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CLOR-N-OIL™ Test Kit As A PCB Screening Tool

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INTRODUCTION

Utah Power & Light (UP&L) has been faced with the necessity of testing large numbers of transformers and other equipment to determine the PCB content of the dielectric fluid. EPA promulgated marking and disposal regulations of PCBs in 1978 and in 1979 consolidated these into the Use Prohibition Regulations. These regulations established the transformer categories of non-PCB (less than 50 ppm); PCB-contaminated (50-500 ppm); and PCB (greater than 500 ppm).
These regulations have been further refined, mostly as a result of court actions, to include:

Periodic inspection of PCB transformers,
Identification of PCB transformers in food and feed locations,
Removal of such by October 1, 1985,
Identification of PCB transformers in commercial buildings,
Notification of building owners and fire departments by December 1, 1985, and finally,
Removal of some by October 1, 1990.

In addition, UP&L instituted a program to remove and dispose of its PCB transformers by December 31, 1988, a program which requires testing of all Company transformers.

In the scramble to meet all of these requirements, UP&L has investigated every method of testing or screening of PCBs that research has brought to light. So far the Clor-N-Oil™ test kits have been found to be the most effective screening system for UP&L applications given the time limitations imposed by the regulations.

DISCUSSION

The Clor-N-Oil™ test kits were developed by General Electric under contract from the Electric Power Research Institute (EPRI). DEXSIL Chemical Corporation has exclusive license from EPRI to mass-produce the kits for industry-wide use. This kit evaluated by UP&L is designed to give an indication of whether a mineral oil contains more than or less than 50 ppm PCBS. The kit does not measure PCBs but rather measures chlorine content of the oil. It is designed to read positive if the chlorine content of the oil is greater than 21 ppm.

The cut-off point of 21 ppm is based on the chlorine content of the least halogenated Aroclor (1242). In other words, 50 ppm of Aroclor 1242 will contain at least 21 ppm chlorine.

The kit is hand-held and portable. Each kit has its own set of instructions and can be used in the field. The test only takes a few minutes, and the result is an easy-to-read calorimetric determination of the presence of chlorine. The kit will only work on PCB-contaminated mineral oils and Askarel fluids; it will not work on soils, waters, or other material.

One kit will test one oil sample and costs from $3 to $6, depending on quantity purchased at one time. Laboratory Gas Chromatograph (GC) analysis of one sample of mineral oil currently costs $20 to $40. Testing programs can generally be completed much sooner if the test kit is utilized, since it is not necessary to send all samples to the laboratory for GC analysis.

UP&L uses the test kit to screen its distribution transformers for PCB content. In the past, UP&L has not purchased or utilized PCB-type transformers in its distribution plant. It has, however, classified these, by rule, as PCB-contaminated transformers. From our experience, between 80% and 90% of all distribution-type transformers are screened out (classified as non-PCB) by the test kit.

Current computer records show 198,464 distribution transformers in six regions throughout the UP&L system. Some of the regions cover metropolitan areas such as Salt Lake City, and others cover remote areas in Wyoming. In most of the regions, there is considerable irrigated agriculture, with substantial distances between each transformer.

Line crews have been commissioned to collect the samples and deliver them to a central location for testing, or run the test themselves in the field. They take the sample by inserting a piece of polyethylene tubing into the pressure relief valve of the transformer. The oil sample is then collected in new 2-ounce glass vials. They also label the vials

and complete the paperwork which will be used to enter the test information into the company-wide computer.

If the samples test positive (50 ppm or greater) with the Clor-N-Oil™ kit, they are sent to a Utah State-certified laboratory to be tested by GC methods. If a sample tests negative, it is sent to a central facility where it is permanently stored in case GC analysis on the sample is needed at some point in the future, such as in the case of an oil spill.

If a sample tests positive with the test kit (over 50 ppm PCB) and negative (less than 50 ppm PCB) by GC methods, it is termed a "false positive." If it is negative by the kit and positive by GC, it is considered a "false negative". False positives are expected but the rate of false negatives should be very low if the kit is to be considered an effective screening tool.

