

**Signature Assessment
130 Liberty Street Property
and
4 Albany Street Property**

**Technical Memorandum
*S1: Aerosolization of Ultra Fine Fibers and
Particles from WTC Dust***

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Technical Memorandum

S1: Aerosolization of Ultra Fine Fibers and Particles from WTC Dust

Summary

This study was undertaken to determine airborne concentrations of respirable (breathable) particles associated with resuspended¹ WTC Dust and WTC Hazardous Substances within the Deutsche Bank buildings located at 130 Liberty Street and 4 Albany Street, New York, NY (the "Buildings"). Cascade impactors, which separate particles based on (aerodynamic) particle diameter,^{2,3} were used to sample respirable particles in the size range that is most hazardous to human health.⁴ Respirable airborne particles were measured inside the Buildings during different activities, and were measured outside the Buildings to establish baseline concentrations. Additionally, analyses were performed to positively identify the particle source as WTC Dust.⁵ This report summarizes the experts' investigation of the presence of respirable particles in resuspended WTC Dust.

Key Findings

- WTC Dust is readily aerosolized.¹
- Asbestos fibers present in aerosolized WTC Dust are respirable.
- Airborne respirable asbestos included fibers longer than 5µm.
- Aerosolized, respirable, WTC Dust contains significant quantities of WTC Hazardous Substances.
- Indoor activities resulted in airborne concentrations of respirable asbestos fibers in excess of outdoor levels collected in this study and EPA background level⁶ of 0.00024 S/cm³.

¹ The term aerosolized refers to particles dispersed or suspended in air. The term is synonymous with the term resuspended.

² John, Walter, "Sampling for Respirable and Fine Aerosol," Particle Size-Selective Sampling for Particulate Air Contaminants, Vincent, J. editor., Cincinnati, OH, American Conference of Governmental Industrial Hygienists. pp 155-167, 1999.

³ Marple, V.A., and Willeke, K., "Impactor Design," Atmospheric Environment, Vol. 10, pp 891-896, 1976.

⁴ The EPA defines PM 10 as "particles less than 10 micrometers in diameter, that include both fine and coarse dust particles. These particles pose the greatest health concern because they can pass through the nose and throat and get into your lungs." U.S. Environmental Protection Agency (EPA), "PM 10 Fact Sheet," http://www.epa.gov/wtc/pm10/pm_fact_sheet.html, May 2003; accessed March 4, 2004.

⁵ RJ Lee Group, WTC Dust Signature Reports, December, 2003.

⁶ U.S. Environmental Protection Agency (EPA), "World Trade Center Residential Dust Cleanup Program - Draft Final Report," March, 2004; accessed March 25, 2004.

- Aerosolized, respirable particles in the Buildings were determined to be WTC Dust.

Conclusion

This study demonstrates that typical building maintenance and remodeling activities performed inside the Buildings caused the resuspension of measurable amounts of fine, respirable particles that originate from WTC Dust. The airborne respirable asbestos fiber concentrations were present at levels that averaged up to 45 times higher than outdoor concentrations of airborne respirable asbestos fibers. Elevated airborne concentrations of respirable asbestos represent an increased risk of exposure to occupants of the Buildings.

1.0 Purpose

The purpose of this study was to determine whether respirable particles in WTC Dust will become resuspended during activities in the Buildings and to assess exposure to persons involved in routine maintenance activities within the Buildings.

2.0 Description of System

The use of Soitas Cascade Impactors⁷ is a standard means of determining the respirable^{2,3} fraction of particles in the air. Soitas Cascade Impactors consist of four impaction stages and a final filter stage that allows for the separation and collection of respirable airborne particles into five different size ranges. Each stage of the impactor consists of an accelerator plate and collection plate in succession (Figure 1). Air is drawn through the impactor using a sampling pump and is accelerated through the initial accelerator plate of each stage. Particles in the accelerated air stream having a large enough inertia will impact on the collection plate where a collection substrate has been mounted. Smaller particles unable to become impacted on the collection substrate will pass to the subsequent stages. By designing each successive stage with increasing air velocities through the accelerator plates, smaller particles will be collected at each subsequent stage. An after filter stage is the final collection substrate where the ultra fine particles are collected.

