Signature Assessment
130 Liberty Street Property

Expert Report
WTC Dust Signature

Report Date: May 2004

Prepared by:

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Prepared for:
Deutsche Bank

EXPERT REPORT OF Richard J. Lee, Ph.D.
SUBMITTED ON BEHALF OF DEUTSCHE BANK AG

1.0 Area of Expertise and Summary of Qualifications

Dr. Richard J. Lee has spent 30 years developing techniques for characterizing respirable particles. Dr. Lee has used these techniques to investigate dust and debris in buildings throughout the United States. He has studied respirable asbestos, mineral wool, lead, fly ash, and other particle types found in WTC Dust. He is widely regarded as a pioneer in this area, having developed the first computer-controlled electron microscope methods for determining the size and composition of airborne particles in an automated fashion. As early as 1980, he was retained by EPA to design a state-of-the-art particle characterization laboratory. His laboratory, RJ Lee Group, Inc., is the largest commercial electron microscope laboratory in the world. His company employs over 200, including personnel with advanced and specialized degrees in the areas of biology, chemistry, mineralogy, physics, geology, chemical engineering, electrical engineering, computer science, materials science, environmental science/engineering, civil engineering, mechanical engineering and industrial hygiene. Dr. Lee has published more than 100 papers in peer-reviewed journals, and has presented invited papers both nationally and internationally.

2.0 Expert Qualifications

Dr. Lee has been qualified as a witness in State and Federal Courts as an expert in theoretical physics, materials science, exposure assessment, history of asbestos analysis and standards, particle characterization, aerosol physics, particle physics, particle transport, failure analysis, concrete analysis, cement chemistry, scanning electron microscopy, optical microcopy, transmission electron microscopy, chemical analysis, gas chromatography, physical testing, and product identification. Dr. Lee has testified on behalf of plaintiffs and defendants. He has not been precluded from testifying as an expert in any court.

3.0 Curriculum Vitae

The curriculum vitae of Dr. Richard Lee is attached in the appendix.

4.0 Purpose and Subject of the Report

In April of 2002, RJ Lee Group was retained by the law firm of Pitney Hardin LLP, on behalf of the Bank, to oversee and investigate the presence, type, amount, and extent of environmental contaminants in the building located at 130 Liberty Street, New York, NY (the "Building") and to recommend remediation strategies. This report summarizes the results of studies relating to the unique characteristics of the dust and hazardous substances derived from the WTC Event. The findings set forth in this report are based upon RJ Lee Group's review of the results of its own extensive set of analyses, its background, experience, and education in this area, as well as its study of recognized scientific literature. The findings of prior Contamination Reports published with respect to the buildings located at 130 Liberty Street and 4 Albany Street in New York City, New York and the references cited therein; the underlying analytical data that have been previously published; and Technical Memoranda produced in conjunction with this report are incorporated by reference in this report.

5.0 Opinions

1. Dust in the Building has an identifiable signature based upon the relative levels of components in the dust and certain chemical and morphological characteristics of particles in the dust. The characteristics of the dust are a result of the collapse of the WTC Towers and the subsequent fires at the WTC site which collectively were unique events that produced unique dust. The unique characteristics of this dust are collectively referred to as the WTC Dust Signature.

2. The Building is contaminated with WTC Dust that contains WTC Hazardous Substances, including, but not limited to, asbestos, lead, mercury, cadmium, PCBs, PNAs, quartz, beryllium, mineral wool and dioxins/furans, in concentrations substantially in excess of those found in dust in other buildings unaffected by the WTC Event.

3. The WTC Dust and WTC Hazardous Substances pervasively contaminating the Building are a result of the WTC Event.

4. Dust in the Building has been confirmed to be WTC Dust using conventional forensic and statistical methodologies.

5. The Building is contaminated with respirable (breathable) asbestos fibers that have morphological characteristics which make them more readily aerosolized than asbestos in dust found in other buildings not impacted by the WTC Event.[1]

6. The respirable (breathable) lead contaminating the Building has morphological characteristics that make it more readily aerosolized than lead in dust found in other buildings not impacted by the WTC Event.

7. The Building is contaminated with respirable (breathable) WTC Dust, including WTC Hazardous Substances in addition to asbestos and lead, with morphological characteristics that make it more readily aerosolized than dust found in other buildings not impacted by the WTC Event.

8. Lead in the WTC Dust has an identifiable speciation and morphology which distinguishes it from other potential sources.

9. The WTC Dust and WTC Hazardous Substances contaminating the Buildings' mechanical, electrical, and plumbing systems are conductive, corrosive and abrasive.

[1] The term "other buildings" will be used throughout this report to describe office buildings and residences evaluated in the past by the author. These buildings generally have asbestos-containing surfacing materials, thermal insulation products and/or lead paint, and, in particular, "other buildings" refers to buildings studied in Prudential and Anzon cited herein. Reference to these buildings are distinguished from reference to "RJ Lee Group, 'Contamination Report Pursuant to Testing Protocol *Background Levels in Buildings* Summary Report,' December, 2003." evaluated as part of this investigation.

6.0 Basic Facts/Methodology

This report supplements prior reports on WTC Dust[2] and focuses on the unique properties of WTC Dust that differentiate it from other building dust. In previous reports, we have documented the extensive investigation performed at the Building to evaluate the extent and significance of the contamination of the Building caused by the WTC Event.[3] The results demonstrated that the Building was pervasively contaminated with WTC Dust and WTC Hazardous Substances. The WTC Dust infiltrated the entire Building, even penetrating interior wall cavities, sprayed-on fireproofing, HVAC systems, and electrical outlets. The pressure differential was caused by the onrush of the WTC Dust cloud that was created by the collapse of the WTC Towers[4] with a low pressure inside Building components and high pressure outside. A huge pressure difference was created that caused large quantities of dust laden air to move through unplanned pathways. [5,6] Individual components or devices with internal spaces effectively acted like a vacuum cleaner pulling the dust into them with great force.

The extensive environmental study conducted by Deutsche Bank was necessary because the Insurers took the position that the only demonstrable contamination was in the *gash* area of the Building.[7,8] The Insurers and their experts claimed that the WTC Dust in the remainder of the Building was either innocuous or, to the extent that it contained contamination, resulted from a pre-existing condition.[9,10] Further, it was the Insurers' and their experts' position that the WTC Dust, regardless of its origin, could be remediated using conventional asbestos abatement procedures.[7]

It was the Bank's belief, based on my advice and that of other experts, that the WTC Dust was not innocuous; that the WTC Dust was not a condition pre-existing the WTC Event; and that the remediation of the Building using industry standard asbestos abatement procedures would not necessarily return the Building to its pre-WTC Event condition, but would likely leave reservoirs of WTC Dust and WTC Hazardous Substances that could

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[2] RJ Lee Group, WTC Dust Signature Reports, December, 2003.
[3] RJ Lee Group, All Contamination Reports, December, 2003.
[4] Milke, James A., "Bankers Trust Building Airflow Analysis," April, 2004.
[5] Anis, Wagdy A.Y., "The Impact of Airtightness on System Design," American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ASHRAE Journal, pp 31-35. December, 2001.
[6] Brennan, Terry et al., "Unplanned Airflows & Moisture Problems," American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., ASHRAE Journal, pp 44-49. November, 2002.
[7] Scariano, Anthony (VeriClaim), "Re: Taunus Corporation d/b/a Deutsche Bank Cat 48 - September 11, 2001 World Trade Center Terrorist Attack," letter, December 13, 2002.
[8] Deutsche Bank, meeting with RJ Lee Group, Young Laboratories, and the Insurers, April 30, 2002.
[9] Scariano, Anthony (McLarens Toplis), "Re: Insured: Taunus Corporation d/b/a Deutsche Bank Loss Location: 130 Liberty Street Date of Loss: September 11, 2001 (Cat 48)," letter, June 10, 2002.
[10] Deutsche Bank, meeting with RJ Lee Group, Young Laboratories, and the Insurers, August 15, 2002.

recontaminate the Building in the future.[8,10,11,12,13,14] There was little guidance available to the Bank to establish clearance levels for the remediation of the Building, a Class A office building, which had been contaminated with the mixture of contaminants constituting the WTC Hazardous Substances. The Bank and its representatives acted prudently in undertaking investigations and studies to evaluate the extent and significance of the contamination, levels to which such contaminants should be remediated (clearance levels) and the likelihood that the contamination could be satisfactorily remediated to these clearance levels. In addition, the Bank needed to assess the health risks involved with exposure to WTC Dust and WTC Hazardous Substances and the impact that would have on its decision regarding remediation and re-occupancy of the Building.

