PCB CONTAMINATION IN AN OFFICE BUILDING

M.X.Petreas[1], B.Renzi[2], D.Wijekoon[1], W.M.Draper[1], R.D.Stephens[1]
Hazardous Materials Laboratory[1] & Toxic Substances Control Program[2]
California Department of Health Services
*2151 Berkeley Way, Berkeley, CA 94704, USA*

Abstract

A six-story office building was repeatedly monitored for PCB contamination following an electric switch explosion and subsequent clean up. Wipe samples from the Heating Ventilating and Air Conditioning (HVAC) surfaces showed concentrations of Aroclor 1016/1242, 1254 and 1260 ranging from <0.4 to 2208 $\mu g/m^2$. Subsequent air sampling throughout the building, revealed levels of, basically, the lower molecular weight PCBs ranging from <0.01 to 0.07 $\mu g/m^3$. Results are presented and potential sources are discussed.

Introduction

An electric switch explosion in the vault of an office building was followed by a series of clean up and sampling operations. One of the wipe samples from a ventilation duct showed 760 $\mu g/m^2$ PCB and indicated the need for a thorough evaluation of the presence of PCBs inside the Heating, Ventilating and Air Conditioning (HVAC) system, as well as in the indoor air. The objectives of the study were: 1) to determine the extent of PCB contamination in the HVAC and in the building air, 2) to compare the findings to results from other studies and 3) to evaluate the potential health risks to persons working in this building. A stepwise approach was taken, with the HVAC study conducted first, followed a few months later by an air quality investigation.

Experimental

1. **Building characteristics**

The 1st floor of this 6-story building is served by a separate HVAC system with ducted supply and return. Floors 2 through 6 are served by an HVAC with ducted supply and dropped ceiling (plenum) return. Two parallel return air shafts, one in the north and the other in the south side of the building, connect the return air plena from each floor. Fluorescent light fixtures with PCB containing ballasts are used throughout the building.

2. **Sample location and methodology**

Wipe samples were collected from supply and return air ducts, from the mechanical room fans and return air baffles, and from the two shafts at the points where the return air plena on each floor meet the shafts. Samples were collected using cotton gauze pads soaked in hexane. Because of the complexities of the surfaces to be sampled (curvature, access, etc.), varying surface areas were sampled ranging from 20cm x 12cm to 50cm x 50cm. Since the surfaces of the HVAC could be very dusty in some locations, we obtained an estimate of the concentration of the PCBs in the dust (mass of PCBs per mass of dust), in addition to the conventional mass of PCBs per area sampled, by weighing the pads before and after sampling.

Air sampling took place during a 3-day holiday, when most of the employees were away from the building. The HVAC system, however, was set to operate under normal, working hours conditions, throughout the 60+ hours of sampling. Small size personal pumps were used at a flow rate of about 500 mL/min for about 60 hrs. The sampler consisted of a 37mm cassette holding a glass fiber filter, followed by a glass tube, 110mm x 8mm OD, containing two sections (400 and 200 mg) of Florisil. Flow rates were monitored twice a day by a calibrated rotameter.

Air samples were collected systematically throughout the building. The pumps were placed on desktops to sample from what would be the breathing zone of a seated person. Four pumps were placed in the 1st floor conference room to get an estimate of the variability of airborne PCBs. Outdoor air was sampled on the roof.

**3. Analytical methods**

Wipe samples Following the post-sampling weighing, the gauze pads and their vials were Soxhlet-extracted with hexane for 16 hrs and the solvent exchanged to iso-octane. Aliquots were injected into a GC/ECD with a 60m DB-5 capillary column. PCBs were identified and quantitated using 5 marker peaks from each of Aroclor 1242, 1254 and 1260. It is not possible to distinguish between Aroclor 1242 and 1016 with this analytical procedure; results of this low molecular weight fraction are reported as Aroclor 1016/1242.

Air samples A modification of NIOSH Method 5503 was used to extract and analyse the samples. The filter and the front section of the Florisil tube were combined and extracted with 10 mL of hexane for 30 min on a vibrating platform, the solvent exchanged to iso-octane and aliquots analysed as above. The back-up sections were analysed separately to check for breakthrough.

## Results and Discussion

Wipe samples from the HVAC were collected in June of 1989. Air samples were collected in January 1990 and additional wipe samples were collected after the completion of the air sampling, to confirm the levels in the HVAC. The results are summarized in Table 1.

In addition to confirming the high levels initially measured in a duct, the June round of sampling indicated widespread PCB contamination in the HVAC. Aroclor 1016/1242, 1254 and 1260 were measured at all locations but the Aroclor-specific profile varied with no consistent pattern. When all Aroclor types were summed and expressed as total PCB, the distribution appeared log-normal with a geometric mean (G.M.) of 142.9 $\mu g/m^2$ and a geometric standard deviation (G.S.D.) of 2.8. Expression of the results in $\mu g/m^2$ is used here for comparative purposes only, since it is not appropriate in this case because of the varied dust loading on the duct surfaces. Results expressed in $\mu g/g$ take into account the dust loading and are more relevant; however, historically, data have not been reported in these units and cannot be used for comparison. Table 1 shows the summary statistics in both types of dimensions. The total PCB measurements were higher than levels reported from three other buildings with PCB measurements in the HVAC. These buildings[1,2] included two office buildings with no known history of transformer failure that had, respectively, G.M. of 129 and 47 $\mu g/m^2$ and G.S.D. of 2.6 and 2.3, and a building with a PCB transformer fire that had a mean of 50 $\mu g/m^2$ and a standard deviation (SD) of 110 $\mu g/m^2$. These same buildings had also been sampled for airborne PCBs. The relationship between PCBs in the HVAC and PCBs in the indoor air of those three buildings indicated that air levels in the building under investigation might be unacceptably high. This possibility prompted the air sampling to evaluate the airborne PCB levels to which people working in this building might be exposed.

