



DEPARTMENT OF THE NAVY
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C. 20375-5000

IN REPLY REFER TO:

3900
Ser 6180-752

NOV 12 1991

From: Commanding Officer, Naval Research Laboratory
To: Commander, Naval Sea Systems Command (SEA 5122P)
Subj: RESULTS OF QUALIFICATION OF AFFF LIQUID CONCENTRATE FIRE
EXTINGUISHING AGENTS MANUFACTURED BY THE CHUBB NATIONAL
FOAM COMPANY
Ref: (a) Chubb National Foam Ltr, dated 11 June 1991
Encl: (1) Two copies of subject report

1. In accordance with reference (a), the subject products have been tested in order to determine their compliance with the requirements of MIL-F-24385E(SH). A report covering the work is forwarded herewith as enclosure (1).


W.B. FOX
By direction

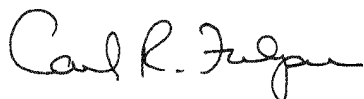
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NAVSEASCOM (Code 56Y5, Darwin)
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6180-752A:CRF
30 October 1991

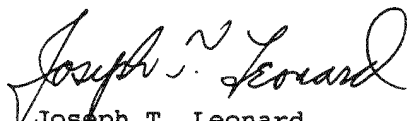
Subj: RESULTS OF QUALIFICATION OF AFFF LIQUID CONCENTRATE FIRE
EXTINGUISHING AGENTS MANUFACTURED BY CHUBB NATIONAL
FOAM COMPANY

Ref: (a) Military Specification, "Fire Extinguishing Agent, Aqueous
Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea
Water," MIL-F-24385E(SH), November 1990
(b) Qualified Products List, "Products Qualified under Military
Specification MIL-F-24385, Fire Extinguishing Agent, Aqueous
Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea
Water," QPL-24385

1. AFFF concentrates manufactured by the Chubb National Foam Company and designated as Aer-o-water, 3EM (3% type 3) and Aer-o-water, 6EM (6% type 6) were tested in accordance with the procedures outlined in reference (a) and AFFF agents listed in reference (b).
2. The test data obtained are summarized in the attached tables.
3. Both candidate AFFF concentrates met the requirements of reference (a).



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Attachments

- 1) Tables 1-12
- 2) "Results of 96-hour, Fundulus heteroclitus Flow-Through Acute Toxicity Tests on an Aqueous Film Forming Foam (AFFF) Sample from the Naval Research Laboratory," EA Engineering, Science and Technology, October 1991.
- 3) "Final Report: The Acute Toxicity of Aer-o-water 6EM to Mummichog (Fundulus Heteroclitus), May 1991.

Encl (1) to NRL ltr
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Table 1. Concentrate Chemical and Physical Characteristics
Test Results (Paragraph 3.3)

Characteristic Measured	Specifications Requirements		Results	
	Type 3	Type 6	Type 3 3EM	Type 6 6EM
Refractive Index, minimum	1.3630	1.3580	1.3697	1.3587
Viscosity (centistokes)				
maximum @ 5° C	20.0	10.0	6.2	3.3
minimum @ 25° C	2.0	2.0	3.3	2.0
Hydrogen Ion Concentration (pH)	7.0-8.5	7.0-8.5	8.1	8.5
Spreading Coefficient, minimum	3.0	3.0	8.1	8.5
Foamability, minimum				
Fresh Water; Expansion Ratio	6.0	6.0	8.8	9.1
25% Drain Time (minutes)	2.5	2.5	4.4	4.4
Sea Water; Expansion Ratio	6.0	6.0	8.1	7.7
25% Drain Time (minutes)	2.5	2.5	3.6	3.8
Film Formation and Sealability	No Sustained Ignition	No Sustained Ignition	No ignition	No ignition
Fresh Water; Half Strength	(for all solutions)	(for all solutions)	No ignition	No ignition
Full Strength			No ignition	No ignition
Sea Water; Half Strength			No ignition	No ignition
Full Strength			No ignition	No ignition
Quintuple Strength			Flashed-NS	Flashed-NS
Corrosion				
General; maximum				
-Steel (milli in./yr)	1.5	1.5	<1.5	<1.5
-Cu-Ni (milli in./yr)	1.0	1.0	<1.0	<1.0
-Ni-Cu (milli in./yr)	1.0	1.0	<1.0	<1.0
-Bronze (milligrams)	100	100	<100	<100
Localized CRES -Steel	No pits	No pits	No pits	No pits
Total Halides, maximum (ppm)	500	250	328	174
Dry Chemical Compatibility				
Burnback Resistance, minimum (s)	360	360	396	361
Environmental Impact				
Toxicity, LC ₅₀ , minimum (mg/l)	500	1000	>500 ⁽¹⁾	>1000 ⁽²⁾
COD, maximum (mg/l)	1,000,000	500,000	476,778	283,231
BOD ₂₀ /COD, minimum	0.65	0.65	0.92	0.94

(1) Tests conducted by EA Engineering, Science, and Technology, Inc.

(2) Tests conducted by Aqua Survey, Inc. showed at 1000 ppm (1000 mg/L) of 3% AFFF concentrate had a 5% mortality rate was observed. This indicates that the LC₅₀ value would be above the 1000 mg/L minimum specified in the MIL SPEC.

NS No Sustained Ignition

Table 2. Stability Test Results (Paragraph 3.3.2)

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Type 3</u>		<u>Type 6</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Spreading Coefficient, minimum Concentrates (fresh water only)	3.0	6.6	---	6.9	---
Foamability, minimum					
Concentrates; Full Strength (fresh and sea)					
Expansion Ratio	6.0	8.8	7.6	9.0	7.9
25% Drain Time (minutes)	2.5	4.1	3.2	4.4	3.4
Pre-mixed Solutions; Full Strength (fresh/sea)					
Expansion Ratio	6.0	8.6	7.4	10.0	8.0
25% Drain Time (minutes)	2.5	4.4	3.3	4.3	3.6
Film Formation and Sealability					
Concentrates; Half Strength	No Sustained Ignition	NI	NI	NI	NI
Full Strength	No Sustained Ignition	NI	NI	F-NS	NI
Pre-mixed Solutions; Full Strength	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28 ft ²)					
Concentrates; Half Strength (fresh/sea)					
-Extinguishment Time, maximum (s)	45	42	43	40	44
-Burnback Time, minimum (s)	300	(1)	(2)	644	(3)
Concentrates; Full Strength (fresh/sea)					
-Extinguishment Time, maximum (s)	30	30	30	30	29
-Burnback Time, minimum (s)	360	513	398	501	444
Pre-mixed Solutions; Full Strength (fresh/sea)					
-Extinguishment Time, maximum (s)	30	29	30	28	30
-Burnback Time, minimum (s)	360	418	373	475	365
Stratification					
Concentrates	None	None		None	
Pre-mixed Solutions; Full Strength	None	None	None	None	None
Precipitation, maximum (% volume)					
Concentrates	<0.05	<0.05		<0.05	
Pre-mixed Solutions; Full Strength	<0.05	<0.05	<0.05	<0.05	<0.05

- (1) Burnback pan removed at 300 sec; burnback fire self-extinguished at 615 sec.
(2) Burnback pan removed at 289 sec; burnback fire self-extinguished at 338 sec.
(3) Burnback pan removed at 202 sec; burnback fire self-extinguished at 250 sec.
NI No Ignition
F-NS Flashed, Not Sustained

Table 3. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of 3M FC203CE and CNF 3EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	9.0	9.0	9.6	8.1
25% Drain Time (minutes)	2.5	4.3	4.1	4.0	3.9
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	F-NS
Fire Performance, 2.6 m ² (28 ft ²)					
Extinguishment Time, maximum (s)	30	29	25	28	27
Burnback Time, minimum (s)	360	473	432	447	394
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

F-NS Flashed, Not Sustained
NI No Ignition

Table 4. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of 3M FC-203CF and CNF 3EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.3	8.0	9.1	8.6
25% Drain Time (minutes)	2.5	4.6	4.1	4.1	3.5
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	F-NS
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	29	27	28	28
Burnback Time, minimum (s)	360	544	389	462	374
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

F-NS Flashed, Not Sustained
NI No Ignition

Table 5. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of Ansul AFC-5A and CNF 3EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.7	7.9	9.0	7.3
25% Drain Time (minutes)	2.5	4.3	4.0	4.0	4.1
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	24	27	24	27
Burnback Time, minimum (s)	360	567	444	485	435
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

NI No Ignition

Table 6. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of 3M FC-206CE and CNF 6EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.5	8.5	8.8	7.8
25% Drain Time (minutes)	2.5	4.4	4.4	4.5	3.9
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	27	28	29	28
Burnback Time, minimum (s)	360	547	459	624	506
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

NI No Ignition

Table 7. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of 3M FC-206CF and CNF 6EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.8	8.5	9.5	9.0
25% Drain Time (minutes)	2.5	4.0	3.3	4.2	3.6
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	30	29	27	30
Burnback Time, minimum (s)	360	481	393	505	444
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

NI No Ignition

Table 8. Interagent Compatibility Test Results (Paragraph 3.3.3)
for 50/50 Mixture of Ansul AFC-5 and CNF 6EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.3	7.1	8.6	7.9
25% Drain Time (minutes)	2.5	4.4	3.9	4.4	4.1
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	29	28	25	27
Burnback Time, minimum (s)	360	479	450	544	433
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

NI No Ignition

Table 9. Interagent Compatibility Test Results (Paragraph 3.3.3)
for one-quarter/one-quarter/one-quarter/one-quarter Mixture
of Ansul AFC-5A, 3M FC-203CE, 3M FC-203CF and CNF 3EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	9.5	8.5	9.0	7.5
25% Drain Time (minutes)	2.5	3.8	4.1	3.8	4.3
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	29	28	27	28
Burnback Time, minimum (s)	360	476	397	488	461
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05
NI	No Ignition				

Table 10. Interagent Compatibility Test Results (Paragraph 3.3.3)
for one-quarter/one-quarter/one-quarter/one-quarter Mixture
of Ansul AFC-5, 3M FC-206CE, 3M FC-206CF and CNF 6EM