From time to time during the investigation, the Bank's experts met with Insurers and their experts to describe the results of the investigation as it progressed, to seek input on the testing programs, and to determine whether the information provided satisfied the Insurers' questions as to the origin, pervasiveness, and toxicity of the contamination caused by the WTC Event.[15] The Insurers' experts consistently took the position that the data provided was insufficient to convince them of the origin and pervasiveness of the contamination or the statistical significance of the results outside of the *gash*.[8,10,16]

The investigation results proved that the dust in the Building is not normal building dust or residual contamination from the original construction of the Building or subsequent modifications thereof. The investigations proved that the Building is pervasively contaminated with WTC Dust, unique to the WTC Event.[2] The scientific evaluations included developing the WTC Dust Signature; demonstrating that WTC Dust in all parts of the Building had a common origin; and correlating the amount of WTC Dust in various sectors of the Building with the average quantity of WTC Hazardous Substances present in those locations.[3]

Separate studies were performed to determine if and how the WTC Dust and WTC Hazardous Substances could be remediated and whether unremediated reservoirs of WTC Hazardous Substances will recontaminate the Building

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[11] Fenton, Kevin (Deutsche Bank), "Re: Response to letter of Young Laboratories Inc. dated April 17, 2002 to McLarens Toplis North America, Inc. regarding Deutsche Bank's 130 Liberty Street Building," letter, May 22, 2002.
[12] Fenton, Kevin (Deutsche Bank), "Re: Your letter of June 10, 2002," letter, July 3, 2002
[13] Bishop, Walter A. and Fenton, Kevin (Deutsche Bank), "Memo from meeting on April 4, 2002," memo, April 12, 2002.
[14] Deutsche Bank, meeting with RJ Lee Group, Young Laboratories, and the Insurers, November 6, 2002.
[15] Deutsche Bank, meeting with RJ Lee Group, Young Laboratories, and the Insurers, September 25, 2002.
[16] Deutsche Bank, meeting with RJ Lee Group, Young Laboratories, and the Insurers, March 20, 2002.

through normal Building activities.[17,18,19,20,21,22,23,24]

The WTC Dust Signature was developed by examination of the WTC Dust in the obviously contaminated parts of the Building, by analysis of WTC Dust taken from the debris piles surrounding Ground Zero, and by review of the findings of U.S. EPA and other investigators analyzing the dust resulting from the WTC Event.[25,26,27,28,29,30,31] From these data, the most significant contaminants were identified. A set of ten analytes were evaluated throughout the Building and its subsystems. As a result of microscopic and chemical analysis of the components of the WTC Dust, it was determined that the average level of contaminants were present in direct proportion to one another throughout the Building, as they are in other WTC impacted buildings evaluated.[32] While on average by Sector of the Building, the relationship of the levels of WTC Dust and the levels of WTC Hazardous Substances are statistically predictable, there is significant variability in the levels of WTC Dust compared to the WTC Hazardous Substances which precludes the use of visual assessment of WTC Dust to predict levels of WTC Hazardous Substances for remediation purposes. The relative abundance of the contaminants was found to be highly correlated throughout the Building

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[17] RJ Lee Group, "Technical Memorandum *R2: Test Cell Remediation and Recontamination*," May, 2004.
[18] RJ Lee Group, "Technical Memorandum *S2: The Relationship between Surface and Airborne Concentrations of WTC Dust Under Known Conditions*," May, 2004.
[19] RJ Lee Group, "Technical Memorandum *R4: Cell System, Wire Pull Test and Cable Contamination*," April, 2004.
[20] RJ Lee Group, "Technical Memorandum *R5: Active Test Cell Recontamination*," May, 2004.
[21] RJ Lee Group, "Technical Memorandum *R1: Surface Remediation in Gash Area Post Abatement*," May, 2004.
[22] RJ Lee Group, "Technical Memorandum *R3: Ductwork Remediation,*" May, 2004.
[23] RJ Lee Group, "Technical Memorandum *R9: Fireproofing Remediation*," May, 2004.
[24] RJ Lee Group, "Technical Memorandum *R12: Airflow Pathways Demonstration*," May, 2004.
[25] U.S. Environmental Protection Agency (EPA), "Interim Final WTC Residential Confirmation Cleaning Study, Volume 1," http://www.epa.gov/wtc/confirmation_clean_study.htm, May, 2003; accessed March, 2004.
[26] Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Taskforce Working Group, "World Trade Center Indoor Air Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks," May, 2003.
[27] Lioy, Paul J., et al., "Characterization of the Dust/Smoke Aerosol that Settled East of the World Trade Center (WTC) in Lower Manhattan after the Collapse of the WTC 11 September 2001," Environmental Health Perspectives, Vol. 110, No 7, July 2002.
[28] Chatfield, Eric J. and Kominsky, John R., "Summary Report: Characterization Of Particulate Found In Apartments After Destruction Of The World Trade Center", October 12, 2001
[29] Millette, James R., et al., "Microscopical Studies of World Trade Center Disaster Dust Particles," Microscope, Vol 50:1, 29-35. 2002.
[30] U.S. Federal Emergency Management Agency (FEMA), "World Trade Center Building Performance Study," FEMA 403, May, 2002.
[31] Landrigan, Philip J. et al., "Health and Environmental Consequences of the World Trade Center Disaster", Environmental Health Perspectives [Online 18 February 2004] http://www.ehponline.org, accessed March, 2004.
[32] RJ Lee Group, "A Review of the Post-9/11 Building Conditions at 100 Church Street." March 10, 2003.

in relationship to the average amount of WTC Dust that was present in various sectors of the Building. This relative presence of analytes, when displayed graphically, has a characteristic appearance termed the "WTC Dust Signature."[2]

The methodology employed in the study was to divide each floor of the Building into a series of sampling grids. Each grid was coded with a unique identifier. The number of grids per floor was selected on the basis of prior experience in other buildings which indicated that dust distributions tended to be randomized representations of a mathematical distribution called "lognormal distributions."[33]

This means the number of samples to achieve a given precision can be mathematically estimated. The sampling program was designed, where possible, to provide sufficient data such that the results could be evaluated with a 95/95 confidence level.[34] The 95/95 rule is used to define the certainty that differences in two numbers (e.g., average concentrations on two floors) are statistically significant. At each location, a set of eight to ten samples was collected representing the suite of WTC Hazardous Substances selected as the predominant indicators of potential contamination. In systems for which either access was restricted, or the number of tests otherwise limited, logical groupings were selected to create a representative sampling based on knowledge of the system.

[33] Gilbert, R.O., "Statistical Methods for Environmental Pollution Monitoring," Van Nostrand Reinhold, New York, NY, pp 164-176. 1987.

[34] The 95-95% UTL (Upper Tolerance Limit) refers to the upper limit of the calculated range in which 95% of all values are expected to occur, calculated for a stated confidence of 95%.