⁷ Misra, Chandan, et. al., "Development and Evaluation of a Personal Cascade Impactor Sample (PCIS)," *Aerosol Science*, Vol. 33, pp 1027-1047. 2002.



Figure 1. Photo of Cascade Impactor and all its Components.

When operated at a flow rate of 9 liters per minute, the four impaction filters result in the collection of airborne particles with the following median cut points⁷ (Table 1):

Table 1. Median particle diameter for each of the five cascade impactor stages.

Stage Level	Median Cut Point (μm)
Stage A	2.5
Stage B	1.0
Stage C	0.5
Stage D	0.25
After Stage (E)	<0.25

Particles in the <0.25 to 2.5 μm aerodynamic diameter size range are considered respirable based on the National Institute of Occupational Safety and Health (NIOSH) reference of a 4.0-micrometer median cut point for respirable dust.⁸

3.0 Procedure

Each cascade impactor was pre-loaded with a sampling media specific to the type of analyte (e.g., asbestos, metals) that was being tested. The impactors were set up in close proximity to the activity being monitored. Air was then drawn through the impactor using a sampling pump.

After samples were collected, the impactors were sealed and sent back to the laboratory where the collection media were extracted and prepared for analysis. Both loading and unloading operations were conducted in a controlled environment to prevent potential contamination of the filter

⁸ National Institute of Occupational Safety (NIOSH), "Particulates Not Otherwise Regulated, Respirable," NIOSH Method 0600, Revised January 15, 1998. <http://www.cdc.gov/niosh/nmam/pdfs/0600.pdf>; accessed March, 2004.

media. Extracted filters were segregated and distributed to appropriate laboratory departments for analysis using industry standard procedures.⁹

3.1 130 Liberty Street Building

Cascade impactors were operated alongside stationary and personal air sampling devices during wall demolition and fireproofing removal work activities in a remediated interior test cell. Stationary and personal air samplers collected airborne particles in all size ranges while cascade impactors collected airborne particles only in the respirable size range.¹⁰

Work activities were monitored during remediation within test cells that were HEPA vacuumed and wet-wiped prior to the onset of testing.

Four different activities were monitored within the 130 Liberty Street building:

Test Cell Construction. Samples were collected during the construction of a test cell in an unremediated area. The activities included sawing wooden posts, removal of carpeting and lighting, and installation of a protective polyethylene covering on the floor and ceiling.

Furniture Remediation. Samples were collected inside remediated test cells during furniture remediation activities.

Wall Demolition. Samples were collected inside remediated test cells during the demolition of a wall.

Fireproofing Removal. Samples were collected inside remediated test cells during the removal of dry fireproofing.

Outdoor. Outdoor samples were collected with cascade impactors in the vicinity of both Buildings to establish baseline concentrations. The baseline concentrations provided a reference point to compare the indoor levels at both the 130 Liberty Street building and the 4 Albany Street building.

3.2 4 Albany Street Building

Cascade impactors were operated alongside stationary and personal air sampling devices during activities at the 4 Albany Street building. The activities included aggressive air tests in unremediated areas and work activities that took place in a remediated test cell.¹¹

⁹ Asbestos analysis completed using indirect preparation TEM AHERA procedures. Metals and WTC Dust analysis followed protocols described in RJ Lee Group, "Contamination Report Pursuant to Testing Protocol-01 Interior Spaces Summary Report," December, 2003.

¹⁰ RJ Lee Group, "Technical Memorandum R2: Test Cell Remediation and Recontamination," May, 2004.

¹¹ RJ Lee Group, Inc., "Laboratory Data from the Bank to the Insurers, Project LSH204785," Hard Drive, 2003, CD-ROM, 2004.

In connection with the following tests, it should be noted that the 4 Albany Street building had been remediated during November, 2001¹² using abatement practices prevalent at the time in the WTC area for buildings impacted by the the WTC Event.

Aggressive Air Test. Samples were collected during aggressive air tests, which employed the use of a leaf-blower to generate a stream of air that was applied to surfaces to liberate the suspendable fraction of particles into the air.¹³

Post Aggressive Air Test. Samples were taken after a twenty-four hour settling period following the aggressive air test.

