UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE ADMINISTRATOR

In the Matter of:

PROPOSED TOXIC POLLUTANT EFFLUENT STANDARDS FOR POLYCHLORINATED BIPHENYLS (PCBs)	)	FWPCA (307) Docket No. 4

AFFIDAVIT OF GERALD J. LAUER

DR. GERALD J. LAUER, being duly sworn, deposes and says:

1. I am Senior Scientist and Director of Operations of Ecological Analysts, Inc., Middletown, New York. Seventeen years of my professional life have been devoted to the study of the effects of environmental stresses on aquatic life. Included were six years as a commissioned officer in the United States Public Health Service's Division of Water Supply and Pollution Control research program to determine the fate and effects of pesticides in our Nation's waters. Additional biographical information is contained in the resume which I attach as Exhibit A to this Affidavit.

2. The United States Environmental Protection Agency (EPA) has been given the assignment to develop a prodigious array of standards for discharges into our nation's

waters, including toxic effluent standards for Polychlorinated Biphenyls (PCBs). My comments that follow are intended to constructively assist EPA with the difficult task of establishing a sound rational effluent standard for PCBs. In preparing my affidavit, I have reviewed the Criteria Document prepared by the EPA, and the prepared testimony of all EPA witnesses in this proceeding which bear on the topics I discuss below.

3. The task of promulgating effluent standards for PCBs is very much complicated by the many environmental, experimental, analytical, and chemical variables that must be considered.

4. The toxicity of toxicants such as PCBs varies from species to species and for different life stages of the same species, and depends on a host of variables including the chemical constituents and quality of the receiving water, the duration of exposure, the fate and physical-chemical state of the pollutant in the receiving water, the prior health of the exposed organisms, presence of other pollutants, previous history of exposure, etc.

5. Several different experimental designs are available and have been used for determining the toxicity

and bioaccumulation of pollutants. These include static, intermittent flow-through and continuous flow-through procedures that are imposed for times ranging from hours to a year or more, depending upon the objectives of the investigator. There are a number of other ancillary factors associated with bioassays that can substantially change the experimental result, such as the number of test organisms used, holding effects, disease and treatment of disease, availability and nutritional adequacy of food, solubility of the toxicant and unsuspected losses of the toxicant from the test.

6. Analytical methods employed for PCB residue analyses can also have a variable influence on the results and interpretation of bioassay data. The methodologies have been changing over the past several years, and still require considerable personal judgment on the part of the analysts to modify methods according to the equipment available and the nature of the sample at hand.

7. Judicious use documentation and reporting of quality control procedures, such as control tests, replication, tests of analytical recovery efficiency and accuracy, and monitoring of deviations from standard test operating procedures and methods is required to minimize unrecognized

anomalies caused by the many variables described in paragraphs 4, 5 and 6 above.

8. An additional complicating factor is that PCBs are not a single chemical entity. Each of the commercially available grades of PCB is a complex mixture of PCB isomers and non-PCB species such as chloroterphenyls, chloronsphalenes, and chlorodibenzofurans. (EPA Criteria Document Tables II. 1.1, II. 3.1, and II. 5.2). Mixtures of PCBs have been marketed under various trade names (e.g., Aroclor)*/ that contain 21, 31, 41, 42, 48, 54, 60, 62, 68, or 71 percent chlorine. Since 1971 there has been in the United States a shift to the production and use of the lower chlorinated Aroclors 1221, 1016, 1242 and 1254 (EPA Criteria Document, Table II. 2.2). During this period, Aroclor 1016 has accounted for about two-thirds of U.S. PCB sales (Peakall, 1975)1/ and probably a considerably higher fraction of the total industrial PCB emissions into the Biosphere. Aroclor 1016 differs markedly from that of PCBs marketed prior to 1971 in having less PCBs containing more than four (4) chlorines per

*/ PCBs are sold commercially by the Monsanto Company under the trade name Aroclor.

molecule (1 percent vs. 9 to 100 percent) and polychlorodibenzofurans (≤0.001 ug/ℓ vs. 0.8 to 13.6 ug/ℓ). (EPA Criteria Document Table II. 5.2)

