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@@, @@, 2012

Mr. @@
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Dear Mr. @@,

Polychlorinated biphenyls (PCBs) have been detected in floor boards, a concrete slab, and soil at and beneath Building @@ in @@, Massachusetts. I have been asked, as a toxicologist, to assess whether demolition, renovation, and other recent activities at the site would have harmed workers' health due to PCB-exposures.

To make this assessment, I asked my colleagues Stephen Zemba, Ph.D., P.E., and Richard Lester to estimate the concentrations of PCBs likely to have been in air breathed by workers during sawing of PCB-contaminated floor boards in Building @@.[1] Their estimate is 0.02 micrograms of PCBs per cubic meter of air (0.02 $\mu g/m^3$).

The relevant permissible exposure-limit for PCBs, established by the federal Occupational Safety and Health Administration (OSHA), is 500 $\mu g/m^3$, averaged over an 8-hour work-day (29 *CFR*, 1910.1000 Table Z-1); this is also the guideline developed by the American Conference of Governmental Industrial Hygienists (ACGIH; 2001). *Per* ACGIH, the guideline "is intended to minimize the potential for eye, skin, and respiratory tract irritation; liver cell toxicity; and chloracne." Several studies of workers (Meigs *et al.*, 1954, and other studies, as discussed in NIOSH, 1977), however, suggest adverse health effects at PCB-concentrations as low as 100 $\mu g/m^3$. Accordingly, to be conservative and health-protective, I have chosen to use a safety factor of 50 relative to the OSHA and ACGIH limits, thus generating an exposure-limit of 10 $\mu g/m^3$.

Because our exposure-estimate for @@ workers (that is, 0.02 $\mu g/m^3$) is well within this conservative, health-based limit of 10 $\mu g/m^3$ (and, clearly, within the OSHA and ACGIH limit of 500 $\mu g/m^3$), the data indicate that exposures at this site were harmless. Relevant details are as follows.

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[1] I focused on floor-board sawing because it would have been the largest source of PCB-exposures to workers at this site. PCBs were detected in a concrete slab between Buildings @@ and @@, but this slab has not been disturbed and would thus not have resulted in any significant worker-exposures. PCBs were also detected in crawlspace soil beneath @@, but any exposures there would have been much smaller, and less frequent, than those associated with sawing. Further, any lead or asbestos abatement-work done in the crawlspace would have involved personal protective equipment that would have essentially excluded exposure to PCB-containing dust.

**Exposures and health effects due to PCBs**

From the 1930's through the 1970's, PCBs were used in many industrial processes and hundreds of products. Prominent among these products were various types of electrical equipment. Dielectric fluids used in electrical transformers and capacitors, for example, contained PCBs at concentrations ranging from 30% to essentially 100% (Monsanto, 1995), and saturating baths for wire insulation formerly (in the 1930's and '40's) contained large concentrations of PCBs and related compounds. In contrast, as tabulated below, the average concentration of PCBs detected in floor-boards in Building @@ is only 5.8 parts per million (ppm) — which is 0.00058%.

PCBs have very little acute toxicity, so that short-term exposures — such as over days, weeks, or several months — to moderate amounts are not known or expected to be harmful. In contrast, chronic — that is, on the order of five months or more (Meigs *et al.*, 1954) — and direct contact with PCBs-rich fluids, and/or exposure to large concentrations of PCB-vapors and aerosols in air, proved early-on to be dangerous to factory-workers, leading in some cases to the development of a severe form of acne (termed chloracne) and, in extreme cases, liver failure (Jones and Alden, 1936; Schwartz, 1936; von Wedel *et al*., 1943). Recognition of these hazards led to much tighter control of workplace exposures (via skin as well as via inhalation of PCB-vapors and aerosols), such that occupational exposures since the 1950's are not known to have caused chloracne, liver toxicity, or other diseases (ACGIH, 1986).

The weight of scientific evidence indicates that even high-level occupational exposures to PCBs have not caused cancer in humans (ATSDR, 1999; Golden & Kimbrough, 2009), so that the much lower-level exposures to PCBs prevalent today (in the workplace and in our general environment) would not be expected to cause cancer. Large and sustained exposures to PCBs do cause tumors in laboratory rodents, but rodents appear to be more susceptible than humans to PCB-induced toxicity, and even the high-level occupational exposures of decades past are smaller than exposures used in the rodent studies (Golden & Kimbrough, 2009).

