WONDER MAKERS
ENVIRONMENTAL

Negative Exposure Assessment Study Using the Wonder Makers Asbestos Bulk Sampler

Conducted by
Wonder Makers Environmental
and
EMSL Laboratories

December 7, 2017

Wonder Makers Environmental, Inc. P. O. Box 50209 • Kalamazoo, MI 49005-0209 • 269.382.4154 • Fax 269.382.4161 • www.wondermakers.com

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Investigator Safety: Reducing Exposure to Fibers during Asbestos Building Inspections by Utilizing Wonder Makers Asbestos Bulk Sampling Equipment

Negative Exposure Assessment Verifies That Proper Collection of Asbestos Samples Protects the Inspectors

Written by:
Michael A. Pinto, Wonder Makers Environmental; David A. Batts, Wonder Makers Environmental; Jody Thomason, EMSL Laboratories

Introduction

Wonder Makers Environmental invented the original, detachable core sampling system designed specifically for assisting inspectors when conducting building evaluations for asbestos. Shortly after its introduction in 1988, testing was done which proved that, when used according to accepted industry practices and in conformance with the manufacturer's instructions, inspectors using the Wonder Makers bulk sampling tool were exposed to airborne asbestos levels well below the Permissible Exposure Limit (PEL).

This was an important advancement in the industry as EPA-approved training agencies at the time were recommending that samples of friable (*i.e.,* crushable by hand pressure) materials suspected of containing asbestos should be sampled using a jack knife or steak knife. The specific process taught involved making triangle-shaped cuts in the material and prying the "plug" of suspect material out into a whirl-pack bag or film canister. At the time, both OSHA and EPA indicated that individuals conducting such sampling had to utilize protective gloves, suits, and respirators in order to avoid cross-contamination. In those early training classes, it was specifically mentioned that such sampling activities could create airborne fiber concentrations greater than the Permissible Exposure Limit.

Given that 30 years has passed since the original development and marketing of the asbestos bulk sampling system, a comprehensive review of the product line was undertaken. Realizing that the Permissible Exposure Limits developed by OSHA for asbestos have changed in that time, a determination was made to complete a more formal Negative Exposure Assessment (NEA) for the central parts of the asbestos bulk sampling system, the T-handle and cutter sleeve. The development of this NEA was simplified by the fact that Wonder Makers had developed and published a recommended form for documenting an asbestos NEA.

An important part of the project was a literature review to determine if similar data was already available. Surprisingly, no current technical journal articles were identified which specifically dealt with the subject of asbestos exposure levels for inspectors. Scant support was even identified in the asbestos-related literature for the development of negative exposure assessment for inspection activities rather than specific abatement practices. After the completion of the Wonder Makers NEA sampling, a continued literature review identified the ASTM standard D7886 *Standard Practice for Asbestos Exposure Assessments for Repetitive Maintenance and Installation Tasks*. Similar to the Wonder Makers negative exposure assessment effort, this

voluntary standard recommends that an exposure assessment for repetitive tasks where asbestos disturbance is incidental to the work be conducted such that the airborne fiber concentrations are measured under controlled conditions, not at an actual job site.

The project designed for the NEA was developed by Michael Pinto, CEO of Wonder Makers Environmental. The actual sampling and air monitoring necessary to develop a negative exposure assessment was conducted by Dave Batts, Director of Environmental Services for Wonder Makers Environmental, in accordance with federal, state, and local regulations. Both Mr. Pinto and Mr. Batts hold numerous State of Michigan asbestos licenses, including those as contractor/supervisor, inspector, and project designer. Laboratory analysis, as well as technical support for the sampling and analytical process, was provided by EMSL with Jody Thomason as the primary liaison for the project.

Regulatory Basis for the Negative Exposure Assessment

The OSHA Asbestos Standard for the Construction Industry (29 CFR 1926.1101) provides the primary guidance for individuals working with, or around, asbestos-containing products. Although many of the specific requirements for asbestos inspections in buildings are developed by the EPA, worker protection issues are primarily the province of OSHA. Therefore, the OSHA Standard was used as the basis for completing the Negative Exposure Assessment.

By definition in the Asbestos Standard, building inspections that involve the collection of bulk samples of suspect asbestos-containing material are considered to be "Class III" work. This designation is based on the fact that the collection of bulk samples does not actually remove the material completely but does disturb suspect asbestos-containing materials (ACM) or presumed asbestos-containing materials (PACM). Specifically the definition states:
Class III asbestos work means repair and maintenance operations where 'ACM,' including TSI and surfacing ACM and PACM, is likely to be disturbed.

Section (f) of the OSHA Asbestos Standard details the requirements for exposure assessment and monitoring during regulated asbestos work activities**.** The standard requires that employers conduct an ***initial*** exposure assessment at the start of projects that may disturb asbestos-containing materials. The purpose of this initial exposure assessment is to make sure that the individual supervising the project, known as the 'competent person,' has enough information to assign proper respiratory protection and engineering controls that will protect the asbestos workers and building occupants. This initial exposure assessment involves the collection of personal air samples and is required to be completed for all regulated work activities.

The alternative to conducting an initial exposure assessment for every asbestos building inspection is to utilize a ***negative*** exposure assessment. The OSHA standard indicates that an NEA is for "any one specific asbestos job." The purpose of an NEA is to demonstrate that if a certain asbestos-related task is performed, according to standardized work procedures, that employee exposures will be lower than the Permissible Exposure Limit. An NEA can be based

on "objective data," such as scientific reports, published studies, or air monitoring that collects samples which allow the calculation of both 30 minute short-term exposure limits (STEL) and an eight hour time weighted average (TWA). According to the OSHA standard, an NEA based on air monitoring must be repeated every year unless the data from the monitoring is published as a report in an industry periodical or scientific journal.