The following activities took place in test cells that were HEPA vacuumed and wet-wiped prior to the onset of sampling:

Ceiling Demolition. Samples were collected during ceiling tile and ceiling grid removal activities.

Wall Demolition. Samples were collected during wall demolition activities.

Outdoor. Outdoor samples were collected with cascade impactors in the vicinity of both Buildings to establish baseline concentrations. The baseline concentrations provided a reference point for which to compare the indoor levels at both Buildings.

4.0 Results

130 Liberty Street Building: Asbestos

- Outdoor airborne respirable asbestos concentrations around the 130 Liberty Street building averaged 0.005 structures per cubic centimeter (S/cm³).
- Indoor concentrations of airborne respirable asbestos during all work activities in the 130 Liberty Street building averaged 0.224 S/cm³. The average indoor airborne respirable asbestos concentration is nearly 45 times the average outdoor respirable asbestos concentration.
- 3% of all asbestos fibers detected were found to be greater than 5 µm in length in airborne samples.¹⁴

¹² Tishman, "130 Liberty Street/4 Albany Street - meeting minutes," November, 2001.

¹³ U.S. Environmental Protection Agency (EPA), "Abatement Area Sampling," 40CFR763, Subpart E, Appendix A, Unit III.B.7. July 1, 2003.

¹⁴ Based on a sum of all fibers collected by Cascade Impactor stages.

130 Liberty Street Building: Asbestos

Figure 2

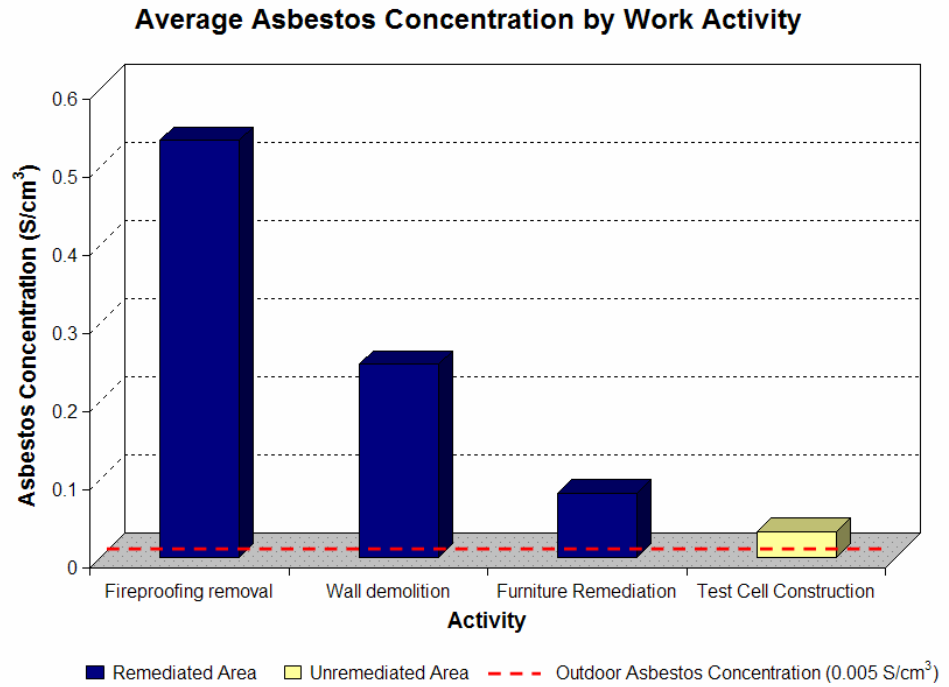


Figure 2 shows the average respirable asbestos concentrations (vertical axis) by work activity (horizontal axis) in the 130 Liberty Street building. The red line represents the outdoor baseline concentration of airborne respirable asbestos.

