PCBs IN SCHOOLS-A GLOBAL LEGACY SOURCES, INDOOR BEHAVIOR AND REMEDIAL MEASURES

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Introduction
In the United States alone, more than 1.4 billion pounds of PCBs (polychlorinated biphenyls) were produced for use in building components such as electrical equipment, hydraulics, paints, plastics, and caulks between 1925 and 1978 [1]. More than one-half of U.S. educational buildings were constructed between 1946 and 1969, and nearly 40 percent were built during or after the 1970s [2]. As a result, the potential for indoor air contamination in schools exists as most were built during the peak application of PCB-laden building materials.

Although the manufacture and most uses of PCBs were banned in 1979, buildings that were constructed or renovated from 1950 to 1978, including schools, may have PCBs in the caulk, lighting fixtures and other building materials. Exposure to PCBs in caulk may occur as a result of their release from the caulk into the air, dust, surrounding surfaces and soil, and through direct contact. In September, 2009, the USEPA published a series of guidance materials pertaining to the management of PCB Caulk in older buildings. The guidance materials explained the current state of knowledge regarding PCB Caulk and set forth best management practices for addressing PCB Caulk.

PCBs Uses and Potential Sources
Common historic uses of PCBs in building materials include the following: Sealants, Paints, Coolants, Electric Fluids, Caulking, Adhesives, Flame Retardants, Heat Transfer Fluids, Hydraulic Lubricants, De-dusting Agents, Cutting Oils, and Carbonless Copy Paper.

Primary Sources
The primary sources include those building materials that were manufactured containing PCBs or had PCBs added during construction. These sources include caulking, fluorescent light ballast capacitors, and window glazing.

Lighting Ballast
If PCBs are identified in the air, the first potential source to examine is light fixture ballasts. Common to school settings, PCB ballasts that have failed or are leaking can contribute to PCB in air concentrations. Survey Results for PCB-containing fluorescent light ballasts representing four (4) schools located in New York City are shown in Table 1. From these data it was concluded that the majority of the ballasts examined likely contained PCBs (44-95% of total numbers surveyed). [3]

Table 1. PCB-containing fluorescent light ballast survey results from four (4) NYC schools. [3]

School	Ballasts Not Containing PCBs	Ballasts Likely Containing PCBs	Total Ballasts in School	% Ballasts Likely Containing PCBs
1	310	417	727	57%
2	114	373	487	77%
3	344	275	619	44%
4	48	879	927	95%

Removal and replacement of the PCB light ballasts and associated fixtures had pronounced effect in terms of lowering PCB levels in air in the three (3) New York City schools in which more than one remedy was implemented. PCB containing lighting ballasts remain in use in older buildings within the New York City school population. These lighting ballasts serve as a primary source of PCBs. Higher PCB emissions are associated with leaking or failed capacitors and ballasts. PCB residues that remain on lighting fixtures that previously housed PCB containing ballasts and/or capacitors also serve as a source. [3]

Caulking
Caulks and glazings, which are potential sources for PCBs throughout a building, can be identified by performing building surveys. Each homogenous material identified during the building survey can then be analyzed for PCBs (EPA Method 8082). Those caulks and glazings with PCB concentrations ≥50 mg/kg are classified as PCB Bulk Product Wastes. Building materials with PCB concentrations <50 mg/kg may not be regulated. However, the building owner must be able to demonstrate that these materials have not been altered by subsequent renovations or contaminated by materials that were already in place. Removal of PCB Bulk Product Wastes is required and PCB concentrations in indoor air may decrease following removal actions.

The majority of the interior caulk samples (82% of the 427 samples collected) representing six (6) schools in New York City contained PCBs less than 50 ppm PCBs. Only 6% of the samples contained greater than 100,000 ppm PCBs. Conversely, only 37% of the exterior caulk samples collected contained PCBs less than 50 ppm PCBs, while 41% contained greater than 10,000 ppm PCBs. [3]

Secondary and Sink Sources – PCB Fate and Transport Indoors
Secondary sources include building materials that contain PCBs introduced during product manufacture, as well as, sink or reservoir materials that have adsorbed PCBs from room air overtime emitted initially from primary sources such as caulking and light ballasts.

The New York City Pilot Study results indicate that various PCB caulk remedial alternatives did not result in corresponding significant reductions in PCB concentrations in room air. As a result, it is likely that caulking does not represent the only significant source at those locations where remediation took place. USEPA analyses of data from four (4) schools concluded that room air PCB concentrations in two (2) of the schools were higher than the maximum estimated air concentrations attributable to emissions from caulk sources alone. These data suggest that other non-caulk PCB containing materials or secondary sources represent significant emissions sources of PCBs in a number of the pilot schools examined. [3]

Sink materials will adsorb PCBs emitted into indoor air. Some of the strongest sink materials include petroleum based and latex based paints, and certain types of carpet. Conversely, some of the weakest sinks include solvent-free epoxy coatings, brick masonry and some types of flooring. After the primary sources have been removed (ballasts and caulking for example) the sink materials may become secondary sources and re-emit sorbed PCBs.[5] This phenomenon may help explain higher than expected post remediation air concentrations that have been observed in some schools.

