Remediation Assessment
130 Liberty Street Property

Technical Memorandum
R12: Airflow Pathways Demonstration

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Summary

The World Center ("WTC") destruction commencing on September 11, 2001 ("WTC Event") resulted in the contamination of the building located at 130 Liberty Street, New York, NY (the "Building") with soot, dust, dirt, debris and hazardous substances.[1] Previous studies[2] demonstrated that WTC Dust and WTC Hazardous Substances are present throughout the Building including the interior and curtain wall cavities, and all system raceways. This smoke test study was performed to demonstrate that air flow pathways exist for the migration of WTC Dust and WTC Hazardous Substances from these areas to occupied spaces of the Building. Airflow pathways were demonstrated to exist through wall cavities, conduit systems, fiber optic cable closets and pathways, the Cell Systems, curtain wall and window mullions. The movement of smoke demonstrated that respirable particles are able to migrate through the pathways. This technical memorandum reports the findings of the experts.

Key Findings

- Pathways for air movement exist between the following structures and occupied spaces: wall cavities, conduit systems, fiber optic cables including related closets and pathways, the Cell Systems and curtain wall window mullions.
- Unless these areas are remediated, WTC Dust and WTC Hazardous Substances will be transported from these areas through air flow pathways into the occupied spaces of the Building as a result of normal building air flow.
- Other studies have concluded that the Building has "loose" construction; there are multiple airflow pathways in the Building.[3]

Conclusion

The normal Building environment, including external wind pressure, thermal gradients and mechanical building ventilation (HVAC), causes sufficient pressure differentials across the Building's boundaries to induce airflow through pathways. These airflow pathways of the Building are

[1] RJ Lee Group, "Contamination Report Pursuant to Testing Protocol-01 *Interior Spaces* Summary Report," December, 2003.
[2] RJ Lee Group, All Contamination Reports, December, 2003.
[3] Milke, James A., "Bankers Trust Building Airflow Analysis," May, 2004.

mixed with the air of the occupied spaces. If internal areas and systems are left unremediated, they will act as a reservoir for WTC Dust and WTC Hazardous Substances to recontaminate the occupied spaces of the Building.

1.0 Purpose

The purpose of this study was to investigate the existence of air flow pathways between the interstitial areas of the Building and the occupied spaces of the Building; and to determine if these pathways could act as a vehicle for the transport of WTC Dust and WTC Hazardous Substances from unoccupied areas into the occupied spaces.

2.0 Description of System

The following Building systems were investigated in this study:

1. Interior wall cavities,[4] including penetrations through the test wall such as electrical receptacles and light switches.
2. The ceiling plenum, including the ceiling with its openings for diffusers and light fixtures.
3. Conduit system. Figure 1 shows the initial portion of the investigated conduit system.
4. Fiber optic cables including related closets and pathways.
5. Cell Systems including raceways and headers[5], with openings on the floor above and fireproofing covering the bottom deck and raceway plate. Figure 2 presents an enclosure in which the raceway smoke test was conducted. (Cell Systems are under floor channels in which wires are run to provide electrical and communication connectivity from central systems to office and desk locations on the floor.)
6. Curtain wall window mullions.[6]

[4] RJ Lee Group, "Contamination Report Pursuant to Testing Protocol-06 *Interior Wall Cavities* Summary Report," December, 2003.
[5] RJ Lee Group, "Contamination Report Pursuant to Testing Protocol-09 *Cell Systems and Risers* Summary Report," December, 2003.
[6] RJ Lee Group, "Technical Memorandum *R6: Contamination Results of the Internal Components of the Curtain Wall*," May, 2004.

Figure 1. Beginning of Conduit Pathway on Floor 33.

Figure 2. Preparation for the Cell System raceways smoke test.

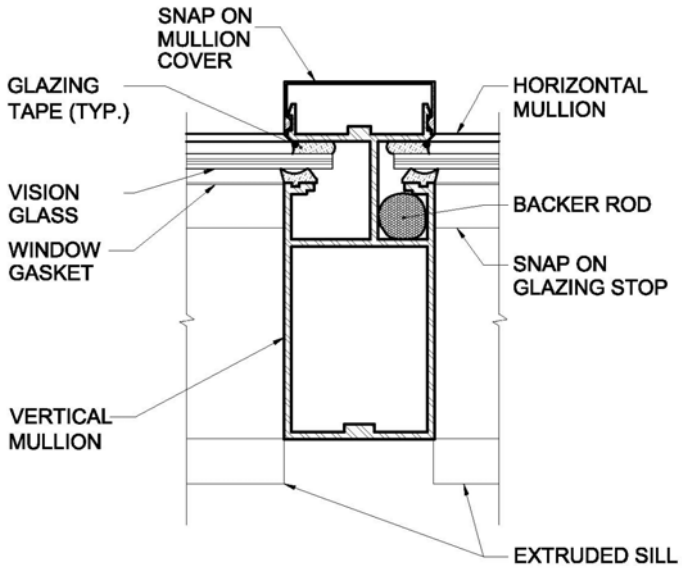

Figure 3. Cross section of a window mullion.

The glass on the curtain wall is held in place by the window mullions. Window mullions are comprised of aluminum extrusions. Many cavities between the extrusion and glass are inaccessible for remediation. See Figure 3.

