

Industrial **BIO-TEST** *Laboratories, Inc.*

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June 13, 1969

Mr. Elmer P. Wheeler, Manager
Environmental Health
Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166

Dear Mr. Wheeler:

Re: IBT No. A7204 - Four-Day Fish Toxicity
Studies on Seven Materials

We are submitting herewith our laboratory report dated
June 13, 1969 prepared in connection with the above study.

Very truly yours,



J. C. Calandra
President

JCC/kjl

DSW 380661

STLCOPCB4100679

REPORT TO
MONSANTO COMPANY
FOUR-DAY FISH TOXICITY STUDIES ON
SEVEN MATERIALS

IBT NO. A7204

I. Introduction

At the request of Monsanto Company, four-day fish toxicity studies in Rainbow Trout (Salmo gairdnerii) and Bluegills (Lepomis macrochirus) were conducted on the following seven materials:

- 1) Aroclor 1242, Lot #AK-255
- 2) Aroclor 1254, Lot #AK-38
- 3) Aroclor 1260, Lot #AK-3
- 4) Aroclor 5460, Lot #AK-390
- 5) Toxaphene
- 6) Technical DDT (2-1/2#), B0903604
- 7) Halowax 1099, 52 percent Cl

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II. Summary

The results of the four-day fish toxicity studies are summarized below. Due to the paucity of one of the seven test materials (Halowax 1099), complete data are not available and the figures in parentheses represent only range-finding data.

<u>Test Material</u>	<u>Four-Day LC₅₀ (ppm)</u>	
	<u>Rainbow Trout</u>	<u>Bluegill</u>
Aroclor 1242	> 100.0 0.2 ppm	0.66
Aroclor 1254	> 100.0	0.66
Aroclor 1260	> 100.0	> 100.0
Aroclor 5460	> 100.0	> 100.0
Toxaphene	0.0080	0.0056
Technical DDT	0.0052	0.0078
Halowax 1099	(10-100)	(> 100.0)

Respectfully submitted,

INDUSTRIAL BIO-TEST LABORATORIES, INC.

Carmen Mastri

Report prepared by:

Carmen Mastri, B.S.
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Report approved by:

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Otis E. Fancher

Otis E. Fancher, Ph.D.
Director

June 13, 1969

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psh

III. Procedure

The procedure was generally the same for both bluegills and rainbow trout with each test material.

Healthy, young fish with an average length of 35 to 75 millimeters were used as test animals. All fish were kept under observation for a period of not less than ten days prior to experimental use. During this period, the fish were observed for general health and suitability as test animals. The fish were held in large aerated stock tanks and were fed frozen brine shrimp until three days immediately prior to testing. The rainbow trout were maintained at a temperature of 13°C and the bluegills at a temperature of 24°C. All stock tanks and bioassay vessels contained reconstituted, deionized water. The following compounds were added in the amounts stated per liter of deionized water:

- 30 mg calcium sulfate
- 30 mg magnesium sulfate
- 48 mg sodium bicarbonate
- 2 mg potassium chloride

Preliminary screening was conducted in order to find the general level of toxicity before beginning the actual bioassay. Once this level had been determined one to five concentrations were selected for the actual bioassay. Bioassay vessels lined with disposable polyethylene bags were filled with ten liters of well aerated reconstituted water. To evaluate the selected concentrations, ten trout were placed in each bioassay vessel. In the case of the bluegills only five fish were placed in each bioassay vessel in order to insure adequate dissolved oxygen concentration (D.O.)

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in the warmer water; therefore two groups of five bluegills were tested at each selected concentration. An untreated control group consisting of 10 fish was also employed.

After a 24-hour acclimatization period, calculated amounts of test material necessary to produce the desired one to five concentration levels were dispensed into the respective vessels. The test solutions were prepared within one hour of the bioassay.

Following the introduction of the test material the fish were observed for 96 hours during which time all mortalities and/or untoward behavioral reactions were recorded. The concentration of dissolved oxygen was determined for all test solutions in which mortalities occurred, to insure that adequate oxygen was available to the test specimens*. Concentrations of dissolved oxygen of 4 mg/l (4 ppm) for warm water fish (bluegill) and 5 mg/l (5 ppm) for cold water fish (trout) were considered to be minimal for valid testing. The pH of the test solution was also determined when mortalities were recorded.