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>			
		<u>Concentrates</u>		<u>Pre-mixed Solutions</u>	
		<u>Fresh</u>	<u>Sea</u>	<u>Fresh</u>	<u>Sea</u>
Foamability, minimum					
Expansion Ratio	6.0	8.3	8.3	9.1	6.7
25% Drain Time (minutes)	2.5	4.0	4.2	4.5	4.3
Film Formation and Sealability	No Sustained Ignition	NI	NI	NI	NI
Fire Performance, 2.6 m ² (28.0 ft ²)					
Extinguishment Time, maximum (s)	30	27	25	22	25
Burnback Time, minimum (s)	360	436	412	479	548
Stratification	None	None		None	None
Precipitation, maximum (% volume)	<0.05	<0.05		<0.05	<0.05

NI No Ignition

Table 11. Fire Performance Test Results (Paragraph 3.4)

<u>Property Measured</u>	<u>Specification Requirement (all solutions)</u>	<u>Results</u>	
		<u>Type 3 3EM</u>	<u>Type 6 6EM</u>
2.6 m ² (28.0 ft ²) Fire Tests			
Extinguishment Time, maximum (s)			
Fresh water, Half Strength	45	37	39
Full Strength	30	29	24
Sea water, Half Strength	45	38	41
Full Strength	30	30	27
Quintuple Strength	55	31	32
Burnback Time, minimum (s)			
Fresh water, Half Strength	300	452	(1)
Full Strength	360	431	468
Sea water, Half Strength	300	413	439
Full Strength	360	425	406
Quintuple Strength	200	304	330
4.6 m ² (50 ft ²) Fire Tests			
Extinguishment Time, maximum (s)	50	38	36
Burnback Time, minimum (s)	360	371	407
40 s Summation, minimum	320	325	320

(1) Burnback pan removed at 248 sec; burnback fire self-extinguished at 311 sec.

Table 12. Cap Removed Torque Test Results (Paragraph 5.1.1.1.1)

<u>Pass/Fail Criteria</u>	<u>Results</u>	
<u>Maximum Torque (In-lb)</u>	<u>Type 3 3EM</u>	<u>Type 6 6EM</u>
50	37	44



RESULTS OF A 96-HOUR *Fundulus heteroclitus*
FLOW THROUGH ACUTE TOXICITY TEST
ON AN AQUEOUS FILM FORMING
FOAM (AFF) SAMPLE FROM THE
NAVAL RESEARCH LABORATORY

Prepared for

Naval Research Laboratory
Washington, D.C.

Prepared by

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October 1991

EA Project 70003.10

Report Number 10

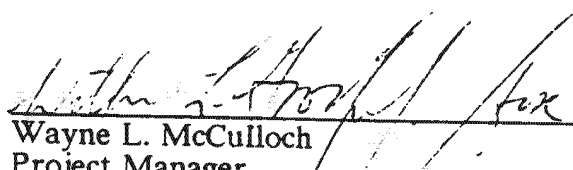
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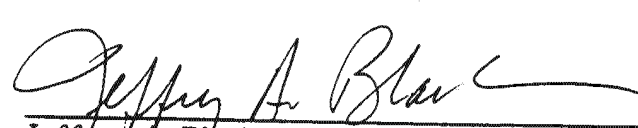
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17 October 1991
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October 1991

1. INTRODUCTION

At the request of the Naval Research Laboratory, Washington, D.C., EA Engineering, Science, and Technology, Inc, performed a flow-through acute toxicity test on a sample of aqueous film-forming foam (AFFF), fire fighting agent. The product tested was AER-O-FOAM XL-3 which is manufactured by Chubb National Foam, Inc. The objective of these tests was to determine the 96-hour median lethal concentration (LC50) of the test material to Fundulus heteroclitus (mummichogs) using lethality as the endpoint.

2. METHODS AND MATERIALS

2.1 SAMPLE DESCRIPTION

The test sample was delivered to EA by courier. Two liter bottles each containing Chubb National Foam's AER-0-FOAM XL-3 aqueous film-forming foam (AFFF) were shipped to EA, logged in, visually inspected against the Chain of Custody Records, and assigned an EA accession number (EA sample number (AT1-776). The foam concentrate sample was stored at room temperature (20°C) when not in use.

2.2 TEST ORGANISMS

Juvenile mummichogs, Fundulus heteroclitus, constituted the test organisms. The test organisms were 30-35 days old at test initiation. The fish were obtained from cultures maintained at Multi Aquaculture Systems, Inc., Amagansett, New York.

The lot of F. heteroclitus (Lot Number FU-005) was received on 18 September 1991. The fish were fed flaked food daily until used in testing. The mean acclimation temperature and salinity for Lot FU-005 were 20.1 ± 0.5 and 22.2 ± 0.7 ppt.

There was no mortality observed in this lot of fish during the acclimation period. The mean length and weight of Lot FU-005 organisms were 18.18 mm (± 1.57) and 0.12 g (± 0.03) respectively.

2.3 DILUTION WATER

The water used for acclimation, holding, and for the flow-through studies was 20 ppt artificial seawater. Dry synthetic sea salts (Forty Fathoms, Marine Enterprises, Towson, Maryland) were added to dechlorinated tap water and allowed to age prior to use. A summary of the chemical characteristics of Forty Fathoms is presented in Table 1. The source of the makeup water was Baltimore municipal water supply, which upon entry

into the laboratory was passed through a high capacity activated carbon dechlorination unit which removed chlorine and hexane soluble compounds.

2.4 TOXICITY TEST OPERATIONS AND PERFORMANCE

At 1500 on 25 September 1991, a 48-hour static acute rangefinding test was initiated to provide information for the selection of test concentrations in the flow-through test. The concentration series employed in the rangefinding test was 100, 300, 1,000, 3,000, 10,000 ppm and a Forty Fathoms dilution water control. There was one replicate container per test concentration, and five organisms were placed in each chamber.

The 96-hour flow through study was initiated 1600 on 27 September. Test procedures used in the flow-through study followed those described in the protocol ATS-FAF-GT-01 (Attachment I) which is contained in EA's Aquatic Toxicology Laboratory Quality Control and Standard Operating Procedures Manual (EA, 1986). EA's protocol is in conformance with guidelines contained in ASTM's E729 dynamic procedure, and with EPA (Peltier and Weber, 1985) and Standard Methods (APHA, 1989) documents.

The test employed Masterflex peristaltic pumps which continuously delivered test solution from the stock solution tanks to splitter assemblies for each test concentration. The fill and dump splitter assemblies divided the solution flow equally to the two replicate chambers for each test concentration. The test was comprised of five concentrations and a control. The AER-O-FOAM XL-3 AFFF test series was 135, 240, 420, 750 and 1350 ppm (vol/vol) and control.

Daily, a fresh 60 liter batch of each test concentration was prepared in a 20 gallon aquarium using 20 ppt Forty Fathoms artificial seawater as dilution water and control. There were a total of six 20 gallon aquaria, one for each test concentration and control. The Masterflex pumps were calibrated to deliver test solution at 40 ml/min to each concentration's splitter assembly. Masterflex silicone tubing was used, and test

solution did not come in contact with any pump parts. The test chambers were 19 L all glass aquaria, which were calibrated to hold 14 L of test solution at the standpipe overflow. Each test concentration exposure group consisted of two replicate chambers with 10 organisms each.

Mortality observations, pump delivery calibrations and water quality determinations were made daily throughout the 96-hour exposure period, and were recorded on the data sheets. Copies of the original data sheets are included in Attachment II. Temperature, dissolved oxygen, pH and salinity were measured in each batch of new test solution daily and for the old test solutions in at least one replicate of each concentration at 24, 48, 72, and 96 hours. Aeration was provided to all of the test chambers when the dissolved oxygen-saturation in the high test concentration dropped below 40 percent. The aeration rate was 100 bubbles/minute per EPA guidance. Using the total number of dead organisms per replicate and concentration at the end of the exposure period, the 96-hour median lethal concentration (LC50 value) was calculated by the binomial, moving average, and probit analysis methods as described as Stephan (1977). Copies of the statistical analysis are included in Attachment III.

2.5 REFERENCE TOXICANT TESTS

The reference toxicant used was sodium dodecyl sulfate (SDS). The test species was exposed to the appropriate graded concentration series to determine if the lots of organism were within the acceptable limits of EA's Aquatic Toxicology Laboratory. The test duration was 24 hours and treatments were not replicated.

2.5 ARCHIVES

Original data sheets, memoranda, notes, and computer printouts are archived at EA's laboratory facilities in Sparks, Maryland. Primary data and associated information are retained for a period of 5 years unless a longer period of time is requested by the Naval Research Laboratory.

3. RESULTS

In the rangefinding test initiated on 25 September, all organisms exposed to 3,000 and 10,000 ppm AER-O-FOAM died within 24 hours. At 1,000 ppm there was 20 percent survival after 48 hours, and at concentrations of 300 ppm and below there was 100 percent survival at 48 hours. The 48-hour LC50 for the rangefinding test was 682 ppm. Aeration was provided to all test chambers 17.8 hours after the start of the 48 hour rangefinding test when the DO in the 1000 ppm chamber was measured at 3.8 ppm (40 percent saturation).

A summary of the water quality measurements recorded during the 96-hour flow-through study is presented in Table 2. On Day 1 of the study, aeration was provided to all head tanks and exposure chambers due to depressed dissolved oxygen levels in the test chambers. The results of the acute toxicity test are presented in Table 3. At the end of 96 hours of exposure, there was 100 percent survival in the 135, 240, 420 ppm AER-O-FOAM and the control treatment groups. In the 750 ppm treatment group there was 5 percent survival after 96 hours. All organisms exposed to 1,350 ppm AER-O-FOAM died within 24 hours. The resulting 96-hour LC50 for this test was 583 ppm with a 95 percent confidence interval of 420-750 ppm.

The LC50 for the reference toxicant test conducted on F. heteroclitus lot FU-005 was 13.1 mg/L sodium dodecyl sulfate (SDS). This test result was within EA's acceptability range of 4.3 - 18.6 mg/L SDS for F. heteroclitus reference toxicant tests.