3.0 Procedure

Preparation. Prior to the smoke test in the conduit system, wipe and lift samples were collected from the conduit system.

Smoke test. For testing smaller Building systems, the procedure consisted of setting up a smoke generator. A source of smoke (smoke candles, smoke pellets or flares) was placed into an industrial-grade vacuum cleaner and ignited. The vacuum cleaner was equipped with a variable transformer to adjust airflow. A hose was connected from the vacuum exhaust to the tested system. The fan speed of the vacuum cleaner was adjusted so that smoke slowly poured into the tested Building component (wall cavity, conduit or mullion) to demonstrate airflow through the structures and the corresponding pathways.

Air passage through Cell Systems was demonstrated by arranging test cells on the floor below the Cell System at a sufficient positive pressure to cause airflow through the Cell System to the floor above.

This was adjusted to approximate the air flow previously observed that was caused by stack effect. Smoke was released in the lower test cells and observed coming out onto the floor above through wiring devices, access ports, and sweeps.

Airflow through fiber optic cable closets during the test resulted from the stack effect in the Building on the day of the test.

Smoke test documentation. The smoke tests were documented using digital-still and video cameras to capture the movement of smoke through the pathways.

While testing the Cell Systems pathways, the concentration of respirable smoke particles passing through the pathways was measured using a DustTrak™ Aerosol Monitor, Model 8520 of TSI Inc. Visual observation of smoke was also used to confirm the migration of larger smoke particles through the pathway.[7]

Sample analysis. Wipes and lift samples were collected and analyzed from conduit for asbestos and WTC Dust using industry standard analytical laboratory methods described previously.[1]

4.0 Results

All smoke tests identified the presence of air flow pathways between the point of smoke origin and nearby occupied spaces.

- *Interior wall cavities.* Pathways exist between the interior wall cavities and occupied spaces through the ceiling plenum and ceiling openings, through wall penetrations such as outlets and switches, at the base of walls and through joints. Figure 4 shows interior cavity smoke entering the occupied spaces through a ceiling light fixture.

[7] Jet Pulverizer Company, "Reference Information: Table of Standard Sieves, Table of Relative Sizes and Table of Equivalent Sizes," http://www.jetpul.com/custom/custref.htm#2, 2002; accessed April 6, 2004.

Figure 4. Interior cavity pathway.

- *Conduit.* Pathway exists between panel boxes on different floors through conduit. This was demonstrated by testing the conduit between several floors. Results of the pre-test sampling establish the presence of WTC Dust in the conduit system (Table 1).

Table 1. TEM Asbestos in Conduit before Smoke Test

Floor (Overlay)	Part of Conduit	Asbestos Concentration (S/cm^2)
32 (30)	Electrical Panel	249,100
36 (30)	Pull Panel	12,700
32 (30)	Electrical Panel	280,500
32 (30)	Electrical Panel	84,130,900
36 (30)	Pull Panel	5,500

Average Appropriate Level = 156 S/cm^2

- *Fiber optic cable closets.* Pathways exist between fiber optic cable closets on adjacent floors through the connecting floor conduit sleaves. Figure 5 shows the tops of two floor sleaves for the fiber optic cable system. Smoke can be seen emerging from one of the sleaves.

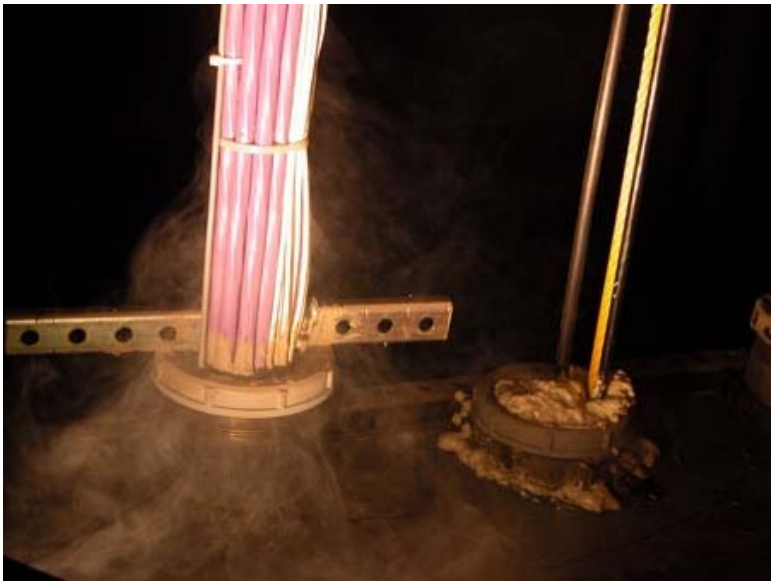

Figure 5. Smoke coming out of a stub of fiber optics cables.

- *The Cell Systems.* Pathways exist between the ceiling in a room and the floor above through the Cell Systems.
- *Curtain wall window mullions.* Pathways exist through the window mullions into occupied spaces. These pathways not only lead to the occupied space on the same floor but also to occupied spaces on adjacent floors (below and above). Figure 6 shows red smoke from a window mullion entering the occupied space.

Figure 6. Smoke test of window mullions.