Additional Testing and Results Reported Herein:

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

S2: The Relationship between Surface and Airborne Concentrations of WTC Dust Under Known Conditions

S3: Resuspension Characteristics of WTC Dust Under Controlled Conditions

S4: Resuspension and Settling of WTC Dust over a Three-Day Period

S5: Airborne Fiber Dimensions: A Comparison of Asbestos Resuspended from WTC Dust to Airborne Asbestos in Other Buildings

S6: Impact of Indirect Preparation Techniques on the Number of Asbestos Fibers Observed in WTC Dust

S7: Relationship between Contaminant Distribution, WTC Dust Concentration, and "Hot Spots" in 130 Liberty

S8: Side-by-Side Comparison of Sampling Methods: Microvac vs. Wipe

S9: Abrasive Characteristics of WTC Dust

7.0 Summary of Specific Grounds for Each Opinion

Source of Dust Constituents

The National Resources Defense Council (NRDC) report estimated more than 1.2 million tons of building materials were pulverized during the WTC Event including an estimated 300 to 400 tons of asbestos,[35] mainly from insulation and from fireproofing. It is estimated that 50,000 personal computers were destroyed, with each containing approximately four pounds of lead.[36] Additionally, tens of thousands of fluorescent light bulbs, switches and other mercury-containing items were destroyed, releasing thousands of grams of mercury into the surrounding environment.[35] Other building materials from which the WTC Towers were constructed include structural steel, non-asbestos containing insulating fibrous material (mineral wool and glass fibers), cement and aggregate (concrete), wallboard, ceiling tiles, ducts, wiring, paint, plate glass, and other components. Building contents of the WTC Towers included other electronic equipment, furniture, office supplies, plastics and polymers, electrical wiring, plumbing fixtures, solder, welds, and a myriad of other items.[30,35]

The brittle and friable components of these materials were pulverized during the collapse and the combustible components were partially burned in the ensuing fires.[31]

In a building related disaster, the dust and emissions reflect the precise nature of the event. The WTC Event combined several cataclysmic destructive processes in a single event. This report supplements prior reports and focuses on the unique characteristics of WTC Dust and WTC Hazardous Substances deposited in the Building as a result of the aircraft impacts on the WTC Towers, the collapse of the twin WTC Towers, ground impact of that collapse, fires, pressure forces, and other phenomena arising from the WTC Event.

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35 Nordgrén, Megan D., et al., "The Environmental Impacts of the World Trade Center Attacks - A Preliminary Assessment," National Resources Defense Council. February 2002.

36 U.S. Environmental Protection Agency (EPA), "Part IV: 40 CFR 260 et al., Hazardous Waste Management System; Modification of the Hazardous Waste Program; Cathode Ray Tubes and Mercury-Containing Equipment; Proposed Rule," http://www.epa.gov/epaoswer/hazwaste/recycle/electron/crt-fr.pdf, June 12, 2002; accessed May 4, 2004.

1. Dust in the Building has an identifiable signature based upon the relative levels of components in the dust and certain chemical and morphological characteristics of particles in the dust. The characteristics of the dust are a result of the collapse of the WTC Towers and the subsequent fires at the WTC site which collectively were unique events that produced unique dust. The unique characteristics of this dust are collectively referred to as the WTC Dust Signature.

Detailed characterization of WTC Dust revealed that it possesses a unique set of characteristics by which it can be identified and differentiated, to a reasonable degree of scientific certainty, from dust that had other origins. Thus, dust that was found as a pervasive contaminant in the Building was unequivocally identified as coming from the WTC Event.

Comparison of the composition from "Baseline" Interior Spaces (TP-01) with samples of dust collected from the Background Buildings[1] revealed a composition pattern or "signature" that permits the reliable identification of WTC Dust. The signature is based on a pattern of the presence and concentrations of multiple components, not on a single component. The WTC Dust Signature is shown in Figure 1.

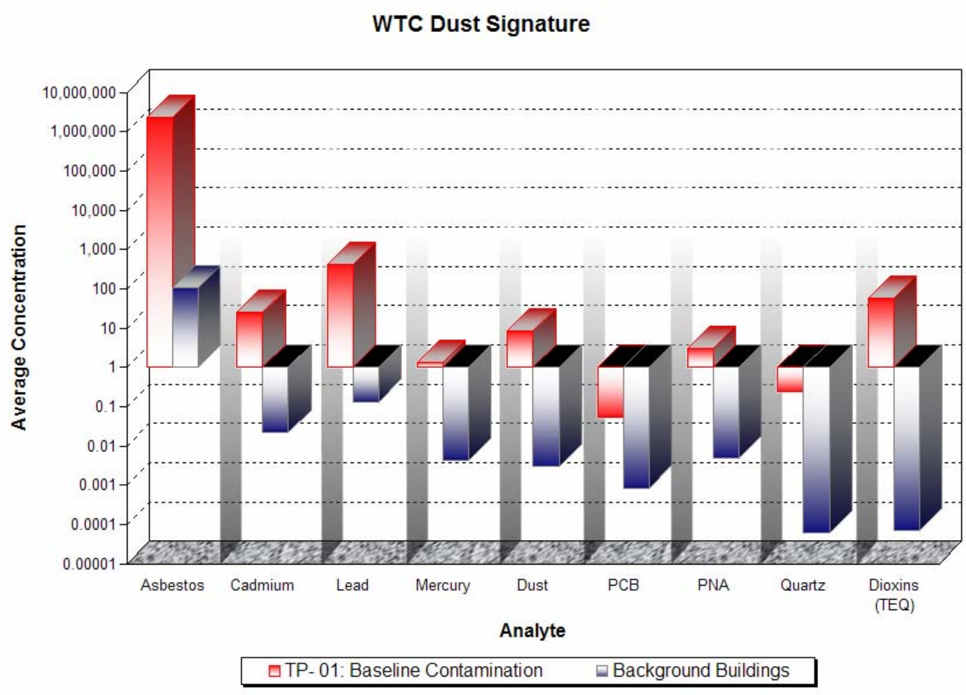

Figure 1. WTC Dust Signature (TP-01) compared to Background Buildings[37]

[37] *Note: In the above figure, the series are plotted on a logarithimic Y-axis and centered around the value of "1". "1" is used to visually distinguish between WTC Dust (majority greater than 1) and Background Buildings (majority less than 1)*

The identity, concentration and characteristics of the particles and the chemical composition of the WTC Dust constitute a complex, recognizable pattern or "signature" that is based on a profile comprised of WTC Dust Markers that include:

Chrysotile asbestos occurring as long, thin bundles and fibrils (Figure 2 A)

Gypsum occurring as fine particles (Figure 2 A and B)

Mineral wool occurring as short and fractured fibers (Figure 2 C)

Vesicular carbonaceous particles that result from the partial burning of plastic (Figure 2 D)

Spherical iron and spherical or vesicular silicate particles that result from exposure to high temperature (Figure 2 E and Figure 2 F)

The source of the WTC Markers can be directly linked to the WTC Event by the composition and morphology of the particles; the asbestos, mineral wool and gypsum were used in the WTC Towers' construction material, and the heat affected particles result from the fires that ensued following the WTC Event.

