THE BINGHAMTON STATE OFFICE BUILDING PCB TRANSFORMER INCIDENT: FROM BUILDING CLOSURE IN 1981 TO REOPENING IN 1994

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On February 5, 1981, at 5:30 AM, in the State of New York office building in Binghamton, New York, 200 miles northwest of New York City, an electrical panel and nearby wiring in a basement near one of two PCB containing transformers burned following an unexplained surge of electricity and failure of circuit breaking equipment. Two large transformers of about 1060 gallons each were located nearby. These transformers contained a mixture of 65% PCBs (Aroclor 1254) and 35% tri and tetra chlorinated benzenes.[1,2] The transformer nearest the burning electrical panel overheated and released about 180 to 200 gallons of transformer fluid. This generated a large amount of soot, which spread throughout the building through vertical air vents which opened in the two washrooms on each floor. In addition, a fire safety mechanism for removing smoke from the building included trap doors at the roof of the building over each of two stairways. These trap doors opened at the time of the fire, increasing the movement of soot through and ultimately reaching the outside the building where the temperature was about -5 degrees F. PCDF/PCDD and PCB contamination was documented for most of the sampled areas from subsequent air and wipe tests done throughout the building on floors, walls, desks, air, file cabinets, typewriters, air handling ducts and telephone wire containing ducts.[2] The Binghamton incident was the first documentation of the potential hazard of building contamination with PCBs, dioxins and dibenzofurans from electrical transformer related fires or arcing.

Initially, it was hoped that the cleanup could be accomplished in a matter of days by a professional cleanup crew, New England Pollution Control Corp, New Jersey. Next, when it was realized that the contamination was more extensive, involving all floors in the eighteen-story building, New York State janitorial staff was mobilized from central New York for the cleanup. This involved a 24 hour, 7 day per week, schedule of activity. During the first week following the fire it was believed that the cleanup was of PCB contaminated soot only. By the second week, preliminary chemical analysis showed that dibenzofurans also were probably present.[3] At that point, the initial cleanup efforts were halted and State officials established long term goals. Further analysis by H. R. Buser established that many dibenzofuran congeners, including those found in the Yushu and Yucheng rice oil poisonings of Japan and Taiwan, respectively, were present, as were many other dioxin congeners.[4]

The New York State Health Department, faced with the need for cleanup and reentry guidelines for a mixed PCB/PCDF/PCDD contaminated building, began the first practical development and application of the "dioxin toxic equivalents" concept. This was used to address the question of what cleanup goals were protective of human health in

reference to the mixed contamination of this office building. These were based on a 1 in a million excess cancer risk extrapolation. Intake scenarios were established by Kim and Hawley for dioxin and dibenzofuran congeners,and for PCBs, expressed as an Aroclor 1254 mixture. Theoretical, and then experimentally validated dioxin toxic equivalency factors were used for dioxins and dibenzofurans. Each PCDF or PCDD congener was assigned a weighting factor reflecting its toxicity relative to 2,3,7,8-TCDD, defined as equal to 1.0. Other toxic congeners, with chlorines in the 2,3,7 and 8 positions, were given a relative toxicity rating of as little as 0.001. PCDD/F congeners without the toxic substitution of chlorines at the 2,3,7, and 8 positions are weighted as zero. Eadon and associates at the New York State Health Department validated this approach with animal studies using the Binghamton soot as well as a simulated mixture of the Binghamton soot, demonstrating that toxicity corresponded to the sum of the amounts of each congener multiplied by the toxic equivalency factor. That is, there was an additive response.[5] Since that original use of dioxin toxicity factors by the New York State Health Department, others have used different weighting factors as a best overall approximation of human toxicity based on current toxicologic and human evidence.[6,7]

In February 1981, the Broome County Health Department, under the supervision of one of us (AS), established an emergency medical surveillance for potentially exposed workers or concerned members of the general public. This was later turned over to the New York State Health Department. Medical histories and physical examinations as well as screening and also PCB blood testing were done initially and approximately one year later for about 400 potentially exposed persons. Later, State Officials decided that the New York State Department of Health would continue only "passive monitoring', reviewing New York State cancer and birth defects registry data periodically for persons in the surveillance. Medical signs, such as liver enzyme abnormalities and some ultrastructural hepatic parenchymal cell lesions were initially described as well as certain medical symptoms, including fatigue, insomnia, transient abdominal pain, paresthesis, personality changes such as increased irritability, and decrease in sexual abilities in some males.[8,9] The first US demonstration of the use of dioxin and dibenzofuran congener specific analysis of blood and fat in workers to demonstrate intake of dioxins was reported in 1983 as part of the Binghamton medical evaluation and followed by other studies.[10] The demonstration that the general US population had a body burden of 2,3,7,8-TCDD and other toxic congeners was first performed with 1983 tissue measurements from reference patients.[11]