EPA Region VIII has been contacted regarding the use of the test kit as a screening tool. Region VIII said they had no problem with using the kit, but when asked to put this in writing, hesitated. UP&L then inquired further of EPA in Washington D.C. They responded:

> ".....the Agency presently finds gas chromatography to be the minimum acceptable method for determining the concentration and nature of PCBs in most samples. There is no prohibition against the use of test kits utilizing total chlorine analysis as rough field screening devices to determine if further testing is required. However, any analytical errors resulting from such testing would not insulate a company against prosecution should the Agency obtain evidence of a violation of the PCB rule."[1]

Since UP&L intended to use the test kit extensively in a testing program to be completed in 1986, and since EPA took the position that test kit results could not be used to insulate the Company from prosecution should an analytical error be made with the test kit, UP&L decided to study the probability that such an error might occur. The goals and objectives of the study are as follows:

[1] U. S. EPA correspondence to Utah Power & Light Co. dated February 14, 1985, signed by John S. Seitz, Chief Executive Officer, Office of Compliance Monitoring, Pesticides and Toxic Substances Branch.

GOALS AND PROGRAM OBJECTIVES

1. Determine what percent of a large random sample of distribution transformers could be expecte4m to be "screened out," i.e., test negative, with the Clor-N-Oil™ PCB test kit.

2. Determine whether the portion of transformers screened out by the test kit varies with the transformer manufacturer.

3. Determine what portion of those samples testing positive with the test kit will test positive by GC methods.

4. Of those samples testing positive, determine what portion would be expected to test between 50 and 500 ppm; over 500 ppm PCB.

5. Of those samples testing negative with the kit, determine how many would be expected to test positive by GC methods; i.e., the portion that would be false negatives, and compare this false negative rate with that which would be expected from the Clor-N-Oil™ test kit.

6. Evaluate the probability of a false negative with the kit vs. the probability of a false negative by GC methods.

METHODOLOGY

1. There are approximately 198,000 transformers on the UP&L system. Some of these transformers have been installed since the PCB regulations became effective in 1979. It is company policy to rely on the individual manufacturer's non-PCB certification rather than test these transformers. However, 51,032 transformers have been tested with the kit or with both the kit and the GC. The samples taken to date have been taken from transformers selected at random. The number of transformers sampled so far represents approximately 35% of all the transformers to be tested.
2. Records on each transformer sampled indicate the manufacturer as well as other data. This data has been compiled on the computer and is accessible by various sort programs.
3. All samples testing positive are tested by GC methods at a Utah state-certified laboratory. The results of the GC tests are entered into the computer data base along with the other information mentioned in "2" above.
4. The results of the GC tests, once entered into the computer data base, can be sorted into the PCB-contaminated (50-500 ppm PCB) and PCB (over 500 ppm PCB) categories.
5. Ninety-nine samples testing negative with the kit were tested with the GC to determine if any were actually positive.
6. Twenty samples were prepared by an independent Utah State-certified laboratory to accomplish objective 6. They contained 50 ppm of Aroclor 1260 plus or minus 5%. These samples were then tested by GC methods at another laboratory and by the test kit. The number of test kit negatives was compared with the number of negatives by the GC method.

Various computer sort programs were used to accomplish objectives 1 through 4 and a simple tabulation of the test results satisfied Objectives 5 and 6.

RESULTS

1. Of the 51,032 tests run with the Clor-N-Oil™ kit, 4,523, or 8.9%, tested positive. Therefore, 91.1% of all samples tested were "screened out" with the test kit.

2. From the information in Table I, the test kit seems to be able to screen the transformers made by certain manufacturers slightly better than those made by others. T&R Electric and Standard do not seem to screen as well with the test kit as some of the other manufacturers, since they have a higher rate of false positives. The data shows Northwest to have a 100% positive rate; however, only one Northwest transformer was tested.