The original air monitoring data generated by Wonder Makers Environmental in support of the asbestos bulk sampling system was discussed at a number of industry conferences and the subject of numerous articles in trade publications. However, the passage of 30 years has made the retrieval of those publications fairly difficult. Since the publication of the original information, the reduction in the OSHA-approved Permissible Exposure Limit also drove the decision to update the negative exposure assessment. The results would be shared so the NEA could become objective data rather than project-related air monitoring which would have to be repeated on an annual basis.

Overview of the Project

Several approaches were considered for the Negative Exposure Assessment. Conducting air monitoring while doing sampling as part of a field investigation would seem to be the logical approach to such a project; but poses many practical difficulties. A primary concern is that the presence, as well as the specific type and percentage, of asbestos is unknown until the initial bulk sample results from a building investigation are received. Another practical consideration is that background air monitoring results typically are not available prior to the collection of bulk samples. As such, it would be difficult to confirm that any fibers recovered in the air samples would be the result of the sampling process rather than the ambient conditions in the room that has suspect asbestos with varying damage levels. A third bar to conducting a negative exposure assessment while involved in an actual building investigation is that the number of samples to be collected in a concentrated block of time so that there is a reasonable volume for the air samples is significant.

These considerations, and others, led to the decision to set up an isolated environment and collect multiple samples of asbestos-containing pipe insulation using the Wonder Makers asbestos bulk sampling system in an area that would facilitate the collection of multiple air samples. Sections of aircell and woolfelt pipe insulation were obtained from an abatement project and then set up on a pipe stand. The selection of those two specific types of insulation was made based on the common industry understanding that aircell pipe insulation is relatively easy to sample while woolfelt style insulation with its multiple wraps of paper is significantly more difficult to cut through to get a full depth sample. Analysis of representative bulk samples of the two types of pipe insulation revealed that the air cell style insulation consisted of 40% chrysotile asbestos with the woolfelt insulation having 30% chrysotile asbestos as part of its makeup.

A determination was made that the work process and sampling procedure for the NEA should be set up in order to represent a "worst-case" scenario for an inspector. In this way, if the NEA

results showed that the concentrations of airborne asbestos fibers were below the PEL, there would be additional support for the data being applicable to a variety of inspection processes.

In general, building investigations for asbestos involve quite a bit of visual evaluation, assessment of material conditions, selection of the appropriate number of samples of each suspect material and specific sampling locations, documentation, and collection of bulk samples. Since bulk samples of suspect materials have to be taken in a representative fashion, sampling is often conducted in multiple areas of the structure. Such a process tends to minimize the potential exposure levels to airborne asbestos as only a few samples are typically collected from a specific area. By conducting the NEA testing in a small area combined with the collection of a large number of samples, this significantly increases the potential for elevated fiber concentrations. Overall, 33 separate bulk samples of the two types of pipe insulation were collected in a room with interior dimensions of approximately 8' x 9' x 71/2' tall. As a worst-case scenario, this would represent a small mechanical room with multiple insulated pipe runs and pieces of mechanical equipment that had to be sampled as part of an inspection.

Although the OSHA standard calls for initial exposure assessments and negative exposure assessments to be completed using personal air monitoring, it was determined that supplementing such personal monitoring with area samples would be beneficial. While bulk sampling activities generally bring the inspector within arms-length of the suspect material thereby creating the potential for an immediate exposure risk in the breathing zone, aggressive bulk sampling methods (such as knife cutting, sawing, prying, etc.) can also cause disturbance along the length of pipe. Such forceful handling of the material can result in airborne fiber releases at the seams of the insulation pieces or other openings. This is especially true for aircell insulation which has a waffle-like texture on the inside with many air channels. Gathering eight area samples inside the small work area while the bulk collection was underway would help determine whether the Wonder Makers asbestos core sampling process was protecting the general environment as well as the individual using the equipment.

At the time the original testing was done in support of the Wonder Makers asbestos bulk sampling equipment, transmission electron microscopy as an analytical technique for asbestos samples was still relatively rare and expensive. In the intervening decades, the availability of that analytical technique for air samples has expanded dramatically with the process being refined as well. Partnering with EMSL Laboratories for this negative exposure assessment added independent, high-quality analysis using both phase contrast microscopy (PCM) and transmission electron microscopy (TEM) to the in-house PCM microscopy.

Sample Collection Methodology

The asbestos-containing pipe insulation materials were removed within a room regulated with a Danger Asbestos Warning Sign on the door. Despite the fact that past evidence indicated that such personal protective equipment was not necessary, to conduct the NEA in compliance with

OSHA rules the inspector collecting the samples wore a disposable suit with attached hood and booties, half-face negative pressure respirator with HEPA filters, and disposable rubber gloves.

The collection of 33 core samples was conducted following the instructions which are provided with every set of Wonder Maker asbestos bulk sampling equipment. This involved a number of simple steps as follows:

1. The surface of asbestos-containing pipe insulation was wetted with surfactant sprayed from a small spray bottle.
2. At the spot where the insulation was wetted, a small amount of asbestos-containing pipe insulation was removed using a sharp aluminum coring tool (cutter) with a removable handle attached to it.
3. Using a twisting motion the inspector pushed the cutter so that it cored through all the layers of the insulation until the cutter reached the pipe underneath the insulation.
4. The twisting motion not only allowed the cutter to penetrate through the suspect materials but enclosed the insulation within the cutter at the same time.
5. After working through the full depth of the material, the cutter was immediately placed into a plastic tube and the handle removed from the cutter.
6. Once the cutter, with the full depth sample inside, was inside the collection vial it was sealed air tight with a rubber cap.
7. The exposed hole in the pipe insulation was then sealed by squeezing a high temperature encapsulant (a product named ‘Wonder Fill’) from a plastic bottle to replace the section of insulation that was removed for testing.
    a. Since trowel grade encapsulants designed for asbestos shrink a small amount when they dry, each core hole was slightly overfilled after the sample had been extracted.