Building reentry occurred in October 1994, between 13 and 14 years after the initial incident. There were especially difficult items and areas to clean, such as cars and typewriters, which were discarded in some instances, as well as concrete surfaces and air and wiring ducts. Concrete floor areas near the transformer had to be removed, and new concrete applied. Epoxy resin coatings were also used. Despite this aggressive treatment, surface and nearby air levels continued to exceed reentry guidelines for many years. Ducts for air transport and where electrical, computer or telephone wire existed, were difficult to clean. They consisted of steel embedded in concrete. In order to decontaminate these areas, cleanup crews made holes in the ducts and cleaning material soaked in organic solvent was pulled through, in a fashion similar to a clarinet swab. A policy decision of the New York State Health Department to clean the entire building to the specified reentry guidelines before allowing any workers to reenter the building served to slow the reoccupancy process.

Rising air levels of chemicals during warmer weather also was a concern.

The reentry guidelines are shown on Table I with values found in representative areas in 1994 and 1995, 13 and 14 years after the incident. In general, levels are considerably lower than in earlier years.[2,12,13] Table II shows PCDD/F TEQs at various time periods from prior to reopening in 1994 and afterwards, in February 1995. Although the levels are below reentry guidelines, they are higher in these more recent samples and were close to or at reentry guidelines in July, several months prior to reopening. Table III presents PCBs and PCDD/F TEQ at several locations in February, 1995, showing certain variation at different sample sites. Even at this late date, one value, 23.2 I-TEQ, almost exceeds the reentry limit.

Table I. Binghamton State Office Building: Summary of Test Results for Feburary 1995 (Post Reoccupancy) Compared to July-September, 1994 (Preoccupancy)*

Location	Contaminant	Guideline	July-Sept 1994	Feb 1995
Office Spaces (Air)	PCBs	1 microgram/ cubic meter	0.06 (July)	0.02 (range 0.01-0.03)
	Dioxin Equivalents	10 picogram/ cubic meter	1.03 (July) 1.02 (Sept)	0.48 (range 0.41-0.55)
Office Spaces (Surfaces)	PCBs	100 microgram/ square meter	0.67 (July)	0.50
	Dioxin Equivalents	25 nanogram/ square meter	0.38 (July) 0.19 (Aug)	0.14
Above Ceiling (surfaces)	PCBs	100 microgram/ square meter	2.88 (July)	1.36
	Dioxin Equivalents	25 nanogram/ square meter	22.7 (July) 2.17 (Aug) 6.22 (Sept)'	10.4

* Results reported as averages for all samples in that category
'Only one sample from light fixture, remainder from tops of ducts and acoustic batting
Reference 17

Table II. PCDD/F Toxic Equivalency levels on the tops of light fixtures and other surfaces above the ceiling from 1994 and 1995

Date	PCDD/Fs (nanogram/square meter) B-TEQs	I-TEQs
July 1994	22.7	20.8
August 1994	2.17	1.88
September 1994	6.22	4.64
February 1995	10.4	9.37

Reference 17
B-TEQ = NY State TEQs; I-TEQ = International TEQs

Table III. Levels of PCBs and PCDD/F TEqs on the Tops of Light Fixtures on February 1, 1995

Floor	PCBs (microgram/square meter)	PCDD/Fs B-TEQs*	I-TEQs**
17th	1.24	14.5	12.4
14th	2	23.4	23.2
10th	3.36	3.27	2.87
7th	0.4	3.85	3.62
6th	0.36	13.9	11
1st	0.8	3.37	3.19
Average	1.36	10.4	9.37

* Reference 5
** Reference 16
Table adopted from Reference 17

Initial analytic data in 1981 showed the soot to be 5% PCB as Aroclor 1254. In addition, 2,168,000 parts per billion (ppb) of PCDFs, 20,000 ppb of PCDDs as well as 50,000 ppb of PCBs were also found in other soot samples.[1,2] As this paper shows, levels are much lower at the present time. Environmental sampling is planned for up to two years following reentry. There has been consideration of a longer sampling time, possibly for the life of the building, as might be done with a building containing asbestos in hidden spaces. There is no clear explanation for apparent but occasional elevations in levels of PCBs or PCDD/Fs in certain locations since reopening. This may reflect sampling variation, or it may indicate movement of chemicals from hidden spaces to areas more likely to be involved with human exposure. It may prove instructive to follow the air and surface levels of the chemically well characterized building over time. In the case of the San Francisco, One Market Plaza building PCB transformer fire, there was some evidence of an increase in measured PCB levels after reentry, although there was no further resampling.[14] The Binghamton incident was the first to suggest the potential health hazards of such PCB transformer fires. Also, this incident illustrated the considerable costs involved in the cleanup, which was estimated to have been up to $53,000,000 for a building which originally cost $17,000,000 to construct less than 10 years prior to the fire which lead to its closure. [15] Such studies may contribute to understanding the degree of release of PCBs and dioxins with time, if any, after a cleanup of the kind employed in this very complex modern office building.

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