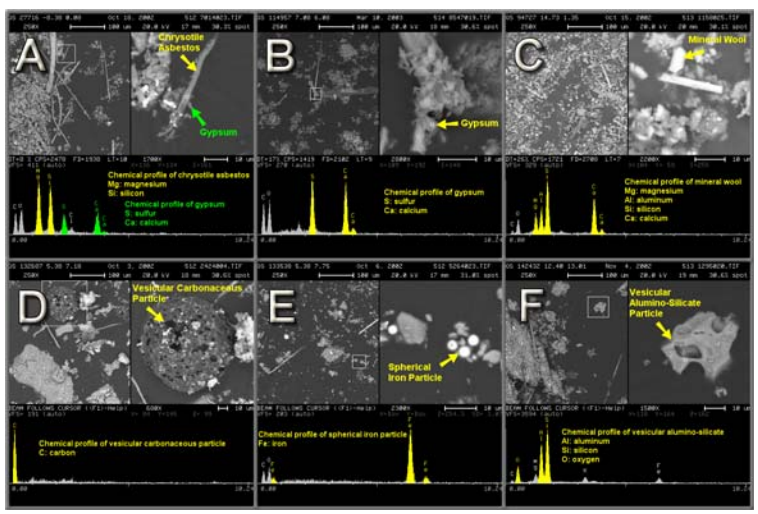

Figure 2. SEM/EDS images of WTC Dust Markers in samples from the Building.

A: Chrysotile asbestos coated with gypsum	**D: Vesicular carbonaceous particle**
B: Fine gypsum particles	**E: Spherical iron particle**
C: Mineral wool fragment	**F: Heat-affected vesicular aluminosilicate particle**

An additional characteristic of WTC Dust is the presence of coated particles and fibers. The coatings vary in thickness from monolayers to finely-dispersed sub-micron sized particles. The coated particles have been detected by low voltage back-scattered electron imaging, x-ray microprobe analysis, and high resolution x-ray photoelectron spectroscopy (XPS) as illustrated as an example in Figure 3 and Figure 4. Figure 3 shows traces of lead compounds identified on the surfaces of mineral wool by XPS, and the analysis of x-ray photoelectron spectra led to the identification of two peaks containing either lead oxide or lead sulfate (Figure 4). The presence of lead oxide on the surface of mineral wool indicate the existence of extremely high temperatures during the collapse which caused metallic lead to volatilize, oxidize, and finally condense on the surface of the mineral wool.

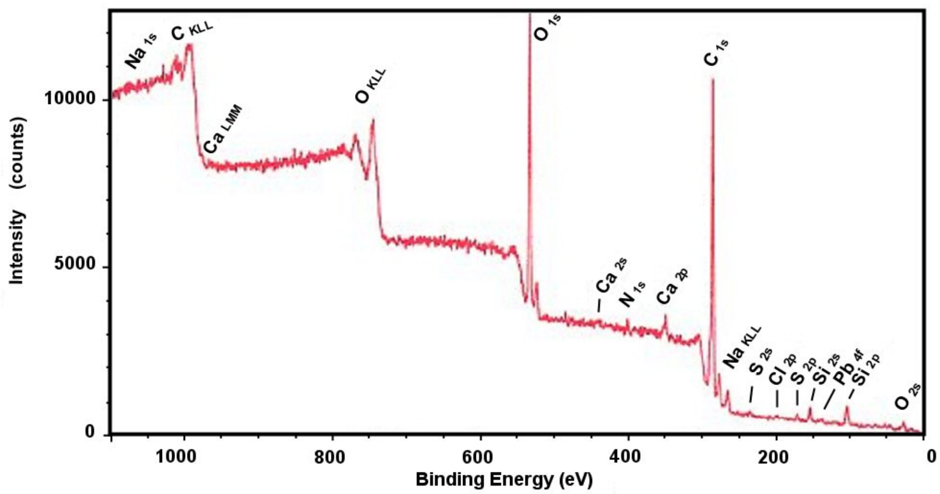

Figure 3. Wide scan of mineral wool particle in WTC Dust sample.

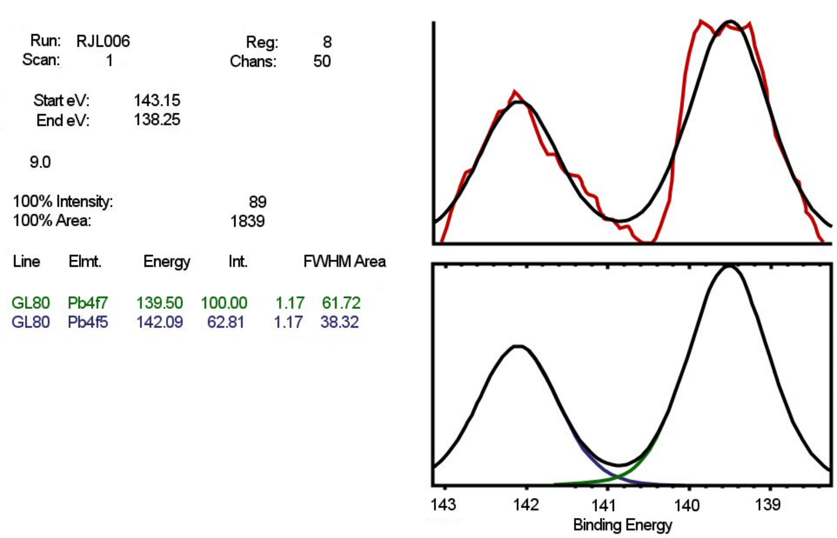

Figure 4. Lead peaks on mineral wool in WTC Dust sample by high res. XPS

2. **The Building is contaminated with WTC Dust that contains WTC Hazardous Substances, including, but not limited to, asbestos, lead, mercury, cadmium, PCBs, PNAs, quartz, beryllium, mineral wool and dioxins/furans, in concentrations substantially in excess of those found in dust in other buildings unaffected by the WTC Event.**

The concentrations of hazardous substances in other office buildings are negligible as demonstrated by the analysis of samples collected, using the same protocols as were used in the Building, from occupied spaces in office buildings not affected by the WTC Event.[1]

The only places where hazardous substances are likely to be encountered in other buildings are in immediate proximity to building materials that contain a hazardous substance that have been disturbed (e.g., adjacent to damaged asbestos-containing fireproofing). When present in other buildings, the asbestos is in much lower concentrations than observed in the Building. Estimates of the weight percentage of asbestos in dust in buildings containing ACM materials are generally in the 0.0001-0.01 percent range[38,] while estimates of the asbestos concentration in the dust in the Building are between 0.5 and 1% on average, with some samples having as much as two or three percent asbestos. Similar results were obtained for other analytes as seen below.

Table 1 compares, by analyte, the dust in the Building to that of Background Buildings. The average concentration, maximum concentration, the number of samples and statistical differences (results of an unpaired t-test assuming unequal variance)[39] are shown. The concentrations of the analytes demonstrate a distinct difference between WTC Dust collected in the Building and dust from the Background Buildings. In all cases, the concentrations of the analytes are dramatically higher in WTC Dust than in the Background Building samples.[1]

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[38] RJ Lee Group, "Expert Report of Richard J. Lee, PhD.," Prepared in connection with Prudential vs. USG, et al., August 2, 1996.

[39] The unpaired t-test compares the average (mean) values taken from two groups and determines the probability (or likelihood) that the observed difference simply occurs by chance. The usual comparison is to determine if the difference is different than "0". The chance is reported as a p-value. A p-value close to 1 means that it is very likely that the two groups have the same mean. A small p-value means it is unlikely that such a difference would occur by chance if the two groups had the same average.

Table 1. Concentrations of Analytes in the Building (below ceiling) and in Background Buildings.