Figure 2 (Continued) Stage	Asbestos Concentration by Work Activity (S/cm ³)				
	Fireproofing Removal	Wall Demolition	Furniture Remediation	Test Cell Construction	Outside
A	0.045	0.045	0.034	0.011	0.001
B	0.045	0.018	0.018	0.016	0.001
C	0.042	0.023	0.012	0.002	0.001
D	0.002	0.159	0.004	0.003	0.001
E	0.401	0.002	0.015	0.001	0.001
Overall Average:*	0.535	0.247	0.082	0.034	0.005

* Overall average is the sum of the values for the five stages, averaged for each activity

4 Albany Street Building: Asbestos

- Outdoor airborne respirable asbestos concentrations averaged 0.005 S/cm³.
- Concentrations of airborne respirable asbestos during indoor activities in the 4 Albany Street building averaged 0.172 S/cm³. The average indoor airborne respirable asbestos concentration is nearly 35 times the average outdoor airborne respirable asbestos concentration.
- 2.6% of all asbestos fibers detected in airborne samples were greater than 5 μm in length.

4 Albany Street Building: Asbestos

Figure 3

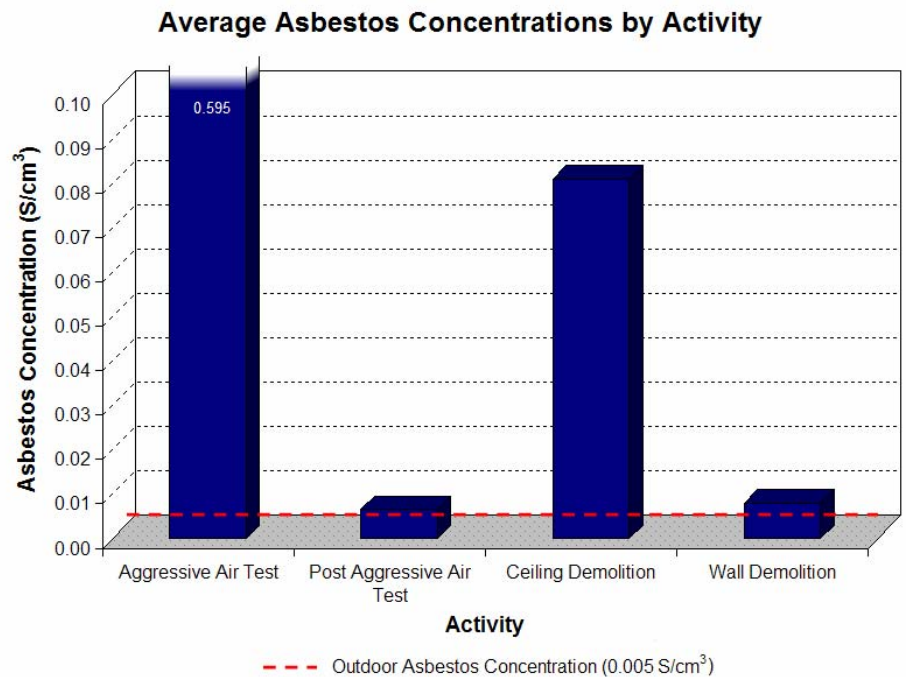


Figure 3 shows the average airborne respirable asbestos concentrations (vertical axis) during aggressive air testing compared to post aggressive air testing, ceiling demolition and wall demolition at the 4 Albany Street building (horizontal axis). The red line represents the outdoor baseline concentration of airborne respirable asbestos.

Figure 3 (continued) Stage	Asbestos Concentration by Activity (S/cm ³)				
	Aggressive Air	Post Aggressive Air	Ceiling Demolition	Wall Demolition	Outside
A	0.250	0.001	0.025	0.000	0.001
B	0.178	0.001	0.009	0.002	0.001
C	0.086	0.001	0.035	0.003	0.001
D	0.042	0.002	0.005	0.001	0.001
E	0.039	0.002	0.006	0.002	0.001
Overall Average:*	0.595	0.007	0.080	0.008	0.005

*Overall average is the sum of the values for the five stages, averaged for each activity

130 Liberty Street Building and 4 Albany Street Building: WTC Dust Markers

- WTC Dust Markers,⁵ such as asbestos, lead, gypsum and mineral wool were observed in the indoor air samples from both Buildings (Figure 4 through Figure 7).
- The presence of these WTC Markers indicates that WTC Dust is the source of the respirable asbestos.