TABLE 1 SUMMARY OF WATER QUALITY CHARACTERISTICS ASSOCIATED WITH
FORTY FATHOMS MARINE MIX HYDRATED TO A DENSITY OF 1.025
USING DISTILLED WATER

<u>Parameter</u>	<u>Molecular Weight</u>	<u>Forty Fathoms (ppm)</u>
Aluminum	27.0	0.06
Antimony	121.7	0.0005
Arsenic	74.9	0.01
Barium	137.3	0.12
Bicarbonate	61.0	174.0
Beryllium	9.0	0.0002
Boron	10.8	2.1
Bromide	79.9	62.0
Cadmium	112.4	0.009
Calcium	40.0	410.0
Carbonate	60.0	10.0
Cerium	140.0	0.0007
Chromium	52.0	0.02
Chloride	35.4	18,600
Cobalt	58.9	0.0025
Copper	63.5	0.007
Fluorine	19.0	1.9
Gallium	69.7	0.0004
Germanium	72.6	0.00005
Iodine	126.9	0.03
Iron	55.8	0.03
Lithium	6.9	0.24
Magnesium	24.3	1,290
Manganese	54.9	0.008
Mercury	200.6	0.0007
Molybdenum	95.9	0.005
Nickel	58.7	0.009
Nitrogen	14.0	0.85
Phosphorus	31.0	0.04
Potassium	39.1	380
Silicon	28.1	4.5
Sodium	23.0	10,400
Strontium	87.6	12.4
Sulfur (SO ₄)	96.1	2,600
Thallium	204.4	0.000007
Tin	118.7	0.006
Titanium	47.9	0.004
Tungsten	183.9	0.004
Vanadium	50.9	0.0009
Zinc	65.4	0.24

TABLE 2. SUMMARY OF WATER QUALITY RANGES FOR 96-HOUR FLOW-THROUGH
ACUTE TOXICITY TESTS FOR THE NAVAL RESEARCH LABORATORY

<u>Test Number</u>	<u>EA Accession Number</u>	<u>Temperature (C)</u>	<u>pH</u>	<u>DO (mg/L)</u>	<u>Salinity (ppt)</u>
FT-09-27-91-786	AT1-776	17.3-20.7 ^(a)	7.2-8.2	<1.0-7.5 ^(b)	18.2-20.3

(a) Temperature measured on Day 1 and 2 old test solutions was below the 20±2 C target temperature. It is EA's opinion that the below-range temperatures did not affect the test results.

(b) A DO value of 3.4 mg/L (40 percent saturation) was measured in the 1350 ppm concentration on Day 1. All test vessels were aerated at this time.

TABLE 3. RESULTS OF THE 96-HOUR FLOW-THROUGH ACUTE TOXICITY TESTS
USING Fundulus heteroclitus

Test number: FT-09-27-91-786
Sample Description: AER-O-FOAM XL-3
Accession Number: AT1-776
LC50 value^(a): 583 ppm
(420-750)^(b)

Exposure Concentration (ppm)--Percent Survival

Control--100
135--100
240--100
420--100
750-- 5
1350-- 0

(a) LC50 value was calculated using the binomial method.

(b) Values in parentheses represent 95 percent confidence intervals.

ATTACHMENT I
PROTOCOLS

24. FLOW-THROUGH ACUTE 96-HOUR LC50 ASSAY WITH A FISH

1. TEST OBJECTIVE

To assess the toxicity of a test article to a fish species under flow-through conditions and determine the 96-hour LC50 using lethality as the test end point.

2. TEST ARTICLE

2.1 Description/Identification

Unless otherwise specified, the test article will be supplied by the client. Adequate chemical specifications with special reference to hazardous properties and storage conditions also will be supplied by the client.

2.2 Methods of Synthesis

Information on the methods of synthesis, stability, and data on composition or other characteristics which define the test article are on file with the client.

3. EXPERIMENTAL DESIGN

3.1 Test Organisms

A fish will constitute the test species as defined by project needs.

3.2 Source

Stocks are laboratory reared, obtained from a scientific organism vendor, or field collected using techniques that will be specified in the report.

3.3 Holding Conditions

Upon receipt, fish are transferred to holding tanks which are continuously replenished with dechlorinated municipal tap water, synthetic seawater, or other appropriate dilution water. The fish are acclimated to laboratory conditions for a minimum of 7 days prior to testing. The laboratory is maintained on a 16-hour light, 8-hour dark photoperiod cycle by a programmable electrical timer. All fish stocks are examined regularly throughout the work week. Dead fish, or those displaying abnormal swimming behavior, discoloration, or pronounced lethargy are removed as observed, and recorded on appropriate log sheets. Fish

stocks are fed a commercial fish food a minimum of once daily throughout the work week. They are not fed for 48 hours prior to initiating a test.

3.4 Dilution Water

The source of dilution water is the City of Baltimore Municipal Water System. Upon entry to the laboratory, the water is passed through a high-capacity, activated-carbon filtration system to remove chlorine, detergents, and hexane-soluble organic materials. This water source has proven safe for aquatic organism toxicity testing, as evidenced by maintenance of the multigeneration *Daphnia* cultures, with no evident loss of fecundity. If requested, reconstituted fresh water, synthetic sea water, or other dilution water may be used.

3.5 Test Concentration Series

The test concentration series to be used for definitive toxicity tests will be selected following preliminary tests to bracket appropriate concentration ranges. A minimum of five concentrations and diluent water controls will be used. If it proves necessary to use a carrier solvent to disperse the test article in aqueous solution, an additional set of solvent controls will be used. All test concentrations and controls will normally be conducted with two replicates. Additional replicates may be used at the client's request.

3.6 Toxicant Delivery System

A solenoid-activated proportional diluter system similar to that described by Peltier and Weber (1985) will constitute the toxicant delivery system. The proportional diluter will be calibrated prior to test initiation and at test termination. Each test concentration should be at least 50 percent of the next highest concentration in the series. Test vessel calibrations, cycle times, flow rates, and other pertinent data will be reported.

3.7 Test Vessels and Test Volume

Test vessels will be of sufficient volume as to not exceed the organism loading ratio and minimum number of daily tank volume replacements.

3.8 Test Organism Number

A minimum of 10 test organisms will be used in each test replicate, constituting a minimum number of 20 fish per treatment group. Fish will be randomly assigned to each test replicate.

3.9 Test Environment

The test vessels will be maintained at a temperature similar to that at which the fish have been acclimated, but within the recommended test range for that species. Test temperature will not vary more than ± 2 C from specified acclimation temperature. The tests will be conducted on a 16-hour light, 8-hour dark photoperiod cycle.

3.10 Analysis of Test Concentrations for Test Article

If required, test solution replicates may be analyzed for chemical analytical verification of achieved test concentrations. The analytical method and number of determinations will be formulated after consultation with the client. Where chemical analyses are necessary, both nominal and actual measured test solution concentrations will be reported.

3.11 Test Observations

Test organisms will be observed at a minimum of 24, 48, 72, and 96 hours after test initiation to determine number of animals killed by test article concentrations. The study will terminate after completion of the 4-day observation period. The study may be extended, however, at the request of the client.

Routine water quality measurements are performed on the test solutions and diluent water controls according to the following schedule: temperature is measured daily from all test chambers; dissolved oxygen, salinity (when applicable), and pH are measured initially from all test chambers as well as at test termination, and from the control, low, medium, and high concentration at 24-, 48-, and 72-hour intervals. Specific conductance, total alkalinity, and total hardness are measured from the diluent water and sample (when applicable). Specific conductance may also be used for concentration monitoring at the request of the client. Test solutions will not be aerated unless dissolved oxygen concentrations fall below 40 percent of saturation. Analytical methods will be conducted according to APHA et al. (1985) and EPA (1979).

Dead fish are removed when observed. At the end of the 96-hour test period, a minimum of 30 surviving fish are removed from the test containers, placed in labeled specimen bags, and frozen. The fish are subsequently thawed, measured to the nearest mm (standard length), patted dry, and weighed to the nearest 0.01 g. The average length and weight of the test fish are reported, along with their respective ranges and standard deviations.

3.12 Data Analysis

The LC50 values and associated statistics will be derived by the probit analysis, moving average, and binomial test methods as described by Stephan (1977). Depending on the nature of the data, other methods may be used including the probit approximation method of Litchfield and Wilcoxon (1949), SAS probit analysis (SAS Institute 1979), or graphical interpolation using the log concentration vs. percent lethality as described by APHA et al. (1985). The methods used will be specified in the report.

4. FINAL REPORT

The final report will be prepared to contain the following information:

- . Objectives and procedures stated in the approved protocol, including any changes made to the original protocol
- . Identity of the test articles by name or code number and their strength (i.e., quality/purity) and a description of any pretreatment
- . Source of the dilution water, its chemical characteristics, and a description of any pretreatment
- . Test concentration series used and duration of the assay
- . Mean standard lengths and weights of test fish, the respective ranges, and approximate loadings of fish to test volume (g/L)
- . Routine water quality characteristics of dilution water and selected test concentrations
- . Any unforeseen circumstances that may have affected the quality or integrity of the study
- . Signature of the project coordinator, program manager, and quality control officer as authorization of the report.
- . Location of all archived data and the original copy of the final report at EA

Items of data to be included in the report consist of: experimental design and test performance; effects on general appearance of test organisms; morbidity and mortality; tabular presentation and appropriate

statistical evaluation of water quality characteristics; and survival data where necessary.

5. QUALITY ASSURANCE

5.1 Amendments to Protocol

Amendments to the authorized protocol instigated by EA or by the client will be made only after proper authorization. Such authorization is achieved by completion of the Amendment to Protocol form by EA and the client.

5.2 Standard Operating Procedures

Unless otherwise specified, all procedures mentioned in the protocol are subject to detailed Standard Operating Procedures (SOPs) which are contained in the SOP manuals of the participating departments. These SOPs and protocols follow the U.S. EPA's Good Laboratory Practice Standards (GLPs) (EPA 1983).

5.3 Reference Toxicant

A reference toxicant bioassay, utilizing sodium dodecylsulfate (SDS) or other appropriate reference toxicant, will be used as an internal quality check of the sensitivity of each batch of test organisms. Testing will be prior to or concurrent with the test or following the acclimation period for newly acquired organisms. The results of each test will be compared with historical toxicological information of reference toxicant tests performed at EA on the species, to determine if the results are within acceptable limits using the control charts outlined in Peltier and Weber (1985).

5.4 Quality Assurance Evaluation

The study described in this protocol may be subject to internal audit by the Quality Assurance Unit. A quality control officer will be responsible for monitoring each study to assure the client that the facilities, equipment, personnel, methods, practices, records, and controls are in conformance with EA's QC program and EPA's GLPs.

5.5 Inspection by Regulatory Authorities

In the event of an inspection of EA by an outside authority during the course of the study, the client will be consulted before inspectors are permitted access to any of the project records or the experimental areas.