	130 Liberty			Background Buildings			Significant Statistical Difference
	Average	Max	Count	Average	Max	Count	
Asbestos (S/cm^2)	2.0 *M*	70.4 *M*	668	106	691	32	YES
Barium ($\mu g/ft^2$)	165	5,050	700	0.356	3.10	32	YES
Beryllium ($\mu g/ft^2$)	1.28	57	700	0	0	32	YES
Cadmium ($\mu g/ft^2$)	10.43	425	700	0.022	0.383	32	YES
Chromium ($\mu g/ft^2$)	94	2,310	700	0.226	1.61	32	YES
Copper ($\mu g/ft^2$)	466	13,500	700	1.01	5.05	32	YES
Lead ($\mu g/ft^2$)	249	7,940	700	0.134	2.53	32	YES
Manganese ($\mu g/ft^2$)	609	23,700	700	0.253	2.73	32	YES
Mercury ($\mu g/ft^2$)	0.50	20.40	682	0.004	0.038	32	YES
Nickel ($\mu g/ft^2$)	36	4,110	700	0.22	3.45	32	YES
Zinc ($\mu g/ft^2$)	6,341	1.5 M	700	4.77	21	32	YES
PCBs ($\mu g/100\ cm^2$)	0.049	2.72	711	0.00085	0.015	32	YES
PNAs ($\mu g/100\ cm^2$)	3.18	134	735	0.00482	0.125	32	YES
Dioxins/Furans (TEQ) ($pg/100cm^2$)	49	2,954	744	0.00007	0.0009	32	YES

M denotes Million

3. **The WTC Dust and WTC Hazardous Substances pervasively contaminating the Building are a result of the WTC Event.**

Under ordinary circumstances dust in a building would have multiple sources and occur in a random distribution with no recognizable geographical pattern. Furthermore, the dust in occupied, unoccupied, and inaccessible locations would be expected to be different in composition because occupied spaces are frequently cleaned and use conditioned air; unoccupied spaces are not routinely cleaned and are not often climate controlled, and inaccessible spaces (e.g., wall cavities, above ceilings) often contain construction material debris. Despite these environmental differences the dust in the Building was found to be the same in occupied, non-occupied and inaccessible spaces**.**

a. *Contaminant concentrations in the WTC Dust correlate with the total amount of dust on surfaces in different sectors of the Building as defined by physical damage and location.* The total dust deposited in the Building followed a flow pattern.[4] The wide grey bars represent the average dust loading in each sector. The dust in the *below gash* sector relative to the *top* of the Building is 10 times higher than the average concentration at the *top* whereas the lead and other metals are comparable to each other in the two sectors. The heavier and coarser (i.e., larger particles) of dust drifted to the lower floors, and the lighter dust and chemicals (i.e., smaller particles) followed Building pathways to the upper floors (Figure 5). When grouped by Building sector from top to bottom of the Building, the pattern of dust and contaminant concentrations are highly correlated and this further demonstrates a common source, the WTC Event (Figure 5). Figure 6 illustrates this correlation. Note the elevated dust levels *below gash* versus the elevated contaminants at the *top* of the Building.

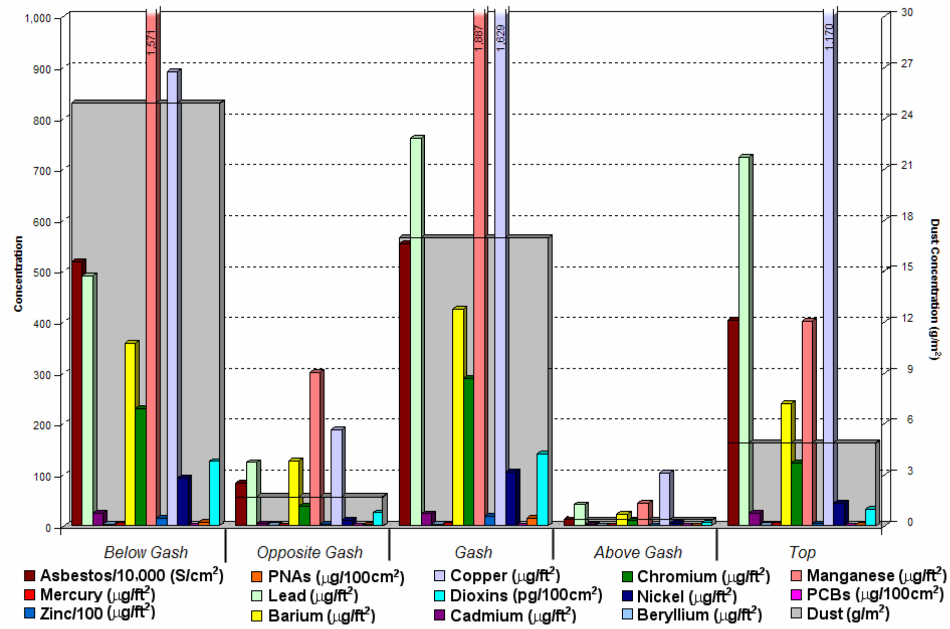

Figure 5. Total Dust Loading/Contaminant Concentration vs. Building Sector

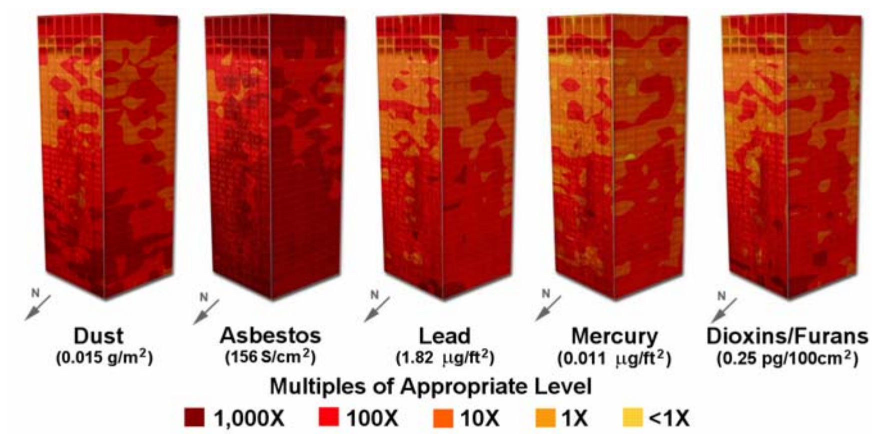

Figure 6. Total Dust Loading[40] and Contaminant Concentration throughout the Building.

b. *WTC Dust was identified in each and every Building system and Building component tested.* An extensive set of contamination reports have been produced detailing the extent of WTC Dust in all major Building systems.[3],[41]

c. *WTC Markers are present in over 95 percent of the WTC Dust lift samples collected.* Prior reports identify a set of particle species that are found together in WTC Dust which became known as WTC Markers (Figure 2).[2]

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[40] The "Appropriate Level" for dust is the average concentration of high contact surfaces.
[41] RJ Lee Group, "Insurance Claim Report, Volumes I, II, and III," May, 2003.

4. **Dust in the Building has been confirmed to be WTC Dust using conventional forensic and statistical methodologies.**

The identification of WTC Dust is based not only on individual chemical and morphological characteristics, but also on a profile comprised of the WTC Dust Markers including the following: asbestos, gypsum, vermiculite, synthetic vitreous fibers, heat treated particles, metals, silica, and other particle types. These concentrations of the WTC Dust Markers exhibit a unique pattern when compared to Background Building dust (Figure 7).

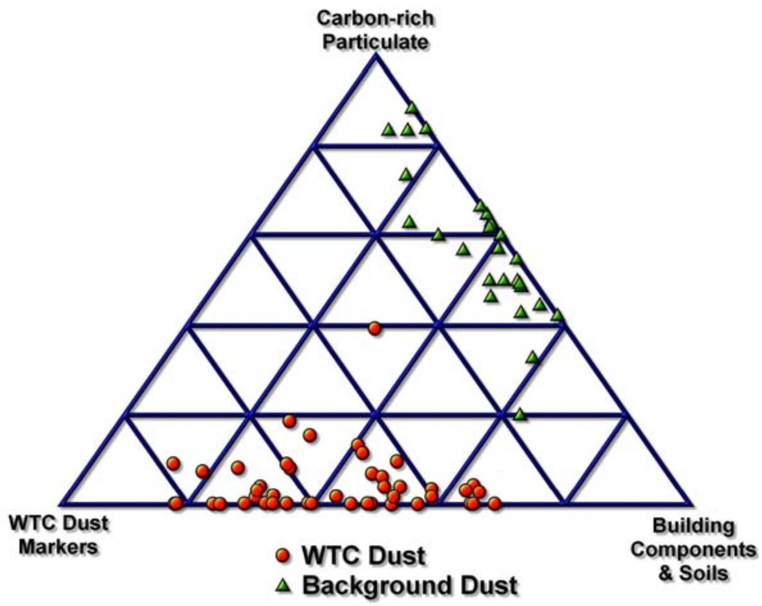

Figure 7. Compositional difference between Background Building dust and WTC Dust.