To avoid any disturbance of the dust loading on the ducts that could bias the air measurements, a second set of wipe samples was collected immediately after the completion of the air sampling. These wipe samples were collected from selected areas adjacent to previous samples to determine any changes in the status of the PCB levels in the HVAC. No major changes were observed between repeat samples and, therefore, the air measurements could be compared to the set of wipe measurements collected a few months earlier.

The air samples showed very low levels of, predominantly, Aroclor 1016/1242. The other two Aroclor types repeatedly found in the HVAC were not detected in the air. When, instead of Aroclor type, individual PCB isomers were examined, the low molecular weight isomers contributed almost exclusively to the total airborne PCBs. No Aroclor was detected in the outdoor air. The four replicate samples from the conference room were practically identical, indicating homogeneity. The results, summarized on Table 1, are in the low end of the range reported in other studies[3,4] of office buildings, home kitchens and schools. Levels in this building were well below the most stringent guideline for airborne PCBs. This guideline of 0.5 $\mu g/m^3$ was set to be equal to or lower to what is commonly found in office buildings, and it is well below that which would pose any significant health risk[1,2].

Aroclor 1016 was identified in all three types of ballasts in the fluorescent lights used in the building. Following the air sampling, a partial inspection of the building revealed that 1/3 of the ballasts examined were leaking. It has been estimated that of all ballasts that have leaked, or otherwise failed, 10% involve a capacitor rupture. In addition, the tar-like insulation material is often contaminated with PCBs even though the capacitor is intact[5].

Other studies had indicated a simple relationship between the levels found inside the HVAC and in the indoor air[1,2]. Such a relationship did not seem to apply in this building. It is likely that, in this building, the HVAC serves primarily as a "sink" for a variety of physical and chemical agents present, at one time or another, in the air. Currently, the predominant source appears to be the fluorescent lights. One may speculate that Aroclor 1016 vaporizing from the ballasts adsorbs onto dust particles that eventually settle on the HVAC surfaces. The presence of other Aroclor types in the HVAC may be similarly attributable to other past sources, including the electric switch failure that triggered the whole study. On the other hand, depending on the temperature and pressure inside segments of the HVAC, low molecular weight PCBs present on the surfaces may be selectively volatilizing and carried into the air flowing past them. This slow rate of release may be the result of good adhesion of the oily particles onto the surfaces that eventually act as a filtering system, trapping more dust particles.

In conclusion, the levels of PCBs in the indoor air of the building were found to be within the normal background levels for office buildings, even though the PCB concentration in the dust inside the HVAC ducts averaged 7 ppm.

Table 1. Summary statistics for total PCBs in wipe and air samples

| | JUNE 1989 | | JANUARY 1990 | | |
|---|---|---|---|---|---|
| | WIPE | | AIR | WIPE | |
| | $\mu g/g$ | $\mu g/m^2$ | $\mu g/m^3$ | $\mu g/g$ | $\mu g/m^2$ |
| N | 22 | | 20 | 6 | |
| min | <0.4 | <20 | <0.01 | 2.2 | 71.4 |
| max | 16.6 | 2208.3 | 0.07 | 7.2 | 133.3 |
| Median | 7.0 | 187.8 | 0.02 | 3.5 | 116.2 |
| Mean | 6.9 | 264.2 | 0.03 | 4.0 | 109.2 |
| SD | 4.1 | 453.5 | 0.02 | 2.1 | 21.3 |
| CV% | 59.3 | 171.6 | 66.6 | 52.5 | 19.5 |
| G.M. | 5.4 | 142.9 | 0.03 | 3.6 | 107.2 |
| G.S.D. | 2.4 | 2.8 | 1.86 | 1.7 | 1.2 |

**Acknowledgement**
Paul Hypnarowski, California Department of General Services, was instrumental in the planning and execution of this study. Mark Leary and Beth Ambacher, with the Toxic Substances Control Program contributed in the planning and sample collection. Jon Rosenberg, M.D., California Department of Health Services, reviewed the study reports and contributed the health risk evaluation.

References

1. Kominsky, JR. Commercial Office Buildings. Boston, Mass. Health Hazard Evaluation Report. HETA 86-472-1832. NIOSH, Cincinnati, Ohio, 1987.

2. Kominsky, JR and Melius, JM. New Mexico State Highway Department, General Office Building. Santa Fe, New Mexico. Health Hazard Evaluation Report. HETA 85-414-1805. NIOSH, Cincinnati, Ohio, 1987.

3. MacLeod, KE. Polychlorinated biphenyls in indoor air. Environ. Sci.Technol. 15: 926, 1981.

4. Oatman, L and Roy, R. Surface and indoor levels of polychlorinated biphenyls in public buildings. Bull.Environ.Contam.Toxicol. 37: 461, 1986.

5. Hypnarowski, P. California Department of General Services. Personal communication.