Following the sampling, the inspector HEPA-vacuumed his disposable suit and respirator with a soft bristle brush attachment; removed his disposable rubber gloves, disposable suit, and respirator cartridges; and placed all of the single use items into an asbestos disposal bag. When all the materials were inside, he evacuated the air out of the asbestos disposal bag with the HEPA vacuum, gooseneck-sealed the disposal bag with duct tape, and placed the disposal bag into an onsite barrel for asbestos waste.

Description of Air Sampling Activity to Support the NEA

Eight area air samples were collected during the course of the bulk sampling process; a period of nearly 4 hours. Four personal air samples and four field blanks were also collected for a total of 18 air samples. The samples were set up so that analysis of some of the samples could be completed via phase contrast microscopy while others were evaluated using transmission electron microscopy. Using both analytical methods allowed the negative exposure assessment to provide very definitive data (since TEM analysis actually identifies asbestos fibers as compared to PCM analysis which counts every fiber with a particular length and width ratio as asbestos) as well as data matching the more common, but less accurate, method used for personal air sampling for asbestos.

Five of the area air samples were collected using an Easy-Air mobile sampling unit manufactured by Wonder Makers. These high-volume sampling pumps allows up to five samples to be collected simultaneously. Three of the area samples were collected using the Triple-Air mobile sampling unit manufactured by Wonder Makers Environmental. This high-volume sampling pump allows up to three samples to be collected simultaneously. The representative exposure samples were collected using Air One personal sampling pumps, model TI-004. Each line of the Triple-Air and the Easy Air, as well as the personal sampling pumps, was calibrated with a rotometer at the cassette face, prior to the collection of the samples.

For the samples that were going to be analyzed by phase contrast microscopy, 25 millimeter (mm) cassettes equipped with a mixed cellulose ester filter of 0.8-micron pore size, a 5-micron backing pad, and a 50-mm conductive cowl were used. For samples designated for transmission electron microscopy (even if initial analysis was going to be conducted via PCM), 25 mm three piece transmission electron microscopy (TEM) cassettes equipped with a mixed cellulose ester filter of 0.45-micron pore size, a 5-micron backing pad, and a 50-mm conductive cowl were used.

Laboratory Analysis

Initial laboratory analysis of the PCM air samples was conducted by Dave Batts of Wonder Makers Environmental, a certified phase contrast microscopist. The PCM analysis was performed according to the NIOSH 7400 method for determining the concentration of airborne asbestos fibers. For the PCM analysis of air samples, the preparation was similar whether the work was completed by Wonder Makers or EMSL. In those cases, the MCE filter was cleared and fixed on a microscope slide with acetone vapor, then immersed in triacetin and covered with a glass cover slip. Fibers were counted at a magnification of 400X using a positive phase contrast microscope.

For TEM analysis, each MCE filter was cleared and fixed on a microscope slide with acetone vapor. It was then carbon-coated, placed on TEM grids and dissolved. The preparations were then analyzed using a Transmission Electron Microscope (TEM) capable of chemical analysis (EDXA) at nominal magnification similar to the original PCM analysis (500-1000x). Identification of fibrous structures took place at high magnifications (19,000x).

Sample Results

A considerable amount of data was generated during the development of the negative exposure assessment for the Wonder Makers asbestos bulk sampling system. A number of the 12 air samples (not counting the field blanks) were analyzed multiple times to improve reliability. Given the amount of data, the information has been summarized in several charts. Attachment #4 provides details related to the type of sample, sample run time, and flow rate, as well as the actual results. Attachment #5 presents the data from the four personal samples to show the calculated eight hour time weighted average as well as a 30 minute short-term exposure limit.

A review of the attachment shows that 18 of the 19 separate results were below the current OSHA permissible exposure limit of 0.1 fibers per cubic centimeter of air (f/cc). The one sample result which was higher than the current PEL was a sample that was analyzed by both phase contrast microscopy and transmission electron microscopy. It was the PCM analysis, which does not differentiate between the various types of fibers identified on the sample which showed a result above the PEL. However, when the same sample was subjected to TEM analysis no asbestos fibers were detected.

Even without the TEM analysis, the one sample that had fiber with a concentration higher than 0.1 f/cc provides positive evidence for the NEA due to the fact that the data came from a short-term exposure limit sample of 30 minutes duration. As such, that sample result should be compared to the OSHA-mandated STEL limit of 1.0 f/cc rather than the eight hour time weighted average that is used for the PEL.

It is interesting to note that the largest variation between the samples analyzed by both PCM and TEM came from the personal air samples rather than the area samples. Only two of the five area samples showed a decrease in the fiber concentrations after the TEM analysis eliminated interference from non-asbestos fibers. In contrast, a much more dramatic decrease was seen in the overall fiber concentrations after the analysis of both the personal samples. Because of the placement of personal samples on protective clothing, it is theorized that some of the fibers picked up on the personal samples were those released from the personal protective equipment rather than fibers generated by the sampling activity.

Even if the less accurate PCM data is utilized, all of the sample results confirmed that the sampling of different types of pipe insulation containing high percentage of asbestos using the Wonder Makers asbestos bulk sampling system protects the inspector. The NEA confirmed that the airborne concentrations of asbestos fibers recovered when using the Wonder Makers' tools were well below the current OSHA permissible exposure limit and short-term exposure limit. These results are further validated by the transmission electron microscopy sample data which proves that exposure levels are even lower.

Conclusion

Wonder Makers Environmental produces an asbestos bulk sampling system which utilizes detachable aluminum core cutters to simplify the collection of samples of suspect materials during an asbestos inspection. The information generated during this negative exposure assessment project indicates that utilizing the Wonder Makers tools also provides a substantive safety benefit. The negative exposure assessment, conducted in accordance with applicable regulations and current industry standards, proved convincingly that collecting bulk samples of suspect asbestos-containing materials using the Wonder Makers equipment kept airborne fiber levels below both the current short-term exposure limits and the permissible exposure limit. Area sampling verified that collecting an extensive number of bulk samples in a small room did not

create an ambient exposure problem. In short, using the asbestos bulk sampling system protects both the inspector and the building occupants from adverse levels of airborne asbestos fibers.