130 Liberty Street Building and 4 Albany Street Building: WTC Dust Markers

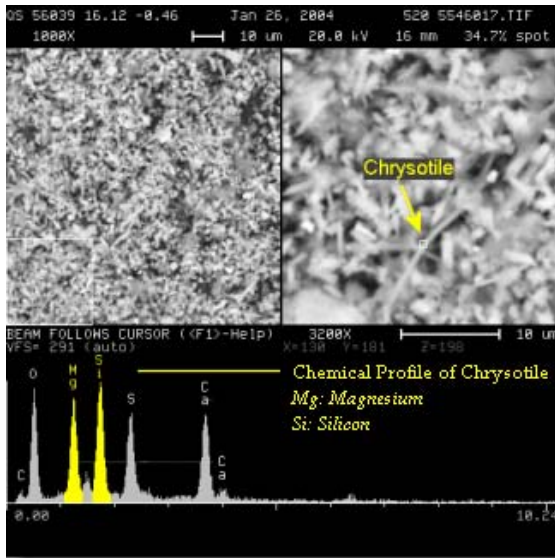


Figure 4. SEM image and EDS of asbestos

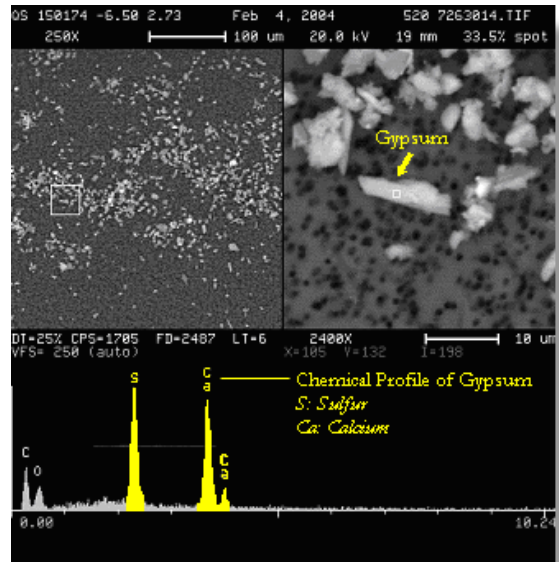


Figure 5. SEM image and EDS of gypsum

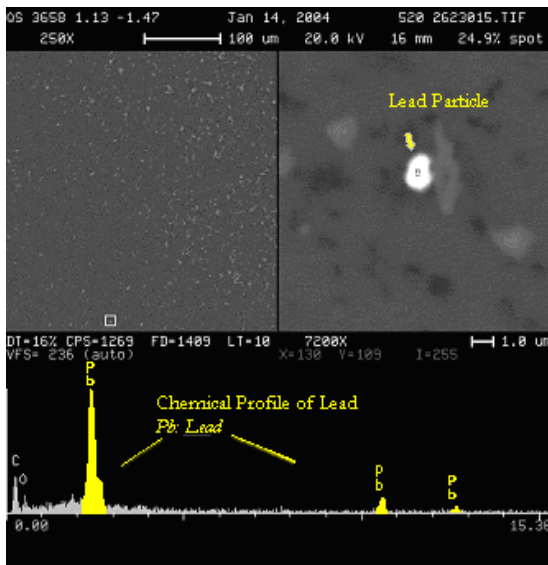


Figure 6. SEM image and EDS of lead

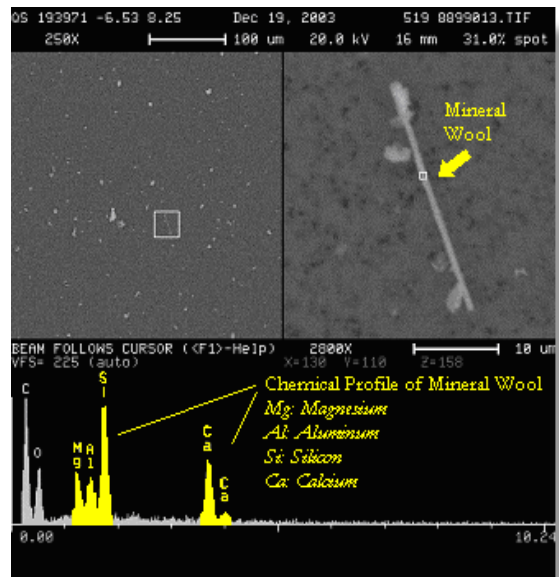


Figure 7. SEM image and EDS of mineral wool