5.6 Archives

Copies of project-specific records shall be transferred to the client promptly after the project is completed or as negotiated and budgeted with each client. Original primary data will be retained by EA for 5 years. Primary data include laboratory data sheets, records, memoranda, notes, photographs, microfilm, and computer printouts that are a result of the original observations and activities of the study and which are necessary for the reconstruction and evaluation of the study report.

5.7 Location

This study will be conducted by the Aquatic Toxicology Services Department of the Scientific Operations Division of EA Engineering, Science, and Technology, Inc. at the Mid-Atlantic Regional Offices, Sparks, Maryland.

6. SPECIFICATIONS FOR FLOW-THROUGH ACUTE TOXICITY TEST WITH FISH

6.1 Basic References

American Public Health Association et al. 1985. Standard Methods for Examination of Water and Wastewater, 16th edition. APHA, Washington, D.C. 1,268 pp.

American Society for Testing and Materials (ASTM). 1980. Standard Practice for Conducting Acute Tests with Fishes, Macroinvertebrates, and Amphibians. ASTM Designation: E729-80, Philadelphia, Pa. pp. 285-309.

EA Manual T-101. 1981. Aquatic Toxicology Studies, Quality Control and Standard Operating Procedures Manual. Revised, August 1986. (Internal document prepared by Aquatic Toxicology Services, EA Engineering, Science, and Technology, Inc.)

Peltier, W.H. and C.I. Weber. 1985. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA-600/4-85-013. U.S. Environmental Protection Agency, Cincinnati, Ohio.

U.S. EPA. 1983. Toxic Substances Control; Good Laboratory Practice Standards, Title 40 CFR Part 792. Fed. Regist. 28(230):53922-53944.

ETC-T-101
EA Engineering, Science,
and Technology, Inc.
Effective May 1981
Revision 3, August 1986

6.2 Test Specifications

Test organism:	A fish species to be specified in final report
Fish age:	All fish for any one test will be selected from the same age-class
Fish length:	The largest fish will not be more than 50 percent longer than the smallest fish
Temperature:	To be specified
Light quality:	Wide-spectrum fluorescent lights
Light intensity:	50-100 f.c.
Photoperiod:	16-hour light, 8-hour dark
Diluter and test chamber flow rate:	Continuous flow--a minimum of five volume replacements per test chamber during a 24-hour period
Aeration:	None, unless dissolved oxygen falls below 60 percent saturation in first 48 hours of the test or below 40 percent saturation thereafter
Loading ratio:	In general, test chambers may not contain greater than 0.8 g/L biomass
Dilution water:	Dechlorinated tap water, reconstituted fresh water, synthetic seawater, or appropriate receiving water
Test container:	19- or 38-L all glass aquaria
No. of concentrations:	Minimum of five concentrations and a control in duplicate series
Test animals per container:	10 (if loading is exceeded, more replicates or larger aquaria may be used)

Feeding regime:	Animals are not fed during the test unless fish are too small to survive 96 hours without feeding. Feeding is terminated 48 hours before test initiation in the lot from which organisms are obtained
Test type and duration:	Rangefinding--24-96 hours Definitive--96 hours Reference toxicant--24 hours
End point:	Lethality--defined as cessation of opercular movement and inability to respond to external stimuli (gentle prodding with glass rod)

ATTACHMENT II
DATA SHEETS

AQUATIC ORGANISMS ACUTE TOXICITY TEST DATA SHEET

Project No.: 70003-10 TEST (Static) Flow-through, Renewal
 Test Article: Fire Fighting Foam Test Container: 8" culture bowl
 Client: Naval Research Test Volume: 500 ml
 QC Test No.: RF-092591-783 Test Duration: 48 hrs.
 Sample No.: ATI-776
 Dilution No.: 20‰ salt H₂O

TEST ORGANISM:
 Common Name: Mummichog
 Scientific Name: F. heteroclitus
 Lot No.: Fu-005
 Source: MA
 Acclimation: 1 day for Age 30 days

Beginning Date: 9/25/91 Time: 1500
 Ending Date: 9/27/91 Time: 1500
 Sample _____ Diluent _____
 Alkalinity: _____
 Hardness: _____
 Conductivity: _____

						ALL TESTS															SALT OR BRACKISH WATER TESTS												
Con. or %	Test Container No.	Number of Live Organisms					Temperature (C)					Dissolved Oxygen (mg/liter)					pH					Salinity (ppt)											
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96		
Control		5	5	5			19.9	19.2	18.8				7.3				8.1	7.8				18.1		18.2									
100 ppm		5	5	5			19.9	19.4	19.0				7.1					7.8					18.3										
300		5	5	5				19.3	19.0				4.8					7.4					18.2										
1000		5	1	1			20.1	19.2	19.2				5.1	3.8				7.0					18.1										
3000		5	0	-				19.2					1.4					6.8					17.8										
10,000		5	0	-			20.3	19.1					7.6	<1.0				8.1	6.7				18.0	17.8									
Instrument Number							93	93	93			2	2	2			93	93	93			1	1	3									
Correction Factor							NA	NA	NA			8.8	8.8	8.9			7.0	7.0	7.0			0.0	0.0	0.0									
Time		1500	1500	1500			1440	1500	1500			1440	1500	1500			1440	1500	1500			1445	1514	1506									
Investigator		KK	LS	SP			LS	LS	SP			LS	LS	SP			LS	LS	SP			LS	LS	SP									

AQUATIC TOXICOLOGY BENCH SHEET - SET UP (SMALL VOLUMES)

Project No.: 70003.10
 Client: Naval Research
 QC Test No.: RF-092591-783

Date/Time	Activity	Investigator
9/25/91 1425	{ Dilutions Made Test Vessels Filled }	LS
9/25/91 1500	Transferred Organisms	LS
9/25/91 1504	Head Counts	KK

Sample No.: A+1-776
 Dilution No.: 20‰ salt H₂O

10,000 ppm stock

Test Concentration	Volume Test Material (ml) (10,000 ppm stock)	Final Volume
Control	0	500 ml
100 ppm	5	↓
300 ppm	15	
1000 ppm	50	
3000 ppm	150	
10,000 ppm	500	

AQUATIC TOXICOLOGY BENCH SHEET

Project No.: 70003 10
 Client: Naval Research
 QC Test No.: RF-092591-783

Date/Time	Activity	Investigator
9/25/91 1700	D.O. of 10,000 ppm rep. = 7.4 (92%) 3,000 3,000 ppm rep. = 7.3 1,000 ppm rep. = 7.0 All fish in 10,000 and 3,000 reps are dead.	LS
9/26/91 0850	D.O. of 1,000 ppm rep = 3.8 (40%) (3 Fish dead)	LS
0950	R Remaining concentrations aerated	LS
1655	D.O. of 1,000 ppm rep = 4.5 (56%)	LS

AQUATIC ORGANISMS ACUTE TOXICITY TEST DATA SHEET

Project No.: 7000 3.10 TEST: Static/Flow-through/Regenwal TEST ORGANISM: Mummichog
 Test Article: Fire Fighting Foam Test Container: 5 gallon Aquaria Common Name: Mummichog
 Client: Naval Research Test Volume: 14 L Scientific Name: F. heteroclitus
 QC Test No.: FT-09-07-91-786 Test Duration: 96 hrs Lot No.: FH-005
 Sample No.: AT1-776 Source: MI
 Dilution No.: 20% C.14 H.0 Acclimation: 9 or Age 30 days

Beginning Date: 9-27-91 Time: 1600
 Ending Date: 10/1/91 Time: 1600
 Sample Diluent Alkalinity: _____ Hardness: _____ Conductivity: _____

						ALL TESTS															SALT OR BRACKISH WATER TESTS											
Con. or %	Test Container No.	Number of Live Organisms					Temperature (C)					Dissolved Oxygen (mg/liter)					pH					Salinity (ppt)										
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	
Control	A	10	10	10	10	10	19.1	19.9	19.7	20.1		7.5	7.5	7.5	7.5		7.1	8.0	8.0	8.1		19.2	19.4	19.6	20.0							
	B	10	10	10	10	10																										
135	A	10	10	10	10	10	19.5	19.9	19.9	20.5		7.5	7.5	7.5	7.4		7.9	8.1	8.1	8.1		18.4	19.7	19.7	20.0							
	B	10	10	10	10	10																										
240	A	10	10	10	10	10	19.5	19.9	19.9	20.6		7.4	7.5	7.4	7.3		7.9	8.1	8.1	8.1		19.5	19.6	19.5	19.9							
	B	10	10	10	10	10																										
420	A	10	10	10	10	10	19.1	19.8	19.9	20.6		7.4	7.5	7.4	7.3		8.0	8.1	8.1	8.1		18.5	19.5	19.6	20.0							
	B	10	10	10	10	10																										
750	A	10	10	2	1	1	19.2	19.5	19.9	20.6		7.1	7.5	7.4	7.4		8.0	8.1	8.1	8.1		18.5	19.3	19.7	20.1							
	B	10	10	0	-	-																										
1350	A	10	0	-	-	-	19.4	-				7.4	-				8.0	-				18.5	-									
	B	10	0	-	-	-																										
Instrument Number							90	93	93	93		2	2	2	2		90	93	93	93		1	1	1	1							
Correction Factor							NA	NA	NA	NA		9.0	8.8	8.9	8.8		7.0	7.0	7.0	7.0		2.0	0.0	0.0	0.0							
Time		1625	1130	1545	1555	1600	1510	1157	1157	0758		1545	1109	1043	1005		1540	1057	1037	0758		1545	1104	1040	1003							
Investigator		KL	KL	LS	LS	LS	KL	KL	LS	LS		KL	KL	LS	LS		KL	KL	LS	LS		KL	KL	LS	LS							

Project No.: 1001-5.10
 Test Article: Fish Fighting Form
 Client: FT-09-27-91-736
 QC Test No.: ATI-776
 Sample No.: ATI-776
 Dilution No.: 20% Saltwater

TEST: Static Flow-through, Renewal
 Test Container: 5 gal. Aquarium
 Test Volume: 14L
 Test Duration: 96 hrs

TEST ORGANISM:
 Common Name: Mummichog
 Scientific Name: F. heteroclitus
 Lot No.: FH-005
 Source: MI
 Acclimation: 9 or Age 30 days