For additional information, review the attached material or contract Wonder Makers Environmental at P.O. Box 50209, Kalamazoo, Michigan 49005-0209, telephone 269-382-4154.

Attachments

1. Negative Exposure Assessment Form for Sampling Conducted with the Wonder Makers Asbestos Bulk Sampling System
2. Photograph Log
3. Sample Collection Log
4. Summary Chart of Sample Results
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6. Asbestos Air Sample Analysis Report – PCM
7. Asbestos Air Sample Analysis Report -- TEM
8. EMSL Fiber Counts by PCM
9. EMSL Fiber Counts by TEM
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David Batts
Wonder Makers Environmental

Michael A. Pinto
Wonder Makers Environmental

Jody Thomason
EMSL Analytical, Inc.

Wonder Makers Environmental

NEGATIVE EXPOSURE ASSESSMENT FORM

Complete Section A *and* Section B1 and B2, *or* B3.

SECTION A

Initial information on abatement work being evaluated for negative exposure assessment (NEA).

1. Description of work: The surface of asbestos-containing pipe insulation was wetted with surfactant sprayed from a small spray bottle. At the spot where the insulation was wetted, a small amount of asbestos-containing pipe insulation was removed using a sharp aluminum coring tool (cutter) with a removable handle attached to it. Using a twisting motion, the inspector pushed the cutter so that it cored through all the layers of the insulation until the cutter reached the pipe underneath the insulation. This twisting motion not only cut through the suspect materials but enclosed the insulation within the cutter. The cutter was immediately placed into a plastic tube and the handle removed from the cutter. Once the cutter, with the full depth sample inside, is inside the collection vial it was sealed air tight with a rubber cap.

2. Type and amount of material: 33 cutters with asbestos cores measuring one half inch in diameter and one inch long were removed from the pipe insulation.

3. Type and percent of asbestos: The Aircell pipe insulation was found to contain 40% Chrysotile Asbestos; the woolfelt pipe insulation was found to contain 30% Chrysotile Asbestos.

4. Engineering controls: Wetting the asbestos-containing insulation materials with surfactant, enclosing the removed materials within an aluminum cutter, and sealing the removed material in an airtight plastic tube with a rubber cap.

5. Contractor's employees' training and experience: The individual performing the work has been a State of Michigan accredited Asbestos Contractor/Supervisor, Asbestos Inspector, Asbestos Management Planner, and Asbestos Project Designer for almost 30 years. Prior to working as an environmental specialist in the asbestos industry for over 24 years, the worker ran a State of Michigan licensed asbestos abatement contracting business and worked as an asbestos abatement worker. Prior to this, he worked as a heat and frost insulator applying asbestos insulating materials to pipes, tanks, and boilers.

6. Class of work: (circle one) I II **(III)** IV

   Class III asbestos work means repair and maintenance operations where "ACM," including TSI and surfacing ACM and PACM, is likely to be disturbed.

If Section A is complete, proceed to Section B. Otherwise, complete information in Section A before proceeding.

SECTION B
Methods of determining NEA (complete 1 *and* 2, *or* 3)

Section B1. Objective data determination

a. Is there statistically reliable evidence that the abatement activity and the material in question will not produce airborne concentrations above the PEL and STEL? Yes **(No)**
(The PEL has been revised since the previous NEA was completed.)

b. Is this answer based on information from objective data such as technical articles, manufacturer's records, trade association reports, etc? Yes **(No)**
Explain and attach supporting data: A literature search did not uncover any published data regarding exposure levels of asbestos fibers during building inspections.

Section B2. Initial exposure assessment (IEA)

Air samples must be taken in the worker's breathing zone, representative of an 8-hour TWA and including a 30-minute STEL.

a. Name of competent person performing IEA: Michael Pinto

b. Was a project design completed for this project? **(Yes)** No
Describe: The asbestos-containing pipe insulation materials were removed within a room regulated with a Danger Asbestos Warning Sign on the door. The worker collecting the samples wore a disposable suit with attached hood and booties, half-face negative pressure respirator with HEPA filters, and disposable rubber gloves. The Wonder Makers Asbestos Bulk Sampler was used to collect numerous core samples from the asbestos-containing pipe insulation within that simulated boiler room. The worker wetted the asbestos-containing insulation materials with surfactant, enclosed the removed materials within an aluminum cutter, and sealed the removed material in an airtight plastic tube with a rubber cap.

Following the sampling, the worker HEPA-vacuumed his disposable suit and respirator with a soft bristle brush attachment; removed his disposable rubber gloves, disposable suit, and respirator cartridges, and placed all of the single use items into an asbestos disposal bag. When all the materials were inside, he evacuated the air out of the asbestos disposal bag with the HEPA vacuum, gooseneck-sealed the disposal bag with duct tape, and placed the disposal bag into an onsite barrel for asbestos waste.

c. Were engineering controls implemented as designed? **(Yes)** No
(The room was isolated with an appropriate warning sign but no abatement-style engineering controls such as negative pressure or decontamination units were utilized).

d. Results of an 8-hour TWA: 0.037 f/cc, 0.011 f/cc

e. Results of a 30-minute STEL: 0.039 f/cc, <0.0642 f/cc (no asbestos fibers were detected in the sample)

f. How were these samples analyzed? (R. Ray, EMSL Analytical, Inc., 21 December, 2017)
For PCM analysis, the MCE filter is cleared and fixed on a microscope slide with acetone vapor, then immersed in triacetin and covered with a glass cover slip. Fibers are counted at a magnification of 400X using a positive phase contrast microscope.