9. Quite obviously, the host of variables briefly discussed in paragraphs 4, 5, 6, 7, and 8 above are the cause of the extremely variable, confusing and frequently contradictory information on toxicity, degradation and bioaccumulation of PCBs contained in the literature and summarized in the EPA Criteria Document. Promulgation of reasonable and technically valid criteria and effluent standards requires a very careful screening of this existing information for data that is both reliable and applicable to the controlling factors operant for each PCB discharge and receiving water body. Consequently, I concur with Dr. William Brungs who testified for the EPA in this proceeding on the need for a case by case approach for regulation of PCB discharges, instead of the single concentration limit of 0.001 ug/ℓ limit for any and all discharges and water bodies in the United States, as now proposed.*/

*/ See Testimony of William A. Brungs, EPA Exhibit U, at page 4.

10. The relative environmental persistence, bioaccumulation and toxicity of Aroclor 1016 compared to higher chlorinated PCBs are about the only important factors that can validly be considered on a somewhat generic basis. The remainder of my comments are addressed to those topics.

11. Persistence is one of the most important determinants of potential for adverse environmental effects by toxicants such as PCBs. Other factors being the same, the less persistent the toxicant is, the lower will be its potential for being dispersed and bio-accumulated. Consequently, the toxic effect of the less persistent toxicants is more localized and restricted to acute effects, except for aquatic organisms that may reside in a mixing zone. Conversely, the more persistent the toxicant, the greater is its potential for being dispersed and bio-accumulated and for causing chronic toxic effects to both aquatic life and consumers of aquatic life, including humans.

12. Laboratory studies indicate that the lower chlorinated PCBs (mono-, di-, tri-, and tetra- CBs), which constitute about 99 percent of Aroclor 1016, are considerably less persistent than higher chlorinated PCBs. Bacteria, aquatic invertebrates and fish are able to decompose mono-, di-, and tri- CBs quite rapidly, but have very little

ability to metabolize tetra- or penta CBs. Applicability of this differential persistence to the natural environment has been substantiated by the observation that most PCBs found in the environment consist of pents and higher CBs, although a substantial fraction of the PCBs released into the environment in the past have been tetra and lower CBs. "The differential persistence and/or bioaccumulation of lower and higher CBs is important in establishing criteria, because it implies differential exposure of human and other target organisms to the various components of the various commercial mixtures."[2/]

13. Bioaccumulation potential for PCBs increases with increased degree of chlorination. Aroclors 1016 and 1242 are composed primarily of CBs lower than tetra whereas Aroclors 1248, 1254 and 1260 are composed primarily of tetra- or higher CBs. Therefore, Aroclors 1248, 1254 and 1260 are generally bioaccumulated to a greater extent than 1242 and 1016. Of special importance is the difference between Aroclor 1016 and 1242 in potential for human exposure to tetra- and higher CBs and chlorinated dibenzofuran. Aroclor 1016 contains on the order of 12 to 32 percent less of those CBs and no detectable chlorinated dibenzofurans. (See Table attached as Exhibit B to this Affidavit)

14. Several studies show convincingly that a given Aroclor is bioaccumulated in direct proportion to the concentration in the surrounding water.[3/ 4/] In other words, the amount of PCB accumulated increases in proportion to increased concentration, but once equilibrium is reached at each concentration, the ratio of PCB concentration in the organism to that of water (bioaccumulation factor) is about the same over a wide range of PCB-water concentrations. Species, and life stages of the same species, often differ considerably with respect to bioaccumulation of the same Aroclor. Also, as indicated above, the bioaccumulation potential of the Aroclor increases with increased degree of chlorination. Consideration must be given to the interaction of both of these variables when evaluating the importance of PCB accumulation.

15. There have been very few laboratory studies wherein biomagnification of different Aroclors by the same species and life stage has been evaluated by the same techniques and investigators, from which one can make comparisons of biomagnification related to degree of chlorination. Two such studies by Hansen, et al.[3/ 4/] showed that sheepshead minnow adults exposed identically to Aroclors 1016 and 1254 for 28 days accumulated about

three times more Aroclor 1254 than Aroclor 1016. These data are contained in the table attached as Exhibit C to this Affidavit. This 3:1 Aroclor 1254 to 1016 bio-accumulation ratio by sheepshead minnow compares to the 5:1 ratio tetra- and higher CBs in Aroclor 1254 versus Aroclor 1016, as shown in Exhibit B.