   Although there was some variability in the rate of false positives among the various manufacturers, no single manufacturer was considered to have a false positive rate high enough to significantly reduce the usefulness of the test kit as a screening

TABLE I

Manufacturer	Total Tested w/Clor-N-Oil™	No. testing Pos. w/CNO	Total Test. Pos. w/GC	% Positive by GC
Allis Chalmers	2,244	82	9	0.40
Bullock	1	-	-	-
Chance	42	-	-	-
Central Moloney	4,846	811	43	0.88
Colt	46	1	-	-
Dowzer electric	28	14	-	-
Delta Star	49	1	-	-
General Electric	14,635	1,986	1,242	8.48
Howard Industry	901	10	4	0.44
Hill	3	-	-	-
Kuhlman	2,512	20	-	-
Larkin	16	-	-	-
Line Material	1,592	32	2	0.13
McGraw Edison	2,213	39	2	0.09
Moloney	1,185	233	14	1.18
Northwest	1	1	1	100.00
Pacific Electric	2	-	-	-
Pennsylvania	393	90	15	3.82
Porter	61	2	1	1.64
Pole Star	262	12	-	-
RTE	3,961	143	2	0.05
Sorenson Electric	33	2	1	3.03
Spokane	3	-	-	-
Square D	2	-	-	-
Standard	233	36	30	12.88
T&R Electric	31	27	15	48.38
Wagner	3,512	119	38	1.08
Westinghouse	12,029	1,466	562	4.67

3. Of the 4,523 samples testing positive with the Clor-N-Oil™ kit, 2,537, or 56.1%, tested negative by GC methods.

4. Of the 4,523 samples testing positive, 1,830, or 40.45%, were between 50 and 500 ppm by GC methods, and 158, or 3.49%, were greater than or equal to 500 ppm by GC method.

5. Of 99 samples testing negative with the kit, 5 were actually found to be positive when tested by GC methods. All were run again by GC and the result ..confirmed When the 5 samples were retested with the Clor-N-Oil™ test kit, they all tested positive.

6. Twenty samples prepared by an independent Utah State-certified laboratory were certified to be 50 ppm Aroclor 1260 plus or minus 5%. These samples were tested by both GC methods and with the test kit.

The results were as follows:
a.The GC test results on the 20 known samples were as follows:

TABLE 2

PCB Conc. (ppm)	Frequency
47	2
48	1
49	1
52	1
53	2
54	2
55	1
56	2
57	2
58	2
59	1
61	2
62	1
	20

As can be seen from Table 2 above, the GC test was negative on four samples.

b. The same samples were tested with the Clor-N-Oil™ test kit. Seventeen tested positive and three tested negative.

As can be seen from the data above, the GC test actually did not predict as well as the test kit in terms of false negatives. (4 false negatives versus 3 false negatives.) It must be emphasized that the 50 ppm samples were plus or minus 5% and that 20 is a fairly small sample size.

CONCLUSIONS

1. The test kit is an economical PCB screening tool since over 90% of all samples tested were "screened out".

2. The probability of false negatives with the test kit as determined by the data herein is not higher than the probability of a false negative by GC test methods. However, the rate of false negatives experienced by UP&L (5%) is higher than that experienced by other researchers (1.2%, 2.5%) [1,2]. Since all of the false negatives tested positive when retested with the Clor-N-Oil TM kit, the analytical precision of the kit is probably better than indicated by this experiment.

3. There is insufficient variability in the rate of false positives among manufacturers to conclude that the Clor-N-Oil TM kit will not screen the transformers from a particular manufacturer economically.

4. The Clor-N-Oil™ test kit is an analytically acceptable method for screening PCBs in distribution transformer oils.

[1]Riley, Michael T., Detroit Edison Co., "Utility PCB Practices", presented at 1985 T & D Exposition May 14, 1985, Chicago, Illinois (see Table 5), found false negative rate of 1.5% out of 247 tests.

[2]Tahiliani, Vasu H., EPRI "Field Determination of PCB in Transformer Oil, Volume 2: Clor-N-Oil™ PCB Screening Kit", EPRI El-3766, October 1984, Appendix B, pg. 8-10, found false negative rate of 2% out of 1,506 tests.