Paints may be amongst the most important of all secondary sources. This is attributable to the relatively high concentrations of PCBs found in paints in New York City schools (median 39.1 ppm; 143 samples) and large areas represented by painted surfaces. [3]

Test chamber results and mass transfer model estimates demonstrate that the PCB sorption concentrations in a sink increases as a function of time, while the actual rate of sorption decreases as a function of time. The sink sources adsorb PCBs present in room air and continue to do so while the primary sources remain in place. Once the primary sources are removed the sink sources now may serve as re-emitting PCB sources. [5]

PCB homologue patterns present in sink materials often are similar to the homologue patterns present in the primary sources (light ballasts and caulking). These findings prohibit identification of sources contributing to indoor air concentrations based solely on PCB patterns. These observations are attributable to the behavior of PCBs within indoor environments. More specifically, emissions from primary sources are comprised primarily of the more volatile PCB congeners (lower molecular weight and higher vapor pressures). Sorption by sink sources is comprised primarily of the less volatile PCB congeners (higher molecular weight and lower vapor pressures). These two (2) competitive processes result in the presence of very similar, but not identical patterns in both primary and sink sources. [5]

The transport of PCBs from indoor air to settled or surface dusts is primarily influenced by sorption capacity of the solid. As a result, the transport of the higher molecular weight and less volatile PCB congeners is favored. [5] Dust to source and dust to dust partitioning is a more important transport mechanism for PCBs than partitioning that occurs between indoor air and dusts. [5]

Mitigation and Abatement Measures

EPA recommends a series of "best practices" to minimize potential exposures to airborne PCBs or dust contaminated with PCBs. A building owner may implement these practices without performing any sampling that might trigger other regulatory requirements. These practices include improved ventilation to reduce dust levels. Improving ventilation has been demonstrated as an effective means for reducing PCB concentrations in indoor air. For buildings with central air handling systems the building owner should take measures to make sure that ventilation systems are functioning properly (including fresh air intakes), balanced, and that sufficient maintenance is performed including changing out air filters to keep potentially contaminated dust from spreading throughout the building. For buildings without ventilation systems, EPA recommends opening windows or installing fans but these methods are less effective and may not be feasible. Improved housekeeping procedures can also be employed to reduce dust levels. It is recommended that wet mopping or vacuuming with high efficiency particulate air (HEPA) filters be used as these are most effective in removing dust as dry sweeping may only spread potentially PCB-contaminated dust. The focus of the improved housekeeping procedures should be on high use areas (e.g., desks or cafeterias) as these are the areas where the greatest potential exposures to PCBs can occur. However, the building owner should also evaluate cleaning areas that are never or infrequently addressed during routine housekeeping. These are areas where potentially contaminated dust can accumulate and continue to be a source of PCBs to the indoor environment.

New York City Pilot school data confirm that dust removal represents a significant remedial measure for the mitigation of PCBs present in indoor environments. These remedial measures should include the removal of both bulk and surface dusts. Dusts represent an important exposure pathway that includes inhalation, non-dietary ingestion and dermal contact. Cleaning of schools will reduce dust levels and in turn reduce exposures to PCBs found in indoor air and on dust laden surfaces. [3]

The New York City Pilot Study remedial investigation demonstrated that measures taken could substantially reduce indoor air PCB concentrations in schools with elevated pre remedial levels. A considerable part of the reduction occurred after school cleaning (e.g. remove dusts) and removal of PCB containing light fixtures. The remedial measures implemented (caulk remediation, light fixture and ballast, removal, cleaning, ventilation, etc.) in the schools were "successful in substantially reducing the indoor air concentrations and exposures to PCBs." [3]

Caulking Remedial Measures – Some Cautions!

Bulk samples collected from replacement (non-PCB) caulk nine (9) and nineteen (19) months after the new caulk was installed indicated that PCBs from the original caulk appear to have contaminated the underlying substrates, and in turn, those PCBs had penetrated and contaminated the replacement caulk. These results suggest that removal and replacement of PCB caulk, without additional remedial measures to isolate and/or treat (e.g. chemically) the underlying substrate prior to installing the new caulk, is of limited benefit. [3]

Long-term monitoring results consisting of wipe samples from surfaces of PCB caulk that were encapsulated at a New York City school indicated that PCBs from the caulk had migrated through the encapsulant layer to the surface over time. These results indicate that the coatings used and methods employed in the pilot study do not represent an effective remedial measure for encapsulation of PCB caulk. USEPA laboratory tests performed with ten (10) commercially available coatings indicated that encapsulation was not effective when high concentrations of PCBs were present in the caulk. Furthermore, none of the ten (10) encapsulants examined by

USEPA were found to be truly impenetrable to PCBs. [6] As a result, encapsulation of PCB caulk using commercial products that are currently available may only represent a short term or interim control measure and not a long term or permanent remedial measure, especially when high concentrations of PCBs are present.

References

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