Beginning Date: 9-27-91 Time: 1600
 Ending Date: 10/1/91 Time: 1600
 Sample Diluent
 Alkalinity: _____
 Hardness: _____
 Conductivity: _____

Conc. or %	Test Container No.	All Tests															Salt or Brackish Water Tests									
		Number of Live Organisms					Temperature (C)					Dissolved Oxygen (mg/liter)					pH					Salinity (ppt)				
		0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96
<u>Control</u>	<u>A</u>							<u>17.3</u>		<u>18.4</u>			<u>7.5</u>		<u>8.0</u>			<u>8.0</u>		<u>8.2</u>			<u>18.6</u>		<u>19.8</u>	
	<u>B</u>								<u>17.6</u>		<u>20.1</u>			<u>7.7</u>		<u>7.8</u>			<u>8.1</u>		<u>8.0</u>			<u>19.6</u>		<u>20.0</u>
<u>1.35</u>	<u>A</u>							<u>17.5</u>		<u>18.6</u>			<u>5.3</u>		<u>6.5</u>			<u>7.9</u>		<u>7.8</u>			<u>18.7</u>		<u>19.8</u>	
	<u>B</u>								<u>17.7</u>		<u>20.5</u>			<u>5.8</u>		<u>6.5</u>			<u>7.8</u>		<u>7.8</u>			<u>19.5</u>		<u>20.0</u>
<u>2/10</u>	<u>A</u>							<u>17.6</u>		<u>19.4</u>			<u>4.4</u>		<u>5.2</u>			<u>7.8</u>		<u>7.5</u>			<u>18.7</u>		<u>20.0</u>	
	<u>B</u>								<u>17.8</u>		<u>20.6</u>			<u>4.8</u>		<u>5.2</u>			<u>7.6</u>		<u>7.5</u>			<u>19.6</u>		<u>20.1</u>
<u>1/20</u>	<u>A</u>							<u>17.6</u>		<u>19.7</u>			<u>3.8</u>		<u>4.0</u>			<u>7.8</u>		<u>7.4</u>			<u>18.6</u>		<u>20.1</u>	
	<u>B</u>								<u>17.9</u>		<u>20.7</u>			<u>(46%) 7.7</u>		<u>4.5</u>			<u>7.3</u>		<u>7.4</u>			<u>19.7</u>		<u>20.3</u>
<u>7/50</u>	<u>A</u>							<u>17.4</u>		<u>19.7</u>			<u>3.5</u>		<u>1.6</u>			<u>7.8</u>		<u>7.2</u>			<u>18.4</u>		<u>20.1</u>	
	<u>B</u>								<u>18.2</u>		<u>20.7</u>			<u>(44%) <1.0</u>		<u>(41%) 3.7</u>			<u>7.2</u>		<u>7.3</u>			<u>19.7</u>		<u>20.2</u>
<u>13/50</u>	<u>A</u>							<u>17.5</u>					<u>3.4</u>					<u>7.8</u>					<u>18.7</u>			
	<u>B</u>												<u>(40%)</u>													
Instrument Number								<u>93</u>	<u>93</u>	<u>93</u>	<u>93</u>		<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>		<u>93</u>	<u>93</u>	<u>93</u>	<u>93</u>		<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>
Correction Factor								<u>NA</u>	<u>NA</u>	<u>NA</u>	<u>NA</u>		<u>9.0</u>	<u>8.9</u>	<u>8.8</u>	<u>8.4</u>		<u>7/10</u>	<u>7/10</u>	<u>7/10</u>	<u>7/10</u>		<u>0.0</u>	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
Time								<u>0845</u>	<u>0910</u>	<u>0850</u>	<u>1530</u>		<u>0855</u>	<u>0917</u>	<u>0900</u>	<u>1547</u>		<u>0845</u>	<u>0910</u>	<u>0850</u>	<u>1530</u>		<u>0850</u>	<u>0915</u>	<u>0857</u>	<u>1540</u>
Investigators								<u>KK</u>	<u>LS</u>	<u>LS</u>	<u>LS</u>		<u>KK</u>	<u>LS</u>	<u>LS</u>	<u>LS</u>		<u>KK</u>	<u>LS</u>	<u>LS</u>	<u>LS</u>		<u>KK</u>	<u>LS</u>	<u>LS</u>	<u>LS</u>

DREDGED MATERIAL SOLID PHASE BIOASSAY FLOW RATES SHEET

Project No.: 70003.10

Client: Naval Research

QC Test No.: FT-09-2791-7826

Initiated: Date 04-27-91 Time: 1600

Target Flow Rate: 40 ml/min ± 2

[illegible]

AQUATIC TOXICOLOGY LABORATORY BENCH SHEET

Project No.: 70003,10
 Client: Naval Research
 Test No.: FT-09 2771 786

TEST SET-UP

TEST INITIATION

TEST CONCENTRATION SERIES

Date/Time	Initials	Activity	Test Conc. (% or mg/l)	Volume Test Material (ml)	Final Volume
9/27/91 1430	RSH	Dilutions made	Control	0	60 L
9/27/91 1445	RSH	Test Vessels Filled	135	8.1 ml	
			240	14.4 ml	
			420	25.2 ml	
9-27-91 1600	RSH	Transferred Organisms	750	45 ml	
9-27-91 1625	KL	Head Counts	1356	81 ml	✓

Comments: _____

INTERMEDIATE DILUTION PREPARATION AND FEEDING

DILUTION PREPARATION

FEEDING

Food: N/A

Day	Time	Initials	Sample/Diluent	Day	Time	Initials	Time	Initials	Amt.	Amt.	Amt.
0	1430	RSH	ATI-776/20 ppt salt	0							
1	1000	KK	ATI-776/20 ppt salt	1							
2	1015	LS	ATI-776/20% salt H ₂ O	2							
3	0940	LS	ATI-776/20% salt H ₂ O	3							
4				4							
5				5							
6				6							

AQUATIC TOXICOLOGY BENCH SHEET

Project No.: 7000310
 Client: Naval Research
 QC Test No.: FT-042791786

Date/Time	Activity	Investigator
-----------	----------	--------------

9/29/91 0725	All fish in 420 ppm Tanks A+B are at the surface gulping air. Two fish in 750 ppm Tank A are alive but jumping out of water and gulping air. All other fish in Tank A + B are dead.	L
-----------------	--	---

D.O. of 420 ppm Head Tank = 3.8 (46%)

D.O. of 750 ppm Head Tank = < 1.0

Aeration in all Head Tanks + Test Tanks increased.

	D.O.'s:	135 ppm	Test Tank	Head Tank	
1610			6.5	7.1 (88%)	LS
		240 ppm	5.6	6.9	
		420 ppm	2.9 (35%)	6.8	
		750 ppm	2.2 (26%)	6.8	

10/1/91 0940	Ten liter dilutions added to Head Tanks of 135, 240, and 420 ppm to maintain flows until test duration.	L
-----------------	---	---

Length-Weight Data Sheet

NAVAL RESEARCH

Project No(s): 70003.10Investigator: LSQC Test No(s): FT-092791-786Time, Date: 10/8/91 1410Test Species: F. heteroclitusLot No.: FH-005

Individual No.	Weight (g)	Standard Length (mm)
1	0.07	16.38
2	0.15	21.63
3	0.19	21.88
4	0.10	18.29
5	0.08	16.64
6	0.13	18.78
7	0.12	18.11
8	0.10	18.22
9	0.13	19.47
10	0.14	20.03
11	0.07	15.84
12	0.10	16.56
13	0.10	17.74
14	0.10	15.76
15	0.12	18.30
16	0.10	17.74
17	0.09	16.89
18	0.09	16.74
19	0.11	18.00
20	0.09	17.17
21	0.10	16.72
22	0.12	18.48
23	0.13	18.79
24	0.08	15.68
25	0.14	18.87
26	0.17	19.71
27	0.14	19.16
28	0.14	19.36
29	0.16	19.13
30	0.15	19.27
Range	0.07 - 0.19	15.68 - 21.88
Mean	0.12	18.18
S.D.	0.03	1.57

Length-Weight Data Sheet

NAVAL RESEARCH

Project No(s): 70003.10Investigator: ESQC Test No(s): FT-002791-186Time, Date: 1/8/91 1410Test Species: F. heteroclitusLot No.: FH-005

Individual No.	Weight (g)	Standard Length (mm)
1	0.07	16.38
2	0.15	21.63
3	0.19	21.88
4	0.10	18.29
5	0.08	16.64
6	0.13	18.78
7	0.12	18.11
8	0.10	18.22
9	0.13	19.47
10	0.14	20.03
11	0.07	15.84
12	0.10	16.56
13	0.10	17.74
14	0.10	15.76
15	0.12	18.30
16	0.10	17.74
17	0.09	16.89
18	0.09	16.74
19	0.11	18.00
20	0.09	17.17
21	0.10	16.72
22	0.12	18.48
23	0.13	18.79
24	0.08	15.68
25	0.14	18.87
26	0.17	19.71
27	0.14	19.16
28	0.14	19.36
29	0.16	19.13
30	0.15	19.27
Range	0.07 - 0.19	15.68 - 21.88
Mean	0.12	18.18
S.D.	0.03	1.57

QC'd 10/13
JLM

ATTACHMENT III
STATISTICS

[190,192]STEFZZ.BAC 13-Oct-91 11:25 AM

TEST NAME: NAVAL RESEARCH RANGEFIND-783

CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB. (PERCENT)
10000	5	5	100	3.125
3000	5	5	100	3.125
1000	5	4	80	18.75
300	5	0	0	3.125
100	5	0	0	3.125

AT A CONFIDENCE LEVEL OF 95 PERCENT THE BINOMIAL TEST
SHOWS THAT THE LC50 IS BELOW 3000
SHOWS THAT THE LC50 IS ABOVE 300

AN APPROXIMATE LC50 OF 682.424 IS OBTAINED BY
NONLINEAR INTERPOLATION BETWEEN 300 AND 1000

WHEN THERE ARE LESS THAN TWO CONCENTRATIONS AT WHICH THE
PERCENT DEAD IS BETWEEN 0 AND 100, NEITHER THE MOVING
AVERAGE METHOD NOR THE PROBIT METHOD CAN GIVE ANY
STATISTICALLY SOUND RESULTS.

COMPARE RESULTS WITH ORIGINAL DATA TO SEE IF THEY ARE REASONABLE.

