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Building K-1, Room 3B35
February 13, 1978

Dr. James D. McKinney
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Dear Dr. McKinney:

My apologies for not getting to you faster with the background information on the samples of used and unused transformer-type PCB formulations, or the issues of concern. The story turned out to be a bit more complicated than I had realized.

Basic Concerns. To my knowledge, every reported episode of chronic human poisoning (e.g., chloracne, etc.) associated with exposure to PCB's has involved a PCB preparation that was either known to contain toxic contaminants or else had been subjected to considerable heating, or both. In the most dramatic and recent episode, the 1968 Yusho incident in Japan, the heating occurred in a heat exchanger, considerable alteration of the PCB resulted, and sizeable amounts of the highly toxic PCDF's are known to have been formed. However, heat exchangers are not the only devices where PCB's are exposed to heat. For forty years, a few percent of all transformers manufactured in this country have contained PCB-based dielectric fluids (another few percent were dry-type, and the remaining 90% filled with a special grade of mineral oil). The PCB-filled transformers were those designed for indoor use in factories, public buildings, laboratories, etc. (you've probably got one somewhere in your own lab) and also on railroads. Both types are designed for a maximum operating temperature around 100°C - far less than might have been encountered in, e.g., heat exchanger applications - but in some instances such temperatures may have been frequently attained over prolonged periods. Eventually, any transformer is likely to show up at a service shop for maintenance and repair - operations in which exposure of workers to the dielectric-soaked component parts is almost inevitable. To date, I am aware of no reports of human toxication resulting from such exposure (or, for that matter, to any other PCB-containing product made in the US since 1950); however, in view of the serious effects seen in Yusho, and the large numbers of warm PCB-filled transformers scattered around the country, it seems prudent to find out whether any strange PCB conversion products are being found in those transformers.

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Source of "Used" PCB. According to my informant, Dr. R.C. Osthof the used PCB I sent you came from an industrial transformer that had been subjected to fairly heavy duty for 20 years, i.e., probably 8 hours a day, 5 days a week close to its design limit of 65° over ambient or nearly 100°C. I'll comment on ways of making sure it had that length of service later on. The resulting severity of exposure probably represents close to the upper limit for transformer PCB's in the field. Railroad transformers are designed for a 75° rise over ambient but the ambient averages a lot lower, the maximum loadings are only rarely attained, and they get beat up and leak, so that the PCB doesn't stay in them as long. Fluid loss can occur in industrial transformers too, for reasons that are not well understood; one known route is periodic sampling to check on dielectric properties, which can be quite a drain if practiced over-zealously.

Composition of PCB-based Transformer Fluids. Now for the complicated part: the nitty-gritties about what's actually in those samples. The labels on the containers say "Pyranol," but that is merely a generic trade name for GE-purified and blended non-inflammable dielectric fluids (Askarels), and the 6-digit number that indicates the specific composition has been lost in both cases. So a bit of background and sleuthing is required.

The GE "Pyranols" were all based on commercial PCB's (Aroclors from Monsanto) that had been given quite intensive treatment with "fuller's earth" (specifically, attapulgite clay from the Florida-Georgia border region) to remove all traces of polar impurities. They also contained traces of added HCl-scavengers as "stabilizers." Beyond this, the Pyranols used in capacitors were essentially straight PCB's (Aroclor 1254 up to 1954; mostly Aroclor 1242 from 1954 to 1970; and Aroclor 1016 from 1971 to 1977), while those used in transformers always contained some added tri- and tetrachlorobenzenes for viscosity control and decreased flammability. The historical pattern on transformer-grade Pyranols runs mainly as follows:

1. Prior to the early 1950's, Monsanto used a different PCB production process from their ultimate one, and hence in very old specimens (probably not what you've got here) the distribution of trace impurities at the time of manufacture would be different from that in modern materials; and possibly like that in the European and Japanese PCB's. GE also used tin tetraphenyl as the stabilizer at that time, so if you find any tin in a GE transformer fluid you know you've got a real antique.

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2. During the period 1953-1963, when your "used" Pyranol was probably put in service (assuming that there was no make-up, and it really is all 20 years old) the composition used was 45% Aroclor 1260, 40% trichlorobenzene (commercial mixed isomers; about three-quarter 1,2,4- and one-quarter 1,2,3-), 15% tetrachlorobenzene (also commercial mixed isomers) and 0.125% 3,4-epoxycyclohexyl-3,4-epoxycyclohexane carboxylate as stabilizer.

3. In the late 1960's the favored blend was 80% Aroclor 1242, 13% trichlorobenzene, 7% tetrachlorobenzene, with the same epoxide stabilizer.

4. Since 1970, GE usually used 65% Aroclor 1254, 25% trichlorobenzene, 12% tetrachlorobenzene in manufacturing, but the service shop often used a 60% Aroclor 1254-40% trichlorobenzene blend, or even a Westinghouse "Inerteen" (often a 70%-30% blend) for make-up. The same epoxide stabilizer has remained in the GE transformer-type Pyranols; I don't know what W. puts in their Inerteens.

5. Regardless of original date of manufacture, it is important realize that no one, least of all the manufacturer, really knows for sure what a customer's maintenance crew does to a transformer once they get it. If they lose fluid for any reason, they may use just about anything for make-up: old "Pyranol" they had in storage; new "Pyranol" or Westinghouse "Inerteen" of different composition, or even (rarely) mineral oil. Don't panic if your search for trace contaminants and conversion products turns up something wild; just complain politely and we'll go after another sample.

In short, the bad news is that there's a high probability that the nice new unused "Pyranol" we sent you has a different composition from the used fluid; if it doesn't, it's because somebody drained and re-filled the transformer from which the oil came sometime within the past 7 years. Also, there's no real chance of duplicating the original 1953-63 fluid; it hasn't been used in 15 years, and Aroclor 1260 itself hasn't been made since 1970.

The good news is that because of the progression in Aroclor uses (1260 to 1242 to 1254), and the early switch in stabilizers, it should be possible to confirm the ages of transformer fluids from their chemical compositions. As a minimum, I would strongly recommend that you check

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the gross GC on both the used and unused Pyranol specimens in order to verify their alleged ages. If for any reason you'd rather we do it, let me know and I'll send the other gallon of used oil back to the Transformer Lab people.

My information sources are Drs. Robert C. Osthoff, Manager - Transformer Programs, Tel (413) 494-4381 and William Fessler, an Organic Chemist in the Transformer Laboratory, Tel (413) 494-4391, both located at the GE Large Transformer Dept, 100 Woodlawn Ave, Pittsfield Mass. 01201. They've asked me to handle discussions of toxic impurities in PCB for them, but both are readily available by phone if you need solid information in a hurry and can't get ahold of me.

Sincerely yours,

John F. Brown, Jr.

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