For TEM analysis, the MCE filter is cleared and fixed on a microscope slide with acetone vapor. It is carbon coated, placed on TEM grids and dissolved. The preparations are then analyzed using a Transmission Electron Microscope (TEM) capable of chemical analysis (EDXA) at nominal magnification similar to the original PCM analysis (500-1000x). Identification of fibrous structures takes place at high magnifications (19,000x).

g. Are the results less than the PEL and STEL? (**Yes**) No

h. Were the samples taken representative of all the operations which will take place during the work?
(**Yes**) No
Explain: The Wonder Makers Asbestos core sampler can be used to check a large quantity of suspect asbestos-containing materials. The process of wetting the material, collecting a full depth core sample, and careful extraction/containerization of the sample are steps consistent with sampling of different materials.

Section B3. Previous data

a. Is the data being used for comparison older than 12 months? Yes (**No**) **(See Section B2)**
If yes, when was it obtained?

b. Was the monitoring and analysis on the comparison project performed using the correct methods?
Yes No

c. What methods were used?

d. Does the work on the comparison project closely resemble the work to take place on this project?
Yes No
Explain:

e. Does the material from the comparison project closely resemble the material to be worked on this project? Yes No

f. What type and percent of asbestos was removed?

g. Do the control methods/engineering controls used in the comparison project closely resemble those that will be used on this project? Yes No
Explain:

h. Does the employees' training and experience history closely resemble that of the employees who will work on this project? Yes No
Explain:

i. Do the environmental conditions of the comparison project closely resemble those of this project? Yes No
Explain:

j. Did the results of the comparison project exceed the PEL and STEL? Yes No
Summarize results:

CERTIFICATION OF NEGATIVE EXPOSURE ASSESSMENT

Based on the information described in Section B and attachments, the asbestos abatement activity can proceed with the engineering controls detailed in Section A.

_____ _____

Name (please print) Signature

_____

Date

Wonder Makers Environmental

PHOTOGRAPH LOG

PROJECT:	AM17-14913	**DATE:**	12/7/17
PROJECT NAME:	NEA	**SPECIALIST:**	D. Batts

1. The door to a simulated boiler room constructed at the Wonder Makers facility where a negative exposure assessment (NEA) was updated during the sampling of asbestos-containing pipe insulation in that room. A Danger Asbestos Warning Sign was placed on the door to regulate that area during the sampling. The Wonder Makers Asbestos Bulk Sampler was used to collect numerous core samples from the asbestos-containing pipe insulation within that simulated boiler room.

2. The asbestos-containing pipe insulation within the simulated boiler room. The white pipe insulation to the left in the photo is aircell which contained 40% Chrysotile Asbestos. The brown insulation to the right in the photo is woolfelt which contained 30% Chrysotile Asbestos.

3. Plastic sheeting was placed on the floor below the asbestos-containing pipe insulation within the simulated boiler room in order to facilitate any clean-up in case of inadvertent damage/debris from the pipe insulation.

4. Representative area samples were set up in numerous locations within the simulated boiler room.

5. The area samples, as well as two personal samples, were collected during the asbestos sample collection using the Wonder Makers Asbestos Bulk Sampler.

6. A Multi-Air High Volume Air Sampling Pump manufactured by Wonder Makers was used to collect representative air samples in five locations within the simulated boiler room during the asbestos sampling process.

7. A Triple-Air High Volume Air Sampling Pump manufactured by Wonder Makers was also used to collect representative air samples during the collection of bulk samples. As its name implies, this pump was able to collect air samples in three locations within the simulated boiler room while the aircell and woolfelt insulation was being sampled.

8. The individual conducting the asbestos core sampling using the Wonder Makers Asbestos Bulk Sampler had two asbestos air sampling cassettes positioned in his breathing zone area during the sample collection process. Personal sampling pumps were worn on the sample collector's belt attached with tygon tubing to the asbestos air monitoring cassettes. The sampling was done according to EPA guidelines and manufactures instructions, including the pre-sampling step of wetting the material to be sampled.

9. A small spray bottle of surfactant was used to wet the asbestos-containing pipe insulation at the point where the asbestos bulk sample was collected with the Wonder Makers Asbestos Bulk Sampler.

10. The Wonder Makers Asbestos Bulk Sampler Aluminum Cutter Sleeve was used to core into the asbestos-containing pipe insulation to collect a full depth sample of the pipe insulation.

11. The aluminum cutter sleeve allows full depth sampling even for denser materials such as the wrapped layers of paper that make up woolfelt pipe insulation. This ensures accurate sampling even when asbestos may only be present on the inner layer of the pipe insulation.

12. After each core of asbestos was extracted from the pipe insulation, the cutter sleeve and sample were both placed into the plastic collection vial that comes with every cutter sleeve.

13. After putting the sample in the collection vial, each one was sealed air tight with a red rubber cap that is part of the book sampling system.

14. Wonder Fill, a blue encasement and encapsulant mastic, was used to fill the voids created by the collection of the samples from the asbestos-containing pipe insulation.