At the end of the observation period all data were collected and arrangements were made to calculate the 96-hour LC_{50} employing the technique of Litchfield and Wilcoxon**.

* Standard Methods for the Examination of Water and Wastewaters, Twelfth Edition, American Public Health Association, Inc., 1790 Broadway, New York, N. Y.: Part III, pp. 406-410.

** J. T. Litchfield, Jr. and F. Wilcoxon, "A Simplified Method of Evaluating Dose-Effect Experiments," J. Pharm. & Exp. Ther., Vol. 96, No. 2, pp. 99-113.

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IV. Results

No deaths or untoward behavioral reactions were noted among any of the animals in the untreated control groups.

A. Rainbow Trout

1. Aroclor 1242, Aroclor 1254, Aroclor 1250, Aroclor 5460, Toxaphene, Technical DDT, Halowax 1099*

- a. Mortality, DO, and pH Data

The mortality, dissolved oxygen content, and pH data are presented in Tables I through IV.

* Range finding mortality only.

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TABLE I

TEST MATERIAL: Aroclor 1242, 1260, 5460, 1254

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Test Material	Concentration* (ppm)	Number Dead						Total Number Dead	Per Cent Dead	Dissolved Oxygen (ppm) and pH							
		Hours:								1-6 Hr.	24 Hr.	48 Hr.	72 Hr.	96 Hr.			
		1-6	24	48	72	96											
Aroclor 1242	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	
Aroclor 1254	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	
Aroclor 1260	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	
Aroclor 5460	100.0	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	

Four-Day LC50

Aroclor 1242 > 100.0 ppm
 Aroclor 1254 > 100.0 ppm
 Aroclor 1260 > 100.0 ppm
 Aroclor 5460 > 100.0 ppm

* The test materials were dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual test material as received.

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100,000

~ 0.01 ml added

~ 10³ ppm acetoneerror of 0.001 ml
= 10³ ppm

TABLE II

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead						Total	Per Cent Dead						Dissolved Oxygen (ppm) and pH																		
	Hours:							Number Tested	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH														
	1-6	24	48	72	96	Dead																										
0.0056	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.010	0	9	0	0	0	9	10	90	-	-	8.2	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0.018	0	9	1	-	-	10	10	100	-	-	8.2	7.6	8.0	7.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0.032	0	4	6	-	-	10	10	100	-	-	7.8	6.9	8.1	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0.056	0	10	-	-	-	10	10	100	-	-	8.1	7.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Four-Day LC₅₀ = 0.008 ppm

^a The test material was dispensed into the bioassay vessels in the form of a 0.01 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Toxaphene as received.

 10^{-3} ml 100 ppm soln

 $10^3 \mu\text{l} \therefore 1 \mu\text{l} = 10^{-3} \text{ml}$

TABLE III

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead						Total Number Tested	Per Cent Dead	Dissolved Oxygen (ppm) and pH						
	Hours:								24 Hr. 48 Hr. 72 Hr. 96 Hr.						
	1-6	24	48	72	96	Dead		DO	pH	DO	pH	DO	pH	DO	pH
0.001	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	10	0	-	-	-	-	-	-	-
0.0056	0	0	4	1	2	7	10	70	-	-	-	8.0	7.3	7.8	7.2
0.01	0	6	3	1	-	10	10	100	-	-	8.2	7.3	8.0	7.2	-

Four-Day LC₅₀ = 0.0052 ppm

* The test material was dispensed into the bioassay vessels in the form of a 0.001 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Technical DDT as received.

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TABLE IV

TEST MATERIAL: Halowax 1099

Range Finding Fish Toxicity Study - Rainbow Trout

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead				Total		Dissolved Oxygen (ppm) and pH											
	Hours:				Number	Dead	1-6	24	48	72	96	Dead	Per Cent	1-6 Hr.	24 Hr.	48 Hr.	72 Hr.	96 Hr.
	1-6	24	48	72	96	Dead	Tested	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH	DO
100.0	0	0	0	0	2	2	2	100	-	-	-	-	-	-	-	-	-	-
10.0	0	0	0	0	0	0	2	0	-	-	-	-	-	-	-	-	-	-

Four-Day LC50 = 10-100 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Halowax 1099 as received.