[190,192]STEFZZ.BAC 13-Oct-91 11:28 AM

TEST NAME: NAVAL RESEARCH F-T 786

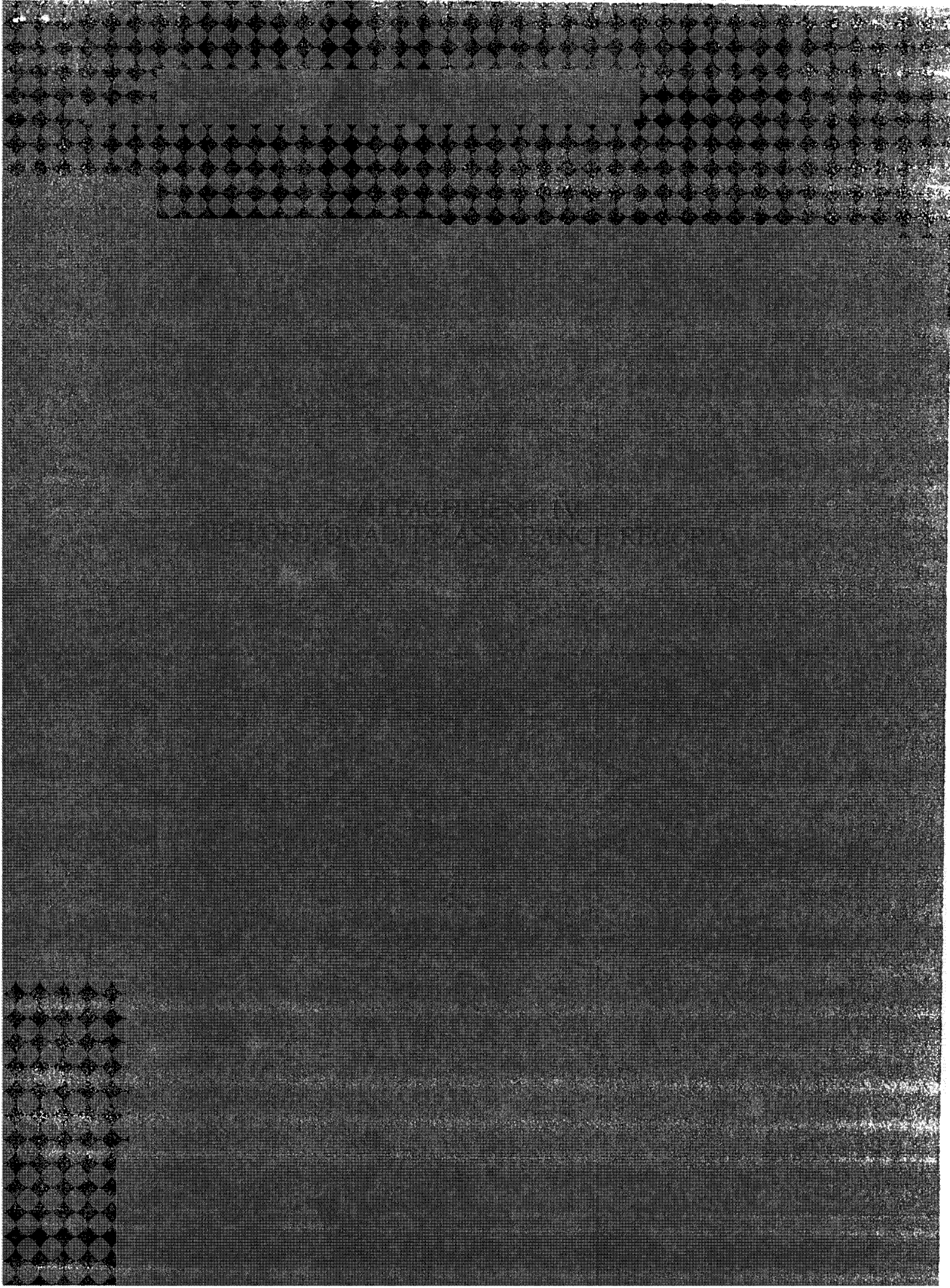
CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB.(PERCENT)
1350	20	20	100	LESS THAN 0.001
750	20	19	95	.200272E-02
420	20	0	0	LESS THAN 0.001
240	20	0	0	LESS THAN 0.001
135	20	0	0	LESS THAN 0.001

THE BINOMIAL TEST SHOWS THAT 420 AND 750 CAN BE
USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT
CONFIDENCE LIMITS BECAUSE THE ACTUAL CONFIDENCE LEVEL
ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE LC50 OF 583.039 IS OBTAINED BY
NONLINEAR INTERPOLATION BETWEEN 420 AND 750

WHEN THERE ARE LESS THAN TWO CONCENTRATIONS AT WHICH THE
PERCENT DEAD IS BETWEEN 0 AND 100, NEITHER THE MOVING
AVERAGE METHOD NOR THE PROBIT METHOD CAN GIVE ANY
STATISTICALLY SOUND RESULTS.

COMPARE RESULTS WITH ORIGINAL DATA TO SEE IF THEY ARE REASONABLE.



REPORT QUALITY ASSURANCE RECORD

CLIENT Naval Research Laboratory EA REPORT NO. 881
 PROJECT NUMBER 70003.10 TYPE ANALYSIS Flow-through
 AUTHOR Wynne McCulloch TEST ORGANISMS E. coli

REPORT CHECKLIST

QA/QC ITEM	REVIEWER	DATE
1. Samples collected, transported, and received according to study plan requirements.	<u>William J. H. [Signature]</u>	<u>15 Oct 91</u>
2. Samples prepared and processed according to study plan requirements.	<u>[Signature]</u>	<u>15 Oct 91</u>
3. Data collected using calibrated equipment.	<u>[Signature]</u>	<u>15 Oct 91</u>
4. Calculations checked: - Hand calculations checked	<u>Richard A. Connolly</u>	<u>16 Oct 91</u>
- Documented and verified statistical procedure used.	<u>[Signature]</u>	<u>15 Oct 91</u>
5. Data input/statistical analyses complete and correct.	<u>Richard A. Connolly</u>	<u>16 Oct 91</u>
6. Reported results and facts checked against original sources.	<u>Richard A. Connolly</u>	<u>16 Oct 91</u>
7. Data presented in figures and tables correct and in agreement with text.	<u>Richard A. Connolly</u>	<u>16 Oct 91</u>
8. Results reviewed for compliance with study plan requirements.	<u>[Signature]</u>	<u>15 Oct 91</u>

	AUTHOR	DATE
9. Commentary reviewed and resolved.	<u>Wynne McCulloch</u>	<u>17 Oct 91</u>
10. All study plan and quality assurance/control requirements have been met and the report is approved:		

<u>[Signature]</u>	<u>15 Oct 91</u>
PROJECT MANAGER	DATE
<u>Richard A. Connolly</u>	<u>16 Oct 91</u>
Q.C. OFFICER	DATE
<u>Jeffrey H. Black</u>	<u>16 Oct 1991</u>
SENIOR TECHNICAL REVIEWER	DATE



AQUA SURVEY, INC.

FINAL REPORT

THE ACUTE TOXICITY OF
AER-O-WATER 6EM TO MUMMICHOG
(FUNDULUS HETEROCLITUS)

MAY 7, 1991

BR91-1567A

JOB #91-143A

Report: The Acute Toxicity of Aer-O-Water 6EM
to Fundulus heteroclitus.

Sponsor: Chubb National Foam, Inc.
Union and Adams Streets
West Chester, PA 19382

Testing Facility: Aqua Survey, Inc.
49 Point Breeze Road
Flemington, NJ 08822

Study Number: 91-143A

Report # 1567A

Date
Test Started: May 2, 1991

Date
Test Finish: May 6, 1991

Date
Reported: May 7, 1991

Personnel: Y. Terrell
C. Lawrence
C. Nally


York Terrell
Study Director

5/9/91
Date

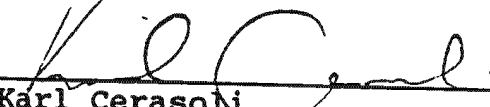
QUALITY ASSURANCE UNIT INSPECTION
STATEMENT FOR THE ACUTE TOXICITY OF AER-O-WATER,
6EM TO MUMMICHOG (*FUNDULUS HETEROCLITUS*)

In accordance with the regulations set forth in Good Laboratory Practice for Nonclinical Laboratory Studies, 40 CFR 792, Federal Register, vol. 48, November 29, 1983, part 4, The phase of study inspection, along with the dates(s) of inspection are shown below:

<u>Phase of Study</u>	<u>Date(s) of Inspection</u>
Preparation and set-up	5/2/91
Exposure period and daily observations	5/3-4/91
Notebook entries	5/8/91
Correlation of notebook entries to final report	5/8/91

Comments:

At the time of this inspection, all work had been or was being performed in a manner consistent with the Good Laboratory Practices.


Karl Cerasoni
Quality Assurance Officer

5/9/91
Date

Summary

A sample of Aer-O-Water 6EM was received from Chubb National Foam, Union and Adams Streets, West Chester PA 19382 on February 22, 1991. It was tested for potential lethality to the saltwater finfish, Fundulus heteroclitus on May 2, through May 6, 1991. The test was conducted under flow-through conditions, at a nominal concentration of 1000 ppm, for 96 hours.

Five (5) percent mortality (1/20) was observed at the 24 hour live count, no other mortality was observed during the test. Surviving organisms were observed quiescent (1/19) or surfacing (8/19) beginning between the 24 and the 48 hour observation periods and lasting in some instances through 96 hours.



I. Objective

The objective of this study was to determine the acute toxic effects of Aer-O-Water 6EM when in the environment of aquatic vertebrates, under flow-through conditions for 96 hours.

II. Test material

Source: Chubb National Foam
Union and Adams Streets
West Chester, PA 19382

Name: Aer-O-Water 6EM

CAS No.: 112-34-5, 107-21-1 (hazardous
ingredients)

Batch No.: ACR-29-86 (Expt1)

Date of
Manufacture: 2/91

Expiration
Date: None

Specific
Gravity: 1.04

Solubility: 100% in water

Appearance: Straw yellow liquid; mild pleasant odor

Date
Received: February 22, 1991

Amount
Received: 4 liters

III. Materials and Methods

A. Method

The method employed was a modification of the ASTM Standard Guide for Conducting Acute Toxicity tests with Fishes, Macroinvertebrates and Amphibians E 729-88a.
See Appendix A for the protocol.