Figure 7 is a triangular graph in which each corner represents 100% of a group of compounds (e.g., A=WTC Dust Markers, B=Soil, and C=Carbon-Rich particles, flakes, and fibers). The location of points on the graph is derived by calculating the percentage of particles that fall into each of the three categories and plotting the points in the location relative to these percentages. For example, if a sample contains 100% WTC Dust Markers, it is plotted at A, if it contains 50% of WTC Dust Markers and 50% Soil; it is plotted midway between Point A and Point B. If a sample contains equal amounts of A, B, and C, it is plotted in the middle of the graph.

Additionally, WTC Dust can be differentiated from other building dust on the basis of its unique composition and morphology.[2] WTC Dust Markers exhibit characteristics of particles that have undergone high stress and high temperature. Asbestos in the WTC Dust was reduced to thin bundles and fibrils as opposed to the complex particles found in a building having asbestos-containing surfacing materials. Gypsum in the WTC Dust is finely pulverized to a degree not seen in other building debris. Mineral wool fibers have a short and fractured nature that can be attributed to the catastrophic collapse. Lead was present as ultra fine spherical particles. Some particles show evidence of being exposed to a conflagration such as spherical metals and silicates, and vesicular particles (round open porous structure having a Swiss cheese appearance as a result of boiling and evaporation). The presence of these particles, confirmed using conventional forensic and statistical methodology, in conjunction with one another, identifies the source as the WTC Event.

5. **The Building is contaminated with respirable (breathable) asbestos fibers that have morphological characteristics which make them more readily aerosolized than asbestos in dust found in other buildings not impacted by the WTC Event.**[1]

The airborne asbestos fibers in resuspended WTC Dust in the Building are longer than in other buildings. Asbestos fibers recognized as being a hazard are longer than five micrometers and thin (less than 1 micrometer in physical diameter).[42,43] More than 16 percent of airborne asbestos fibers in the Building were longer than five micrometers, and more than five percent were longer than 10 micrometers. These percentages of long fibers are 10 fold greater than the percentage found in other building studies (Table 2).

Table 2. Comparison of Fiber Size Distribution in Air Samples from the Building and Buildings Not Impacted by the WTC Event (TEM Direct Preparation).

Length:	≥5 µm	≥5 µm	≥10 µm	≥10 µm
Width:	<0.5 µm	<0.15 µm	<0.5 µm	<0.15 µm
130 Liberty	16.4%	6.0%	5.5%	1.9%
Buildings Not Impacted by the WTC Event[44]	0.7%	0.2%	0.2%	0.1%

The asbestos fibers in the WTC Dust in the Building are longer and thinner

[42] Health Effects Institute - Asbestos Research. "Asbestos in Public and Commercial Buildings: A Literature Review and Synthesis of Current Knowledge," 1991.
[43] Health Effects Institute - Asbestos Research, "Asbestos in Public and Commercial Buildings, Supplementary Analyses of Selected Data Previously Considered by the Literature Review Panel," 1992.
[44] Lee, R.J., Van Orden, D. R., Corn, M., and Crump, K. S., "Exposure to Airborne Asbestos in Buildings," Regulatory Toxicology and Pharmacology, Vol. 16, pp. 93-107, 1992.

than asbestos fibers that occur in other buildings. Asbestos fibers in the Building could not have come from material used in construction or renovation of the Building since asbestos was not used in the Building's fireproofing, insulation or surfacing materials. Therefore, the only source of asbestos could be the WTC Event. This conclusion is supported by the morphology of the asbestos fibers found in the Building (i.e., asbestos fibers in the absence of matrix material). The diameter of the asbestos in WTC Dust was below the limit of detection by polarized optical microscopy (PLM) (the limit of the PLM is ~2-5 micrometers in diameter in complex systems).[45,46] This led initial investigators to underestimate the amount of asbestos in WTC Dust and therefore the hazard associated with the WTC Dust.[47] Insurers' analyses by PLM detected asbestos in 5.2% of the samples.[48] However, in our analysis using the SEM, which has a somewhat higher resolution than the PLM, more than 50 percent of the samples were found to contain free respirable fibers of asbestos.[3] Using the highest resolution analysis, the TEM, asbestos fibers were found in about 90% of the samples.[3]

Asbestos was found in the Building in different locations and in a different form than asbestos that occurs in other buildings not impacted by the WTC Event.[49] Asbestos in other buildings is typically only found in significant concentrations on surfaces that are in close proximity to asbestos-containing building materials such as sprayed-on fireproofing or thermal insulation products.[50] Asbestos is released from the asbestos containing materials by a mechanical process or disruption and primarily occurs as part of a larger matrix that consists of binders and fillers that make up the building products.[38] The asbestos released from asbestos containing material is generally found as millimeter or larger sized particles that are too large to be respired. This asbestos is rarely in the form of free-respirable fibers because the binder material is soft and weak relative to the embedded asbestos fibers and, when the building material breaks, it generally breaks through the binder leaving the asbestos embedded in the remaining parts.[51]

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[45] U.S. Environmental Protection Agency (EPA), "Interim Method for the Determination of Asbestos in Bulk Insulation Samples," Washington, DC, EPA-600/M4-82-020. 1993.
[46] St. John, Donald A., et al., "Concrete Petrography: A Handbook of Investigative Techniques," Arnold, London. 1998.
[47] U.S. Environmental Protection Agency (EPA), "EPA's Response to the World Trade Center Towers Collapse," Code 2002-0000702. January 27, 2003.
[48] Riker Danzig Scherer Hyland Perretti, LLP, CDs from Insurance Company - (AA (MY) 000001-AA (MY) 007179). December 16, 2003.
[49] Ewing, William M., et. al., "Observations of Settled Asbestos Dust in Buildings," Environmental Information Association Technical Journal, Vol. 4, No. 1, pp 13-17, Summer 1996.
[50] Millette, James R. and Hays, Steve M., "Settled Asbestos Dust Sampling and Analysis," CRC Press, Inc. 1994.
[51] Millette, James R. et al., "A Close Examination of Asbestos-Containing Debris," NAC Journal, pp 38-40. Fall 1990.

Under normal circumstances, the only time respirable fibers are released from asbestos-containing materials is when the products are sawed, ground, sanded or otherwise severely impacted.[42] Without respirable fibers in the dust, the air in buildings containing asbestos is no different than outside air, even during ordinary maintenance activities.[44,52,53]

Buildings that do not contain asbestos surfacing materials are impacted only by environmental asbestos which is less than 0.1 micrometers in physical diameter,[54] and occurs in low concentrations.[38,42] This is what would have been expected in the Building, as no asbestos-containing surfacing materials were used in the Building.