Wonder Makers Environmental

SAMPLE COLLECTION LOG

PROJECT #: AM17-14913 **PROJECT NAME:** NEA **SPECIALIST:** D. Batts

Date	Sample No.	Sample Code	Description	Location	Time			Flow Rate		
					On	Off	Elapsed Time (min.)	Start	Stop	Ave. Flow Rate
12-7-17	14913-01	AA PCM	Field blank	—	—	—	—	—	—	—
12-7-17	14913-02	AA PCM	Field blank	—	—	—	—	—	—	—
12-7-17	14913-03	AA PCM	PS, D. Batts	IR, Simulated boiler room	12:33	13:03	30	1.9	1.9	1.9
12-7-17	14913-04	AA PCM	PS, D. Batts	IR, Simulated boiler room	13:05	16:20	195	1.9	1.8	1.85
12-7-17	14913-05	AA TEM	Field blank	—	—	—	—	—	—	—
12-7-17	14913-06	AA TEM	Field blank	—	—	—	—	—	—	—
12-7-17	14913-07	AA TEM	PS, D. Batts	IR, Simulated boiler room	12:33	13:03	30	1.41	1.41	1.41
12-7-17	14913-08	AA TEM	PS, D. Batts	IR, Simulated boiler room	13:06	16:17	191	1.41	1.41	1.41
12-7-17	14913-09	AA PCM	AS	IR, Simulated boiler room	12:34	16:32	238	4.6	4.6	4.6
12-7-17	14913-10	AA PCM	AS	IR, Simulated boiler room	12:34	16:30	236	4.6	4.6	4.6
12-7-17	14913-11	AA PCM	AS	IR, Simulated boiler room	12:34	16:29	235	4.6	4.6	4.6
12-7-17	14913-12	*	*	*	*	*	*	*	*	*
12-7-17	14913-13	AA TEM	AS	IR, Simulated boiler room	12:35	16:27	232	4.6	4.6	4.6
12-7-17	14913-14	AA TEM	AS	IR, Simulated boiler room	12:35	16:26	231	4.6	4.6	4.6
12-7-17	14913-15	AA TEM	AS	IR, Simulated boiler room	12:35	16:25	230	4.6	4.6	4.6
12-7-17	14913-16	AA TEM	AS	IR, Simulated boiler room	12:35	16:23	228	4.6	4.6	4.6

Date	Sample No.	Sample Code	Description	Location	Time			Flow Rate		
					On	Off	Elapsed Time (min.)	Start	Stop	Ave. Flow Rate
12-7-17	14913-17	AA TEM	AS	IR, Simulated boiler room	12:35	16:22	227	4.6	4.5	4.55
12-7-17	14913-18	AB PLM	Aircell pipe insulation, 40% Chrysotile Asbestos	IR, Simulated boiler room						
12-7-17	14913-19	AB PLM	Woolfelt pipe insulation, 30% Chrysotile Asbestos	IR, Simulated boiler room						

***Sample number not used**

Sample # - Consecutive numbers regardless of sample type. Sampling media labeled with project prefix and sample code.
Sample Code – AA=asbestos air, PCM=phase contrast microscopy, TEM=transmission electron microscopy, PLM=polarized light microscopy
Description – Includes additional detail of sampled material and codes for specific types of samples. AS=area sample; PS=personal sample
Location – Includes building, floor, area, room number, etc. OR=outside restricted area; IR=inside restricted area
Time – Military time
Flow Rate – Flow rate in liters per minute.

Wonder Makers Asbestos Bulk Sampling System Negative Exposure Assessment (NEA)
Summary Chart of Sample Results

Sample number[1]	Description	Start Time	Stop Time	Run time	Flow rate[2]	Volume[3]	WM PCM results[4]	EMSL PCM results[5]	EMSL TEM results[6]
14913-03	Personal sample, PCM –STEL[7]	12:33	13:03	30	1.9	57	0.039		
14913-04	Personal sample, PCM	13:05	16:20	195	1.85	361	0.084		
14913-07	Personal sample, TEM –STEL[7]	12:33	13:03	30	1.41	42		0.230[8]	No asbestos detected
14913-08	Personal sample, TEM	13:06	16:17	191	1.41	269		0.069[8]	0.0276
14913-09	Area sample	12:34	16:32	238	4.6	1095	0.083		
14913-10	Area sample	12:34	16:30	236	4.6	1086	0.073		
14913-11	Area sample	12:34	16:29	235	4.6	1081	0.066		
14913-13	Area sample	12:35	16:27	232	4.6	1067		0.038	0.0380
14913-14	Area sample	12:35	16:26	231	4.6	1062		0.019	0.0190
14913-15	Area sample	12:35	16:25	230	4.6	1058		0.031	0.0066
14913-16	Area sample	12:35	16:23	228	4.6	1049		0.023	0.0173
14913-17	Area sample	12:35	16:22	227	4.55	1032		0.022	0.0220

1. Sample numbers 01, 02, 05, and 06, are not included because they were field blanks with zero fibers identified. Sample number 12 was not used.
2. Calculated in liters per minute (LPM).
3. Calculated in liters of air (L).
4. Calculated as fibers per cubic centimeter of air (f/cc) using phase contrast microscopy (PCM) by Wonder Maker's analyst.
5. Calculated as fibers per cubic centimeter of air (f/cc). using phase contrast microscopy (PCM) by EMSL analyst.
6. Calculated as fibers per cubic centimeter of air (f/cc) using transmission electron microscopy (TEM) by EMSL analyst.
7. Sample collected to determine the Short Term Exposure Limit (STEL) according to OSHA rules.
8. A portion of the TEM filter was removed and subjected to PCM analysis prior to submission for TEM analysis.

Wonder Makers Environmental

EMPLOYEE ASBESTOS EXPOSURE RECORD

Eight Hour Time Weighted Average (TWA) and Short-Term Exposure Limit (STEL)

PROJECT #:	AM17-14913	**DATE:**	12-7-17
PROJECT NAME:	NEA	**SPECIALIST:**	D. Batts
ACTIVITY DESCRIPTION:	Bulk sampling asbestos pipe insulation	**RESPIRATOR**	3M half-face

Sample Numbers	TWA (PCM)	Sample Numbers	TWA (TEM)	Sample Numbers	STEL (PCM)	Sample Numbers	STEL (TEM)
14913-03 14913-04	0.037	14913-07 14913-08	0.011	14913-03	0.039	14913-07	<0.0642*

All results listed in fibers per cubic centimeter of air (f/cc)
Current OSHA Permissible Exposure Limits: TWA = 0.1 f/cc STEL = 1.0 f/cc
*No asbestos fibers were identified in the sample so the result is based on the calculated lower limit of detection

Wonder Makers Environmental

ASBESTOS AIR SAMPLE ANALYSIS REPORT (SAMPLES ANALYZED USING PHASE CONTRAST MICROSCOPY)