B. Test Organisms

Species

The test species for this test, being representative of a salt water finfish, was Fundulus heteroclitus.

Size/Age/Physical Condition

Animals used for this test were field collected and appeared to be in good condition. The mean length of the organisms was 41.6 mm, while the mean weight was 0.794 gm.

Source/Acclimation

All animals utilized in this test were from Aquatic Research Organisms, New Hampshire. Organisms were acclimated to this laboratory for 14 days.

C. Test System

Source of Dilution Water

Water utilized for this test was natural seawater obtained from the Manasquan River Inlet, Manasquan, New Jersey. It was filtered through a 0.45 micron filter.

See Appendix B for water characterization.

Temperature

The test temperature was 22 +/- 2° C

Test vessels

The test vessels were 20 liter all glass aquariums (20x25x40 cm), containing 10 liters of test solution at a depth of 13 cm.

Photoperiod

A 16-hour light and 8-hour dark photoperiod with 15 to 30 minute transition period between light and dark.

Loading

Ten animals were selected at random and loaded into each test vessel containing 10 liters of test solution. The loading factor did not exceed 1.0 grams per liter of solution passing through the chamber in a 24 hour period.

Test Levels

This was a screening test and a concentration of 1000 ppm was chosen. Two replicates of ten organisms were exposed to this concentration.

Control

A control was run concurrently using the same dilution water and the same number of organisms as the test concentrations.

Beginning the Test

The test was conducted under flow-through conditions. The test was initiated by randomly introducing fish acclimated in accordance with the test design into the test chambers within 30 minutes after 10 liters of the test solution was introduced into the chambers.

Proportional dilutors were used to deliver additional test solutions. The dilutors were set to deliver 900 ml of dilution water to 100 ml of a 10,000 ppm stock solution of Aer-O-Water 6EM (prepared in ASI DI water), mixed immediately before introduction to the test chambers.

The flow rate through each test chamber was 6.2 cycles per 24 hours and each chamber was aerated.

All test vessels were examined at 24, 48, 72 and 96 hours; the number of dead were recorded and the dead animals were removed and discarded. The fish were observed at the same time and any unusual behavior was noted.

Measuring Temperature/DO/pH

The temperature of each test vessel was measured and recorded at the beginning of the test and at 24, 48, 72 and 96 hours.

The dissolved oxygen (DO) concentration of each test vessel was measured at the beginning of the test and at 24, 48 72 and 96 hours.

The pH of each test vessel was measured at the beginning and at the end of the test.

Salinity

The salinity was measured in each test vessel at the beginning and at the end of the test.

IV. Results

There was 5% mortality in the 1000 ppm concentration after 96 hours. No mortality was observed in the control group; however, one fish in the control group as well as three from the 1000 ppm group escaped through the overflow pipe between the 24 and the 72 hour observation periods (see Table 1).

The test solution temperature was maintained at $22 \pm 2^{\circ}$ C. (See Table II).
Dissolved oxygen was maintained between 5.6 and 7.8 mg/l. (See Table III).
The pH of the test solutions are presented in Table IV.
The salinity is presented in Table V.
Length and weight data are presented in Table VI.

V. Source of Documentation

All original data documentation is being maintained at
Aqua Survey, Inc.
499 Point Breeze Road
Flemington, NJ 08822
in Chubb National Foam Notebook 003 page 9 through 24.

Table I

Mortality Data (% Dead)

Time Hrs	<u>Concentration</u>			
	<u>0.0</u>		<u>1000 ppm</u>	
	A	B	A	B
0.0	0	0	0	0
24	0	0	10	0
48	0	*0	**10	0
72	0	*0	**10	0
96	0	*0	**10	0

* One fish escaped from tank through overflow pipe
** Three fish escaped from tank through overflow pipe

Table IITemperature in Degrees C.

Time Hrs	<u>Concentration</u>			
	<u>0.0</u>		<u>1000 ppm</u>	
	A	B	A	B
0.0	21.5	21.5	21.5	21.5
24	22.0	22.5	22.5	22.5
48	21.5	21.5	22.0	22.0
72	21.5	21.5	22.0	22.0
96	22.0	22.5	22.5	22.5

Table IIIDissolved Oxygen mg/l

Time Hrs	<u>Concentration</u>			
	<u>0.0</u>		<u>1000 ppm</u>	
	A	B	A	B
0.0	7.7	7.7	7.8	7.8
24	6.5	6.6	6.0	5.9
48	7.2	7.2	6.8	6.8
72	6.8	6.8	6.6	6.4
96	6.7	6.6	6.1	6.0

Table IVpH

Time Hrs	<u>Concentration</u>			
	<u>0.0</u>		<u>1000 ppm</u>	
	A	B	A	B
0.0	8.0	8.0	8.0	8.0
96	7.9	7.9	7.8	7.8

Table VSalinity

Time Hrs	<u>Concentration</u>			
	<u>0.0</u>		<u>1000 ppm</u>	
	A	B	A	B
0.0	26.5	26.5	24.0	24.0
96	27.5	27.5	25.0	25.0

Table VILength-Weight Data (Fish and Grass Shrimp Only):

Test Concentration (% Effluent)	Replicate	Total Length (mm)		Weight (g)		Loading Factor (g/l)
		$\bar{X}$	s	$\bar{X}$	s	

30 ORGANISMS WERE RANDOMLY SELECTED AND
SACRIFICED TO OBTAIN THE FOLLOWING DATA:

MEAN WEIGHT IN GRAMS: 0.794

STANDARD DEVIATION FOR WEIGHT: +/- 0.136

MEAN LENGTH IN MILLIMETERS: 41.6

STANDARD DEVIATION FOR LENGTH: +/- 1.88

LOADING FACTOR IN GRAMS/LITER: 0.794

Length of longest measured test organism (mm): 45

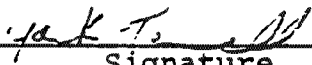
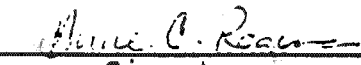
Length of shortest measured test organism (mm): 38

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ASI NO: 9001.06
APRIL 26, 1991

PROTOCOL

ACUTE TOXICITY TEST FOR
MUMMICHOG FUNDULUS HETEROCLOTUS
(96 HOUR SCREENING)SPONSOR: Chubb National Foam, Inc.
Union and Adams Streets
West Chester, PA 19382STUDY NUMBER: 91-056A (91-143A)TESTING FACILITY: Aqua Survey, Inc.
499 Point Breeze Road
Flemington, New Jersey 08822
United States of AmericaPROPOSED START DATE: May 2, 1991PROPOSED COMPLETION DATE: May 10, 1991STUDY DIRECTOR  5/1/91
Signature DateQA OFFICER:  5/1/91
Signature DateSPONSOR APPROVAL:  4-29-91
Signature Date

OBJECTIVE:

to determine the acute toxicity of the test material in the aquatic environment to mummichog under flow-through (intermittent-flow) conditions for 96 hours.

TEST ARTICLE:

The test article is Aer-O-Water 6EM which was received from Hubb National Foam on February 22, 1991; the test article is Straw Yellow Liquid (description). The sample is labeled with an ASI number 91-056 A. Any test article remaining after the test is completed will be disposed of according to the instructions from the sponsor or returned to the sponsor.

TEST ARTICLE CHARACTERIZATION:

Data concerning stability, uniformity, composition and additional chemical/physical characteristics of the test article will be provided by the sponsor on the Test Substance Form (supplied by ASI). Chemical analyses will be the responsibility of the sponsor unless prior arrangements have been made for ASI to assume that responsibility.

CONTROL ARTICLE:

None required.

TEST SYSTEM:

This test will be conducted on Mummichog, Fundulus heteroclitus,

JUSTIFICATION:

Mummichog are considered the appropriate test system as they are a characteristic system in which the response to toxicological agents can be evaluated.

DILUTION WATER:

Natural or artificial seawater will be used for this study. Natural seawater will be filtered through a filter with a pore size of less than 45 microns prior to use in the test. Artificial seawater will be prepared by adding commercially available formulations or by adding specific amounts of reagent-grade chemicals to deionized water.

EVENTS:

Whenever possible, the toxicant will be introduced into the test solution without the use of solvents other than distilled or deionized water. If alternative solvents are necessary, they are used sparingly, at not exceeding 0.1 ml/L in a solution.

TEST MATERIAL:

The technical grade, end-use product or both will be used in this test. The brand name or chemical names and a lot number are used to define a test material, mixtures are defined by ingredient and percent of each ingredient, where possible.

TEST ORGANISMS:

Common mummichog, Fundulus heteroclitus, is the organism specified for this test. Fish used in this test will be from the same age and be of normal size and appearance for their age. The longest fish will not be more than twice the length of the shortest and weigh between 0.1 and 5.0g each. Fish will not be used if they exhibit abnormal behavior or if they have been used in a previous test, either in a treatment or in a control group.

During holding, organisms are fed newly hatched brine shrimp nauplii Artemia salina or other appropriate food. Prior to testing, organisms are observed for signs of disease, stress, physical damage and mortality. Organisms exhibiting any of these signs are remedially treated prior to use in testing or discarded.

EXPOSURE CHAMBER:

Twenty (20) 19.5 liter all glass aquariums or other appropriate size glass or perfluorocarbon plastic chambers will be used.



TEST PROCEDURES:

A minimum of twenty (20) fish will be exposed to one concentration of the test article (equal numbers in two replicates).

Each test will include control (vehicle and/or untreated) consisting of the same dilution water, conditions, procedures, and fish from the same population or culture container, except that none of the chemical is added. If a vehicle control is used, the volume of the vehicle will be equal to that used in the test concentration.

The test article is introduced into each of the chambers.

The test is started by randomly introducing fish acclimated in accordance with the test design into the test chambers within 30 minutes.

Fish in the test and control chambers are observed periodically during the test, dead fish removed and the findings recorded.

The dissolved oxygen concentration, pH, temperature, salinity and other water quality characteristics are measured at specified intervals in the test chambers.

The flow rate through each test chamber will be at least five(5) additions per 24 hours.

ACCLIMATION:

If the holding water is not from the same source as the dilution water, acclimation to the dilution water will be gradually over a 48 hour period. The fish will then be held an additional 14 days in the dilution water prior to testing.