The WTC Dust in the Building contains asbestos that occurs as ultra fine fibers, having less than 0.25 micrometer aerodynamic diameter.[55] The significance of short fibers is generally viewed as minimal, but short, ultra fine fibers (less than 0.15 micrometers in diameter) have been suggested as potential disease agents because of their propensity to translocate across tissue boundaries,[31] and have been implicated as a cause of mesothelioma.[56] Asbestos fibers that are thick or non-respirable (i.e., without the ability to remain suspended in air and penetrate into the lung) are not considered a health hazard.[35] The ultra fine fibers in WTC Dust are of particular concern because they also carry other toxins[2] and have the potential to penetrate deep into the lungs.[57,58,59]

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[52] Corn, Morton, et al., "Asbestos Exposures of Building Maintenance Personnel," Applied Occupational and Environmental Hygiene, Volume 9, Number 11, pp. 845-852. November, 1994.

[53] U.S. Environmental Protection Agency (EPA), "Assessing Asbestos Exposure in Public Buildings," 560/5-88-002.

[54] RJ Lee Group, "Report of Analysis, City of Baltimore vs USG et. al.," December 16, 1991.

[55] RJ Lee Group, "Technical Memorandum *S1: Aerosolization of Ultra Fine Fibers and Particles from WTC Dust*," May, 2004.

[56] Gibbs, A.R., et Al., "Comparison of Fibre Types and Size Distributions in Lung Tissues of Paraoccupational and Occupational Cases of Malignant Mesothelioma," British Journal of Industrial Medicine, Vol 47, pp. 621-626, 1990.

[57] Misra, Chandan, et al., "Development And Evaluation Of A Personal Cascade Impactor Sample (PCIS)," Aerosol Science, Vol. 33, pp 1027-1047. 2002.

[58] Nicholson, W.J. and Landrigan, P.J., "Asbestos: A Status Report," Current Issues in Public Health Vol 2, pp 118-123. 1996.

[59] Suzuki, Y. and Yuen, S.R., "Asbestos Fibers Contributing to the Induction of Human Malignant Mesothelioma," Annals NY Acad Sci Vol 982, pp 160-176. 2002.

Table 3 shows the percentage of long thin fiber from surface samples in the Building as compared to other buildings in New York not impacted by the WTC Event.

Table 3. Percentage of Long, Thin, Fibers in surface samples collected from the Building and NY Buildings

Length:	≥5 μm	≥5 μm	≥10 μm	≥10 μm
Width:	<0.5 μm	<0.15 μm	<0.5 μm	<0.15 μm
130 Liberty	3.8%	2.9%	0.8%	0.6%
NY Buildings	1.1%	1.1%	0%	0%

6. **The respirable (breathable) lead contaminating the Building has morphological characteristics that make it more readily aerosolized than lead in dust found in other buildings not impacted by the WTC Event.**

The distribution of the lead in the WTC Dust is primarily in the respirable fraction. In contrast, the predominant source of lead in other buildings is lead paint which often occurs in conjunction with paint debris, and is therefore coarse and non-respirable.[60] In the Building, lead was found in the ultra fine fraction, (Table 4) and is as much as a million times more respirable than lead in other dust.[55,61]

Table 4. Size distribution (diameter in μm) of lead occurrences in the Building

Total Count	Median Diameter	Frequency Type	Percent Frequency Within Specified Size Range									
			0-1	1-2	2-5	5-10	10-15	15-25	25-35	35-45	45-55	>55
448	4.0	In-class	6.3	29.2	23.0	24.6	7.8	5.4	2.0	0.2	0.2	1.3
		Cumulative	6.3	35.5	58.5	83.0	90.8	96.2	98.2	98.4	98.7	100

[60] RJ Lee Group, "Expert Report of Richard J. Lee, PhD.," Prepared in connection with Wagner, et al., v. Anzon. February, 1994.
[61] Gaborek, Bonnie J., "Pentagon Surface Wipe Sampling Health Risk Assessment," Toxicology and Industrial Health, Vol. 17: 254-261, 2001.

7. **The Building is contaminated with respirable (breathable) WTC Dust, including WTC Hazardous Substances in addition to asbestos and lead, with morphological characteristics that make it more readily aerosolized than dust found in other buildings not impacted by the WTC Event.**

The WTC Dust was transported into the Building over a horizontal distance of more than two hundred fifty feet from WTC 2. Normal physical forces acted as a filter with the finer dust being transported up into the Building and coarser dust settling as the dust cloud moved away from the collapsing towers.[4] Thus most coarse debris was deposited outside the Building, in the *gash* and lower floors. Millette examined WTC Dust collected a month after the WTC Event and concluded, "More of the WTC dust is in the small size range than is seen in other dusts."[29]

The WTC Dust and WTC Hazardous Substances, as components of WTC Dust, are more readily resuspended than other building dust. Airborne contaminants, including asbestos and lead, have been detected in samples being collected under passive conditions in the Building,[62] and in other buildings impacted by the WTC Event.[28] This means that elevated airborne concentrations can be produced by the simple act of setting air pumps with no other deliberate activity (i.e., passive condition). Similarly, the airborne concentrations in EPA's cleaning studies exceeded EPA risk levels.[15,25]

The resuspension effectiveness[63] (k-factor) estimated in studies in the Building exceeded estimates for surface dust resuspension by as much as 10,000 fold. In other words, for the same surface dust concentration, as much as 100 times the airborne concentration of asbestos and 10,000 times the concentration of lead are produced when disturbing WTC Dust as reported in other studies.[61,67] These results are in stark contrast to previous work, including my own work,[54] where I found that no correlation existed between the surface dust and airborne concentrations in buildings with asbestos-containing materials. The difference is the asbestos in the dust in other buildings is produced by low energy events that tend to create large particles (i.e., debris) whereas the dust in the Building is a result of the WTC Event which created free fibers and small particles that predominated as the dust cloud moved away from Ground Zero.

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[62] RJ Lee Group, "Technical Memorandum *S4: Resuspension and Settling of WTC Dust over a Three-Day Period*," May, 2004.

[63] The resuspension effectiveness (RE) is a measure of how the air concentration relates to the surface concentration; the asbestos RE values are calculated by dividing the asbestos air concentration in S/cm^3 by the asbestos surface concentration in S/cm^2.

Airborne levels of asbestos, lead, and other WTC Hazardous Substances in the Building correlated with surface dust concentrations during aggressive air tests, work activities, and using low-velocity air pulses on a variety of surfaces in the Building (Figure 8).[18,64] In contrast, no correlation with work activity was found by the Missouri EPA during sweeping floors covered with asbestos debris,[65] or in studies of homes following the Northridge Earthquake.[54]

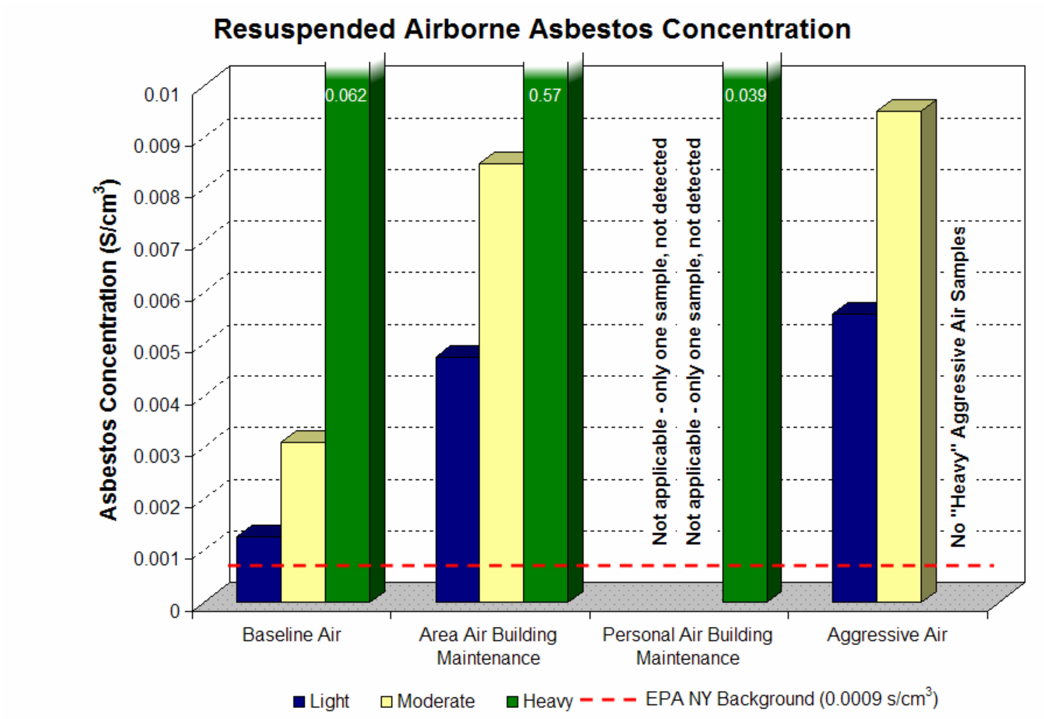

Figure 8. Resuspended asbestos concentrations according to light, moderate or heavy visual dust for baseline air, area and personal building maintenance activities, and aggressive air tests. [66]