PROJECT: AM17-14913 **DATE:** 12-7-17

PROJECT NAME: NEA **SPECIALIST:** D. Batts

Sample Number	Sample Description	Total Volume (liters)	Fibers /Fields	Fibers/Cubic Centimeter
14913-01	Field blank	—	0/100	—
14913-02	Field blank	—	0/100	—
14913-03	PS, IR, D. Batts, simulated boiler room	57	4.5/100	0.039
14913-04	PS, IR, D. Batts, simulated boiler room	361	61.5/100	0.084
14913-05	Field blank	—	0/100	—
14913-06	Field blank	—	0/100	—
14913-07	PS, IR, D. Batts, simulated boiler room	42	20/100	0.230
14913-08	PS, IR, D. Batts, simulated boiler room	269	38/100	0.069
14913-09	AS, IR, simulated boiler room	1095	102/55	0.083
14913-10	AS, IR, simulated boiler room	1086	101.5/63	0.073
14913-11	AS, IR, simulated boiler room	1081	101/69	0.066
14913-12	AS, IR, simulated boiler room	*	*	*
14913-13	AS, IR, simulated boiler room	1067	83.5/100	0.038
14913-14	AS, simulated boiler room	1062	41.5/100	0.019
14913-15	AS, IR, simulated boiler room	1058	66.5/100	0.031
14913-16	AS, IR, simulated boiler room	1049	48.5/100	0.023
14913-17	AS, IR, simulated boiler room	1032	45.5/100	0.022

*Sample number not used

SAMPLE DESCRIPTION SYMBOLS: **AS** = area sample; **PS** = personal sample; **IR** = inside restricted area

ANALYSIS PROCEDURE : For PCM analysis, the MCE filter is cleared and fixed on a microscope slide with acetone vapor, then immersed in triacetin and covered with a glass cover slip. Fibers are counted at a magnification of 400X using a positive phase contrast microscope.

Wonder Makers Environmental

ASBESTOS AIR SAMPLE ANALYSIS REPORT (SAMPLES ANALYZED USING TRANSMISSION ELECTRON MICROSCOPY)

PROJECT: AM17-14913 **DATE:** 12-7-17

PROJECT NAME: NEA **SPECIALIST:** D. Batts

Sample Number	Sample Description	Volume (Liters)	Asbestos Fibers (Type)	7402 Adjusted (TEM) F/cc
14913-05	Field blank	—	None Detected	N/A
14913-06	Field blank	—	None Detected	N/A
14913-07	PS, IR, D. Batts, simulated boiler room	42	None Detected	<0.0642
14913-08	PS, IR, D. Batts, simulated boiler room	269	2% Chrysotile	0.0276
14913-13	AS, IR, simulated boiler room	1067	7% Chrysotile	0.0380
14913-14	AS, IR, simulated boiler room	1062	1% Anthophyllite 5% Chrysotile	0.0190
14913-15	AS, IR, simulated boiler room	1058	1.5% Chrysotile	0.0066
14913-16	AS, IR, simulated boiler room	1049	1% Actinolite 9.5% Chrysotile	0.0173
14913-17	AS, IR, simulated boiler room	1032	14% Chrysotile	0.0220

SAMPLE DESCRIPTION SYMBOLS: **AS** = area sample; **PS** = personal sample; **OR** = outside restricted area; **IR** = inside restricted area

ANALYSIS PROCEDURE : For TEM analysis, the MCE filter is cleared and fixed on a microscope slide with acetone vapor. It is then carbon coated, placed on TEM grids and dissolved. The preparations are then analyzed using a Transmission Electron Microscope (TEM) capable of chemical analysis (EDXA) at nominal magnification similar to the original PCM analysis (500-1000x). Identification of fibrous structures takes place at high magnifications (19,000x).

EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077
Tel/Fax: (800) 220-3675 / (856) 786-5974
http://www.EMSL.com / cinnasblab@EMSL.com

EMSL Order: 041735964
Customer ID: WOND25
Customer PO:
Project ID:

Attention: Dave Batts
Wonder Makers Environmental
PO Box 50209
Kalamazoo, MI 49005

Project: AM17-14913

Phone: (888) 382-4154
Fax: (269) 382-4161
Received Date: 12/18/2017 9:14 AM
Analysis Date: 12/19/2017
Collected Date: 12/07/2017

Test Report: Fiber Count by Phase Contrast Microscopy (PCM), NIOSH 7400 Method - A Rules, Revision 3, Issue 2, 8/15/94

Sample	Location	Sample Date	Volume (liters)	Fibers	Fields	LOD (fib/cc)	Fibers/ mm²	Fibers/ cc	Notes
05	Field Blank	12/07/2017	0.00	<5.5	100		<7.01		Field Blank
041735964-0001									
06	Field Blank	12/07/2017	0.00	<5.5	100		<7.01		Field Blank
041735964-0002									
07	Personal Sample, D. Batts	12/07/2017	42.00	20	100	0.064	25.5	0.230	
041735964-0003									
08	Personal Sample, D. Batts	12/07/2017	269.00	38	100	0.010	48.4	0.069	
041735964-0004									
13	Area Sample	12/07/2017	1067.00	83.5	100	0.003	106	0.038	
041735964-0005									
14	Area Sample	12/07/2017	1062.00	41.5	100	0.003	52.9	0.019	
041735964-0006									
15	Area Sample	12/07/2017	1058.00	66.5	100	0.003	84.7	0.031	
041735964-0007									
16	Area Sample	12/07/2017	1049.00	48.5	100	0.003	61.8	0.023	
041735964-0008									
17	Area Sample	12/07/2017	1032.00	45.5	100	0.003	58.0	0.022	
041735964-0009									

The results reported have been blank corrected as applicable.