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b. Reactions

The reactions noted following introduction of the Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460, Toxaphene, and Technical DDT are presented in Tables V through X respectively.

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TABLE V

TEST MATERIAL: Aroclor - 1242

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	24	No Recovery Noted	-
	Inverted Swimming	72	No Recovery Noted	-

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TABLE VI

TEST MATERIAL: Aroclor - 1254

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration		Duration of Reaction		Time of Death Following Dose Administration	
		(hours)	(hours)	(hours)	(hours)	(hours)	(hours)
100.0	No Reactions Noted	-	-	-	-	-	-

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TABLE VII

TEST MATERIAL: Aroclor - 1260

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration		Duration of Reaction		Time of Death Following Dose Administration	
		(hours)	(hours)	(hours)	(hours)	(hours)	(hours)
100.0	Hypoactivity		72	No Recovery Noted	-		

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TABLE VIII

TEST MATERIAL: Aroclor - 5460

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	No Reactions Noted	-	-	-

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TABLE IX

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.0056	No Reactions Noted	-	-	-
0.010	Hypoactivity	24	24	24
0.018	Hyperactivity	24	Until Death	24-48
0.032	Hyperactivity	24	Until Death	24-48
0.056	Hyperactivity	1-6	Until Death	24

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TABLE X

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Rainbow Trout

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	Hyperactivity	1-6	No Recovery Noted	48-72-96
0.01	Hyperactivity Prostration	1-6	Until Death	24-48-72

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B. Bluegills

1. Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460
Toxaphene, Technical DDT and Halowax 1099*

- a. Mortality, DO, and pH Data

The mortality, dissolved oxygen content, and pH data are presented in Table XI through XVII respectively.

* Range finding mortality only.

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TABLE XI

TEST MATERIAL: Aroclor 1242

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead					Total Number Tested	Per Cent Dead		Dissolved Oxygen (ppm) and pH			
	1-6	24	48	72	96		DO	pH	24 Hr. DO	48 Hr. DO	72 Hr. DO	96 Hr. DO
0.10	0	0	0	0	0	10	0	-	-	-	-	-
0.18	0	0	0	0	0	10	0	-	-	-	-	-
0.32	0	0	0	0	0	10	0	-	-	-	-	-
0.56	0	0	0	0	0	10	0	-	-	-	-	-
1.0	0	10	-	-	-	10	100	-	7.6	7.2	-	-

Four-Day LC50 = 0.66 ppm

The test material was dispensed into the bioassay vessels in the form of a 1.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1242 as received.

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TABLE XII

TEST MATERIAL: Aroclor 1254

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead				Total Number Dead	Per Cent				Dissolved Oxygen (ppm) and pH							
	1-6	24	48	72	96	Hours:	1-6	24	48	72	96	DO	pH	DO	pH	DO	pH
0.10	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.18	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.32	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.56	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
1.00	0	0	6	3	1	10	100	-	-	-	-	7.8	7.2	6.5	7.2	6.2	7.1

Four-Day LC₅₀ = 0.66 ppm

* The test material was dispensed into the bioassay vessels in the form of a 1.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1254 as received.

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TABLE XIII

TEST MATERIAL: Aroclor 1260

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead			Total Number Tested	Per Cent 1-6 Hr.			Dissolved Oxygen (ppm) and pH					
	1-6	24	48	72	96	Dead	DO	pH	DO	pH	DO	pH	DO
100.0	0	0	0	0	0	0	10	0	-	-	-	-	-

Four-Day $LC_{50} > 100.0$ ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 1260 as received.

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TABLE XIV

TEST MATERIAL: Aroclor 5460

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead			Total		Dissolved Oxygen (ppm) and pH											
	1-6	24	48	72	96	Dead	Number	Tested	Dead	Per Cent	1-6 Hr.	24 Hr.	48 Hr.	72 Hr.	96 Hr.	pH	DO
100.0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0

Four-Day LC₅₀ > 100.0 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Aroclor 5460 as received.