Our studies have shown that airborne asbestos and lead concentrations also correlate with the level of activity.

The correlations in the above studies permitted the estimate of resuspension effectiveness ranging from one part in a thousand to one part in ten million. This means, for example, one fiber out of a thousand or one fiber out of ten million will be resuspended into the air. These estimates are more than a thousand times larger than observed in other circumstances.[61,67]

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[64] RJ Lee Group, "Technical Memorandum *S3: Resuspended Dust Study*," May, 2004.
[65] Wickman, Arthur R., et al., "Exposure of Custodial Employees to Airborne Asbestos," Missouri Department of Health, Bureau of Environmental Epidemiology. EPA Project No. J100746B-01-0, pp. 1-22.
[66] No aggressive air samples in the heavy dust loaded area were collected. This was at the discretion of the field technicians who believed that the amount of dust would overload the filters for TEM analysis.
[67] Sansone, E. B. "Redispersion of Indoor Surface Contamination and Its Implications." Treatise on Clear

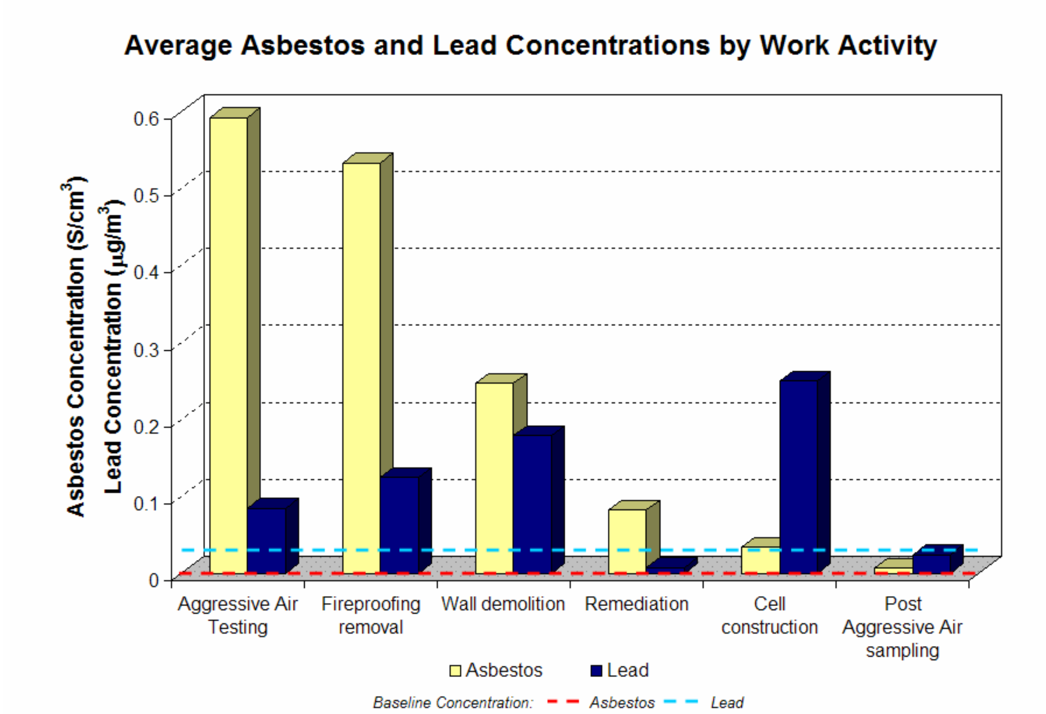

Figure 9. Average Asbestos and Lead Concentrations by Work Activity

8. **Lead in the WTC Dust has an identifiable speciation and morphology which distinguishes it from other potential sources.**

Lead particles in WTC Dust are predominantly spherical particles that are between 0.25 and 5 µm in diameter. Chemically, lead with small quantities of chlorine predominate (50%), free lead (37%), leaded glass (lead with silica, 1%), residual lead paint and solder (12%). In contrast, free lead particles in air handling systems in other buildings tend to be automotive in origin (i.e., lead bromide) or lead paint fragments if the building contains lead paint.

9. **The WTC Dust and WTC Hazardous Substances contaminating the Buildings' mechanical, electrical, and plumbing systems are conductive, corrosive and abrasive.**

WTC Dust has permeated every component in the Building. The WTC Dust has been shown to be corrosive to unprotected metal, to affect the conductivity of circuit boards in a manner that will cause intermittent failures, and to be severely abrasive when present in lubricants at only five percent of the volume.[68]

Surface Technology, Vol. 1. Ed. K. L. Mittal, pp. 261-290. 1987.

[68] RJ Lee Group, "Technical Memorandum *S9: Abrasive Characteristics of WTC Dust*," May, 2004.

Appendix B
Curriculum Vitae of Richard J. Lee, Ph.D.

Richard J. Lee

Affiliation: RJ Lee Group, Inc.
350 Hochberg Road
Monroeville, PA 15146

Education:
Ph.D., Theoretical Solid State Physics, 1970, Colorado State University
B.S., Physics, 1966, University of N. Dakota

Career/Employment:
- RJ Lee Group, Inc., President, 1986 - Present
- U. S. Steel Technical Center, Head - Physics, Electron Microscopy and Surface Analysis Section, 1973 - 1985
- Purdue University, Associate Professor, 1971
- Purdue University, Assistant Professor, 1970
- Lake Region Junior College, Instructor, 1966

Summary:
- Pioneered the use of quantitative electron diffraction techniques for the identification of asbestos
- Development of automated techniques for combined x-ray microanalysis and electron microscopy
- Developed and manufactured first PC-based Scanning Electron Microscope
- Developed and manufactured Forensic product for GSR
- Developed and manufactured Forensic LIMS software

Honors, Awards, Fellowships & Memberships:
- Microbeam Analysis Society
- ASM International
- ASTM Committee
- American Concrete Institute
- American Ceramic Society
- National Stone, Sand and Gravel Association
- International Standards Organization
- Health Effects Institute - Asbestos Research Literature Review Panel
- EPA Scientific Review Panel on Air Chemistry and Physics (1989)
- EPA Select Panel for Development of Methodology for Asbestos Analysis by Transmission Electron Microscopy (1987-Present)
- Advisor on asbestos analysis to the Environmental Protection Agency
- External Advisory Committee for the College of Natural Sciences, Colorado State University
- National Defense Education Act Fellowship - 4 years
- Honorary Doctor of Science – University of North Dakota, 1996
- Entrepreneur of the Year – Mid-Atlantic States, 1991
- Innovator of the Year – North Dakota, 1998

Publications & Presentations: 177

Patents: 3

Richard J. Lee, PhD
Publications & Presentations

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