16. Concentration factors for Aroclor 1016 ranged from 2,500 to 8,100 for fry, 4,700 to 14,000 for adults and 10,000 to 34,000 for juveniles. Concentration factors for pinfish in ten exposures to Aroclor 1016 ranged from 3,000 to 24,000.[5/] Veith[6/] reported a concentration factor of 50,000 for fathead minnows exposed to 1016 for 32 days. Veith[7/] later reported a concentration factor of about 10-40,000 for fish held in a live-car downstream of an industrial discharge to the Hudson River. A frequency histogram of reported concentration factors for Aroclor 1016 is presented in Exhibit D to this Affidavit. Of the 31 concentrations reported from laboratory studies to-date, ninety-seven percent are below 30,000. The highest bio-accumulation factor demonstrated in the laboratory for Aroclor 1016 to-date is the 50,000 value for fathead minnows, as reflected in Exhibit E to this Affidavit.

17. Studies reported by Nebeker, et al.[8] provide the opportunity to compare bioaccumulation factors for Aroclors 1242 and 1254. Aroclor 1242 is generally similar to 1016 except that 1242 has approximately 30 percent more tetra-CBs and 10 times more penta- and higher CBs, so more of the Aroclor 1242 would be expected to persist and be bioaccumulated than Aroclor 1016. The data from Nebeker's paper are summarized in Exhibits D, F and G to this Affidavit. The bioaccumulation factors for Aroclor 1242 are indeed quite similar to those for Aroclor 1016. The single notable exception is the 477,000 value from a test concentration of 0.86 ug/l. While it is not possible to judge whether the 477,000 figure is an error, the only reasonable approach is to consider it an anomaly and remove it from computations for comparisons with Aroclors 1016 and 1254, and for establishment of a criterion for Aroclor 1242. With the removal of that extreme value, ninety-six percent of the bioaccumulation factors compiled for Aroclor 1242 are less than 100,000, and the values ranges from 21,000 to 107,000. (See Exhibit F)

18. Information on toxicity of PCBs to aquatic life is sometimes contradictory and confusing. Some earlier acute (96 hour) static bioassay data indicated that toxicity was highest in the lower chlorinated PCBs.[9]

The validity of these results is questionable because some of the concentrations employed considerably exceeded the water solubility of the PCBs, and most of the more recent information indicates the reverse pattern of increasing toxicity with increasing percentage of chlorine. 3/ 6/

19. Exposure time is an important determinant of toxicity of PCBs to aquatic life. Tolerance to toxic concentrations decreases with increase in exposure time. (See Exhibit H to this Affidavit) But there are concentrations which cause no apparent adverse effect on survival, growth or reproduction even when the exposure time exceeds the generation time of the organisms. Chronic toxicity data for PCBs indicate that most species tested tolerate low part per billion (ug/l) concentrations in the water with no apparent adverse effects on survival, growth or reproduction. Consideration of this time-dose aspect of PCB toxicity is of fundamental importance for determining case-by-case criteria and effluent standards for the various Aroclor mixtures.

20. In summary, a case-by-case approach is the most technically valid approach for establishing criteria and effluent standards for PCB emissions to aquatic environments, rather than the proposed use of a single

numerical standard for all of the United States. The principal considerations which support the case-by-case approach rather than the proposed single across-the-board approach are as follows:

(a) It is my understanding that the United States capacitor industry is now committed to the use of Aroclor 1016.

(b) There is a significant difference (3 fold or more) between Aroclor 1016 and the more chlorinated Aroclors 1254 and 1260 in persistence/bioaccumulation.