Organisms will not be subjected to more than a 3°C change in water temperature in any 12 hour period. The range of salinity will be less than 2g/kg or 20‰ of the average, whichever is higher. Organisms will be held for a minimal of 7 days at the test temperature prior to testing.

During the final 48 hours of acclimation, organisms will be maintained in facilities with background colors and light intensities similar to those of the testing area and will not be fed.

TEST PARAMETERS:**TEMPERATURE:**

The test temperature will be maintained at 22 +/- 2°C. In at least one test chamber, the maximum and minimum temperature will be monitored daily. In addition, the temperature will be measured concurrently at the beginning and end of the test in all test chambers.

DISSOLVED OXYGEN:

The dissolved oxygen (DO) concentration in each test chamber will be from 60 to 100% of saturation at all times during the test. Measurement will be made at the beginning and end of the test and at least every 48 hours in between.

pH:

The pH will be measured at the beginning and end of the test.

SALINITY:

Salinity will be measured at the beginning and end of the test.

PHOTOPERIOD:

A photoperiod of 16 hours light and 8 hours dark with a 15 to 30 minute transition period.

LOADING:

Loading will not exceed 1.0 grams per liter of solution passing through the chamber in a 24 hour period.

OBSERVATIONS:

The number of dead and affected organisms in each test chamber will be counted every 24 hours after the beginning of the test.

WEIGHT AND LENGTH:

After all 96 hour evaluations have been performed, a random sample of 30 surviving fish are sacrificed for weight and length determinations.



REPORTING:

In addition to the general reporting requirements, the reporting of test data shall include the following:

1. The source of the dilution water, its chemical characteristics and description of any pretreatment.
2. Detailed information about the test organisms.
3. A description of the test chambers, the depth and volume of solution in the chamber, the way the test was begun, the number of organisms per treatment, the number of replicates, the loading and the lighting.
4. The number and percentage of organisms that died or showed any other adverse effects at 24, 48, 72 and 96 hours. The age and scientific names are reported.

RECORDS:

All raw data, data manipulations, draft reports and final reports will be retained by Aqua Survey, Inc. Records will be surrendered to the sponsor upon their written request.

QUALITY ASSURANCE:

This study will be conducted in accordance with a modification of ASTM Standard Guide for Conducting Acute Toxicity Tests with fishes, macroinvertebrates and amphibians, E 729-88a.

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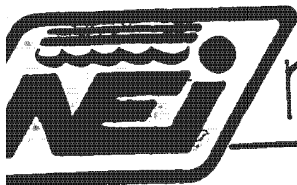
N

D

I

X

B



TOTAL ANALYTICAL SERVICES FOR A SAFE ENVIRONMENT

nytest environmental inc.

Project No.: 9117891
Log in No.: 7861
P.O. No.: Pending
Date: April 30, 1991

ANALYTICAL DATA REPORT
PACKAGE FOR

Aqua Survey Inc.

499 Point Breeze Rd.

Flemington, NY 08822

ATTN: Jim Todd
REF: Lab Water

SAMPLE
IDENTIFICATION

LABORATORY
NUMBER

SAMPLE
MATRIX

SEE NEXT PAGE

WE CERTIFY THAT THIS REPORT IS A
TRUE REPORT OF RESULTS OBTAINED
FROM OUR TESTS OF THIS MATERIAL.

PARAG K. SHAH, PH. D.
ORGANIC LAB. MANAGER

kb

RESPECTFULLY SUBMITTED,
NYTEST ENVIRONMENTAL INC.

Douglas Sheeley
DOUGLAS SHEELEY
LABORATORY DIRECTOR
NJ Cert# 73469

Report on sample(s) furnished by client applies to sample(s). Report on sample(s) obtained by us applies only to lot sampled. Information contained herein is not to be used for reproduction except by special permission. Sample(s) will be retained for thirty days maximum after date of report unless specifically requested otherwise by client. In the event that there are portions or parts of sample(s) remaining after Nytest has completed the required tests, Nytest shall have the option of returning such sample(s) to the client at the client's expense.

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US00000415

NYTEST ENVIRONMENTAL INC.

LABORATORY
NUMBER

SAMPLE
IDENTIFICATION

TYPE OF
SAMPLE

7861001
7861002
7861003

LG SALT
LG FRESH
LP FRESH

Water
Water
Water

nytest environmental inc.

DATA REPORTING QUALIFIERS

- U Indicates compound was analyzed for but not detected. Report the minimum detection limit for the sample with the U (e.g. 10 U) based on necessary concentration dilution actions. (This is not necessarily the instrument detection limit.) The footnote should read U-Compound was analyzed for but not detected. The number is the minimum attainable detected limit for the sample.
- J Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed or when the mass spectral data indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero (e.g.: If limit of detection is 10 ug/l and a concentration of 3 ug/l is calculated, report as 3J.)
- B This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
- T This flag identifies all targeted compounds that were found above the method detection limits.
- NA This flag indicates that the compounds are not applicable.
- A Aldol condensation product.
Note: Data on soil samples expressed on a dry weight basis.

All non-water samples are reported on soil forms. This includes samples whose matrix is listed as miscellaneous.

The initial and continuing calibration dates and times for the volatile fraction are listed on the BFB summary forms. The initial and continuing calibration dates and times for the semi-volatile fractions are listed on the DFTPP summary forms.

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nytest environmental inc.

REPORT OF ANALYSIS

Log In No.: 7861

We find as follows:

Parameter(s)	Sample Identification			
	LG SALT (7861001)	LG FRESH (7861002)	LP FRESH (7861003)	Method Blank
pH	7.66	--	--	NA
Salinity, ppt	29.8	--	--	<1
Results in mg/l:				
Ammonia Nitrogen	0.130	0.22	--	<0.05
Bromide	40.8	--	--	<1.0
Fluoride	0.576	--	--	<0.02
Iodine	<1	--	--	<1
Nitrate	<0.04	--	--	<0.04
Phosphate	<0.04	--	--	<0.04
Residual Chlorine	<0.1	<0.1	<0.1	<0.1
Sulfide	<0.10	--	--	<0.10
Sulfate	1910	--	--	<1
Total Cyanide	<0.01	--	--	<0.01
Total Suspended Solids	3	5	--	<1

ppt = parts per thousand

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US00000418

nytest environmental inc.

REPORT OF ANALYSIS

Log In No.:7861

We find as follows:

Results in mg/l:

Parameter(s)

Sample Identification

	LG SALT (7861001)	LG FRESH (7861002)	LP FRESH (7861003)	Method Blank
Aluminum	<0.2	--	--	<0.2
Arsenic	<0.010	--	<0.010	<0.010
Beryllium	<0.005	--	--	<0.005
Boron	3.3	--	--	<0.1
Cadmium	<0.005	--	<0.005	<0.005
Calcium	271	--	--	<1.0
Chromium	<0.010	--	--	<0.010
Cobalt	<0.05	--	--	<0.05
Copper	<0.025	--	<0.025	<0.025
Cron	<0.050	--	--	<0.050
Lead	<0.050	--	<0.050	<0.050
Magnesium	932	--	--	<1.0
Manganese	<0.015	--	--	<0.015
Mercury	<0.0002	--	<0.0002	<0.0002
Molybdenum	0.16	--	--	<0.010
Nickel	<0.040	--	<0.040	<0.040
Potassium	348	--	--	<1.0
Selenium	<0.010	--	--	<0.010
Silver	<0.010	--	--	<0.010
Zinc	<0.020	--	<0.020	<0.020
Total Organic Carbon	20.5	11.3	--	<1.0

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NYTEST ENVIRONMENTAL INC.

TCL PESTICIDE/PCB ORGANICS ANALYSIS DATA SHEET

SAMPLE MATRIX: WATER SAMPLE ID: LG SALT
CONC. LEVEL: LOW LAB SAMPLE ID: 7861001
EXTRACTION DATE: 4/9/91 DIL FACTOR: 1.00
ANALYSIS DATE: 4/18/91 % MOISTURE: NA

CMPO #	CAS Number	PESTICIDE/PCB COMPOUND	UG/L
1	319-84-6	Alpha-BHC	0.050 U.
2	319-85-7	Beta-BHC	0.050 U.
3	319-86-8	Delta-BHC	0.050 U.
4	58-89-9	Gamma-BHC(Lindane)	0.050 U.
5	76-44-8	Heptachlor	0.050 U.
6	309-00-2	Aldrin	0.050 U.
7	1024-57-3	Heptachlor Epoxide	0.050 U.
8	959-98-8	Endosulfan I	0.050 U.
9	60-57-1	Dieldrin	0.100 U.
10	72-55-9	4,4'-DDE	0.100 U.
11	70-20-8	Endrin	0.100 U.
12	33213-65-9	Endosulfan II	0.100 U.
13	72-54-8	4,4'-DDD	0.100 U.
14	1031-07-8	Endosulfan Sulfate	0.100 U.
15	50-29-3	4,4'-DDT	0.100 U.
16	53494-70-5	Endrin Ketone	0.100 U.
17	72-43-5	Methoxychlor	0.500 U.
18	57-74-9	Chlordane	0.500 U.
19	8001-35-2	Toxaphene	1.000 U.
20	12674-11-2	Aroclor-1016	0.500 U.
21	11104-28-2	Aroclor-1221	0.500 U.
22	11141-16-5	Aroclor-1232	0.500 U.
23	53469-21-9	Aroclor-1242	0.500 U.
24	12672-29-6	Aroclor-1248	0.500 U.
25	11097-69-1	Aroclor-1254	1.000 U.
26	11096-82-5	Aroclor-1260	1.000 U.

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ORGANOPHOSPHOROUS PESTICIDES

Log in No.: 7861
Sample ID No.: LG SALT
Lab ID No.: 7861001

Parameters (ug/l)	Detection Limit (ug/l)	Found
Vapona (Dichlorvos)	0.2	ND
Phorate	0.2	ND
Diazinon	0.6	ND
Naled (Dibron)	0.2	ND
Dementon - S	0.2	ND
Disulfoton	0.2	ND
Ronnel	0.3	ND
Chlorpyrifos (Dursban)	0.3	ND
Bolstar (Sulprofos)	0.2	ND
Stirophos	2.0	ND
Fensulfothion	5.0	ND
Azinphos methyl (Guthion)	1.5	ND
Coumaphos	1.5	ND
Malathion	0.3	ND
Parathion	0.3	ND

ND = Not Detected

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