Analyst(s):

Susan Muir PCM (8)

Benjamin Ellis, Laboratory Manager
or Other Approved Signatory

Limit of detection is 7 fibers/mm². Intra-laboratory Sr values: 5-20 fibers = 0.36, 21-50 fibers = 0.39, 51-100 fibers = 0.22. Inter-laboratory Sr values (Average of EMSL round robin data) = 0.30. EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. EMSL is not responsible for data reported in fibers/cc, which is dependent on volume collected by non-laboratory personnel. Results have been blank corrected as applicable. The results in this report meet all requirements of the NELAC standards unless otherwise noted. Samples received in good condition unless otherwise noted.

Samples analyzed by EMSL Analytical, Inc. Cinnaminson, NJ NYS ELAP 10872, AIHA-LAP, LLC--IHLAP Accredited #100194, NJ DEP 03036, PA ID# 68-00367

Initial report from: 12/21/2017 08:51:34

EMSL Analytical, Inc.
200 Route 130 North, Cinnaminson, NJ 08077
Phone/Fax: (800) 220-3675 / (856) 786-5974
http://www.EMSL.com cinnasblab@EMSL.com

EMSL Order: 041735964
CustomerID: WOND25
CustomerPO:
ProjectID:

Attn: **Dave Batts**
Wonder Makers Environmental
PO Box 50209
Kalamazoo, MI 49005

Phone: (888) 382-4154
Fax: (269) 382-4161
Received: 12/18/17 9:14 AM
Analysis Date: 12/20/2017
Collected: 12/7/2017

Project: **AM17-14913**

Test Report: Asbestos Analysis of Air Samples by Transmission Electron Microscopy via NIOSH Method 7402

Sample	Volume (Liters)	Non Asbestos Fibers	Asbestos Type(s)	Asbestos Fibers	PCM F/cc	*Asbestos % of total	7402 Adjusted (TEM) F/cc	Notes
05 *041735964-0001*	0	1	None Detected			0 %	**N/A**	Field Blank 1
06 *041735964-0002*	0	0	None Detected			0 %	**N/A**	Field Blank 1
07 *041735964-0003*	42	0.5	None Detected		0.230	0 %	**<0.0642**	
08 *041735964-0004*	269	3.5	Chrysotile	2	0.069	40.0 %	**0.0276**	
13 *041735964-0005*	1067	0	Chrysotile	7	0.038	100 %	**0.0380**	
14 *041735964-0006*	1062	0	Anthophyllite Chrysotile	1 5	0.019	100 %	**0.0190**	
15 *041735964-0007*	1058	6	Chrysotile	1.5	0.031	21.4 %	**0.0066**	
16 *041735964-0008*	1049	4	Actinolite Chrysotile	1 9.5	0.023	75.0 %	**0.0173**	
17 *041735964-0009*	1032	0	Chrysotile	14	0.022	100 %	**0.0220**	

Analyst(s)

Frank Craig (3)
Peter Harrison (6)

Benjamin Ellis, Laboratory Manager
or other approved signatory

Initial report from 12/21/2017 08:53:12

EMSL Analytical, Inc.
200 Route 130 North, Cinnaminson, NJ 08077
Phone/Fax: (800) 220-3675 / (856) 786-5974
http://www.EMSL.com cinnasblab@EMSL.com

EMSL Order:	041735964
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Attn: **Dave Batts**
Wonder Makers Environmental
PO Box 50209
Kalamazoo, MI 49005

Phone:	(888) 382-4154
Fax:	(269) 382-4161
Received:	12/18/17 9:14 AM
Analysis Date:	12/20/2017
Collected:	12/7/2017

Project: **AM17-14913**

Test Report: Asbestos Analysis of Air Samples by Transmission Electron Microscopy via NIOSH Method 7402

Sample	*Volume (Liters)*	*Non Asbestos Fibers*	*Asbestos Type(s)*	*Asbestos Fibers*	*PCM F/cc*	**Asbestos % of total*	*7402 Adjusted (TEM) F/cc*	*Notes*

NIOSH 7402 method only reports fibers > 5µm in length and > 0.25µm in width.
This method requires a minimum of 2 field blank analyses per set.
* The results above are blank corrected when possible.
Average number of asbestos fibers on field blanks: 0
Average number of non-asbestos fibers on field blanks: 0.5

Analyst(s)

Frank Craig (3)
Peter Harrison (6)

Benjamin Ellis, Laboratory Manager
or other approved signatory

Initial report from 12/21/2017 08:53:12

EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077

Tel/Fax: (800) 220-3675 / (856) 786-5974

http://www.EMSL.com / cinnasblab@EMSL.com

EMSL Order:	041735976
Customer ID:	WOND25
Customer PO:	
Project ID:	

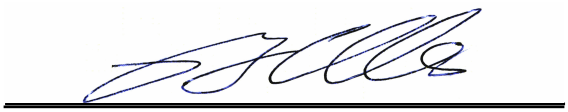
Attention:	Dave Batts	**Phone:**	(888) 382-4154
	Wonder Makers Environmental	**Fax:**	(269) 382-4161
	PO Box 50209	**Received Date:**	12/18/2017 9:14 AM
	Kalamazoo, MI 49005	**Analysis Date:**	12/20/2017
		Collected Date:	
Project:	AM17-14913		

Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

			Non-Asbestos		Asbestos
Sample	**Description**	**Appearance**	**% Fibrous**	**% Non-Fibrous**	**% Type**
18 *041735976-0001*	WM Simulated Boiler Room - Air Cell Pipe Insulation	White Fibrous Homogeneous	40% Cellulose	20% Non-fibrous (Other)	40% Chrysotile
19 *041735976-0002*	WM Simulated Boiler Room - Woolfelt Pipe Insulation	Brown Fibrous Homogeneous	50% Cellulose	20% Non-fibrous (Other)	30% Chrysotile

Analyst(s)

Samantha Rundstorm-Cruz (2)



Benjamin Ellis, Laboratory Manager
or Other Approved Signatory

Initial report from: 12/21/2017 09:27:04