(c) The most technically reliable bases for bioaccumulation criteria are the averages of existing observations. These are:

Aroclor 1016	14,225
Aroclor 1242	64,000
Aroclor 1254	194,000

(d) The more conservative approach used in the EPA Criteria Document of selecting the highest reported value from laboratory studies (but then modified by ignoring the

apparently anamalous data) produce the following bioaccumulation criteria:

Aroclor 1016	50,000
Aroclor 1242	107,000
Aroclor 1254	307,000

(e) Using these data, the appropriate water criteria to avoid exceeding the 5 ppm FDA limit on food for human consumption would then be:

(i) for the average case:

	BIOCONCENTRATION CRITERIA	WATER CRITERIA
Aroclor 1016	14,225 [*]	0.38 ug/l
Aroclor 1242	64,000 [**]	0.074 ug/l
Aroclor 1254	194,000 [**]	0.025 ug/l

(ii) for the conservative case:

	BIOCONCENTRATION CRITERIA	WATER CRITERIA
Aroclor 1016	50,000	0.1 ug/l
Aroclor 1242	107,000	0.046 ug/l
Aroclor 1254	307,000	0.016 ug/l

There is for both of these approaches a built-in 3-4 fold safety factor in that these criteria are designed to keep residues in whole fish at or below 5 ppm, whereas on the average, the portion of fish normally eaten

[*] See Exhibit E.

[**] See Exhibit F.

by people could be expected to contain one-third to one-fourth less PCBs than the whole fish.

(f) While the toxicity information for PCBs is somewhat contradictory, the more recent and, for the most part, the more reliable data indicate that Aroclor 1016 ranges from slightly less toxic to one hundred times less toxic than the more chlorinated Aroclors, e.g., Aroclor 1054.[3/]

(g) The greater solubility of Aroclor 1016 may cause it to be equivalent in toxicity to the higher chlorinated Aroclors for short exposures, as would apply to batch or intermittent discharges. However, the lower persistence, bioaccumulation and somewhat lower toxicity of Aroclor 1016 considerably reduces its potential for widespread transport and chronic toxic potential, compared to the higher chlorinated Aroclors such as Aroclor 1254 and 1260, that would be of more concern for continuous discharges.

(h) The case-by-case approach would provide the opportunity to integrate pertinent information of the kinds described above with site specific information on the kind and amount of the Aroclor involved, the type of discharge (whether batch-intermittent or continuous) dispersal and transport, and biomagnification and toxicity for the aquatic life indigenous to the site, in order to assure promulgation of technically valid criteria and effluent standards that are both reasonable and effective for protecting against unacceptable environmental effects.

GERALD J. LAUER

Subscribed and sworn to before me this ___ day of _____, 1976.

NOTARY PUBLIC

My Commission expires:

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REFERENCES

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(2) Criteria Document; EPA 440/9-76-021 at page 279.

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(7) Veith, Gilman D., J.J. Spagnoli, and J.C. Skea. 1975. Uptake of Aroclor 1016 by fish. II. Field bioaccumulation studies. Unpubished report, U.S. Environmental Protection Agency, Environmental Research Laboratory, Duluth, Minn. (cited as Reference 358 in EPA Criteria Document, at page 332).

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(9) Stalling, David L., and Foster Lee Mayer, Jr., 1972. Toxicities of PCBs to Fish and Environmental Residues. Environmental Health Perspectives (April) pp. 159-164.

(10) Industrial Bio-Test Laboratories, Inc. Report to Monsanto Company. Four-day Static Fish Toxicity Studies with Aroclor 1221, Aroclor 5432, Aroclor 5442, Aroclor 5460, and MCS 1016 in bluegills and channel Catfish. January 12, 1972 IBY No. A9330, 27 p.

(11) Stalling, David L., 1971. Analysis of Organchlorine Residues in Fish, Current Research at the Fish-Pesticide Research Laboratory. Internationl IUPAC Congress of Pesticide Chemistry, 2nd, Tel-Aviv. Edited by A.S. Tahori New York, Gordon and Breach, 1972 Vol. 14.

(12) Taken from summary of data prepared by Monsanto Company and attributed to industrial Bio-Test Laboratories report BTL-69-33.

(13) Ibid. BTL-72-82.

(14) Industrial Bio-Test Laboratories, Inc. Report to Monsanto Company, Four-day Fish Toxicity Studies with Aroclor 1242, Aroclor 1254, and Aroclor 1260 in bluegills and channel catfish. November 17, 1972. BTL-72-103, IBT No. A8570, 19 p.

(15) Selikoff, Irving J., 1972. Polychlorinated Biphenyls-Environmental Impact: A review by the Panel on Hazardous Trace Substances. Environmental Research Vol. 5(3) pp. 249-362; see p. 326.