DSW 380682

TABLE XV

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead					Total Number Tested	Per Cent Dead			Dissolved Oxygen (ppm) and pH											
	1-6	24	48	72	96		1-6	24	48	72	96	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH
0.0010	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
0.0056	0	0	5	0	0	5	50	-	-	-	-	-	-	7.3	7.2	-	-	-	-	-	-
0.01	0	0	7	0	1	8	80	-	-	-	-	-	-	7.3	7.2	-	-	-	-	6.1	7.2

Four-Day LC₅₀ = 0.005695 Percent Confidence Limits of LC₅₀ = 0.0036 - 0.0087 ppm

The test material was dispensed into the bioassay vessels in the form of a 0.01 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Toxaphene as received.

DSW 380683

TABLE XVI.

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead				Total Number Tested	Per Cent 1-6 Hr.				Dissolved Oxygen (ppm) and pH							
	1-6	24	48	72	96	Dead	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH	DO
0.001	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
0.0018	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
0.0032	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
0.0056	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-
0.01	0	10	-	-	-	100	-	-	7.6	7.1	-	-	-	-	-	-	-

Four-Day LC₅₀ = 0.0078 ppm

* The test material was dispensed into the bioassay vessels in the form of a 0.001 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Technical DDT as received.

DSW 380684

TABLE XVII

TEST MATERIAL: Halowax 1099

Range Finding Fish Toxicity Study - Bluegill

Mortality, DO, and pH Data

Concentration* (ppm)	Number Dead				Total Number Tested	Per Cent Dead		Dissolved Oxygen (ppm) and pH											
	1-6	24	48	72	96	Hours:	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH	DO	pH	DO
100.0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-
10.0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-

Four-Day LC₅₀ > 100.0 ppm

* The test material was dispensed into the bioassay vessels in the form of a 10.0 percent (w/v) solution in acetone. Concentrations are expressed in terms of actual Halowax 1099 as received.

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b. Reaction

The reactions noted following introduction of Aroclor 1242, Aroclor 1254, Aroclor 1260, Aroclor 5460, Toxaphene, and Technical DDT are presented in Tables XVIII through XXIII respectively.

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TABLE XVIII

TEST MATERIAL: Aroclor - 1242

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.1	No Reactions Noted	-	-	-
0.18	No Reactions Noted	-	-	-
0.32	Hyperactivity	1-6	24	-
0.56	Hyperactivity	1-6	24	-
1.0	Hyperactivity	1-6	Until Death	24

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TABLE XIX

TEST MATERIAL: Aroclor - 1254

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.1	No Reactions Noted	-	-	-
0.18	No Reactions Noted	-	-	-
0.32	No Reactions Noted	-	-	-
0.56	Hyperactivity Hypoactivity	1-6	24	-
		24	48	-
1.0	Hypoactivity	24	Until Death	48-72-96

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TABLE XX

TEST MATERIAL: Aroclor - 1260

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration		Duration of Reaction		Time of Death Following Dose Administration	
		(hours)	(hours)	(hours)	(hours)	(hours)	(hours)
100.0	Hypoactivity		48	No Recovery Noted		-	

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TABLE XXI

TEST MATERIAL: Aroclor - 5460

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
100.0	Hypoactivity	72	No Recovery Noted	-

DSW 380690

TABLE XXII

TEST MATERIAL: Toxaphene

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	Hypoactivity	48	24	48
0.01	Hypoactivity	24	Until Death	48-96
	Prostration	24		
	Loss of equilibrium	48		

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TABLE XXIII

TEST MATERIAL: Technical DDT

Four-Day Fish Toxicity Study - Bluegill

Summary of Reactions

Concentration (ppm)	Reaction	Time of Onset Following Dose Administration (hours)	Duration of Reaction (hours)	Time of Death Following Dose Administration (hours)
0.001	No Reactions Noted	-	-	-
0.0018	No Reactions Noted	-	-	-
0.0032	No Reactions Noted	-	-	-
0.0056	No Reactions Noted	-	-	-
0.01	Hyperactivity	1-6	Until Death	24

DSW 380692