**Exposure-estimation**

To estimate airborne concentrations of inhalable dust during floor-board sawing, we relied on data from two relevant studies. A study of wood dust among carpenters in the construction industry (Spee *et al.*, 2007) reported a typical concentration of inhalable dust of 3.3 mg/m³. This is the geometric mean of measurements for 26 carpenters at 13 different building projects, and corresponds to what would be expected for a typical construction project. Another study (Teschke *et al.*, 1999) reported geometric mean *total* dust (that is, both inhalable dust and dust that is too large to inhale) concentrations of 1.83 mg/m³ for carpentry and floor laying, 1.77 mg/m³ for lumber and building materials, and 2.33 mg/m³ for carpenters in the construction and maintenance industry. We selected the largest of these wood dust concentrations (3.3 mg/m³) for our exposure-assessment. We made two other, conservative assumptions. First, we assumed that workers at @@ wore no dust-masks or other protective equipment while sawing floor boards. To the extent that they in fact wore such masks, their exposures to dust (and hence to PCBs) would have been smaller than those we have estimated. Second, we assumed that all of

the wood-dust in air was from contaminated floor-boards, whereas in fact some such dust would have been from uncontaminated lumber.

As noted above, if PCBs in air are to be harmful to health, airborne-concentrations must be relatively high — approximately 100 µg/$m^3$ or more. Moreover, for non-acutely toxic compounds such as PCBs, it is exposures over the long term, rather than day-to-day variations in exposure, that determine health-risk. At this site, we understand that floor-board sawing and wood floor replacement took place over a period of approximately 8 weeks, in @@ and @@, 2011 — so that it is the average, airborne exposure to workers over these 8 weeks that is the appropriate metric.

As shown in the Table, the overall average concentration of PCBs in floor-boards in Building @@ is 5.8 parts per million (ppm). To derive this value, we first calculated the average PCB concentration on each floor based on all PCB measurements in wood flooring, assuming that PCBs when not detected could nonetheless have been present in those samples at essentially 99% of the detection limit. Prior to the notice to cease operations on @@, 2011, we understand that floor replacement work was performed on all four floors of Building @@, and on the top two floors of @@. The average PCB concentrations on each of these floors are tabulated below. We estimated the overall PCB concentration to which workers may have been exposed as the mean of the average PCB concentrations on these six floors.

**Average concentrations of PCBs in floor boards where floor replacement occurred**

| Location | Average concentration of PCBs in floor boards (parts per million; *i.e.*, mg/kg) |
|---|---|
| Building @@ -Location 1 | 0.35 |
| Building @@ -Location 2 | 1.9 |
| Building @@ -Location 3 | 29 |
| Building @@ -Location 4 | 1.1 |
| Building @@ -Location 5 | 0.52 |
| Building @@ -Location 6 | 1.8 |
| **Overall average** | **5.8** |

Please note that concentrations of PCBs *in floor boards* — which are expressed as mg of PCBs per kg (equivalently, ppm) of wood, are a different metric than concentrations of PCBs *in air* — which are expressed as µg of PCBs per cubic meter of air.

Based, then, on an airborne dust concentration of 3.3 mg/m³, and an average PCB concentration in that wood-dust of 5.8 ppm, the average PCB concentration in air at this site during floor demolition and replacement would have been this:

3.3 mg dust/m³ × 5.8 mg PCBs/kg × 0.000001 kg/mg × 1,000 µg/mg = **0.02 µg PCBs/m³**

where 0.000001 kg/mg is the conversion factor between milligrams and kilograms, and 1,000 µg/mg is the conversion factor between micrograms and milligrams.

As noted above, the data indicate an airborne concentration of 0.02 µg PCBs/m³ (particularly over a period of only two months) would not have harmed people's health.

Please feel free to call or write should you wish to discuss these or related matters.

Thank you, and best regards.

Laura C. Green, Ph.D., D.A.B.T.
Senior Scientist and President

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