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Building K-1, Room 3B35
November 22, 1978

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Subject: Chemical Constituents of Heavily Used PCB-Based
Transformer Oil

Dear Dr. McKinney,

Thank you for your letter of November 15, and even more for the extra work that you and your collaborators did to provide at least partial resolution of the questions I raised on October 17. If I understand your findings correctly, as reported in your letters of September 22 and November 15, one can now draw the following conclusions:

1. Exposure History. We started out with dielectric fluid from a transformer that had seen 20 years of heavy duty service, but no solid evidence that the fluid had been in there all that time. Your findings that the PCB was predominantly Aroclor 1260 and the stabilizer predominantly phenyl tin puts the date of manufacture of the fluid back in the early 1950's, thus supporting the presumption that it had been in the transformer all the time. Additional support for the presumed exposure history is provided by your observed conversion of the original tetraphenyl tin to triphenyl tin hydroxide.

2. Composition of Exposed Fluid. Your analyses turned up several extraneous contaminants, such as aliphatic hydrocarbons, polycyclic aromatic hydrocarbons, phthalate esters, thiazols, and brominated aromatics, but all at the low levels expected for normal industrial cross-contamination with non-Askarel dielectric fluids, plasticizers, antioxidants, flame retardants, etc. There is no evidence that any sizeable amount of a non-Askarel fluid was ever added as make-up. In short, the fluid exposed in the transformer was indeed a conventional 1950-era Aroclor 1260 - trichlorobenzene-tetrachlorobenzene mixture. The latter two components are prepared by random chlorination of benzen and are known to contain a broad range of isomers and homologs.

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3. Identification of Polychlorinated Diphenyl Ethers in both Used and Unused Fluids. I believe this is the most novel finding to come out of your work, and one that is still enigmatic. At least some of the PCDPE must have been present from the start, but we cannot exclude the possibility that some was also formed in service until we can get ahold of a control sample of 25-year old unused fluid. Monsanto data indicates that there wasn't any PCDPE in their PCB's of recent manufacture. We've checked over some of our GC data here and found one trichlorobenzene spectrum showing peaks in the $C_{12}Cl_x$ range different from those resulting from photochemical coupling, but no mass spec was done at the time to determine whether the contaminants were PCB's or PCDPE's. We've also just run across a chlorodiphenyl ether contaminant in a p-chlorobiphenyl specimen that we were using for biodegradation studies. My guess is that the PCDPE's found in the dielectric fluids got in there as original contaminants in the tri- or tetrachlorobenzenes (the latter would explain the high degree of chlorine substitution seen) but we don't have any definite proof as yet.

4. Undetectability of Polychlorinated Dibenzofurans in Either Used or Unused Transformer Oils. I gather from your November 15 letter that the previous identification of a hexachlorodibenzofuran in unused oil now looks pretty doubtful: the chromatographic behavior (binding weak to silica, strong to alumina) doesn't fit, nor does the mass spec. The presence of PCDPE's at the 2000 ppm level in the old oil certainly complicates the detection of trace levels of PCDF's therein, but it's obvious that that used oil could not contain anything like the 10,000 ppm of PCDF reported for Yusho oil. In addition, you found it to lack the quaterphenyls that were apparently formed by pyrolysis in the Yusho oil at levels some 50-fold greater than those of the PCDF's. I think we must conclude from this that although one cannot exclude the possibility that the level of PCDF in the transformer fluid may have increased slightly over the 0.5 ppm level reported for Aroclor 1260, there is also no evidence that it actually did; and further no evidence that usage in the transformer ever subjected the PCB to sufficient thermal or chemical stress to cause any structural alteration.

Please let me know if the above summary misstates your views in any way. As I indicated in my letter of February 15, we are concerned over the question of PCDF levels in old PCB-type transformers because these devices do show up at our service shops from time to time -

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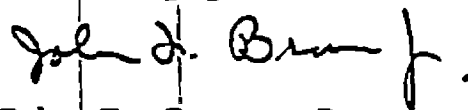
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whether for service, rebuilding, or dismemberment for disposal - and exposure of workers to the PCB-soaked parts is almost inevitable. Existing guidelines for handling PCB's apparently presume that all specimens are as toxic as Yusho oil, and hence probably provide safety factors of many thousands. If there is any evidence that this is not the case, we need to know about it.

I gather from the final paragraph of your November 15 letter that you've already done everything you consider appropriate as regards the detailed chemical analysis of transformer fluids, and would be willing to turn over the raw data (chromatograms, spectra, etc.) if we'd like to have it. We would indeed very much like to have this information; please pack it up and send it to me here.

Again let me thank you for your help with a job that obviously turned out to be far more complex than any of us suspected at the outset.

Sincerely yours,



John F. Brown, Jr.
Mgr - Life Sciences Branch
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cc: I. Selikoff (Mt. Sinai)
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