detected

Explanation of Results

NRA = Non-Regulated Amphibole. A suspected mineral fiber that is a member of the Amphibole group, but is currently not regulated by the Federal government as asbestos.

PCMe structure (modified)= A fibrous structure of aspect ratio > 3:1, longer than 5 um, and which has a diameter >= 0.25 um with no upper width boundary. This definition has been modified from the method to meet the client's project requirements.

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Concentration (all) = include all federally regulated asbestos types (Chrysotile, Amosite, Actinolite, Tremolite, Anthophyllite and Crocidolite) and any Non-regulated Amphiboles

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Concentrations and 95% Confidence Intervals are based on a Poissonian distribution. Structure counts above 31 may be better expressed with a Gaussian distribution. EMSL maintains liability limited to the cost of analysis. This report relates only to the samples reported above and may not be reproduced except in full without written approval of EMSL. EMSL is not responsible for sample collection activities or analytical limitations. Interpretation and use of results are the responsibility of the client.

Robyn Denton
Approved Signatory





# ISO 10312

International Standard for the Determination of Asbestos Fibers-Direct Transfer Transmission Electron  
**Microscopy**  
 Bench Sheet Data

Client:	Tetra Tech			Scope:	04-01
EMSL Sample ID:	041416997-0007	GO area (mm <sup>2</sup> ):	0.0132	Mag:	10,000
Customer Sample:	Filtration Blank	Grid Box :	0414-TetraTech-05: R	Analyst(s):	F. Craig
Chi <sup>2</sup> Test for Uniformity:	N/A	Pore Size (micron):	0.8	Analysis Date:	07/01/2014
Project ID:	NDOT NOA / 10353259			Particulate Loading:	<1%

Grid ID	Grid Opening	Structure Type	Structure Number		Dimensions (µm)		Level of ID	Mineral Type	Image Number	Structure Comments
			Primary	Total	Length	Width				
R6	B8	None Detected								
R6	D9	None Detected								
R6	F4	None Detected								
R6	G10	None Detected								
R6	I7	None Detected								
R7	C5	None Detected								
R7	E2	None Detected								
R7	F6	None Detected								
R7	H3	None Detected								
R7	I8	None Detected								



EMSL ANALYTICAL, INC.  
LABORATORY PRODUCTS TRAINING

**Asbestos Chain of Custody**  
**EMSL Order Number** (Lab Use Only):

041416997

EMSL ANALYTICAL, INC.  
200 ROUTE 130 NORTH  
CINNAMINSON, NJ 08077  
PHONE: (800) 220-3675  
FAX: (856) 786-5974

Company: <b>TETRA TECH</b>		EMSL-Bill to: <input checked="" type="checkbox"/> Same <input type="checkbox"/> Different If Bill to is Different note instructions in Comments**	
Street: <b>7 West 10th AVE - Ste 102</b>		Third Party Billing requires written authorization from third party	
City: <b>Helena</b>	State/Province: <b>MT</b>	Zip/Postal Code: <b>59601</b>	Country: <b>USA</b>
Report To (Name): <b>Ed Surbrugg</b>		Telephone #: <b>406-441-3296</b>	
Email Address: <b>Edward.Surbrugg@tetratech.com</b>		Fax #: <b>406-442-7182</b>	Purchase Order:
Project Name/Number: <b>10393259</b>		Please Provide Results: <input type="checkbox"/> Fax <input checked="" type="checkbox"/> Email <input type="checkbox"/> Mail	
U.S. State Samples Taken: <b>NA</b>		Connecticut Samples: <input type="checkbox"/> Commercial <input type="checkbox"/> Residential	

**Turnaround Time (TAT) Options\* - Please Check**

3 Hour  
  6 Hour  
  24 Hour  
  48 Hour  
  72 Hour  
  96 Hour  
  1 Week  
  2 Week

\*For TEM Air 3 hr through 6 hr, please call ahead to schedule. \*There is a premium charge for 3 Hour TEM AHERA or EPA Level II TAT. You will be asked to sign an authorization form for this service. Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide.

<b>PCM - Air</b> <input type="checkbox"/> Check if samples are from NY <input type="checkbox"/> NIOSH 7400 <input type="checkbox"/> w/ OSHA 8hr. TWA <b>PLM - Bulk (reporting limit)</b> <input type="checkbox"/> PLM EPA 600/R-93/116 (<1%) <input type="checkbox"/> PLM EPA NOB (<1%) Point Count <input type="checkbox"/> 400 (<0.25%) <input type="checkbox"/> 1000 (<0.1%) Point Count w/Gravimetric <input type="checkbox"/> 400 (<0.25%) <input type="checkbox"/> 1000 (<0.1%) <input type="checkbox"/> NYS 198.1 (friable in NY) <input type="checkbox"/> NYS 198.6 NOB (non-friable-NY) <input type="checkbox"/> NIOSH 9002 (<1%)	<b>TEM - Air</b> <input type="checkbox"/> 4-4.5hr TAT (AHERA only) <input type="checkbox"/> AHERA 40 CFR, Part 763 <input type="checkbox"/> NIOSH 7402 <input type="checkbox"/> EPA Level II <input checked="" type="checkbox"/> ISO 10312 <i>Sensitivity to 0.00004</i> <b>TEM - Bulk</b> <input type="checkbox"/> TEM EPA NOB <input type="checkbox"/> NYS NOB 198.4 (non-friable-NY) <input type="checkbox"/> Chatfield SOP <input type="checkbox"/> TEM Mass Analysis-EPA 600 sec. 2.5 <b>TEM - Water:</b> EPA 100.2 Fibers >10µm <input type="checkbox"/> Waste <input type="checkbox"/> Drinking All Fiber Sizes <input type="checkbox"/> Waste <input type="checkbox"/> Drinking	<b>TEM - Dust</b> <input type="checkbox"/> Microvac - ASTM D 5755 <input type="checkbox"/> Wipe - ASTM D6480 <input type="checkbox"/> Carpet Sonication (EPA 600/J-93/167) <b>Soil/Rock/Vermiculite</b> <input type="checkbox"/> PLM CARB 435 - A (0.25% sensitivity) <input type="checkbox"/> PLM CARB 435 - B (0.1% sensitivity) <input type="checkbox"/> TEM CARB 435 - B (0.1% sensitivity) <input type="checkbox"/> TEM CARB 435 - C (0.01% sensitivity) <input type="checkbox"/> TEM Qual. via Filtration Technique <input type="checkbox"/> TEM Qual. via Drop-Mount Technique <b>Other:</b> <input type="checkbox"/>
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Check For Positive Stop - Clearly Identify Homogenous Group      Filter Pore Size (Air Samples):  0.8µm  0.45µm

Samplers Name: **BOBU DANO**      Samplers Signature: *[Signature]*

Sample #	Sample Description	Volume/Area (Air) HA # (Bulk)	Date/Time Sampled
BC-AA-01-00004	Site 1	14,400 L	6-15-14 0758
Field Blank 01514	Field Blank	—	6-15-14 0758
BC-AA-03-00004	Site 3	14,400 L	6-15-14 0818
BC-AA-04-00004	Site 4	14,400 L	6-15-14 0835
BC-AA-02-00004	Site 2	14,400 L	6-15-14 0854

Client Sample # (s): -      Total # of Samples: **5**

Relinquished (Client): *[Signature]* **BOBU DANO**      Date: **6-16-14**      Time: **1200**

Received (Lab): *[Signature]*      Date: **6/17/2014**      Time: **9:42am**

Comments/Special Instructions:

