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Riverside County, California

6. The physical movement of 2,338,900 gallons of Orange from its present locations to the ultimate site of disposal is potentially a serious threat to the environment and we feel the draft statement does not give sufficient information on movement details, such as mode of transportation, off-loading, storage at disposal site, spill containment, decontamination, etc. We recommend the following: (1) careful observance of Department of Transportation safety requirements in the transport of hazardous materials; (2) spelling out of specific modes and routes of transportation so as to plan for any contingency that might occur; (3) separate and individual contingency plans covering such items as immediate field detoxification, health and safety considerations of personnel who might be involved in cleanup; (4) a firm written commitment from the transportation contractor that containment equipment is located and available to the contractor during transportation; and (5) pre-designation of the on-scene coordinator prior to any shipment.

Off-loading areas should be equipped with materials and equipment necessary for rapid cleanup, and off-loading equipment should be checked thoroughly before the commencement of each loading or unloading in order to assure safe and dependable operation. Furthermore, responsible persons engaged in off-loading should be given complete instructions in cleanup techniques along with instructions on how to proceed in case of a spill.

While shipment by water is cheaper than land and there has never been a spill during water transport, it might be recognized that material spilled in a waterway would be distributed by the current. A land spill could be much more easily contained. If shipment is made by rail or truck, cleanup teams and equipment should accompany the transport vehicles.

7. If the drums are deteriorating, consideration should be given to either redrumming or transfer to tankcars. As some of the Orange will be held for up to 2 1/2 years at the disposal site, there is question as to the advisability of storing the Orange in drums at all. If the site has suitable bulk storage tanks available, these should be used. Shipping in bulk and building several storage tanks at the site might prove cheaper and safer than redrumming, shipping and storing drums.

Because of the extensive precautions which should be taken during transportation and the possibility of contamination of other cargo in the event of leakage, we feel the use of Orange drums as filler cargo is inadvisable.

8. In the matter of storage, whether in bulk or in drums, only those areas especially designed for storage of hazardous materials should be used. Such areas should provide (1) structures to prevent surface water runoff from entering the area, (2) pavement and gutters to collect surface water runoff within the area, (3) drains to channel contaminated runoff to a holding facility, (4) materials and equipment necessary for rapid cleanup of spills, and (5) fencing to control admission to the areas. In addition, storage areas should be located remotely from occupied dwellings.

9. The alternative of building a new incinerator in a remote region should be examined in detail.

We appreciate the opportunity to review this draft environmental impact statement.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
WASHINGTON, D.C. 20201

OFFICE OF THE SECRETARY

MAR 13 1972

Mr. Aaron J. Racusin
Acting Assistant Secretary
of the Air Force
(Installations & Logistics)
Washington, D. C. 20330

Dear Mr. Racusin:

The Department of the Air Force draft Environmental Statement for the Disposition of Orange Herbicide by Incineration dated January 1972 has been reviewed. The following comments are offered.

1. The proposal is to destroy 2,338,900 gallons of Orange I and II herbicides by incineration. Orange I is 50/50 (by vol.) butyl 2,4-D and butyl 2,4,5-T. Orange II is 50/50 (by vol.) butyl 2,4-D and iso-octyl 2,4,5-T. Incinerators to be used are at Houston, Texas and Sauget, Illinois.

2. The project description implies that the herbicide orange must be considered a very hazardous chemical which it actually is not. On the other hand, the polychlorinated dibenzo-p-dioxins which are highly toxic are not given that much attention.

3. On page 6 of the project description a contradiction seems to exist: One sentence suggests that impurities in 2,4,5-T could account for the teratogenicity of that product. The next sentence suggests that both compounds are teratogenic or fetotoxic to experimental animals of various species. This discussion, of course, is very important and should have been clarified, particularly regarding the dose/response data which are available in the literature. It is necessary to have this information on the teratogenicity of the nearly pure 2,4,5-T in mice strains, hamsters and chicks and lack of such effects in rats and rabbits available for comparison with the fetotoxicity of the "dioxin" compound in all species in which it has been tested. The difference in the order of magnitude of toxicity of these chemicals is impressive.

SAFCS [illegible]

4. The major reason for concern exists in the first sentence on page 7 regarding the possible formation of dioxins during incineration. This is considered unlikely based on the acidic conditions and would in any case not lead to any emission into the environment because of the high incineration temperature. This judgment is unwarranted, because data exist on formation of dioxin from precursors (equivalent to breakdown products) during pyrolysis (Higginbotham, et al. Chemical and toxicological evaluations of isolated and synthetic chloro derivatives of dibenzo-p-dioxin. Nature 220: 702-703, 1968) which make it clear that the safety of the process depends entirely on the adequacy of the temperature control. The better known dioxins are stable up to a temperature of 700°C, but will break down at 900°C. Whether that is also true of more highly chlorinated dioxins is unknown. However, the chosen temperature of incineration is to be much higher to assure decomposition. No question is raised about the formation of other compounds, as, for instance, hexachlorobenzene during pyrolysis which may withstand the high temperature for some time. There is knowledge about the existence and persistence of other polychlorinated polycyclic compounds formed on combustion of hydrocarbon in the presence of chlorine. Their toxicity has not been investigated.

5. A combustion analysis program to be carried out in collaboration with the USDA is expected to have results on pyrolysis available by July 1972 to assure complete destruction of the herbicide. Considering the difficulties encountered in determining trace amounts of the dioxins, it seems hard to believe that this program will be able to assure anyone of "complete" destruction of all pyrolysis products. This research activity will also not pay adequate attention to formation and destruction of other so far undescribed polymerization products since the time for completion of the study is too short. As these studies will undoubtedly not utilize the large scale facilities for their research, no information on the function of the actual combustion facility will be available when the program gets started.

6. Free HCl (hydrochloric acid) should not go into the air and water as occurs at the Sauget, Illinois incinerator but should be converted to a salt such as sodium chloride before disposal.

7. The concern with the disposal of the drums is excessive. They need to be cleaned out as proposed and thereafter could be handled like other drums which contained pesticides and need not be crushed and buried. Their contents never were that toxic.

8. The alternatives to the proposed action are dealt with too quickly. Because a committee of experts has made its recommendations to EPA, alternative 2 and 3 should be re-evaluated. Alternative 8 is not an alternative to the problem since it considers only the disposal of the drums. Alternative 7 in conjunction with 2 and 3 appears to be the safest procedure. Use in the proper manner and degradation in soil, admittedly over an extended period of time, seems to be the best solution, based on the possible hazard of dioxin or other polychlorinated hydrocarbon production during pyrolysis compared to the known hazard of the herbicide which is relatively small.

The opportunity to review this draft environmental impact statement is appreciated.

Sincerely yours,

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

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MAY 2 1972

Dear Mr. Racusin:

In response to your letter of January 20, 1972, we have reviewed the draft environmental statement for the proposed disposition of Orange Herbicide at Deer Park, Texas, and Sauget, Illinois.

On page 10, it is stated that the incineration plant is capable of burning Orange Herbicide. However, on pages 11 and 12, we find that a combustion analysis program is underway and that the results of the program will not be available until July 1972. Since municipal incinerators are generally incapable of properly handling materials such as Orange Herbicide, the results of these studies should be made available for comment prior to commencement of this program.

Only two incineration sites were presented in the statement. Some commentary and explanation are required. Of the two incineration plants, the one at Deer Park, Texas, has the advantages of distance from a major population center, larger capacity, and a caustic scrubber. The stack should be taller to permit greater mixing of effluent gases, which will include corrosive hydrogen chloride. About 800 pounds of hydrogen chloride will be emitted daily in stack gases. When combined with moisture of the atmosphere, the resultant hydrochloric acid will attack metals and metal finishes and increase acidity of surrounding waters. This could create a shift of aquatic organisms to more acid-tolerant but less attractive recreational species.

Disposal of the drums by sale as scrap or for reconditioning is not an alternative to the total proposed action; however, it is clearly one of several possible alternatives for disposal of the drums after they are emptied. We feel that every effort should be made to recycle as many drums, or the scrap metal, as possible. Disposal of over 42,000 steel drums in a land fill hardly seems acceptable in today's climate. Guidelines for preparation of drums for recycling or for scrap have been developed. Toxic waste disposal systems have also been developed. Information concerning these systems is available through the National Agricultural Chemicals Association.

Finally, we must express concern in regard to the large amounts of sodium chloride (13 tons) and CO_2 (45 tons) which will be discharged daily. These discharges will place a considerable additional burden on the air and aquatic environment, and these potential impacts should be fully evaluated prior to issuance of discharge permits. The best available techniques for control of air and water pollution should be used.

The discharge of large amounts of sodium chloride may adversely affect the aquatic environment. At times of low water (drought), this discharge might increase the salinity so as to favor those aquatic species most tolerant to this change and so cause a shift of aquatic organisms. It is also possible that salinity will increase in parts of Galveston Bay so much that parasitism and predation in oyster beds will increase. These effects would be minimized with high dilution and discharge at a time of high water. Applicable State and Federal air and water quality standards should be included in the statement, and the methods used to meet these standards should be described.

The feasibility of processing the sodium chloride for chlorine, sodium, or alkali in a nearby chlor-alkali plant should be discussed, as well as the irretrievable loss of the herbicide, if burned.

We appreciate the opportunity to review this statement.

Sincerely yours,

Deputy Assistant Secretary of the Interior

Mr. Aaron J. Racusin
Acting Assistant Secretary
(Installations and Logistics)
Department of the Air Force
Washington, D. C. 20330

USAF ENVIRONMENTAL HEALTH LABORATORY
KELLY AFB, TEXAS 78241

APPENDIX M

BIOLOGICAL MONITORING AND TOXICITY STUDIES IN SUPPORT OF "ORANGE" HERBICIDE INCINERATION TESTS AT THE MARQUARDT COMPANY VAN NUYS, CALIFORNIA

June 1974

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

Section Page

Appendix

Tables

Figures

TABLE OF CONTENTS (cont'd)

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I. SUMMARY

A. This report describes ecological and toxicological studies performed in support of incineration tests conducted jointly by the United States Air Force and the Marquardt Company. The incineration tests consisted of technical evaluations of a series of eight burns designed to investigate the destruction of "Orange" herbicide by combustion in a full scale, commercial incineration system. This system provided for the scrubbing of effluent combustion gases with a sodium hydroxide or "caustic" solution. No auxiliary fuel was used to incinerate the herbicide. Each of the test burns lasted from 2.27 to 5.93 hours. The ecological and toxicological studies described in this report provided real-time biomonitoring to rapidly detect biologically detrimental effects of the test burns in the area surrounding the incinerator, and to compliment the chemical analyses of spent scrubber water as regards toxicity.

B. Atmospheric biomonitoring methods utilized plants in the area surrounding the incinerator. Observations were made of the local flora in the area in addition to test plants placed in sixteen locations around the incinerator. The 160 test plants used were young tomato plants. Tomato plants are known to be especially sensitive to chlorophenoxy herbicides. Meteorological data was recorded throughout each test burn. The biomonitoring studies revealed no herbicide or other chemical damage to the plants in areas downwind from the incinerator.

C. Biomonitoring of the eight spent scrubber waters consisted of bioassays performed on a representative sample of each test burn. Each sample was composed of numerous portions of spent scrubber water collected throughout the entire length of a test burn. Test animals used in the bioassays were 3-spine sticklebacks (Gasterosteus aculeatus) and brine shrimp (Artemia salina). No unexpected toxic effects were observed. The chlorine produced by incinerating the herbicide (a chlorinated hydrocarbon) was collected as free, available chlorine in the scrubber waters. As expected, free chlorine in the spent scrubber waters produced lethal effects on sticklebacks at 20-35 times the toxicity seen in scrubber waters in which the chlorine had been removed. The bioassays with the spent scrubber waters were compared to similar toxicity studies with artificial spent scrubber water. The "artificial" spent scrubber water was used to establish the toxicity to be expected when aquatic organisms are exposed to such a solution. Also, toxicity studies were performed to determine the effects of osmotic gradients on the test animals. The toxicities seen with the spent scrubber waters in which free chlorine had been removed were not significantly different from the toxicity found with artificial spent scrubber water. Osmotic toxicity studies indicated that unavoidable osmotic effects contributed largely to the toxic effects seen in the spent scrubber waters.

II. INTRODUCTION

A. SCOPE OF INVESTIGATION

1. Description of Incineration Tests

a. The ecological studies described in this report were in support of a testing program conducted jointly by the United States Air Force and the Marquardt Company to investigate the destruction of "Orange" herbicide by combustion in a commercial incineration system. Results of the incineration tests were reported separately from the ecological studies. A brief description of the incineration tests is presented in the following paragraphs as background information to clarify the objectives of the ecological studies.

b. Incineration tests were conducted at the Air Force-Marquardt Jet Laboratory at Van Nuys, California between 8 October 1973 and 21 December 1973. A full scale, commercial (Marquardt) incineration system was used. This system contained a combustion gas scrubber which used a sodium hydroxide solution to remove potential air pollutants from the incinerator exhaust. Since "Orange" herbicide is composed of chlorinated hydrocarbons, efficient combustion was expected to produce mainly HCl, CO_2, H_2O, Cl_2, CO, and particulate carbon in the effluent gases. These materials were removed in varying proportions by the scrubber system. The spent scrubber water was stored in holding tanks until chemical analyses and bioassays could determine that release of the material would not result in a water pollution problem. No auxiliary fuel was used to incinerate the "Orange" herbicide. A small amount of natural gas was used to preheat the incinerator before the herbicide was injected into the combustion chamber.

c. The following two paragraphs are direct quotes from the summary of the published report of the incineration study entitled, "Report On The Destruction Of "Orange" Herbicide by Incineration," (April 1974). (Hereafter referred to as the "Incineration Report"). The report was written by the Marquardt Company and the USAF Environmental Health Laboratories at Kelly AFB and McClellan AFB. The two quoted paragraphs summarize the chemical analyses performed during the incineration tests and the final results of the tests.

d, "Extensive sampling and analyses were conducted to quantitate the constituents of the unscrubbed combustion gases, the liquid used to cool and scrub the combustion gases, scrubbed effluent gases, drum cleaning samples, and any solid residues deposited in the system. Samples were analyzed by mass spectroscopy, flame ionization, gas chromatography, and atomic absorption. Process system parameters and noise data were observed and recorded.

e. Test data demonstrated that the "Orange" herbicide was effectively and safely destroyed by incineration; no herbicide feed compounds were found (within the limits of detectability) in any combustion gas, scrubbed effluent gas, spent scrubber water or combustion chamber deposit sample resulting from incinerator operation (four test burns) while using slot type fuel injection nozzles. Likewise, no herbicide feed compounds were found in samples resulting from incineration operations (four test burns) while using a central poppet type fuel nozzle except for one combustion chamber deposit sample and one spent scrubber water sample. This anomaly was attributed to the characteristics of poppet nozzle fuel injection. From sample analyses data, conclusions were made regarding possible undetectable discharge mass rates of herbicide constituents, effluent biological impact, formation of pyrolyzates and hydrolyzates, and possible criteria for drum cleaning operations. Criteria were also established regarding incinerator noise generation and incinerator process system functions."

2. Scope of Ecological Studies

The purpose of the ecological studies was to determine if the incineration of "Orange" herbicide could be accomplished without untoward effects on the plant and animal life in the vicinity of the incinerator. In addition, the ecological studies were designed to detect early symptoms of improper incinerator operation by real-time biomonitoring and to detect biologically harmful combustion byproducts should any escape detection in the chemical analyses of incinerator effluents. Environmental protection was provided by biomonitoring the two possible routes of contamination: a) spent scrubber water effluent, and b) air contamination downwind from the incinerator stack.

a. Biomonitoring for Contamination of the Spent Scrubber Waters from Each of the 8 Test Burns

The sodium hydroxide solution used in the incinerator's scrubber was expected to efficiently trap the acid gas products of combustion and any undestroyed herbicides or their incomplete combustion products. Bioassays were performed on spent scrubber water from each burn to insure that there was no unusual toxicity caused by the presence of unexpected chemicals in the SSW that might prove harmful to aquatic biota. The spent scrubber water from each individual burn was stored in a holding tank until completed bioassays with fish and brine shrimp together with chemical analyses indicated that it could be safely released into the Marquardt Company's 1.4 million gallon waste water holding reservoir.

b. Ecological Studies to Determine if Biologically Active Emissions Were Produced

Biota in the area of the incinerator was closely observed to provide early detection of downwind air contamination with corrosive chemicals or unoxidized herbicides should the scrubber system not remove all toxic materials. Records of wind speed and direction were kept for the time period of each burn. The presence of animal life on the Marquardt property was observed and recorded. Condition of native and decorative plants on the Marquardt property and its perimeter was observed and recorded. Also, the condition of 160 tomato plants positioned in 16 stations surrounding the incinerator was closely observed for any damage. These plants were placed in their stations prior to the first burn and then observed for changes in the days following each burn. After the completion of the eight burns, plants selected from areas of highest potential exposure were observed for an additional two week period.

B. METHODS OF SPENT SCRUBBER WATER TREATMENT FOR AQUATIC BIOASSAYS USING STICKLEBACKS AND BRINE SHRIMP

1. Artificial Spent Scrubber Water

a. Aquatic bioassays were utilized as a means of screening for unusually toxic factors that might possibly contaminate the used or "spent" scrubber waters of the 8 test burns. Unexpected toxicity of the scrubber waters could have been caused by a single toxic chemical or by combinations that are synergistic or contain potentiating factors. The results of the aquatic bioassays were reported as an "LC_{50}."*

b. To determine the relative toxicity that would normally be expected with a spent scrubber solution, an artificially "spent" scrubber solution (Art. SSW) was used for comparison or "control" bioassays. This artificial spent scrubber water was formulated by using the calculated quantity of hydrochloric acid that would be produced by Orange incineration in relation to other scrubber and incinerator parameters. These parameters were predicted by computer systems analysis for the Marquardt burner when incinerating "Orange" herbicide. Hydrochloric acid, in quantities representing the chlorine disposition from "Orange" herbicide, was added to fresh scrubber water. Then, the pH was adjusted to 7.0 using commercial grade sulfuric acid before this Art SSW was used in bioassays.

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*LC_{50}, or Lethal Concentration 50%, is a concentration value statistically derived from the establishment of a dose-related response of experimental organisms to a toxicant. The LC_{50} represents the best estimation of the dose required to produce death in 50% of the organisms. Note that a more toxic chemical has a smaller LC_{50}. The time period for which the 50% response was derived must also be indicated. In these tests with SSW, 48 hours was the time of exposure except as noted.

2. Spent Scrubber Water Collection and Treatment

Spent scrubber water from each burn was proportionally sampled and collected in a 55 gallon drum throughout the entire period of each burn. At the end of a burn, a forklift transported the drum to the toxicity testing laboratory. Enough SSW for the bioassays was immediately drawn from the drum and acidified to a pH of 3.5. The SSW was acidified to minimize the potential for alkaline hydrolysis of the relatively toxic herbicide esters should unoxidized herbicides have been present as contaminants. In addition, the acid pH promoted the escape of Cl_2 and CO_2 as gases. (See Appendix B for discussion of relative toxicity and hydrolysis.) Nitrogen was bubbled through the acidified SSW until tests indicated that available chlorine* was less than 0.2 ppm. Just before use in the bioassays the SSW was adjusted back to pH 7 with unused scrubber water.

C. METHODS AND MATERIALS FOR ON-SITE ANIMAL BIOASSAYS

1. Aquatic Test Animals

a. Fish and crustaceans were used as indicator species in the bioassays of the scrubber waters from the eight test burns. The 3-spine stickleback (Gasterosteus aculeatus) was used as the major bioassay test animal. This species of fish is classed as "moderately sensitive" to pollutants.(5) However, sticklebacks can survive in a remarkable range of salinity extremes.(3) This characteristic made the stickleback an ideal species for use in assaying for toxic materials in the high specific gravity scrubber water. Thus, toxic action due to osmotic effects was de-emphasized, allowing a more concentrated solution of SSW to be used. Further, the sticklebacks were good monitors for "Orange" herbicide components since they were found to be very sensitive to the N-butyl ester of 2,4-D. In toxicity studies at the Environmental Health Laboratory at Kelly AFB, Texas (EHL/K), the 48 Hr, LC_{50} was found to be 0.54 ppm.

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*Free available chlorine. The LC_{50} of the first bioassay using spent scrubber water from burn I (SSW I) was compared with the LC_{50} from the artificial SSW. The material from the actual burn was 20 times more toxic than the reference bioassay using Art SSW. (Art. SSW 48 Hr, LC_{50} = 10.4% vs. SSW I 48 Hr, LC_{50} = 0.53%). This unexpected toxicity was found to be due to free chlorine dissolved in the SSW. Since toxicity of the chlorine could conceal the toxic effects of more pertinent contaminants, the above method was utilized to remove it.

b. The sticklebacks were collected from San Antonio Creek at Vandenberg AFB CA. San Antonio Creek is a pristine stream originating by the base and emptying into the Pacific Ocean. It has clear, cold water with a specific gravity of 1.001. The sticklebacks were collected by seining. Only the smaller, sexually immature fish were retained for use so as to eliminate possible sexually-related metabolic differences that could produce added variations in response to toxicants. Mean fish weight was 245 mg. Mean fish length was 3.1 cm. (See Fish Statistics, Table A-1)

c. The fish were acclimated to the laboratory environment a minimum of 5 days before being used. They were held in 30 gallon all-glass tanks equipped with charcoal and dacron-fluff filters. The fish adapted to captivity very rapidly and in two days were reacting with anticipation whenever anyone approached the tanks with food. The fish were fed Tetramin® flakes twice a day.

d. Brine shrimp (<u>Artemia salina</u>) were hatched at EHL/(K) and transported to Van Nuys in insulated containers oxygenated with battery-operated air pumps. They were fed brewers yeast. Brine shrimp were 15-20 days old when used in the bioassays. The culture medium used for the shrimp was made by adding artificial sea salts* to the conditioned tap water to adjust the specific gravity to 1.022. The resulting brine solution was aerated at least 24 hours before it was used.

2. Animal Bioassay Exposure Procedures

a. Dynamic Bioassays

(1) "Dynamic" or continual-flow bioassays were performed on all the assays which used fish to detect toxicants in the spent scrubber water. A proportional diluter (8),(9) was used to provide five logarithmically-spaced concentrations of each spent scrubber solution. A sixth exposure chamber received 100% diluent water as the control. Two proportional diluters were used for these studies. Appendix Table A-2 shows the resultant dilutions of each.

(2) Bioassays were performed in accordance with principles described in <u>Standard Methods</u> (12) and Sprague (10). Test animals were not fasted prior to testing. However, food was withheld during the actual assay period. Ten fish were used in each of the five concentrations and in the control (60 fish total for each assay). Exposure chambers were plastic rat cages modified to contain 4 liters of diluted toxicant. This provided a ratio of 0.6 gm of fish per liter of water. This is a more favorable ratio

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*Marine Land Sea Salts®, Aquatic Systems Inc., East Lake, Ohio than recommended in Standard Methods (12). The flow of diluted toxicant into each chamber was adjusted to a retention time of 2 hours which was equivalent to a 6 hour, 95% replacement time. This provided a better flow rate than the 8 to 12 hours, 90% replacement time recommendations of Sprague (10) and insured adequate maintenance of the dissolved oxygen concentrations.

(3) Response of test animals was recorded throughout a 48 hour test period except for selected runs in which a 96 hour exposure period was used to confirm the absence of cumulative effects. The quantal response measured was death. A fish was counted as dead when all gill movement ceased. Dissolved oxygen and pH were monitored to insure that the cause of death was not lack of oxygen or changes in pH. Water temperature was maintained at 20°C. Probit analysis was performed on the data recorded at 1, 2, 24 and 48 hours of exposure to evaluate quantal response to graded doses. Replicates were not performed due to time limitations and other material considerations.

b. Static Bioassays

Bioassays with brine shrimp were "static" types in which the experimental concentrations were not replenished during the exposure period. Five brine shrimp were placed in 200 ml of each concentration of spent scrubber water. The SSW was diluted with the same artificial sea water that was used to culture the shrimp. Two replicates of each concentration were used. Graded concentrations ranged from 40% to 100% spent scrubber water.

3. Dilution Water

a. Conditioned tap water was used as the diluent in all of the assays using fish. The water was conditioned in a plastic-lined 55 gallon drum. Initially the drum was filled with hot tap water. Water in the drum was aerated continuously to drive off chlorine gas and maintain a high dissolved oxygen level. Temperature was adjusted to 20°C by pumping the water through a stainless steel coil immersed in a refrigerated water bath. The water was then passed through a charcoal filter before it was pumped to the proportional diluters. The dilution water was repeatedly checked to insure that no chlorine residual remained. The resulting conditioned tap water was a fairly soft water (hardness = 56 mg/l) with a pH of 8.1. Comprehensive analytical characterization of the conditioned water is listed in Table A-3 of the Data Appendix.

b. Dilution water for the brine shrimp static assays was prepared in the same manner as the culture medium used for the shrimp. Artificial sea salts were added to the conditioned tap water to adjust the specific gravity to 1.022. The resulting brine solution was aerated at least 24 hours before it was used.

4. Chemical and Physical Monitoring Techniques

a. Each concentration in each exposure chamber was monitored for several parameters throughout the exposure period. Temperature was measured to insure that it remained at 20°C as dictated by the waterbath temperature control system. pH and dissolved oxygen were monitored to insure that these parameters played no part in the fish mortality. Specific gravity and free available chlorine were also measured in all exposure chambers.

b. The methodology used to measure these parameters is described as follows:

(1) pH: An indicating, recording type pH meter (Analytical Measurements, Model 30WP) was used throughout the study. pH standards of 4.7 and 10 were prepared in the laboratory at EHL/K and used for calibration prior to each period of use.

(2) Temperature: Large scale, laboratory thermometers were placed in the water bath and in each bioassay for a continuous monitoring of the desired 20°C. Readings were taken at least 6 times per day to insure proper operation of the bath and bioassay systems.

(3) Dissolved Oxygen: A Yellow Springs Instrument Company, Model 51A Dissolved Oxygen Meter was used in the survey. Calibration was accomplished prior to each use. Measurements of each concentration were taken at 0 time, 24 and 48 hours, during each bioassay. Dissolved oxygen measurements were taken of holding and acclimation aquaria repeatedly throughout the study.

(4) Chlorine: A Prism Viewing, Color Comparator, Federal Stock #6630-087-1838 (O.T. Kit) was used throughout the survey. This test uses a color reaction produced with Orthotolidine to measure the presence of free available chlorine in concentrations larger than 0.2 ppm. Concentrations smaller than 0.2 ppm were detectable as a slight color change.

(5) Specific Gravity: A Urinalysis Hydrometer was used to measure specific gravity of each dilution in the test chambers. The highest value measurable with this hydrometer is 1.060. The more dense, undiluted solutions of spent scrubber water were weighed to determine specific gravity.

5. Treatment of Data

LC_{50}'s were determined by the probit analysis method of Litchfield and Wilcoxon. (6) Confidence limits for the LC_{50} were not calculated because each assay for each individual spent scrubber water was not replicated, nor was it possible to repeat each assay for more balanced and statistically satisfying partial responses on each side of the LC_{50} point. Each of the dynamic assays resulted in definitive dose-related responses. With the dynamic assays, no deaths occurred in the control fish so that no weighted correction factors were used. LC_{50}'s and the slopes of the dose response curves are listed in Table A-4 in the Data Appendix. Other statistical treatments such as variance and standard error of the mean used standard formulas. (4)

D. METHODS AND MATERIALS FOR ON-SITE ECOLOGICAL OBSERVATIONS

1. Ecological Biomonitoring

a. The species of each animal sighted on Marquardt property was noted in the logbook used to maintain all observations. Plant life on the Marquardt property and the surrounding perimeter was monitored before, during and after the burns. The plant life was observed in order to detect any symptoms of auxin-like changes should chlorophenoxy herbicides contaminate the incinerator exhaust. Damage that could result from air contamination with corrosive chemicals such as chlorine or hydrochloric acid was also closely looked for during the observation period.

b. In addition to native and decorative plants, young tomato plants (which are sensitive to highly chlorophenoxy herbicides) were used as bioassay organisms during the monitoring period. One hundred and sixty young plants (2 months old) were divided into groups of 10 and placed at 16 different stations around the test incinerator. The condition of the indicator plants was carefully recorded. Special care was taken to look for auxin-like and corrosive chemical damage. The height of each plant was periodically measured. During each of the eight burns the area around the incinerator was observed to determine which tomato plants were most exposed to the exhaust of the incinerator. On some occasions the steam from the incinerator exhaust was observed to be condensing and the droplets of moisture were falling out onto the tomato plants. After completion of the entire study, plants from six of the stations that received the most exposure were transported back to EHL/K. These plants were observed for two weeks to allow time for any latent damage to appear.

2. Meteorological Monitoring

Wind speed, wind direction, and temperature readings were obtained every half hour during the incineration periods by calling Van Nuys Airport Weather Information.

III. RESULTS AND DISCUSSION

A. RESULTS OF SPENT SCRUBBER WATER STUDIES

1. General Characteristics of the Spent Scrubber Waters

a. The spent scrubber waters (SSW) from the eight burns had a temperature of 164°F at the scrubber outlet collection point. Their pH values ranged from 10.5 to 11.8 and the average specific gravity was 1.057. Available chlorine concentrations ranged from 250-500 mg/l. Available chlorine existed completely as the "free" chlorine moity and none as "combined" available chlorine (12) Table A-5 in the Data Appendix lists other parameter ranges. Sample collection procedures and detailed analytical results are described in the incineration report.

b. The major characteristics described above could reasonably account for severe detrimental effects on aquatic organisms should the scrubber effluent empty directly into a natural body of water. In actual industrial operations some form of treatment is usually used to reduce or eliminate the effects of thermal pollution and acid-base shifts. Free available chlorine can also be removed. However, chlorine is so reactive that its effects are transitory and, in a limited "mixing zone", are often considered acceptable. In most of the bioassays in this study, chlorine was physically removed. The chlorine removal process and pH adjustment increased the average specific gravity of the SSWs from 1.057 to 1.068.

2. Sensitivity of Aquatic Bioassays

a. The general characteristics of SSW mentioned above produced inherent toxic effects on the aquatic test animals that, in effect, reduced the sensitivity of the assays for unknown toxicants. Therefore, the assays could only be expected to reveal the presence of acute, relatively highly toxic contaminants or combinations of contaminants. Based on previous aquatic studies with 2,4-D 2,4,5-T and their esters, the realistic assumption was that toxic effects of significantly toxic contaminants would be additive with the toxic effects normally expected from the high specific gravity scrubber waters. Therefore, the presence of a relatively highly toxic contaminant was expected to result in an obviously smaller LC_{50} (increased toxicity) when compared to uncontaminated scrubber waters. The pessimistic assumption would be that no additive effects occurred so that the presence of low concentrations of toxicants such as the N-butyl ester of 2,4-D would not be detected by an obviously lower LC_{50}.

b. Assuming no additional effects (the pessimistic assumption) the low level of detectability for the N-butyl ester of 2,4-D was calculated to be 3 ppm in the scrubber waters (available chlorine removed). This detection limit was calculated using the dilution range of 5% to 50% for each assay, the high toxicity of the ester to Sticklebacks (48 Hr. LC_{50}=0.54 ppm), and a mean 48 Hr. LC_{50} of 17.9% for all 8 SSWs.

3. Effect of Available Chlorine on Toxicity

a. In the bioassays of the SSW, temperature and pH were held constant. Available chlorine was removed as described in Part II B of this report. However, a few assays were run without chlorine removal. The comparison of toxicities resulting from the absence or presence of chlorine is striking as shown in Table 1 below.

TABLE I: EFFECT OF AVAILABLE CHLORINE REMOVAL ON TOXICITY OF SSW USED IN BIOASSAYS WITH STICKLEBACK.

	CHLORINE REMOVAL	24 Hr. LC_{50}	48 Hr. LC_{50}
BURN I SSW	Yes	12.8%	12.8%
BURN I SSW	No	0.53%	0.53%
BURN III SSW	Yes	28.8%	28.8%
BURN III SSW	No	0.84%	0.84%
BURN VI SSW	Yes	29.5%	20.5%
BURN VI SSW	No	0.75%	0.63%

b. Scrubber waters not bubbled with nitrogen were 20-35 times more toxic. The conclusion that this toxicity was due to available chlorine and not some other factor was based on chlorine measurements of SSW dilutions taken from the exposure chambers. Measurements of 0.4 ppm or greater available chlorine coincided with death in 100% of the fish in those exposure chambers. The 0.4 ppm value for toxic effects is in general accord with chlorine effects observed by other workers. (3),(7)

4. Toxicity of Scrubber Waters (Chlorine Removed)

a. In each bioassay, sticklebacks were exposed to serial dilutions of each scrubber water that ranged from 5% to 50% SSW. The dose-related response of the fish to those concentrations were in the range expected from toxicity due mostly to osmotic effects. To demonstrate the relationship of specific gravity of the scrubber waters to toxicity, new LC_{50} values were calculated based on the specific gravity of the serial dilutions rather than the concentration of SSW. Therefore, the toxicity of SSW from each burn could be considered jointly for dose-response relationships established on the basis of specific gravity and concentration expressed as percent SSW.

TABLE 2

RESULTS OF TOXICITY STUDIES

MATERIAL TESTED	SP. GRAVITY OF TREATED SSW	48 HR LC_{50}		SP. GRAVITY LC_{50} AT 48 Hrs
Art. SSW	1.1270	10.4%		1.017
SEA SALTS	1.011-1.032	NA		1.019
BURN I	1.075	12.8%		1.014
BURN II	1.079	16.0%		1.016
BURN III	1.061	28.8%		1.019
BURN IV	1.063	16.5%		1.016
BURN V	1.076	15.5%		1.013
BURN VI	1.060	24.4%		1.017
BURN VII	1.076	12.5%		1.014
BURN VIII	1.050	16.7%		1.011

b. A completely separate toxicity study was accomplished which established the dose-related response of the sticklebacks to pure differences in specific gravity. This study used a commercial marine salt mixture to compose saline concentrations that produced serial specific gravities ranging from 1.011 to 1.032.

c. The results of all of these studies are summarized in Table 2, "RESULTS OF TOXICITY STUDIES". Comparing the 48 Hr. LC_{50} values shown on Table 2, all 8 SSWs had higher concentrations than the reference "artificial SSW" (Art. SSW). However, the fact that the actual SSWs are less toxic than the Art. SSW is because the Art. SSW has a higher specific gravity than the 8 SSWs. The computer-predicted Art. SSW contained more solutes than the actual SSWs. Had the prediction been more accurate, less dilution would have been required, and the Art. SSW LC_{50} value would probably have fallen somewhere in the range of the LC_{50} of the actual burns.

d. The specific gravity "LC_{50}" (S.G. LC_{50}) in Table 2 shows that the specific gravity expected to kill 50% of the sticklebacks in 48 hours is 1.019 when the solutes are sea salts. When the solutes are more similar to those found in actual scrubber water, as in Art. SSW, the specific gravity LC_{50} drops to 1.017. Therefore, it is reasonable to assume that the toxicity of the SSWs with S.G. LC_{50}s around 1.017 are primarily due to their osmotic effects. BURNS II, III, IV and VI had SSW S.G. LC_{50}s ranging from 1.016 and 1.019.

e. The specific gravity does-response curve of Art. SSW indicates that a 10% death rate would be expected in sticklebacks exposed to a specific gravity of 1.014 (S.G. LC_{10}). BURNS I, V, VII and VIII have S.G. LC_{50} that range from 1.011 to 1.014. Compared to the Art. SSW, these 4 SSWs would be suspected to containing chemicals that contribute an additive effect to the expected osmotic toxicity. However, these studies were not sensitive enough to positively detect such mild effects.

f. The slopes* of the 48 Hr. dose-response curves are similar to the slopes of the dose-response curves for Art. SSW and sea salts. The mean 48 Hr. slope = 1.16 ($\sigma = 0.04$) for all 8 SSWs plotted on a percent SSW to percent response curve. The slope value for Art. SSW = 1.14. When the responses were replotted against specific gravity, the 48 Hr. slopes of the SSW were still indistinguishable from those of Art. SSW and sea salts. (See Table A-4 Data Appendix)

5. Results of Brine Shrimp Studies

Brine shrimp survived in 100% SSW and all serial dilutions of all 8 SSWs for 24 hours. Beyond 24 hours of exposure, death was sporadic and not relative to concentration so that an LC_{50} could not be calculated.

---

*Slope of the dose-response function. (6) (Litchfield and Wilcoxon, 1949).

B. RESULTS OF BIOMONITORING STUDIES

1. Results of Local Flora and Fauna Observations

a. The Marquardt Company property is a very large industrial site surrounded by other industrial and aircraft industry operations. A large Air National Guard Base lies on the northwest perimeter of the Marquardt property (See Figure 1). The northern property line is bordered by aircraft hangars. The eastern perimeter is bordered by the Van Nuys Airport runways.

b. All of these industries had sparse or no vegetation on their property. There were a few conifers in front of a hangar just outside the northeast corner of the Marquardt property. The company's unused strip of land on the northern border had little vegetation. The plants present were mainly tumbleweeds and bermuda grass which were mostly dormant. The tumbleweeds had matured and their seeds were apparently the food source for the blackbirds, house finch and mourning doves that fed in the area. The only other animals sighted were numerous domestic cats which had become feral. Other vegetation that was observed during the test burns included a few shrubs on the east perimeter and a variety of decorative plants and trees buildings on the southwest quarter of the Marquardt property. Trees and some shrubbery in a trailer park outside the southwest corner were also observed. Almost all deciduous plants were dormant or becoming dormant because of the late fall season. No effects of chemical damage were observed throughout the period of the test burns on the few plants that were still green.

2. Results of Tomato Plant Biomonitoring Studies

Figure 1 shows the relationship of each station to the incinerator. There were 16 stations; each with 10 tomato plants. Table 3 is a compilation of weather data taken during each burn. During the periods of low wind velocity the wind direction varied considerably. On these occasions the steam plume from the incinerator drifted from one direction to another and would disappear about 200 feed from the stack. An observer standing underneath the plume could feel droplets of moisture falling from the plume. The condensed moisture sometimes fell directly onto the tomato plants of Station 5. On the two days that the wind velocity was 19 mph, the wind remained constant in speed and direction throughout the burns. None of the tomato plants in the downwind areas exhibited symptons of auxin-like effects as would be expected from chlorophenoxy herbicide contamination. Also, no corrosive chemical damage occurred as would be expected had chlorine or hydrochloric acid been an air contaminant (Appendix B). All the plants from Station 5 and five other stations were shipped to EHL/K after the study. No deleterious effects were noted during the two weeks these plants were held for observation.

FIGURE 1: RELATION OF TOMATO PLANTS TO INCINERATOR

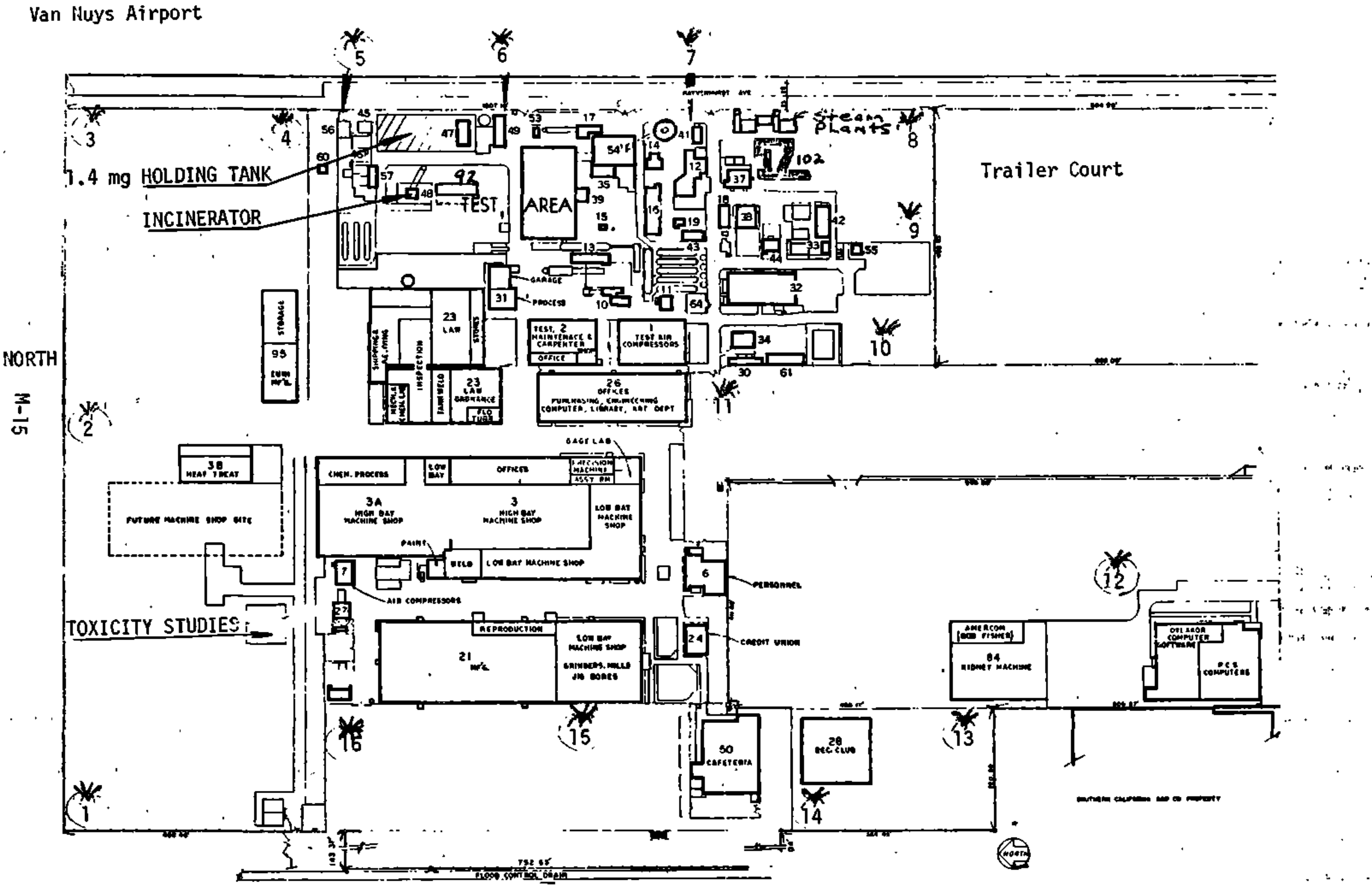

TABLE 3

WIND CONDITIONS DURING TEST BURNS

BURN NUMBER	DATE	RANGE OF WIND DIRECTION	AVERAGE WIND VELOCITY	TEMPERATURE RANGE F
I	13 Nov	130°-155°	7 MPH	55-64
II	16 Nov	120°-180°	5 MPH	55-56
III	19 Nov	340°-NC°	19 MPH	58-NC
IV	20 Nov	120°-160°	9 MPH	62-NC
V	27 Nov	310°-350°	6 MPH	63-69
VI	28 Nov	350°-NC	19 MPH	60-NC
VII	29 Nov	Calm-varied	0	62–NC
VIII	30 Nov	Calm-150°	0-12	60-62

IV. CONCLUSIONS

a. Sticklebacks, when exposed to graded dilutions of spent scrubber waters from each of the eight test burns, sustained mortalities that were directly related to concentration or dose. Acute mortality was maximal at 12 to 24 hours of exposure so that there was little change in LC_{50} values at times beyond 24 hours. In cases where exposure was extended to 96 hours, there was no increase in mortality with the increase in time of exposure.

b. The acute toxicity studies with sticklebacks indicated that when free available chlorine was removed, the toxicities of the spent scrubber waters were not higher than toxicities expected for solutions with similar osmolality. Therefore, no significant concentrations of acutely toxic contaminants were detected in the spent scrubber waters from the 8 test burns. Also, no effects from synergistic or potentiating combinations of chemicals were observed.

c. Osmotic toxicity studies indicated that unavoidable osmotic effects contributed largely to the toxic effects exhibited by the spent scrubber waters.

d. Free chlorine in the spent scrubber waters produced lethal effects on sticklebacks at 20-35 times the toxicities seen in scrubber waters in which the chlorine had been removed. Free available chlorine in the spent scrubber waters is a highly toxic factor that can be removed by proper treatment of such an industrial waste.

e. Observations of local plant life and sensitive biomonitor tomato plants demonstrated that the 8 test burns produced no herbicide or chemical damage to plant life surrounding the incinerator.

V. BIBLIOGRAPHY

1. Brungs, W.A., "Effects of Residual Chlorine on Aquatic Life", J.WPCF, Vol 45, No 10, Oct 1973, pp 2180 - 2193.

2. Cairns, J., Jr., "Fish Bioassays - Reproducibility and Rating", Revista de Biologia, Vol 7, No. 21 & 2, (1969), pp 1-12.

3. Carlander, K.D., "Handbook of Freshwater Fishery Biology", (1969) Iowa State University Press, Ames, Iowa.

4. Dixon, W.J., F. J. Massey, Introduction of Statistical Analysis. 3rd ed., McGraw-Hill, New York, 1969.

5. Jones, J. R., "Fish and River Pollution", 1st ed., Butterworth & Co. Ltd., London England, (1964).

6. Litchfield, J.T. and F. Wilcoxon, "A Simplified Method of Evaluating Dose Effect Experiments", J. Pharmacology & Experimental Therapeutics, Vol 96, (1949), pp 99-113.

7. McKee, J. E. and H. W. Wolf, Ed Water Quality Criteria, California State Water Quality Control Board, Publication No. 3-A, 1963.

8. Mount, D. I. and W. A. Brungs, "A device for Continuous Treatment of Fish in Holding Chambers", Transactions of the American Fisheries Society, Vol 96, No. 1, 20 Jan 1967, pp 55-57.

9. Mount, D.I. and W. A. Brungs, "A Simplified Dosing Apparatus for Fish Toxicology Studies", Water Res, (1967), Vol 1, pp 21-29.

10. Sprague, J. B., "Bioassay Methods of Acute Toxicity", Water Res. Vol 3, (1969), pp 793-821.

11. Sprague, J. B., "Utilizing and Appling Bioassay Results", Water Research, Vol 4 (1970), pp 3-31

12. Standard Methods of the Examination of Water and Waste Water, 13 ed., American Public Health Assoc., New York, (1971).

13. Water Quality Criteria, Federal Water Pollution Control Administration, Washington DC, April 1968.

APPENDIX A
(TO APPENDIX M)

DATA APPENDIX

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TABLE A-1

FISH STATISTICS

		Weight in Gms	Length* in Cm
	Arithmetic Mean	0.246	3.1
	Standard Deviation	0.1013	0.442
	Variance	0.01026	0.196
	Standard Error of Mean	0.0320	0.140
(95%)	Upper Confidence Limit	0.31816	3.42
(95%)	Lower Confidence Limit	0.17326	2.80
	Maximum Value	0.433	3.9
	Minimum Value	0.115	2.5
	Range	0.318	1.4
	Number of Values	10	10

*Fork Length as reported by Carlander(3) indicates a size typical of Sticklebacks 3-4 months old.

TABLE A-2

SERIAL DILUTIONS PRODUCED BY PROPORTIONAL DILUTERS
(Mount & Brungs(8),(9))

DILUTER NO. 4	CONCENTRATION EXPRESSED AS PERCENT OF THE STOCK SOLUTION*
1	0% Control
2	14%
3	19%
4	32%
5	58%
6	100%

DILUTER NO. 5	
1	0% Control
2	11%
3	19%
4	32%
5	58%
6	100%

*Stock Solution for SSWs with Chlorine removed consisted of 50% SSW.

TABLE A - 3

RESULTS OF ANALYSES OF DILUTION WATER

(units in mg/L unless noted)

ITEM	LAB ANALYSIS (mg/l unless noted)								
1. COLOR		0	1	5	.	Units			
2. TURBIDITY		0	0	5	.	Units			
3. CHEMICAL OXYGEN DEMAND	C	0	0	1	1	.			
4. DISSOLVED SOLIDS		0	1	8	8	.			
5. TOTAL SUSPENDED MATTER						.			
6. VOLATILE & FIXED SUSP MATTER						.			
7. OILS & GREASES (Infrared Method)				0	0	.	5		
8. SURFACTANTS (As mg/L LAS)				0	0	.	1		
9. PHENOLS					<	.	0	0	1
10. CHLORIDES			0	2	0	.			
11. FLUORIDES					0	.	4		
12. NITRATES				<	1	.			
13. PHOSPHATES			0	0	1	.	0		
14. SULFATES			0	2	6	.			
15. CADMIUM						.	0	4	
16. CHROMIUM (HEXAVALENT)					<	.	0	1	
17. CHROMIUM (TOTAL)					<	.	0	5	
18. COPPER					<	.	0	2	
19. CYANIDES					<	.	0	1	
20. IRON					<	.	1		
21. LEAD					<	.	0	5	
22. MANGANESE					<	.	0	5	
23. SILVER					<	.	0	1	
24. ZINC					<	.	0	5	
25. Mercury					<	.	0	0	5
26. Total Organic Carbon				<	1	.			

27. Hardness (EDTA as Mg/L $CaCO_3$)=64
28. pH=8.3
29. Specific Gravity=1.005

TABLE A-4 RESULTS OF TOXICITY STUDIES

					SP. GRAVITY LC$_{50}$ AT			SP. GRAVITY OF SOL THAT	
MATERIAL TESTED	SP. GRAVITY OF CL$_2$RxED SSW	24 HR LC$_{50}$	48 HR LC$_{50}$	SLOPE of 48 HR	24 HRS	48 HRS	SLOPE OF 48 HR	100% DEATHS IN 48 HRS	NO DEATHS IN 48 HRS
Art. SSW	1.1270	11.5%	10.4%	1.14	1.018	1.017	1.0018	1.023	1.012
SEA SALTS	1.011-1.032	NA	NA	-	1.019	1.019	1.0018	1.025	1.015
BURN I	1.075	17.5%	12.8%	1.15	1.014	1.014	1.0016	1.019	1.009
BURN II	1.079	17.4%	16.0%	1.21	1.017	1.016	1.0027	1.027	1.010
BURN III	1.061	28.8%	28.8%	1.16	1.019	1.019	1.0014	1.024	1.015
BURN IV	1.063	26.5%	16.5%	1.15	1.016	1.016	1.0018	1.021	1.011
BURN V	1.076	15.5%	15.5%	1.18	1.013	1.013	1.0023	1.023	1.008
BURN VI	1.060	29.5%	24.4%	1.14	1.021	1.017	1.0020	1.024	1.008
BURN VII	1.076	12.5%	12.5%	1.10	1.014	1.014	1.0022	1.016	1.009
BURN VIII	1.050	24.3%	16.7%	1.22	1.013	1.011	1.0023	1.016	1.005
				X=1.16			X=1.0020		
				6 = 0.04			6 = 0.004		

TABLE A-5: RANGE OF SSW PARAMETERS FOR ALL 8 BURNS

Parameter (mg/l unless noted)	Range of Quality
Temperature (°F) when collected	164
pH	10.5 - 11.8
Specific Gravity	1.044 - 1.073
Specific Conductances (pmho/cm)	11.3 -15.8
Total Solids or Total Dissolved Solids (x 10^3)	61-87
Suspended Solids	56-97
Chlorides (x10^3)	16.5 -28.0
Free and Total Chlorine Residuals	250-500
Sodium (x 10^3)	32-38
Iron, Total	3.0 - 5.0
Total Alkalinity (x 10^3 as $CaCO_3$)	32.0 - 52.5
Carbonate Alkalinity (x 10^3 as $CaCO_3$)	22.4 - 36.4
Hydroxyl Alkalinity (x 10^3 as $CaCO_3$)	9.6 - 16.1
Bicarbonate Alkalinity (x 10^3 as $CaCO3$)	0

BURN I SPENT SCRUBBER WATER

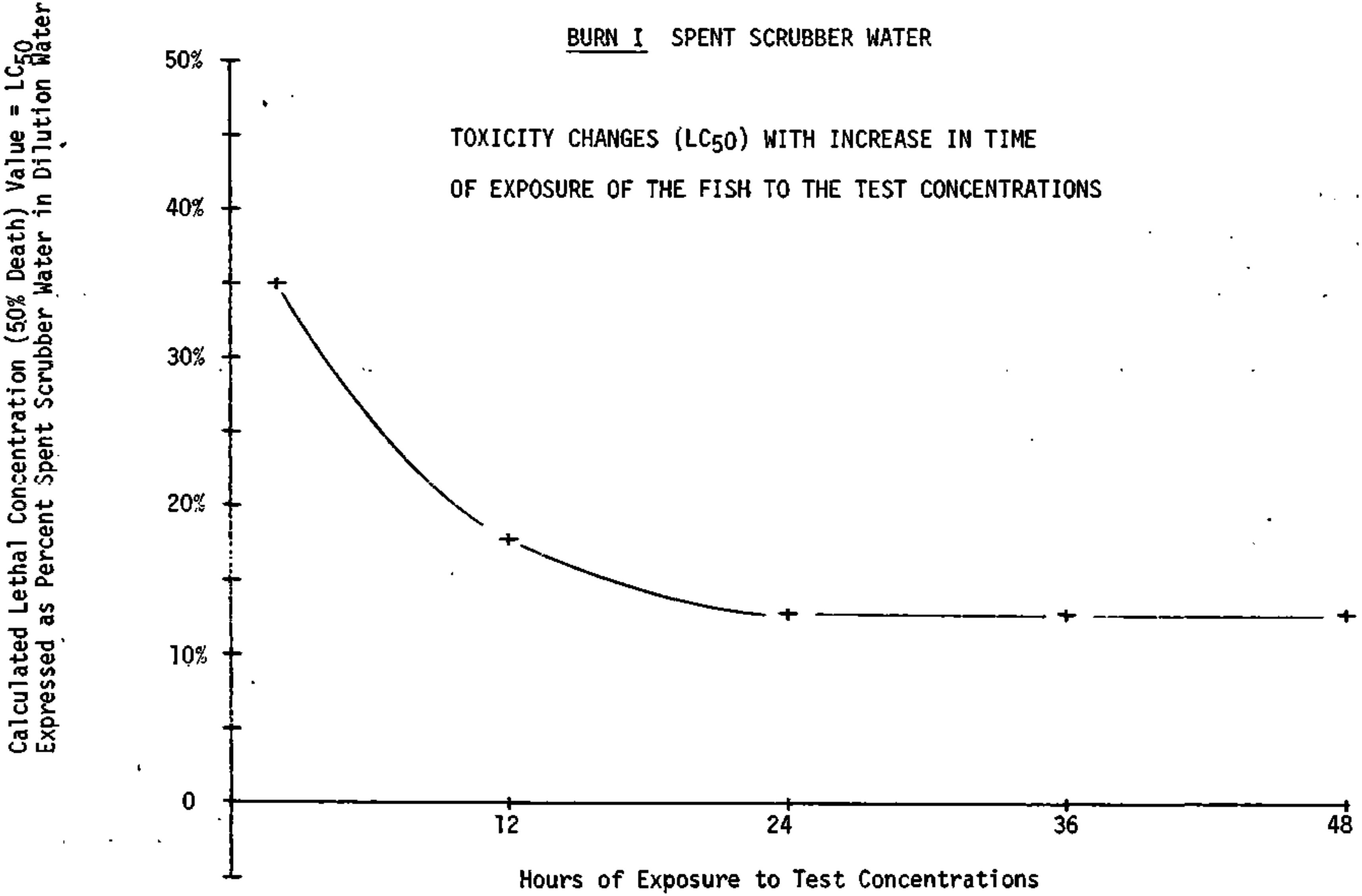


FIGURE A-1

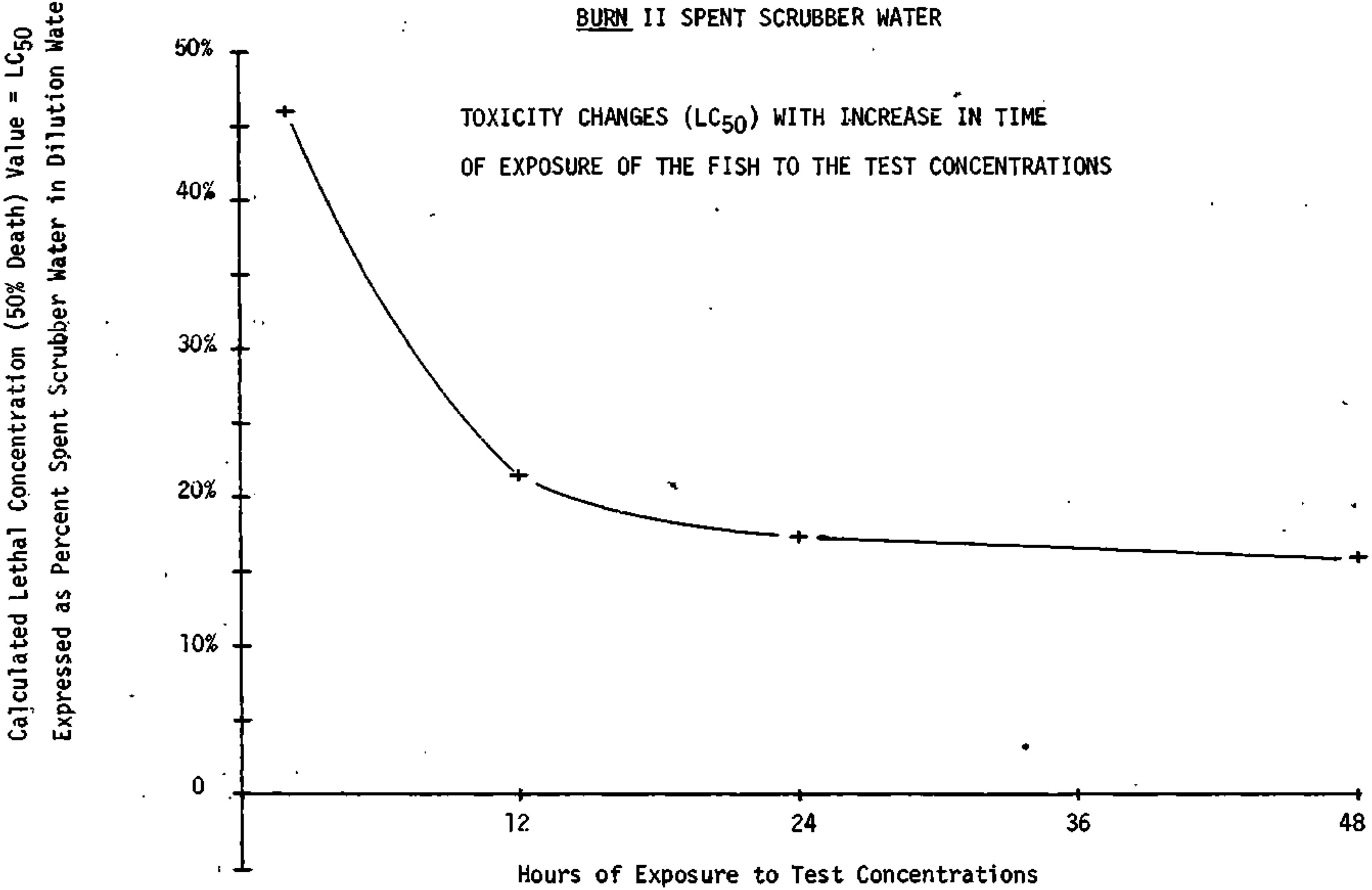
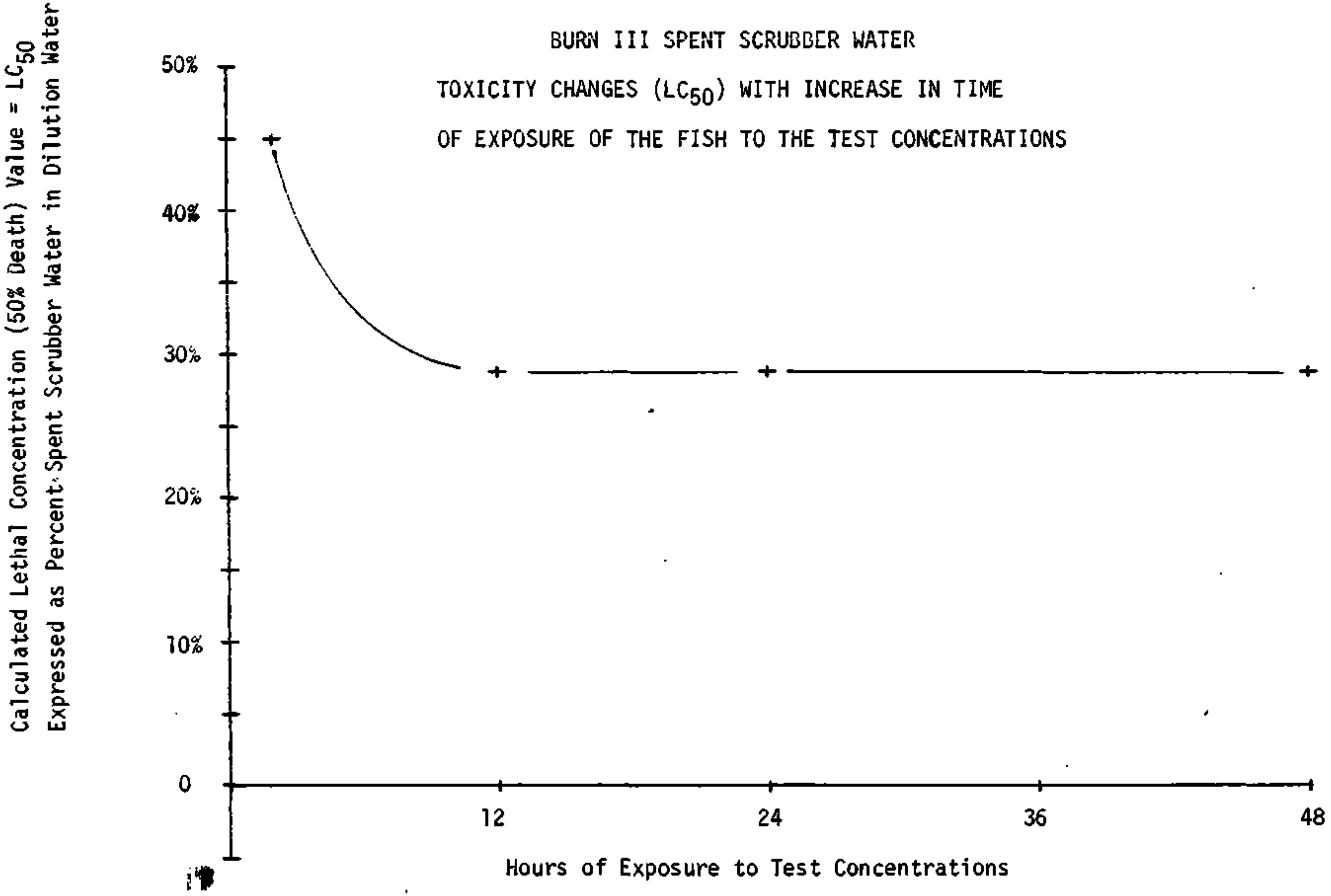

BURN II SPENT SCRUBBER WATER
TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME
OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS
Calculated Lethal Concentration (50% Death) Value = LC_{50}
Expressed as Percent Spent Scrubber Water in Dilution Water
50%
40%
30%
20%
10%
0
12
24
36
48
Hours of Exposure to Test Concentrations

FIGURE A-2



BURN III SPENT SCRUBBER WATER

TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME

OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS

FIGURE A-3

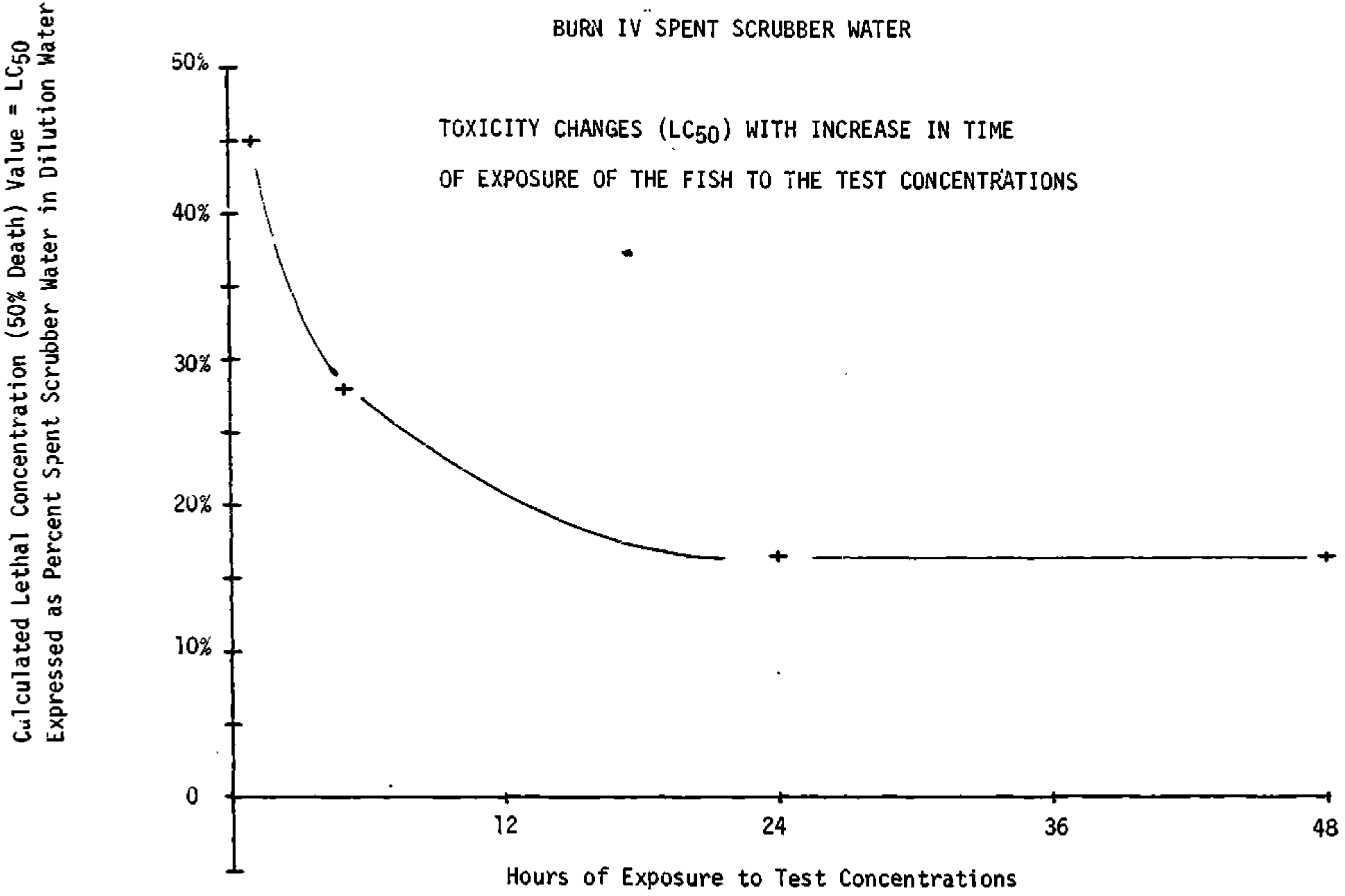

BURN IV SPENT SCRUBBER WATER
TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME
OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS
Calculated Lethal Concentration (50% Death) Value = LC_{50}
Expressed as Percent Spent Scrubber Water in Dilution Water
50%
40%
30%
20%
10%
0
12
24
36
48
Hours of Exposure to Test Concentrations

FIGURE A-4

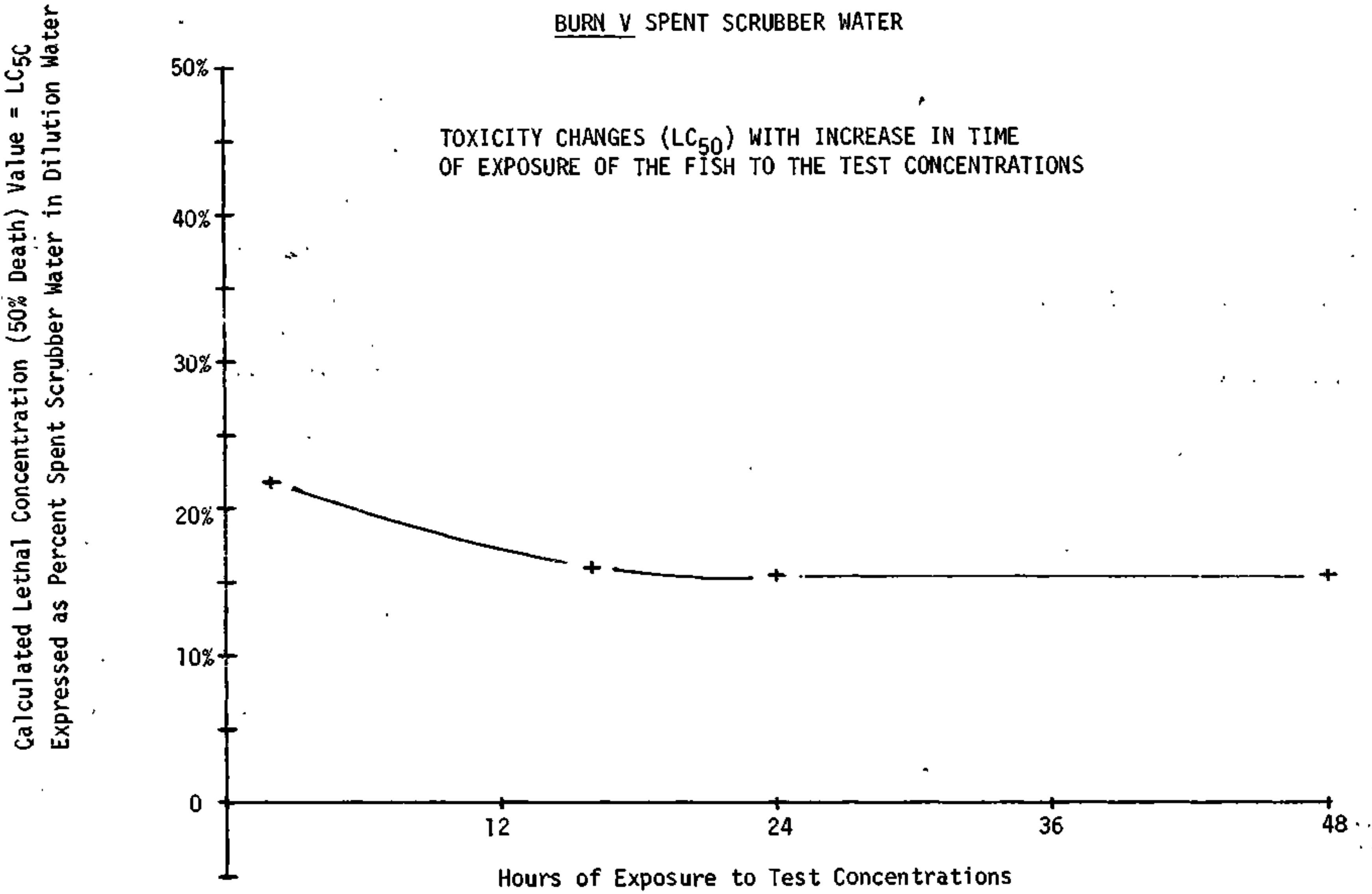

BURN V SPENT SCRUBBER WATER

FIGURE A-5

BURN VI SPENT SCRUBBER

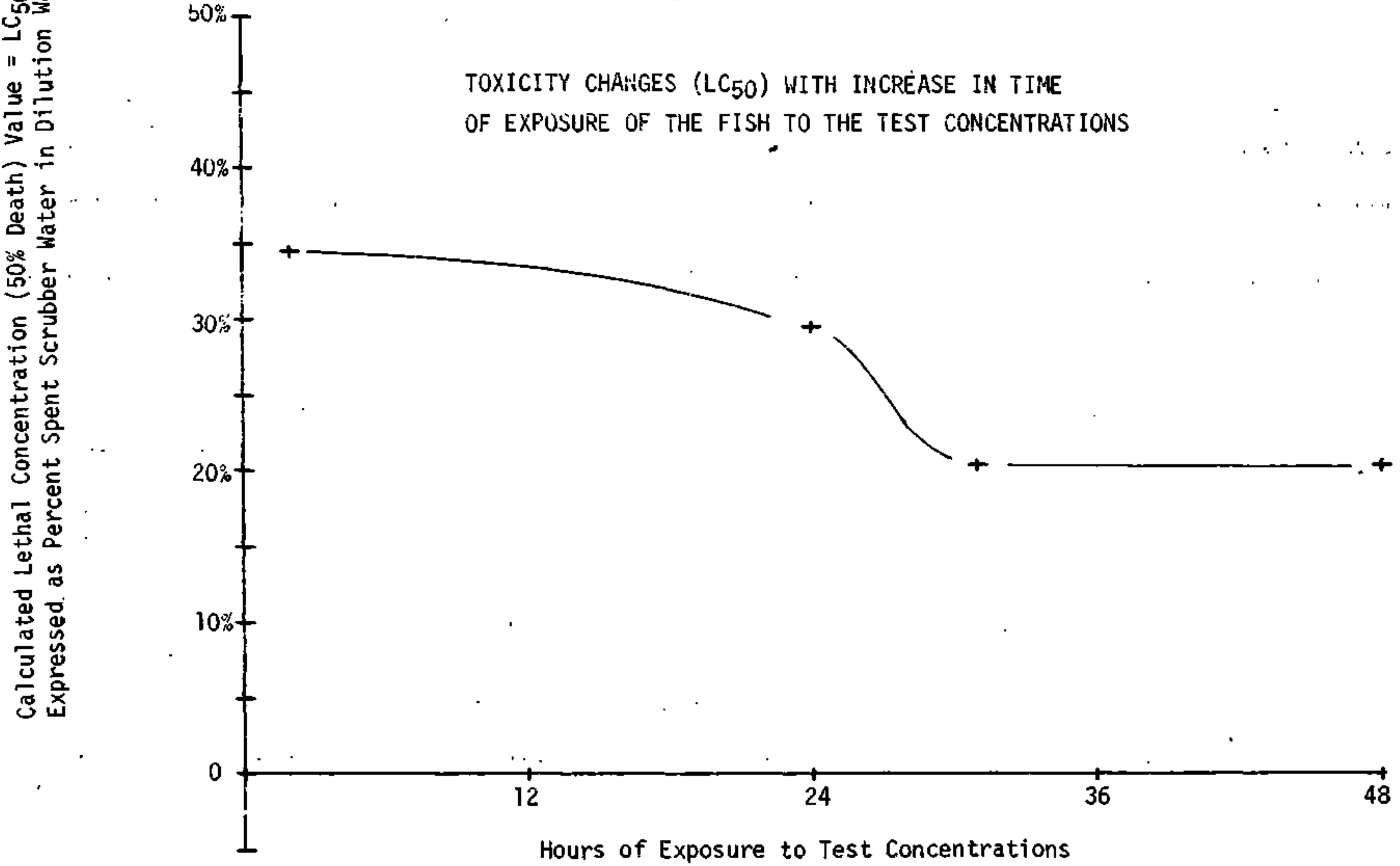
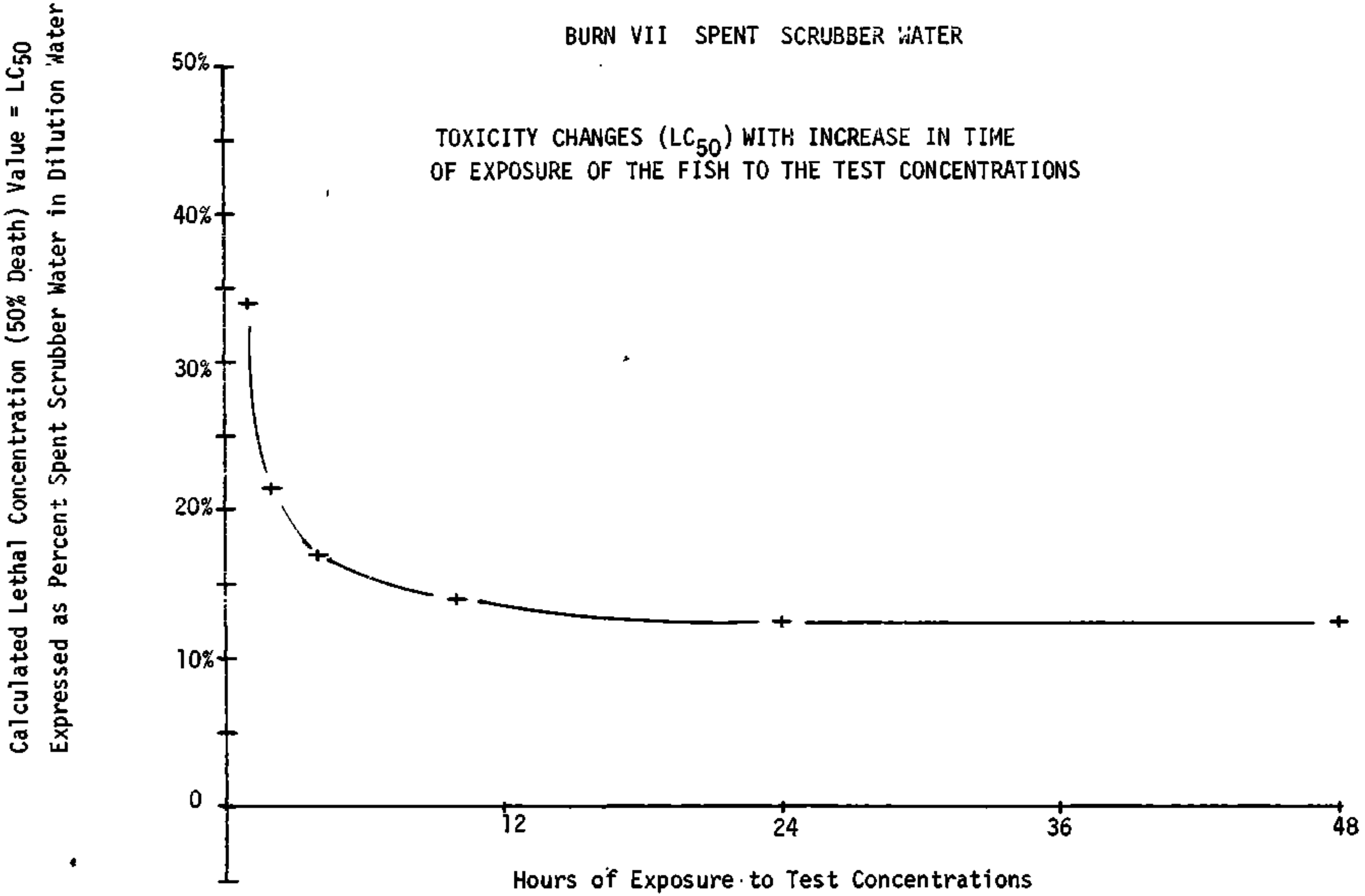


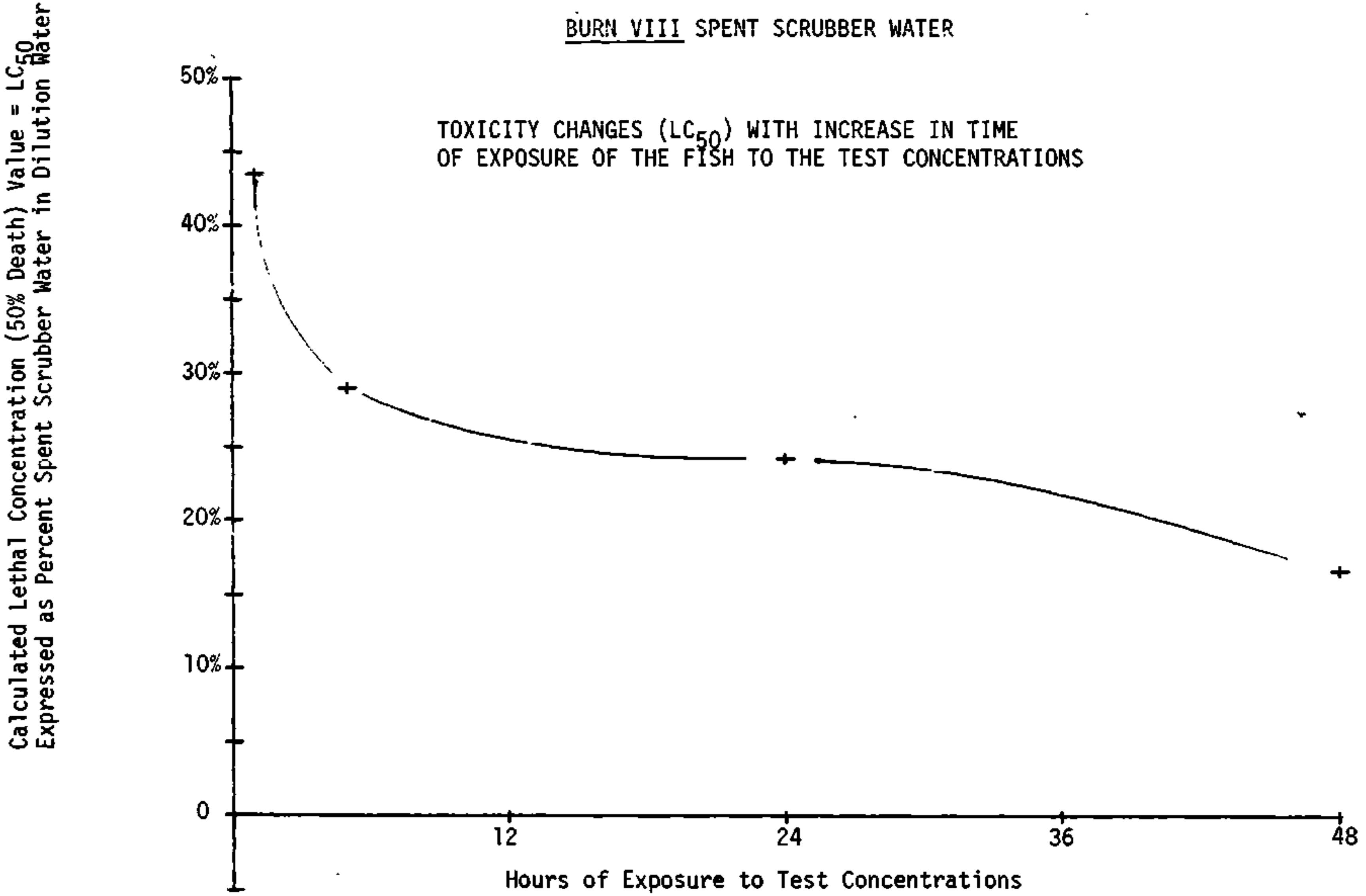
FIGURE A-6



BURN VII SPENT SCRUBBER WATER

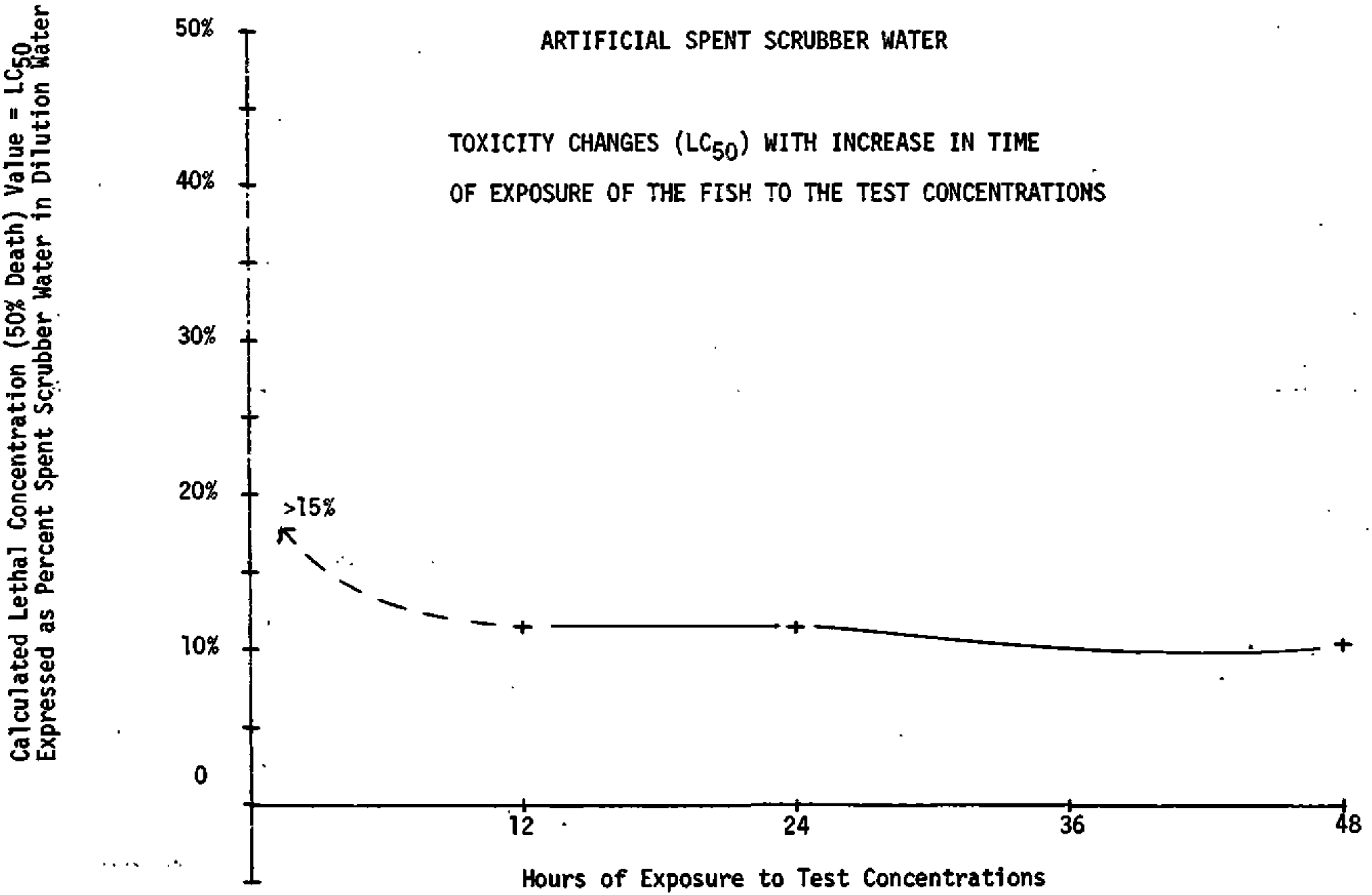
TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS

FIGURE A-7



BURN VIII SPENT SCRUBBER WATER

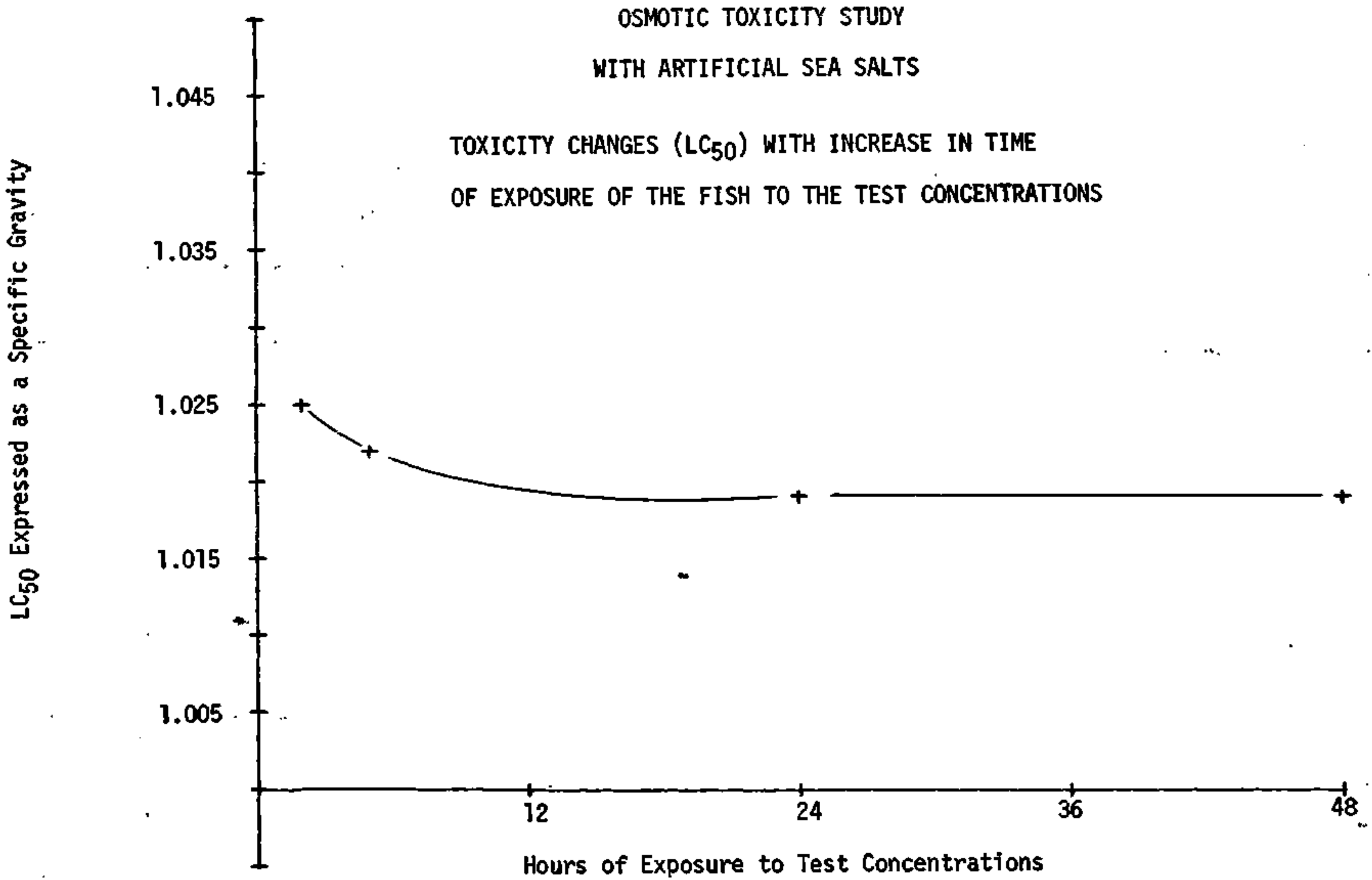
FIGURE A-8



ARTIFICIAL SPENT SCRUBBER WATER

TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS

FIGURE A-9


OSMOTIC TOXICITY STUDY

WITH ARTIFICIAL SEA SALTS

TOXICITY CHANGES (LC_{50}) WITH INCREASE IN TIME

OF EXPOSURE OF THE FISH TO THE TEST CONCENTRATIONS

FIGURE A-10

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APPENDIX B (TO APPENDIX M)

HERBICIDE TOXICITY DISCUSSION

This Appendix consists of information pertinent to this report which describes the effects of chlorophenoxy herbicides on plants and aquatic animals. The material quoted was written by Major Inman for the "Candidate Environmental Statement for Disposition of Orange Herbicide by Incineration", March 1974, USAF Environmental Health Laboratory, Kelly AFB, Texas.

(1) Metabolism and Distribution

(a) General Comparisons: The behavior of the chlorophenoxy herbicides in non-mammalian aquatic animals is quite different than the behavior described for terrestrial mammals and birds. The herbicides have a greater toxic potential for aquatic animals. First, the route of entry is different in most instances. The aquatic animal absorbs the herbicide which is distributed throughout his total environment (absorption is mainly via gills in fish). Then, the differences in renal function must be considered. Generally, non-mammalian aquatic animals do not have highly developed kidneys. Thus, once the herbicide is in the aquatic animal's body, some metabolic changes must occur in the molecule to make it more polar if it is to be excreted. Toxicity testing is also necessarily different with aquatic animals. Usually, aquatic animals are placed in a concentration of the toxicant to gradually absorb the material at a rate depending on the animal's physiology and the behavior of the toxicant in the particular water conditions. Therefore, the actual dose to each animal is not known in most studies with aquatic animals. In contrast, toxicity studies with terrestrial animals usually allow calculation of a known dose per unit weight of each animal. Thus, toxicities are often reported as "LD_{XX}" (Lethal Dose) for terrestrial animals and "LC_{XX}" (Lethal Concentration) for aquatic animals.

(b) Metabolism in Fish: Donald P. Schultz (Fish-Pesticide Research Laboratory, Bureau of Sport Fisheries and Wildlife, 1973) studied the uptake, distribution, and dissipation of ^{14}C-labled dimethyl amine salt of 2,4-D (DMA-2,4-D). Three species of fish were exposed to 0.5, 1.0 or 2.0 mg/l concentrations of herbicide for up to 84 days exposure period. No mortalities occurred, nor were adverse biological effects observed at these exposure levels. The highest radioactive residue found in muscle tissue occurred in Bluegills exposed to 2.0 mg/l for 84 days (1.065 mg/kg). However, gas-liquid chromatography indicated that over 90% of the radioactive residues consisted of metabolites of 2,4-D. The major metabolite in the fish was found to be 2,4-D glucuronic acid conjugate. Current investigations have found at least six metabolites of 2,4-D in fish. Thus, in contrast to many of the organochlorine pesticides which undergo biomagnification through the food chain, DMA-2,4-D is metabolized in fish without accumulation of the parent compound.

(2) Behavior in Aquatic Systems

(a) Solubility Limits and Rates Vs. Hydrolysis Rates: The esters of 2,4-D or 2,4,5-T found in Orange herbicide have a very limited solubility in water. Because of this very low solubility, the actual concentrations of esters produced in a body of water by accidental contamination would likely be much less than the "expected value" calculated from the volumes involved. The USAF EHL(K) is in the process of studying the behavior of Orange herbicide in aquatic systems especially sea water. In one study using artificial sea water*, Orange herbicide was mixed into the water in an amount equal to 150 mg/l. Had all components gone right into solution, by computation, ester concentrations would have been 64 mg/l (2,4-D NBE) and 61 mg/l (2,4,5-T NBE). The actual, measured concentrations were 2 mg/l (2,4-D NBE) and 1.8 mg/l (2,4,5-T NBE) immediately after mixing. These increased to 18 and 22 mg/l of 2,4-D NBE and 2,4,5-T NBE, respectively, at 24 hours and then started a rapid decline to 7.5 and 9.5 mg/l at 48 hours after mixing. The rate of disappearance of the ester of 2,4-D was fairly rapid and was assumed to be mainly a result of hydrolysis. The half-life of the ester was 15 hours. The addition of natural biota such as bacteria, algae and fish would be expected to produce an even faster disappearance of 2,4-D NBE. Evidence that this occurs was observed in studies EHL(K) is conducting with marine animals at the National Marine Fisheries Laboratory in Port Aransas, Texas. In one of these studies, shrimp were exposed in five different concentrations of 2,4-D NBE and natural sea water. The average half-life of the ester in the five concentrations was 5 hours. This was 1/3 of the half-life observed in the situation where no biological systems existed.

(b) Circulation of Water in Relation to Availability of Herbicide for Absorption: Some of the toxicity studies completed so far indicate the complexity of trying to predict the ecological results of a planned or accidental contamination of a body of water with phenoxy herbicides. At EHL(K), Orange herbicide was mixed in a fish tank at a concentration that would theoretically produce a 200 ppm (v/v) concentration if such a high concentration were possible. Most of the herbicide rapidly sank to the bottom of the tank after mixing. Fathead minnows placed in the tank showed no ill effects during two weeks of exposure. Yet in a toxicity study under the same conditions but with continuous agitation of the water by aeration, all of the fish died in a "20 ppm concentration" of Orange herbicide water in 24 hours. Subsequent studies revealed that some circulation of the water was essential if a dose-related response was to be established in toxicity studies with the N-butyl esters of 2,4-D and 2,4,5-T. Thus, the actual effect seen in nature might well depend on a factor such as the degree of mixing in the affected body of water.

(c) Importance of Hydrolysis: It is important that when the esters of 2,4-D and 2,4,5-T hydrolyze, their toxicity to aquatic animals is decreased by almost a factor of 10 (paragraph (3)(b) below). In the static situation described in the paragraph above (no aeration), the rate of hydrolysis was probably faster than the rate that the ester went into solution so that lethal concentrations were never attained. Toxicity studies with freshwater and saltwater animals at EHL(K) have been the so-called "Static Bioassay" in which no attempt is made to maintain a constant concentration of the herbicide ester in each test chamber. "Concentrations" are theoretical and based on volumes of herbicide and water mixed together rather than from analysis of water to quantitate the herbicide. Most studies reported from literature are of the same type. The toxicity tests at EHL(K) revealed that in both freshwater and saltwater, most of the test organisms had responded at twelve hours of exposure. There was rarely any increase in mortality past 24 hours.

(d) Other Factors Affecting Actual Concentration: Many other factors can influence the concentration of N-butyl esters of 2,4-D and 2,4,5-T in a body of water. In studies where large amounts of Orange herbicide were placed in water, the globules of the herbicide appeared to become coated with an opaque material that may have inhibited the ester from going into solution. Cope (1970) treated ponds with 0.5 ppm to 10 ppm propylene glycol butyl ether ester (PGBE) of 2,4-D. He was able to measure residues of herbicide absorbed or adsorbed in vegetation and bottom sediment for 6 weeks after treatment in the 10 ppm treated pond. Crosby (1966) reported that 2,4-D decomposes rapidly in the presence of water and ultraviolet light.

(3) Toxicity

(a) Factors Affecting Toxicity: The toxicity of the chlorophenoxy herbicides to aquatic animals varies considerably with many factors such as water chemistry variables, temperature, and the particular salt, ester or amine form of the herbicide considered. Species susceptibility varies greatly. For example, the 96-hour TL_{50}* for fathead minnows exposed to DMA-2,4-D was found to be 335 mg/l. Yet, for bluegills and channel catfish the TL_{50} values were 177 and 193 respectively. A temperature increase from 17°C to 20°C increased the relative toxicity to the catfish from a TL_{50} of 193 mg/l to 125 mg/l (Schultz, 1973).

(b) Toxicity Comparisons by EHL(K): The USAF EHL(K) (1974), performed static toxicity studies with Orange herbicide. Also, toxicity studies were performed using each individual N-butyl ester of 2,4-D and 2,4,5-T. Freshwater bioassays using the fathead minnow (Pimephales promelas) resulted in a 48 hr LC_{50} of 3.4 ppm for Orange herbicide containing 14 ppm TCDD. The 48 hr LC_{50s} for esters of 2,4-D and 2,4,5-T were 2.8 ppm and 5 ppm respectively. The 48 hr LC_{50} for 2,4-D in the minnows was 270 ppm. The 2,4,5-T 48 hr LC_{50} concentration was 333 ppm. Note that the toxicity of ester formulations were considerably more toxic than the respective acid. Also, EHL(K) found the N-butyl ester of 2,4-D to be more toxic than the N-butyl ester of 2,4,5-T.

In salt water studies by EHL(K), the 48 hr LC_{50} values in the shrimp (Penaeus sp.) were 5.6 ppm for 2,4-D NBE and 33 ppm for 2,4,5-T NBE. Oysters (Crassostrea virginica) were exposed to "potential concentrations" of 2,4-D NBE ranging from 0.5 ppm to 85 ppm. The only acute effect observed was the death of one of the oyster (10%) in the highest concentration at 48 hours.

(c) Other Animals and Other Effects: Many other aquatic animals besides fish can be affected by phenoxy herbicides. Saunders (1971) studied the effects of the propylene glycol butyl ether (PGBE) form of 2,4-D on six freshwater crustaceans. He found the following 48 hr TL_{50} values: Daphnia magna = 0.10 ppm, seed shrimp = 0.32 ppm, scud = 2.6 ppm, sowbug = 2.2 ppm, glass shrimp = 2.7 ppm, and crayfish had an unknown value larger than 100 ppm. Cope (1970) studied the chronic effects of PGBE ester of 2,4-D on the bluegills. Survivors of ponds treated with high concentrations (10 and 5 ppm) had a 2 week delay in spawning. For pathologic lesions, high-treatment fish had earlier and more severe effects than did low-treatment fish. The pathology involved the liver, vascular system and brain. Remarkably, growth of the fish was faster in the ponds receiving the high-treatment than in the lower-treatment ponds. Tables B-1 and B-2 were extracted from a U.S. Forest Service Environmental Impact Statement (EIS-OR, 1973). The tables indicate the effects of herbicides on other aquatic species and point out some toxic effects that can be measured other than death of the organisms.

d. Behavior in Plants

(1) Distribution and Metabolism: Orange herbicide is a systematic herbicide that affects plants by a hormonal type of action usually described as "auxin-like" or "auxin-type". Auxins are any of a group of substances which promote plant growth by cell elongation, bring about root formation, or cause bud inhibition or other effects. 2,4-D and 2,4,5-T are compounds of this type. When applied to leaves of a plant, chlorophenoxy herbicides are absorbed through the cuticle into the plant system. The N-butyl ester forms of 2,4-D and 2,4,5-T found in Orange herbicide are usually more effective than more polar forms because of better absorption into the plant. This is also demonstrated in Yamaguchi's work (1965) in which he found that 2,4-D moves into plant leaves better from acidic solutions than from alkaline solutions. Approximately ten times as much 2,4-D was abosorbed from a medium having pH 3 than one with pH 11. 2,4-D has a pK_a of 2.8 and would be highly disassociated at pH 11. Once the herbicide is in the plant it is translocated to areas where food is being stored as in rapidly growing new roots and shoots. The chlorophenoxy herbicides can be stored in certain cells of the plant. Also, metabolism occurs through degradation of the acetic acid side chain, hydroxylationof the aromatic ring, or conjugation.

(2) Toxicity: Once in the plant, herbicides act by interfering with the photosynthetic, respiratory, and other plant processes causing the plant to lose its leaves and ultimately die. Plant susceptibility to sublethal exposures of 2,4-D is markedly influenced by the growth condition of the plant and by environmental factors. Since most of the injury is expressed by growth response, the plant must be growing in order to show injury. In

TABLE B-1

ACUTE EFFECTS OF 2,4-D DERIVATIVES UPON AQUATIC ANIMALS

DERIVATIVE	ANIMAL	CONCENTRATION	EFFECT	REFERENCE
Isooctyl esters (From 3 manufacturers)	Bluegill	10-31 ppm	48 TLm	Hughes & Davis (1963)
PGBE ester	Bluegill	17 ppm	48 TLm	Hughes & Davis (1963)
Butoxyethanol ester	Bluegill	1.4 ppm	48 TLm	Hughes & Davis (1963)
PGBE ester	Shrimp	1 ppm (48 hrs)	20% mortality or paralysis	Butler (1965)
PGBE ester	Fish (salt water)	0.32 ppm	48 hr TLm	Butler (1965)
Alkanolamine Salt	Bluegill	435-840 ppm	48 hr LC_{50}	Lawrence (1966)
Dimethylamine Salt	Bluegill	166-458 ppm	48 hr LC_{50}	Lawrence (1966)
Isooctyl ester	Bluegill	8.8-59.7 ppm	48 hr LC_{50}	Lawrence (1966)
Dimethylamine Salt	Fathead Minnow	10 ppm	96 hr LC_{50}	Lawrence (1966)
Acetamide	Fathead Minnow	5 ppm	96 hr LC_{50}	Lawrence (1966)
Oil soluble amine salt	Bluegill, Fathead Minnow	2 ppm	4 mo. LC_{10}	Lawrence (1966)
PGBE Ester*	Bluegill, Fathead Minnow	2 ppm	4 mo. LC_{10}	Lawrence (1966)
Butoxyethyl ester	Bluegill & Fathead	2 ppm	72 hr LC_{50}	Lawrence (1966)
Butyl and isopropyl esters, mixed	Bluegill	1.5 - 1.7 ppm	48 hr LC_{50}	Lawrence (1966)
N,N-Dimethyl coco-amine salt	Bluegill	1.5 ppm	48 hr LC_{50}	Lawrence (1966)
Ethyl ester	Bluegill	1.4 ppm	48 hr LC_{50}	Lawrence (1966)
Butyl Ester	Bluegill	1.3 ppm	48 hr LC_{50}	Lawrence (1966)
Isopropyl ester	Bluegill	1.1 ppm	48 hr LC_{50}	Lawrence (1966)

*Propylene Glycol Butyl Ether

TABLE B-2

NON-LETHAL EFFECTS OF 2,4-D DERIVATIVES UPON AQUATIC ANIMALS

DERIVATIVE	ANIMAL	DOSE	EFFECT	REFERENCE
Butoxyethanol ester	Oyster	3.75 ppm (96 hrs)	50% decrease in shell growth	Butler (1965)
Butoxyethanol ester	Shrimp	1 ppm (48 hrs)	No effect	Butler (1965)
Butoxyethanol ester	Fish (salt water)	5 ppm	48 hr. TLm	Butler (1965)
Butoxyethanol ester	Phyto-plankton	1 ppm	16% decrease in CO_2 fixation	Butler (1965)
Dimethylamine	Oyster	2 ppm (96 hrs)	No effect on shell growth	Butler (1965)
Dimethylamine	Shrimp	2 ppm (48 hrs)	10% mortality or paralysis	Butler (1965)
Dimethylamine	Fish (salt water)	15 ppm (48 hrs)	No effect	Butler (1965)
Dimethylamine	Phyto-plankton	1 ppm (4 hrs)	No effect on CO_2 fixation	Butler (1965)
Ethylhexyl ester	Oyster	5 ppm (96 hrs)	38% decrease in shell growth	Butler (1965)
Ethylhexyl ester	Shrimp	2 ppm (48 hrs)	10% mortality or paralysis	Butler (1965)
Ethylhexyl ester	Fish (salt water)	10 ppm (48 hrs)	No effect	Butler (1965)
Ethylhexyl ester	Phyto-plankton	1 ppm (4 hrs)	49% decrease in CO_2 fixation	Butler (1965)
PGBE 1/ ester	Oyster	1 ppm (96 hrs)	39% decrease in shell growth	Butler (1965)
PGBE 1/ ester	Shrimp	1 ppm (48 hrs)	No Effect	Butler (1965)
PGBE 1/ ester	Fish (salt water)	4.5 ppm	48 hr TLm	Butler (1965)

1/ PGBE is propylene glycol butyl ether.

TABLE B-3 Sensitivity of selected plants to 2,4-dichlorophenoxyacetic acid*

Sensitive

- Apple
  - *Malus*, sp.
- Birch
  - *Betula*, sp.
- Boxelder
  - *Acer negundo*, L.
- Dogwood
  - *Cornus*, sp.
- Elderberry
  - *Sambucus*, sp.
- Forsythia
  - *Forsythia*, sp.
- Grape
  - *Vitis*, sp.
- Hickory
  - *Carya*, sp.
- Lambs-quarters
  - *Chenopodium album*, L.
- Linden
  - *Tilia*, sp.
- London plane tree
  - *Platanus acerifolia* (Ait.) Willd.
- Maple, Norway
  - *Acer platanoides*, L.
- Oak, black
  - *Quercus velutina*, Lam.
- Sorrell
  - *Rumex*, sp.
- Sumac
  - *Rhus*, sp.
- Tobacco
  - *Nicotiana*, sp.
- Tomato
  - *Lycopersicon esculentum*, Mill.
- Treeofheaven
  - *Ailanthus altissima*, Mill.
- Wisteria
  - *Wisteria*, sp.
- Yellow wood
  - *Cladrastis lutea*, Koch
- Zinnia
  - *Zinnia*, sp.

Intermediate

- Aster, wild
  - *Aster*, sp.
- Cedar
- Cherry
  - *Prunus*, sp.
- Cherry, choke
  - *Prunus virginiana*, L.
- Corn
  - *Zea mays*, L.
- Gladiolus
  - *Gladiolus*, sp.
- Hemlock
  - *Tsuga*, sp.
- Mulberry
  - *Morus*, sp.
- Oak, pin
  - *Quercus palustris*, L.
- Oak, red
  - *Quercus palustris*, L.
- Peach
  - *Prunus persica*, Sieb. & Zucc.
- Potato
  - *Solanum tuberosum*, L.
- Privet
  - *Ligustrum*, sp.
- Ragweed, giant
  - *Ambrosia trifida*, L.
- Rhododendron
  - *Rhododendron*, sp.
- Rose
  - *Rosa*, sp.
- Spruce, Colorado blue
  - *Picea pungens*, Englm.
- Sweetgum
  - *Liquidambar styraciflua*, L.
- Yew
  - *Taxus*, sp.

Resistant

- Ash
  - *Fraxinus*, sp.
- Bean, bush
  - *Phaseolus vulgaris*, L.
- Cabbage
  - *Brassica oleracea*, L.
- Eggplant
  - *Solanum melongena*, L.
- Pear
  - *Pyrus communis*, L.
- Peony
  - *Paeonia*, sp.
- Rhubarb
  - *Rheum rhaponticum*, L.
- Sorghum
  - *Sorghum vulgare*, Pers.

* FROM AIR POLLUTION CONTROL ASSOCIATION REPORT NO. 1

addition, plants in shaded areas respond more slowly than those exposed to direct sunlight. Because of these various factors which affect plant response to the 2,4-D type herbicide, differences in lists showing plant susceptability should be expected. Orange herbicide is effective on a wide variety of woody and broadleaf plant species. Other lower plant forms can also be affected by auxin-type herbicides. Even unicellular algae exhibit toxic effects or die when exposed to 2,4-D or 2,4,5-T (Walsh, 1972). However, much higher doses of the herbicides are required than for plants with a more complex structure.

(3) Herbicides as Air Pollutants: Although herbicides have long been accepted as environmental pollutants which affect sensitive vegetation, the air pollution aspects of volatile herbicides have not been widely explored. However, there is growing evidence that some 2,4-D compounds may be present in the ambient atmosphere in some parts of the United States at levels sufficient to cause adverse growth effects on sensitive vegetation. During 1962 through 1964, Vernetti and Freed measured 2,4-D concentrations in air samples taken in an agricultural area of eastern Oregon. Concurrently, they surveyed for auxin-like plant damage in the areas where the air samples were taken. In the spring of 1962, measured concentrations of the isopropyl ester of 2,4-D in the air ranged from 0.015 ppm to 0.64 ppm. This was during the time of year when the huge wheat fields of the area were being treated for weeds by aerial application of the isopropyl ester. Plant damage to tomato crops appeared to coincide with periods of highest measured concentrations of the isopropyl ester. Other plants, especially locust trees, also showed growth regulator symptoms. Legislation in the state curtailed the use of the isopropyl ester and decidely reduced the contamination and resulting plant damage. Laboratory studies by Vernetti and Freed indicated that 0.015 ppm would be the threshold concentration of isopropyl ester that tomato plants could be exposed to and still survive under the conditions of the experiment. Volatility studies by the same workers demonstrated that the isopropyl ester was three times more volatile than the butyl ester. In fact, complex analyses of the air samples ruled out butyl and other esters of 2,4-D as principal contaminants.

(4) Relative Species Sensitivity: Different researchers vary in their results of relative plant sensitivity to phenoxy herbicides. From field observations, grapevines and box elder appear to be among the most sensitive since they respond to 2,4-D air pollution when other plants showed no evidence of injury. Injury to grapevines may result from exposure to levels in the ppb range. Other workers report tomato plant damage in the ppt range. Walsh (1972) reports a 50% reduction in growth of unicellular marine algae exposed to phenoxy herbicide concentrations of 50 to 300 ppm. Other relative sensitivities are indicated in Table B-3.

APPENDIX N
INFORMATION ON INCINERATOR SHIPS

Documents included in this appendix are listed in the order of appearance.

*1. Extract from Prof. Dr. Klaus Grasshoff of Kiel University's report on: Possible effects of burning chlorinated hydrocarbons at sea.

*2. Burning of chlorine containing liquids on the incineration ship Matthias. Investigations on combustion gases: 26 August 1971.

*3. Effect on the Marine Environment of the Combustion at Sea of Some Industrial Waste.

**4. L'Incineration in Haute Mer de Residus Industriels Chlores.

**5. Incineration on the High Seas of Chlorinated Industrial Wastes.

6. Testimony by Mr. H. Compaan at the Ocean Incineration Hearing, Houston TX, 4 Oct 74 (Data on Vulcanus incinerator efficiency)

* From a number of documents submitted by Antillian Incinerating Company N.V.

** Original French document provided by Ocean Combustion Services.

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Extract from Prof.Dr.KLAUS GRASHOF of Kiel University's report on: Possible effects of burning chlorinated hydrocarbons at sea.

Page 2, line 27:

By means of extensive controlled measurements, the BAYER Company of Leverkusen, Germany, has established that if the burning of chlorinated hydrocarbons is carried out at temperatures higher than 1,000° C, more than 99.9% of the materials are completely burnt. A combustion of 12 ts per hour of material containing an average of 30% of chlorine will result in 3.6 ts hydrochloric acid and about 19 ts carbon dioxide. (Part of the carbon will also be transformed into carbon monoxide) About 12 kg per hour of chlorinated hydrocarbon will be destroyed only partially or not at all.

The hydrochloric acid condenses quickly with the water vapour contained in the air. In moderate wind conditions, the smoke plume will spread over a sea area of at least 250,000 m^2 before the hydrochloric acid falls into the water. This means that about 15 g hydrochloric acid would fall on a square metre per hour. The sea water has a considerable capacity to neutralize acids, which can be expressed as its total alkalinity, i.e., the sum of all the weak alkalies contained in sea water. Of these, the most important are the acid carbonates (about 76%), the carbonates (20%) and the borates (4%). Other alkalies, due to their small volume, play only a minor role and are therefore not discussed here.

$$A = C_{HCO_3} + 2\ C_{CO_3''} + C_{B(OH)_4'}$$

With a salt content of about 34% (dependent on conditions at the place of combustion) the total alkalinity of the surface sea water will average 2.3 milli equivalents per litre. In other words, 1 m^3 sea water can neutralize about 80 g hydrochloric acid. This neutralization reaction will result in carbon dioxide, boric acid and chlorine ions, as shown below:

$$HCO_3' + HCl = CO_2 + H_2O + Cl^-$$
$$CO_3'' + 2HCl = CO_2 + H_2O + 2\ Cl^-$$
$$B(OH)_4' + HCl = B(OH)_3 + H_2O + Cl^-$$

The water of the North Sea contains an average of 19 g chlorine ions (Cl^-) per litre, or 19 kg per m^3. The 15 g chlorine ions per m^2 resulting from the combustion mentioned above, represents an increase in the chlorine ions content of 0.08 %. In fact, in the North Sea there is a turbulent mixing which produces vertical water exchanges, which extend even to very deep water. In addition, there are fast horizontal movements due to the tides. Consequently, the quantities of hydrochoric acid which fall each hour on the surface of the sea spread in at least 100 times more water. As a result, the increase in chlorine ions content is smaller than 0.001%, and thus too small to be determined by the normal measuring methods. This is also valid for the temporary decrease in total alcalinity, which is probably about 0.4 milli equivalents ~~[illegible]~~ per litre. After the mixing mentioned above has taken place, this decrease will be about 0.004 milli equivalents, which is not measurable either.

2.

In addition, a new equilibrium is restored, as the resulting carbon dioxide escapes into the atmosphere, and the calcium carbonate, from the particles of materials contained in the sea water, is dissolved.

The disturbance of the carbonic acid system through the neutralization of the falling hydrochloric acid appears, in realistic terms, much less than the disturbance brought about by the assimilation (intake of carbon dioxide) or the respiration (output of carbon dioxide) through the natural biological processes.

The possibility of ecological disturbance caused by the small increase of the chlorine ions content can be discarded.

As mentioned earlier, 12 Kg/hour of chlorinated hydrocarbon are not completely burnt. However, these products do not condense immediately with the water vapours, but are spread by atmospheric movement over considerably larger areas. In this way, the quantities of chlorinated hydrocarbons which reach the sea are negligeable compared with those re ching it through the rivers or in other ways, as well as through evaporation of insecticides in the atmosphere.

date: June 22nd.73

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BAYER CORPORATION

MEMORANDUM

Plant: Leverkusen
Management Office

Division: AWALO-Airlaboratory

Subject: Burning of chlorine containing liquids on the incaneration ship Matthias.
Investigations on combustion gases : 26 august 1971.

In order to establish the combustion efficiency, analyses were made of the organic components and the hydrochloric acid contained in the combustion gases resulting from the burning of three different mixtures: a mixture of solvents, belonging to the category of inflamable fluids classified as K 1 (3100 Kg/h); a mixture of liquids classification K 2 (3450 Kg/h) containing Dichlorpropane; and a mixture of liquids classification K 3 (3750 Kg/h) containing Chloronitribenzene as the main component.

The combustion temperature was kept between 1400 and 1500°C. The combustion time length was 3-6 hours for each product.

During each combustion, the following samples were taken:

5 instant samples
3 adsorbtion samples on silica-gel
2 concentration samples in n-Butanol

All the combustion gas samples were taken by using a 2 m long cuartz glass tube, penetrating in the furnace about 0.4m below and at 1 meter distance from the furnace's edge. From this cuartz glass tube, the gases first had to go through a condensate separator.

The following methods were used for the identification and the quantitative analyses of the organic components:

UV analyses, gaschromatography combined with mass spectrography, gaschromatography combined with selective detectors, especially flame ionization and electrons capture detection, the silica gel process for establishing the organic linked carbon.

Summary of results

The gas chromatogram of the instant samples, which were taken in 0.5 l evacuated gas sampling pipes, retained in the zone of higher boiling hydrocarbons, between 2 and 6 components. Their concentration of about 1 vol ppm for each sample, was too low for their identification, even when making full use of the highly resilience ability of the mass spectrography.

The UV-analyses of the 100 l samples of combustion gases concentrated in n-Butanol, did not permit either the identification of the only slightly suggested absorbtion strips.

Volumes between 30 and 100 l of combustion gases absorbed on silica gel, were taken, to determine the organically linked carbon; the total carbon content of 10 to 25 mg/m^3 that was found, corresponds to the concentration established in the gaschromatograms.

For a combustion gas volume of 45,000 m^3/h, the unburnt percentage, calculated from the total content in carbon, respectively from the sum of the higher boiling components, is between 0.02 and 0.08 w %. Consequently, the combustion efficiency is for all 3 burned mixtures higher than 99.9%.

The condensates caught for each of the three mixtures (2-10 ml/100 l combustion gas) were neutralized with NaOH and diluted to 1:50 with aired town water. The toxicity of this liquid was tested in laboratory by using golden orfe (Idus melanotus). Two golden orfe were kept in this liquid for each condensate. After 4 days exposure in these liquids, no harmfull effect whatsoever on the golden orfe could be established.

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the town of NICE

INCIMER
ROTTERDAM
(The Netherlands)

EFFECT ON THE MARINE ENVIRONMENT OF THE COMBUSTION AT SEA OF SOME INDUSTRIAL WASTE

GENERAL REPORT

Project leader : Dr. M. Aubert
Collaborators : A. Fruchart; J. Ph. Breittmayer, G. Flatau;
D. Puel; F. Laumond; M. Perrin; B. Chabanne;
M. Collet-Planas

INDEX

1. INTRODUCTION AND THE OBJECTIVE OF THE STUDY

C.E.R.B.O.M. was requested by the Company INCIMER to study the consequences that a method of incinerating various liquid chlorinated waste at sea, has on the marine environment. This technique is used at present in the North Sea, with the agreement of the Dutch official authorities. Consequently, based on the measurements performed in the North Sea and the samples taken, which were submitted to various laboratory tests, we tried to predict the effect of this incineration in the Mediterranean Sea, where the Company intends to extend its activities.

The studies which we show, had to be performed at short notice, which explains why they are not completed. Nevertheless, they make possible a good approach of the problem and especially, it allows a comparison between the incineration method and the straight throwing into the sea, which is the more frequently used method.

2. MEASUREMENTS AND SAMPLING "IN SITU"

During two days we attended the burning of chlorinated waste, supplied from various sources, in the North Sea, in the zone assigned for this operation by the Dutch official authorities.

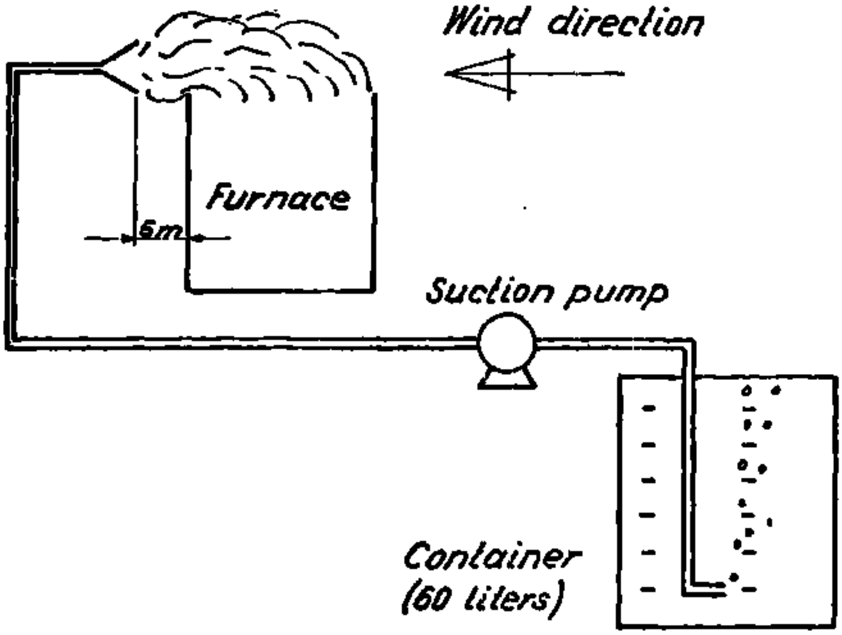
After a preheating with fuel, the waste is injected into the furnace, where it burns by itself at a temperature of about 1300°C. The resulting smoke, although immediatelybeaten down by the wind blowing at 25 to 40 knots, is very rapidly diluted: it is possible to move in the smoke plume as near as ten meters from the furnace, without feeling any discomfort, so much the more, there is no danger whatsoever for the ships that we saw crossing the plume at a distance of few cable lengths.

The measurement of the pH of the sea water under the plume, showed that the increase in acidity is measurable only on a distance of about 50m from the furnace: we took advantage of a moment when the ship faced head wind, for taking measurements along its side, which gave the following results.

Distance to the Furnace	10 m	30 m	50 m	Control samples
p.H.	7.6	7.8	8	8.1 to 8.2
Saltness 0/00	34.31	34.33	34,47	34 to 34.20

Moreover, this minimal acidification is only temporary, because all measurements made during the ship's sailing, before and after the burning within as well as outside the incineration zone, gave pH's of 8.1 to 8.2. Moreover, this acidification has a bearing only on the superficial layer. However, it could be somewhat more pronounced when the sea is totally calm, because then, less diffusion takes place. Anyway, in the Mediterranean Sea, where the pH is 8 to 8.2, one can expect that figures below 7, would be rare. Consequently, these conditions are acceptable. One notes also a slight increase of the saltness, without important consequences.

However we were interested in the smoke falling out in the sea and in its possible toxicity: for this, we took suction in the plume and let the combustion mixture bubble-up in a container filled with sea-water. This container has a very small opening and it is high enough to make the contact between the smoke and the water last as long as possible (see illustration here below).



In the experiment, the capacity of the suction pump was 1 litre/m. The suction took place during thirty-four hours, i.e.: 2040 litres gas at about 40°C, i.e. about 1800 litres at 0°C. During this handling, the pH of the sea water contained in the 60ℓ container, went down with one unit, which corresponds more or less to a contribution of 0.16 mole of hydrochloric acid. If the sucked gas would not have been diluted, one would have recuperated about 20 acid moles.

Consequently, one must admit that the smoke is diluted 100 times at 5m distance from the furnace. Of course, this dilution was enhanced by the very strong wind. However, it is thinkable that with a slight wind, the smoke is not blown down immediately on the sea's surface, and in this way it will be similarly diluted (with air) by the time it reaches the water.

Any way, the concentration we obtained in the 60~~l~~ℓ container, is higher than what one can actually find in the sea. This is important, because this concentrate was used for establishing a laboratory nutrition chain.

Further,we took samples of the plancton, the sea water and of the fish, within and outside the incineration area. Unfortunately we did not find the same kind of fish in both places, which makes the comparisons difficult.

The counting of the phytoplanctonic populations, does not show significant differences between the burning area (samples 1 to 4) and the neighbouring areas (samples 5 and 6). The content in diatomae in all the samples is low, but one could not say that this is caused by the incineration.

Plancton
Sampling Place : Incineration Area
Samples 1 to 4

Sampling Number	Diatomae (per ml)	Dinoflagellates (per ml)	Other flagellates, among which also Nanoplancton (per ml)
1	14	1	570
2	70	-	240
3	4	rare	360
4	8	-	2850

Plancton
Sampling Place : Off Rotterdam
Samples 5 and 6

Sampling Number	Diatomae (per ml)	Dinoflagellates (per ml)	Other flagellates, among which also Nanoplancton (per ml)
5	31	rare	630
6	21	rare.	5760

3. BIOLOGICAL TESTS

1) Unburnt liquid effluent

We investigated the toxicity of the unburnt effluent, with respect to various marine and estuary species:

- cyprinides
- crabs
- nereids
- mussels

For all these organisms, death resulted within less than ten hours, for dillutions up to 1/10,000.

As for the phytoplancton even for a dillution of 1/10,000 one notices a stop in the growth and the mortality of Asterionella japonica and Diogenes sp.

The zooplancton Artemia salina did not live more than one day in a dillution of 1/10,000.

We did not push further these tests, which were made only for allowing some comparisons, and which show that throwing of chlorinated hydrocarbons into the sea, can be catastrophical for the marine environment.

2 The concentrate of smoke in sea water

The same toxicity investigations were carried out during thirty four hours, with the sea water in which the smoke had bubbled-up. Concentrations of 1; $\frac{1}{2}$; $\frac{1}{4}$; 1/8; 1/16; 1/32; 1/64; 1/128; 1/256; 1/500 were used, for the following marine or estuary species:

- cyprinides
- rascassides
- crabs
- nereides
- mussels

No mortality or any physical disturbance was experienced, even when the undilluted "bubbled-up" water was used. The length of the observation periods was seven days.

For the zooplancton Artemia salina no differences were found between the control samples and those living in the bubbled-up water, whatever its concentration was. The observation period was 15 days.

For the phytoplancton, the undiluted bubbled-up water causes to the Diogenes sp. a facing of the colour, indicating a change of the chloroplasts, thus a loss of the photo-synthesis function. Diluted bubbled-up water have no effect within 12 days. With Asterionella japonica a delay of the growth was noticed after the 5th day, whereas normally this takes place only the 8th day, this phenomenon being sensitive mainly for dilutions up to 1/8. Beyond the 11th day, one notices for all the cases a higher mortality than the normal.

This smoke concentrate was then used in a 1/4 dilution to investigate the inducted toxicity.

This dilution was chosen in order to avoid disturbances with the Diogenes sp. and because the Cyprinides used, cannot put up with the strong saltnesses (for this species, fresh water must be added to the sea water).

The tested nutrition chain, has the following components:

phytoplancton ——	Zooplancton ——	fish ——	mamals
(Diogenes sp.)	(Artemic salina)	(Cyprinides)	(Mus musculus)

This chain was chosen because, being of the pelagique type, it fits well to the given problem and because we did not have time for other tests.

The poisoning periods were 8 days for the marine species and 12 days for the mice.

Neither mortality, nor physical disturbance, nor abnormal behaviour was observed at any level.

4. CHEMICAL ANALYSES

A. Nature and composition of the gases: released by the combustion at 1,300°C.

These measurements were performed at the analytical laboratory of C.N.R.S. (National Company of Scientific Research). The samples were taken in a pan made of silicon, placed in a silicon tube, fixed in the upper part of a tubular electrical furnace and heated to 1300°C.

The tube is moved very slowly, in order to have as much as possible a complete combustion. Despite this precaution, the combustion has an explosive characteristic which results in the formation of very fine particles of soot (little quantitative importance).

Under these conditions, the gases are composed of carbon dioxyde and monoxyde, steam, undefined traces of hydrocarbons, and of hydrochloric acid released at a rate of 123 litres per kilogram of chlorinated waste. As explained here above, these gases are very much diluted before falling into the sea and do not represent a danger for the marine environment. Work is being carried out for trying to determine the composition of the soot.

B. Investigation of the chlorinated waste:

This investigation was performed:

- on two samples of sea water from the incineration area
- on two samples of sea water from outside the incineration area
- on four samples of mackerel caught in the incineration area
- on two herrings, caught outside this area
- on one poisoned mouse from the nutrition chain
- on one control mouse

1) <u>Water samples</u>

After extractions are performed on a 250 ml sample, with three times 100 ml petrol-ether, the solvent is dried up by evaporation, retaken in 10 ml hexane, and analyzed by chromatography in vapour phase (Carlo Erba 2200 - column OV101 2m, temperature: 150^oC - flow $(N_200)^{\underline{n}}$30 ml/mn, injected amount 2 µ1 - detection by capture of the ^{63}Ni electron). A solution of the straight effluent at various concentrations is used as standard solution.

2) <u>Fish and mice samples</u>

After pounding a known amount of the sample (muscle for fish, lever, kidney, hart, lungs, muscle for mice) this is purified by being passed through a column of 40g of florisil (200 ml of an extracting solution made of 65% petrol-ether and 35% methylene chloride).

The solution containing the extract is concentrated until it is dry and retaken with 10 ml hexane. A solution of the straight effluent is passed through a similar florisil column and used as standard solution.

Results

We were unable to determine the presence of chlorinated waste in the samples provided for analysis. The solutions standard used for the water analyses being 1.62 ppb, one can estimated in a first approximation that the concentration in effluent is lower than 1.62 ppb, which, when reported to 1 g water sample, it corresponds to a concentration lower than 0.023 mg/g.

We did not find any noticeable difference in the pace of the chromatograms of the control mouse and the poisoned mouse. The chromatograms of the caught fish, show peaks, but these peaks could not be identified with those of the chromatogram of the straight effluent solution.

C. Investigation of heavy metals

This investigation was made for mercury and lead:

- in the fish and plancton caught in the North Sea
- in the waste before the combustion
- in the bubbled-up water
- in the different links of the nutrition chain

The following table gives a summary of the results of these analyses:

			Hg ppm (humid weight)	Pb ppm (humid weight)
Incineration area	Mackerel	(1)	1.03	0.69
	"	(2)	0.33	3.52
	"	(3)	0.66	0.64
	"	(4)	0.80	0.36
	Plancton	(1)	3.54	64.8
	"	(2)	1.58	10.5
	Effluent before burning		0.114 mg/1	
North Sea outside the incineration area	Herring	(1)	0.35	0.50
	"	(2)	0.34	0.24
	"	(3)	0.14	0.62
	Plancton	(3)	1.47	13.2
	"	(4)	5.27	52.7

			Hg (ppm) (humid weight)	Pb (ppm) (h. wt.)
Laboratory Nutrition Chain	Bubbled-up water		0.72 g/1	
	micro-seaweed + control specimen		0.14	0.81
	micro-seaweed + poisoned zooplancton		0.22	4.09
	Control cyprinides	(1)	0.04	0.71
	"	(2)	0.04	0.63
	"	(3)	0.05	0.27
	Poisoned cyprinides	(1)	0.04	0.50
	"	(2)	0.07	0.44
	"	(3)	0.10	0.65
	"	(4)	0.10	0.92
	Control mouse	(1)	0.09	1.-
	"	(2)	0.05	1.-
	"	(3)	0.04	1.-
	Poisoned mouse	(1)	0.09	1.-
	"	(2)	0.09	1.-
	"	(3)	0.08	1.-

From these figures it appears:

1) That the waters receiving the fall out of the incineration, show no difference with the rest of the sea. It is evident that in such changeable environment, the pollutions come from many places and can be found everywhere. The contribution of the burned waste appears negligible, any way short term. It is impossible to follow "in situ" the long term consequences.

2) That no mercury or lead accumulation takes place in the organisms of the nutrition chain living in an environment clearly more concentrated in burned gas than the sea surface during the incineration.

3) That despite all, there are traces of mercury in the effluent. This mercury seems not to be in the form of methyl-mercury, because it is not accumulated in the nutrition chain. However one should make sure that a longer period of exposure to poisoning has no other consequences and that the receiving environment does not contain micro-organisms capable of methylating the mercury.

The measurements concerning cadmium, another dangerous metal, are being carried out.

5. CONCLUSIONS

The purpose of our experiments was to give an answer on the biological and sanitary aspect of the process of incineration at sea of chlorinated liquid waste. These experiments are by no means exhaustive, but they are sufficiently significant for guiding and allowing the taking of immediate decisions, based on the knowledge one has on the short term consequences. Thus, it appears to us:

1) that the process does not seem to bring about changes in the biological mass

2) that smoke entering the marine environment does not seem to have an effect on the productivity. However, if this smoke comes into the sea in large volumes, there are some indications, such as the discolouration of the Diogenes sp., showing that the neutrality is not perfect.

3) that no phenomenon of accumulation through the nutrition chain takes place, neither for the mercury, nor for the lead, nor for the chlorinated hydrocarbons. We did not yet investigate the possible presence of other toxic materials such as cadmium or benzopyrenes, which could exist in the soots, but anyway, they have not caused any disturbance in the various links of the nutrition chain we have studied.

In the present state of our knowledge, it seems that the process of incineration does not cause, certainly not short term, any special harm to the oceanic environment.

It appears anyhow very superior to the method of straight throwing these industrial (waste) into the waters, as it is practiced usually. This straight throwing, causes a complete and immediate destruction of the sealife, even in very low concentrations, much inferior to 1/10,000. Moreover, even lower concentrations than these, will have results with dangerous consequences for the consumer of marine products.

Naturally, this favourable advice for the burning, must be confirmed by the long term continuation of the measurements, as a certain number of points have still to be determined. It is evident that this advice concerns only the tested products and that any change in the nature of the burned waste would reopen the question. Exact measurements would be necessary to evaluate the possible harmfulness of these products.

January 1974.

L'INCINERATION EN HAUTE MER DE RESIDUS INDUSTRIELS CHLORES

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Le Ministère chargé de l'Environnement (Direction de la Prevention des Pollutions et Nuisances) a été, courant 1973, saisi de deux demandes d'autorisation d'incinération formulées par deux sociétés étrangères spécialisées dans la destruction en mer, à partir de navires spécialement équipés, des résidus chlorés (hydrocarbures et solvants clorés) produits par l'industrie chimique.

Les Sociétés Incinératrices et leurs moyens.

La première demande a été formulée par le canal de la Direction générale des services maritimes de la Compagnie Maritime et Charbonnière WORMS par la Société "OCEAN COMBUSTION SERVICE" de Rotterdam.

La S.A.R.L. " INCIMER " de Marseille a été à l'origine de la seconde.

Chacune des sociétés concernées dispose d'un ou de plusieurs navires incinérateurs spécialement équipés : les Mathias I et Mathias II pour INCIMER, le VULCANUS pour l'O.C.S. dont le tableau ci-après (Tableau I) résume les caractéristiques essentielles.

Ces navires ont, sur le plan de la conception, en commun :

- une capacité de stockage de volume variable.

- un ou deux fours circulaires à ciel ouvert, revêtus intérieurement de briques réfractaires.

- un ensemble de brûleurs spécialement adaptés au type de produits à incinérer et fonctionnant avec atomisation d'air comprimé.

- un système d'alimentation du four en air assurant un excès d'air nécessaire à la combustion complete des produits. Cette alimentation est assurée par un ou plusieurs ventilateurs.

Produits incinérés - Nature et Volume.

Les produits pour lesquels les deux sociétés "INCIMER" et "O.C.S." ont sollicité une autorisation d'incinération sont des produits résiduaires de l'industrie chimique en grande partie constitués d'hydrocarbures chlorés, ayant pour formule chimique générale la formule :

$$C_x H_y Cl_z \text{ (o).}$$

dans laquelle x peut être égal à 1,2,3 ou 4, y à 0,1,2,3, ou 4, z à 2,3,4,5 ou 6.

.../...

TABLEAU N° 1

Sociétés	I N C I M E R		O.C.S.
Navires	MATHIAS I - MATHIAS II		VULCANUS
Caractéristiques des navires			
Type		Cargo transformé	cargo transformé
Longueur hors tout	40 m	72,80 m	101,95 m
Largeur	±8 m	10,85 m	14,40 m
Tirant d'eau en charge		5,20 m	7,40 m
Jauge brute			3.089 tx
Vitesse		11 noeuds	13 noeuds
Equipage		12 hommes	16 hommes
Capacité de stockage	550 t	1350 t	3.505 m3
Double fond (hauteur)		0,80 m environ	0,90 m minimum
Nombre de citernes	6	12 + 2 cuves en pontée	15
Ballast		Ne se leste jamais	4 capacités à l'avant + cofferdans et double fond
Installation d'incinération			
Incinérateurs - Nombre	1	1	2
ø extérieur	5		5,50 m
ø intérieur			4,80 m
hauteur	6 m		10,45 m
Alimentation air			90.000 m3/h
Brûleurs - Nombre	6	8	3/incinérateur (type Saack
Débit unitaire	0,8 t/h	1 t/h	
Capacité d'incinération totale	3,6 t/h ou 5 t/h	8 à 10 t/h	20 à 22 t/h
Technique d'incinération			
T° minimale	1000°C	1000°C	1400°C
T° maximale	1450°C	1500° C	1650°C

Ces produits dont la composition n'est pas stable et qui ne peuve donner lieu à aucune réutilisation émanent essentiellement des chaines fabrication de matières plastiques, de chlorure de vinyl monomère à partir d'éthylène, de nombreux produits pharmaceutiques, d'insecticides, de pesticid utilisant toutes les hydrocarbures chlorés comme produit de base.

Comme la formule l'indique, la teneur en chlore de ces résidus peut varier dans de notables proportions, ce que traduisent les chiffres avancés par les industriels et spcialistes qui ont été confrontés aux problèmes d'incinération.

Dans un article consacré à l'"Incinération de rejets liquides et récupération de produits chimiques" et paru dans "Informations Chimie" (*) M. Hidemasa Tsuruta évalue à 65-70 % la quantité de chlore contenue normalement dans les résidus chlorés rejetés par les installations de VCM à partir d'éthylène.

Le Professeur Dr Klaus Grasshof, chef du Département "Chimie des Mers" à l'Institut d'Etudes Maritimes" de l'Université de Hiel, estime, quant à lui, à 30% le pourcentage moyen de chlore contenu dans les rejets brûlés en mer à partir du port de Rotterdam.

D'autres documents enfin font état de teneurs variant de 20 à 80 %, la moyenne se situant aux environs de 50%.

On possède peut de données sur le volume global de ces rejets.

Selon le Professeur Docteur Klaus Grasshoff, cité précédemment, la quantité de tels produits résiduaires atteindrait 100 à 130.000 tonnes/an en Europe Occidentale (dont 50 à 70.000 tonnes en Allemagne Fédérale). La Société SOLVAY évalue, quant à elle, à 200 000 tonnes la quantité d'hydrocarbures et de solvants chlorés rejetés par l'industrie chimique de l'Europe de l'Ouest.

En ce qui concerne la France, les estimations font preuve de la même incertitude et varient selon les sources d'information de 25 à 60 000 tonnes/an, quantités essentiellement en provenance des industries chimiques SOLVAY/PECHINEY - UGINE KUHLMAN/RHONE PROGIL.

Traitement actuel des rejets en France.

Ces produits résiduaires sont actuellement éliminés de façons très diverses légales ou illégales. Au nombre de ces dernières, le rejet de quantités généralement peu importantes transportées en fûts ou par citernes dans les cours d'eau, d'anciennes carrières desaffectées ou décharges d'ordures non surveillées doit être raisonnablement retenu.

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* Information Chimie, n°124, Oct. 1973, pp. 179-186

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Sur le plan légal, il existe actuellement deux stations privées de destruction de liquides organiques chlorés, appartenant respectivement aux sociétés UGINE KUHLMANN et RHONE-PROGIL.

Ainsi cette dernière société dispose-t-elle à Saint Auban (Alpes de Haute Provence) en fonctionnement avec Chloé 1 et les ateliers de trichloréthylène et de divers solvants chlorés d'une unité expérimentale de 0,7 t/h en usage depuis 4 ans et d'une unité industrielle de 1,4 t/h en fonction depuis 3 ans selon le procédé breveté RHONE PROGIL.

La Société Solvay dispose également d'une unité de traitement mais hors de France au niveau du Groupe.

Leur capacité réduite est sans doute le reproche majeur que l'on peut leurs faire.

Dans ces installations il est procédé à la destruction des résidus chlorés par pyrolyse ou combustion en atmosphère oxydante avec récupération d'acide chlorydrique par lavage à eau vive.

En général les liquides résiduaires, à la différence des carburant brûlent mal. Leur incinération pose donc de nombreux problèmes, en particulier ceux liés à la faible chaleur de combustion, à leur viscosité élevée, à la présence de particules solides et dans certains cas à la polymérisation ou à la décomposition des produits.

D'une façon générale une augmentation de la teneur en chlore rend plus difficile leur incinération. De même agissent les fortes teneurs en eau et en cendres. Cependant l'utilisation de brûleurs à haute efficacité permet de brûler, sans carburant auxiliaire, des rejets ayant des pouvoirs calorifiques relativement faibles se situant entre 2.500 et 3.500 K cal/kg.

Cependant pour des teneurs en chlore supérieures à 70 % (pouvoir calorifique inférieur à 3.000 K cal/kg) il s'avère nécessaire pour assurer une bonne combustion, soit d'utiliser un carburant auxiliaire, soit d'ajouter aux produits incinérés un carburant de pouvoir calorifique plus élevé.

Ceci étant et de façon théorique, dans des conditions de combustion optimales, les gaz sortant du four contiennent essentiellement de l'Azote du gaz carbonique, du chlore et de l'acide chlorydrique.

Ces constituants obéissent à plusieurs réactions dont notamment :

$$H_2O + Cl_2 \rightleftarrows 2\ HCl + \frac{1}{2}\ O_2$$

.../...

Cette réaction d'équilibre est déplacée vers la droite quand la température croit - Ainsi la quantité de chlore libre diminue :

- si on augmente la température (les hautes températures sont également utiles pour réaliser une combustion complète des composes organiques, cependant la résitance des matériaux réfractaires limite cette température à environ 1.500° C).

- si on augmente la quantité de vapeur d'eau.

- si on diminue autant que possible la quantité d'oxygène.

Principe de l'Incinération en Mer.

L'incinération en haute mer à partir de navires spécialement équipés fait appel au procédé de pyrolyse évoqué précédemment mais s'en distingue par l'absence d'installations de lavage et de récupération d'acide chlorydrique.

Technique de l'incinération.

Le four est tout d'abord préchauffé au fuel jusqu'à une température de 1000 degrés environ dans le cas des MATHIAS I et II et de 1400 - 1500° C dans le cas du VULCANUS avant que les résidus à incinérer ne soient introduits.

Lorsque ces températures sont atteintes, l'injection des déchets dans la ou les chambres de combustion est entreprise par le moyen de pompes d'injection pouvant être branchées soit sur une seule citerne de stockage, soit simultanément sur plusieurs ou la totalité des citernes.

L'utilisation de brûleurs doubles permet d'introduire directement dans la flamme produite par la combustion du fuel des quantités croissantes de liquides résiduaires et de moduler les apports en fonction de la températu qui doit toujours se maintenir au dessus d'un certain seuil conditionnant la complète pyrolyse des produits traités. L'afflux de fuel peut être ainsi réduit , sinon arrêté totalement. Dans le cas où la température tombe en dessou du seuil de complète pyrolyse, un sytème automatique rétablit l'injection de fuel.

Dans le cas de produits dotés d'un pouvoir calorifique inférieur à 3000 K cal/h, une injection continue de fuel peut s'avérer nécessaire et être rendue effective . Dans les cas extrêmes, l'incinération de résidus aqueux est ainsi possible, moyennant une consommation évidemment très accrue de fuel.

En l'absence d'installations de lavage et de récupération d'acide chlorydrique, la totalité des gaz de combustion se répand dans l'atmosphère puis après condensation par la vapeur d'eau contenue dans l'air est précipitée sur la surface de la mer.

.../...

Cette précipitation a été présentée par les industriels concernés comme sans inconvénient pour la faune et la flore marines. En particulier il a été considéré que l'acide chlorydrique produit serait très rapidement neutralisé du fait des teneurs élevées en éléments basiques que présentent les eaux marines.

Lors de la neutralisation il y aurait production de gaz carbonique d'acide borique et de chlorure.

Il s'établirait en outre après un laps de temps très court un nouvel équilibre du fait que le gaz carbonique dégagé s'échappe dans l'atmosphère, et que le carbonate de calcium présent dans l'eau passe à l'état de solution. Ces réactions auraient ainsi pour effet de rétablir le degré d'alcalinité antérieur.

En fait la complexité des phénomènes qui se déroulent dans le milieu marin dont l'équilibre est souvent précaire ont incité l'Administration à une approche prudente du problème et à demander aux industriels qu'avant tout examen de leur demande, un dossier scientifique et technique aussi complet que possible soit constitué sur les procédés d'incinération en mer et sur les risques de nuisances qui leur sont associés.

A cet effet le Ministère chargé de l'Environnement a proposé aux industriels qu'indépendamment de l'étude des documents ayant trait aux observations et analyses faites par des laboratoires étrangers ou français à l'occasion de campagnes d'incinération au large de la Hollande , une expérimentation grandeur nature portant sur des produits chlorés rejetés par l'industrie chimique française soit réalisée sous le contrôle des Administrations et Organismes concernés par la protection et la défense du milieu marin.

L'EXPERIMENTATION PORTANT SUR L'INCINERATION EN MER ET SES RESULTATS

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But.

L'expérimentation se proposait de recueillir toutes informations sur :

- la qualité des effluents à la sortie des incinérateurs (gaz de combustion et imbrûlés).
- la dispersion et la qualité des effluents gazeux dans l'atmosphère.
- les phénomènes associés à la retombée des effluents gazeux sur la surface de la mer (mesures de pH...)
- l'incidence de ces rejets sur le milieu marin au point de vue écologie.

en partant de produits incinérés ayant, sur le plan des caractéristiques physico-chimiques, valeur de référence pour toute éventuelle autorisation d'incinérer que pourrait ultérieurement délivrer l'Administration.

Moyen mis en oeuvre.

On participé à l'expérimentation qui s'est déroulée du 19 au 22 Avril 1974 au large de ROTTERDAM, à l'intérieur du permis octroyé par les autorités néerlandaises aux navires incinérateurs :

Industriels.

* le navire incinérateur Vulcanus de l'"Océan Combustion Service" pour le compte de la Société Maritime et Charbonnière WORMS
* le navire incinérateur MATTHIAS II, de la société allemande Stahl-Und-Blech-Bau, Bochum pour le compte de la société INCIMER.

.../...

TABLEAU II

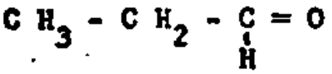
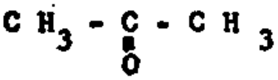
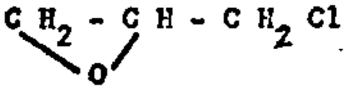
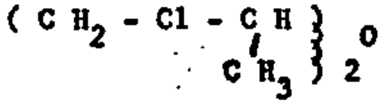
Etude des charges - Mesures
physicochimiques

-:-:-:-:-:-:-:-:-:-

	Charge du Matthias II	Charge du Vulcanus
lesures physiques		
ensité à 20° C	1,051	1,267
iscosité à 20° C	1.085 cs	0,787 cs
ntervalles de distillation ntre 52 et 190 °	97,5 %	97 %
nalyse élémentaire (% pondéral)		
C	43,2	25
H	7,15	4
N	Non détecté	Non détecté
S	Non détecté	Non détecté
Cl	47	71
étaux lourds -(p.p.m.)		
Cr	0,3	0,4
Cu	0,3	0,5
Fe	3	6,5
Hg	0	0
Na	2,5	2
P	7	<0,3
Pb	3,4	0,9
Si	3	2
Zn	0,3	1,2

ETUDE DES CHARGES - MESURES SPECTROGRAPHIQUES

Charge du MATTHIAS II (en % poids)

Hexènes	C_6H_{12}	2,47
Propanal	 $CH_3-CH_2-\underset{H}{C}=O$	14,16
Acétone	 $CH_3-\underset{O}{C}-CH_3$	2,92
1-2 Dichloropropane	$CH_2Cl-CHCl-CH_3$	28,17
Epichlorhydrine		4,24
2-3 dichloroprcpène	$CH_2=CCl-CH_2Cl$	3,02
di (chloroisopropyl)ether	 $(CH_2-Cl-\underset{CH_3}{CH})_2O$	28,54
3 chloropropylether	$(CH_2Cl-CH_2-CH_2)_2O$	5,49
2 chloropropylether	$(CH_3-CHCl-CH_2)_2O$	6,47
autres corps	....	4,52

Charge du VULCANUS (en % poids)

Chloroforme	$CHCl_3$	1,01
+ 1-1 dichloroethane	CH_2Cl-CH_2Cl	
Tetrachlorure de C.	CCl_4	2,35
1-2 dichloroethane	CH_2Cl-CH_2Cl	73,03
Tetrachlorethylène	$CCl_2=CCl_2$	6,60
1-1-2 trichlorethane	$CHCl_2-ClH_2Cl$	11,05
autres corps		6,96

Il convient de noter les différences de composition qui séparent ces deux produits provenant respectivement de l'industrie chimique allemande et anglaise et considérés par les industriels comme représentatifs de la production française en matière de rejets industriels chlorés.

Analyse des effluents à la sortie des incinérateurs.

Deux dosages, celui du chlore et du phosgène, ont été effectués à bord des navires incinérateurs. Leurs résultats figurent ci-après (en p.p.m.)

	Matthias II	Vulcanus *	
Chlore	250	2000	1100
Phosgène	2	<1	

* 2 mesures.

Ces mesures ont été complétées de recherches sur les imbrûlés liquides, solides ou gazeux pouvant provenir d'une combustion incomplète des charges.

Les recherches effectuées sur les produits piégés lors de la combustion des résidus chlorés chargés à bord du Vulcanus ne mettent en évidence dans le gaz de combustion que des quantités négligeables (0,5 p.p.m.) de composés correspondant aux produits les plus lourds de la charge.

On peut donc estimer que la pyrolyse est pratiquement complète dans le cas du Vulcanus.

Des recherches identiques effectuées sur les produits piégés lors de la combustion des résidus chargés à bord du Matthias II donnent des résultats pratiquement identiques quant aux quantités d'imbrulés (de l'ordre de 0,5 p.p.m.).

Cependant il faut noter que parmi ces imbrulés figurent :

- des composés légers type acétone - également présents dans la charge.
- des "goudrons" insolubles dans l'eau, de nature encore indéterminée (recherche d'éventuels cancérigènes en cours).

Le premièr point implique que dans le cas du Matthias II la température de combustion n'est pas uniformément maintenue aux environs de 1000/1100° - comme paraissaient l'indiquer les enregistrements de t° effectués

.../...

Administrations.

- * le Ministère chargé de l'Environnement (Direction de la Prévention des Pollutions et Nuisances - Service des Problèmes de la Mer et des Océans) représenté par Monsieur Jean Marie MASSIN, Chef de Mission.

- * l'Institut Scientifique et Technique des Pêches Maritimes (I.S.T.P.M.) représenté par :

  - le navire océanographique Thalassa.

  - Messieurs ALZIEU et MAGGI

- * le Centre National pour l'Exploitation des Océans (C.N.E.X.O.) représenté par Monsieur MOURLON, coodinateur des actions en mer et Mademoiselle JULLIEN.

- * l'Institut français du pétrole (I.F.P.) représenté par Messieur ROUSSEL et BUZON (Branche Chimie Raffinage - Division physico-chimie appliquée).

- * le Commissariat à l'Energie Atomique (C.E.A.) représenté par :

  Monsieur PLATZER, Coordination de l'Analyse, C.E.A. Fontenay au Roses.

  Monsieur VAVASSEUR et Monsieur LE BRONEC, Département de protection, Service Technique d'Etudes de protection et de pollution atmosphériques C.E.A. Saclay.

  Monsieur HAULET, Département de protection, Service technique d'Etudes de protection et de pollution atmosphériques C.E.A. Fontenay aux Roses.

  Monsieur BLAIN, Département de Recherches et d'Analyses - Servic Etude des Analyses, C.E.A. Fontenay aux Roses.

Analyse des charges.

Un seul type de produit a donné lieu à incinération, sur chacun des navires concernés. Les analyses effectuées sur les prélèvements réalisés à bord des navires ont donné les résultats suivants (Tableaux II et III).

.../...

à partir des thermo-couples montés sur les parois du four - mais localement, tombe en dessous du seuil de dissociation des composés légers (400°).

La présence de goudrons pourrait être quant à elle préoccupante dans la mesure où des éléments cancérigènes seraient mis en évidence. Il faut noter à ce propos que compte tenu des débits de gaz de combustion mis en jeu (de 100 à 140 000 m^3/h), 50 à 70 kg de résidus solides ou goudronneux sont rejetés par heure par le Matthias II.

Etude du panache.

Il a été procédé au dosage de l'acide chlorydrique au voisinage et dans le panache émis par les deux navires incinérateurs. A l'issue de ces dosages, il convient de retenir que les concentrations maximales d'acide chlorydrique dans les panaches, à quelques mètres au dessus du niveau de la mer sont du même ordre de grandeur (quelques v.p.m.) pour le Matthias et le Vulcanus.

Etude de l'eau de mer.

Les mesures de pH effectuées de façon continue à la surface de la mer au cours de l'expérimentation n'ont pu mettre en évidence aucune variation sensible de la qualité du milieu superficiel marin.

Par ailleurs les analyses effectuées sur les prélèvements d'eau de mer réalisés au point d'impact maximum des rejets gazeux sur le milieu marin n'ont décelé aucune trace d'hydrocarbures.

CONCLUSIONS ET OBJECTIFS.

-:-:-:-:-:-:-:-:-:-:-

Des premiers résultats obtenus à l'issue de l'expérimentation il résulte que :

1) En ce qui concerne les charges à incinérer.

- les caractéristiques physico-chimiques des rejets de l'industrie chimiques susceptibles d'être éliminés par incinération sont compte tenu des premiers résultats essentiellement variables.

  La notion de produit (s) testé (s) lors de l'expérimentation et ayant valeur de référence pour toute éventuelle autorisation à incinérer que pourrait délivrer l'Administration doit donc être écartée jusqu'à plus ample information.

  Ceci implique, que si le principe de l'incinération en mer est admis par l'Administration, toute autorisation sera subordonnée à un contrôle rigoureux de la qualité des chargements.
  Ce contrôle pourrait comporter :
    - une analyse relativement sommaire du produit embarqué (en vue de déceler, le cas échéant, la présence de métaux lours en quantités prohibitives).

    - un essai d'incinération à l'échelle réduite afin de déterminer la qualité des effluents de combustion.

2) En ce qui concerne la pyrolyse des charges.

- si la pyrolyse parait complète dans le cas du Vulcanus, quelques réserves peuvent être faites sur la combustion qui s'opère à bord du Matthias II (présence d'imbrulés légers et goudronneux).

  Le facteur température de combustion doit être en conséquence considéré comme primordial.

  Ceci implique que le contrôle des températures au cours de la combustion doit faire l'objet de dispositions spéciales et que toutes les parties du ou des fours puissent être contrôlées en service pour vérifier leur température.

.../...

3) En ce qui concerne l'incidence des retombées des gaz de combustion.

- exception faite des imbrulés solides ou goudronneux (en particuli des imbrulés non miscibles à l'eau dont la nocivité reste [illegible] montrer (étude en cours)) l'émission de chlore et d'acide chlor drique ne parait avoir aucune action sur le milieu marin.

Compte tenu de ce qui précède le Ministère chargé de l'Environnement propose que :

- une législation appropriée pour l'incinération en mer soit élaborée et que des décrets d'application tiennent compte sur le plan technique, en particulier :

  * de la nécessité de contrôler la nature de chaque chargement avant incinération en se référant, le cas échéant, aux indications fournies par un "incinérateur de contrôle" reproduisant en laboratoire les conditions reelles de l'incinération en mer.

  * de la nécessité de disposer de fours et de brûleurs assurant une pyrolyse complète des produits traités.

  * de la nécessité de contrôler de façon continue et en tous points la température du ou des fours de combustion.

- dans l'immédiat un certain nombre de dispositions seront prises pour que les navires incinérateurs puissent exercer leur activité à partir de ports français et à l'intérieur de zones maritimes qui leurs seront spécialement affectées, moyennant toutes précautions relatives à la protection du milieu marin.

FTD-HC-23-14-75

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

INCINERATION ON THE HIGH SEAS OF CHLORINATED INDUSTRIAL WASTES

by

Author Unknown

EDITED TRANSLATION

FTD-HC-23-14-75 10 September 1974

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ë in Russian, transliterate as yë or ë. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

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GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

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rot	curl
lg	log

INCINERATION ON THE HIGH SEAS
OF CHLORINATED INDUSTRIAL WASTES

During 1973, two requests authorizing the incineration of chlorine wastes (hydrocarbons and chlorinated solvents) in specially equipped vessels, were presented by two foreign Companies specialized in the destruction of wastes on the open sea, to the Ministry in charge of Environnement (Pollution and Nuisance Prevention).

Companies of incineration and their equipment

The first request was presented through the Channel of the General Direction of Naval Services of the " Compagnie Maritime et Charbonniere WORMS", by the Society " Ocean Combustion Service" of Rotterdam.

The S.A.R.L. INCIMER of Marseille originated the second request

Both of these Companies own one or several incinerator-ships specially equipped : Mathias I and Mathias II for INCIMER, and the Vulcanus for O.C.S. ; the following table (Table I) will give a summary of their main characteristics.

From a basic point of view, those ships have in common :

- a storage capacity of expandable volume.

- one or two circular furnaces open to the atmosphere, lined with firebricks.

- a set of burners adapted specially for the type of product to incinerate, and functionning by atomisation of compressed air.

- an air-feeding system to the furnace providing air in excess so that the combustion of the products is complete. This air sypply is provided by one or several fans.

Incinerated products - Nature and Volume.

The products for which both Companies INCIMER and O.C.S. have applied for a permit to incinerate are the residual products

TABLE No. 1

COMPANIES	INCIMER		O.C.S.
SHIPS	MATHIAS I	MATHIAS II	VULCANUS
Carasteristics of the ships			
Type	Transformed freighter		transformed freighter
Overall length	40 m	72,80 m	101,95 m
Width	±8 m.	10,85 m	14,40 m
Draught		5,20 m	7,40 m
Cross gauge			3.089 tx
Speed		11 knots	13 knots
Crew		12 men	16 men
Storage capacity	550 t	1350 t	3.505 m3
Double bottom (height)		0.80 m approx.	0.90 m minimum
Number of tanks	6	12 + 2 tanks on deck	15
Ballast		No ballast	4 spaces at the front + cofferdams & double bottom
Incineration Equipment			
Incinerators - Number	1	1	2
Exterior Ø	5		5,50 m
Interior Ø			4,80 m
Height	6 m		10,45 m
Air input			90.000 m3/h
Burners - Number	6	8	3/incinerators (Saack type)
Delivery per unit	0,8 t/h	1 t/h	
Total incineration capacity	3,6 t/h or 5 t/h	8 à 10 t/h	20 à 22 t/h
Technique of incineration			
T° minimum	1000°C	1000°C	1400°C
T° Maximum	1450°C	1500° C	1650°C

of chemical industries, mostly chlorinated hydrocarbons having for their general formula the following :

$$C_x H_y Cl_z (0)$$

where x can be equal to 1,2,3 or 4; y to 0, 1, 2, 3 or 4; z to 2,3,4 5 or 6.

These products of unstable composition and which cannot be re-utilized come essentially from the manufacture of plastics and monomers of vinyl chloride (VCM) from ethylene, and numerous pharmaceutical products, insecticides, pesticides, all using chlorinated hydrocarbons as a basic product.

As indicated in the formula, the chlorine contents of these wastes can vary a great deal, and this is reflected by the figures mentioned by manufacturers and specialists for the incineration problems.

In an article about the "Incineration of liquid wastes and regeneration of chemical products" published in "Information Chimie"* (Chemical Information), Mr Hidemasa Tsuruta estimates that the quantity of chlorine normally present in the chlorinated wastes as a reject from the plants producing VCM from ethylene is about 65-70%.

Professor Klaus Grasshof, head of the Department of "Chemistry of the Oceans" at the Institute fo Marine Studies at Hiel University gives an estimate of 30%, as an average percentage of chlorine content in the wastes burnt at sea off the Harbor of Rotterdam.

Other documents mention amounts varying from 20 to 80%, with an average of about 50%.

Few actual data are given on the total volume of these wastes.

For Dr Klaus Grasshof (mentioned above), the quantity of these residus would be 100 to 130,000 tons (metric tons) per year in Western Europe (50 to 70,000 for West Germany). The Company SOLVAY approximates as 200,000 tons the quantity of hydrocarbons and chlorinated solvents rejected by the Chemical industry of Western Europe.

For France, the estimates present the same inaccuracy and vary with different sources of information from 25 to 60,o00 tons per year, amounts produced mainly by the Chemical Industries of SOLVAY-PECHINEY, UGINE-KUHLMAN, RHONE-PROGIL.

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* Information Chimie 124, October 1973; 179-186.

Actual treatment of the wastes in France.

These residues are actually disposed of by various means, legal or illegal. Among the latter group, the rejects of generally negligible amounts carried by barrels or tanks to streams, disaffected quarries., or un-patrolled dumps, must be reasonably accounted for.

Legally, there are now two privately owned stations of destruction of chlorinated organic liquids, belonging to, respectively, UGINE-KUHLMAN and RHONE-PROGIL.

In St Auban (Alpes of Haute-Provence), the Company RHONE-PROGIL disposes, functionning with Chlor 1 and the Plants of trichloroethylene and various chlorinated solvents , of an experimental unit of 0,7 tons /hour now in use for 4 years; and of an industrial unit of 1.4 t/h using for 3 years a procedure patented by RHONE-PROGIL.

The Company SOLVAY owns also an unit of treatment at the Group level, but outside of France.

The major fault which can be formulated is their reduced capacity.

In those Plants, the chlorinated wastes are destroyed by pyrolysis or combustion by oxidation with recovery of hydrochloric acid by running water washing.

In general, the liquid-waste, unlike the carburants, burns very poorly. Their incineration is bound to many problems, due in particular to their low temperature of combustion, their high viscosity, the presence of solid particles, and in certain cases to the polymerization or decomposition of the products.

Generally speaking, the higher the chlorine contents, the more difficult the incineration. The high water or ash content behave similarly. However, high efficiency burners can consume, without auxiliary carburant, some residue with the low calorific power of 2500 to 3500 Kcal/kg

When the chlorine content is higher than 70% (calorific power less than 3,000 K cal/Kg) it becomes necessary, in order to have a complete combustion, either to use an auxiliary carburant, or to add to the products to be incinerated a carburant with higher calorific power.

In those conditions of optimum combustion, theorically the gasses released by the furnace contain essentially: nitrogen , carbon dioxide, chlorine and hydrochloric acid.

These components follow several reactions such as:

$$H_2O + Cl_2 \rightleftarrows 2\ HCl + \frac{1}{2}\ O_2$$

This equilibrium is displaced towards the right when the temperature increases, so that the amount of free chlorine decreases:

- if the temperature is raised (high temperatures are also useful to realize a complete combustion of organic compounds; however the resistance of the firebricks limits this temperature to 1500° C).

- if the amount of water vapor is increased.

- if the amount of oxygen is lowered as much as possible

Principle of Incineration at sea

The incineration on the high sea by specially equipped ships is based on the forementionned pyrolysis technique, but it does not include the equipment for washing and recovery of hydrochloric acid.

Technique of incineration

The kiln is preheated by fuel to a temperature of approximately 1000° C. for the ships Mathias I and II, and of 1400 to 1500°C. for the ship Vulcanus, before the residues are brought in.

When the above temperatures are reached, the wastes are injected into the combustion chamber (or chambers) by means of injection pumps which can be plugged on one storage tank alone, or simultaneously on several or all of the tanks.

The double burners make it possible to introduce, directly into the flame of the burning fuel, increasing quantities of liquid wastes and to modulate the input as a function of the temperature, which must be maintained above a certain threshold, as a necessary condition for the complete pyrolysis of the treated products. The flow of fuel can then be reduced, if not completely stopped. When the temperature falls below the threshold of complete pyrolysis, an automatic system reactivates the fuel injection.

In the case of the products having a calorific power inferior to 3000 K cal/h, a continuous fuel injection might be necessary, and be still efficient. In extreme cases, the incineration of aqueous wastes is possible, of course with an increased fuel consumption.

In the absence of equipment for washing and recuperation of hydrochloric acid, all the gas of combustion is released to the atmosphere, then after condensation by water-vapor of the air, is precipitated onto the surface of the sea.

This precipitate has been described by the manufacturers as being harmless to the marine fauna and flora. In particular, it is considered that the hydrochloric acid produced would be rapidly neutralized by the high contents of alkaline elements of sea water.

During the neutralisation process, carbon dioxide, boric acid and chlorides would be produced.

After a short time lapse, a new equilibrium would be established because the released carbon dioxide escapes to the atmosphere promptly, and the calcium carbonate present in the water is solubilized. The effect of these reactions would be to re-establish the previous degree of alkalinity.

In fact, the complexity of the impact on the precariously balanced marine media has incited a prudent approach to the problem by the Administration who requires from the manufacturers, before examination of their application, a scientific and technical documentation as complete as possible concerning the procedures for incineration at sea, and the risks of nuisances associated with them.

As a result, the Ministry in charge of Environment has proposed to the manufacturers that, independently of the study of documentations concerning the analysis performed by foreign or french laboratories on the incineration experiments off the coast of Holland, a full scale experiment,directed towards the chlorinated wastes rejected by the French Industry, be realized under control of the Administration and Commission for the protection and defense of marine life.

EXPERIMENT ON INCINERATION AT SEA, AND RESULTS

-:-:-:-:-:-:-:-

Purpose

This experiment proposed to collect data on:

- the quality of effluents released from incinerators (combustion gas and unburnt)
- the dispersion and quality of gaseous output to the atmosphere.
- the facts associated with the gaseous fall-outs on the surface of the sea (pH measurements etc..)
- the effect of these wastes upon the marine life from the point of view of the ecology.

beginning with incinerated wastes having standard physico-chemical characteristics which could be used as reference for an eventual permit of incineration to be granted by the adminsitration.

Means of experiment employed

In the experiment carried out between the 19 and 22nd of April 1974, off Rotterdam, under a permit granted by the Dutch authorities to the incinerator ships:

Manufacturers

- * incinerator ship Vulcanus from "Ocean Combustion Service" representing the Société Maritime and Charbonnière WORMS
- * incinerator ship MATTHIAS II, of the German Company Stahl-Und-Blech-Bau, Bochum for the Company INCIMER

Administrations

- * The Ministry in charge of Environment (Division of Prevention of Pollution and Nuisances - Department of the Problems of Sea and Oceans) represented by Mr Jean Marie MASSIN, Head of the expedition.
- * the Scientific and Technical Institute of the Sea Fisheries (I.S.T.P.M.) represented by

  - the ocean going vessel Thalassa.

  Messrs ALZIEU and MAGGI

* the National Center for the exploitation of the Oceans (C.N.E.X.O.) represented by Mr. MOURLON, coordinator of the experiments at sea and Miss JULLIEN.

* The French Institute of Petroleum (I.F.P.) represented by Messrs ROUSSEL and BUZON (Section Chemical Refinery - Division applied physico chemistry)

* the Atomic Energy Commission (C.E.A.) represented by

  Mr PLATZER, Coordinator of the Analysis, C.E.A., Fontenay aux Roses.

  Mr VAVASSEUR and Mr LE BRONEC, Department of Prevention, Technical Services for the study of protection and air pollution C.E.A. Saclay.

  Mr HAULET, Department of Prevention, Technical Services for the study of protection and air pollution, C.E.A. Fontenay aux Roses.

  Mr BLAIN, Department of Research and Analysis, Section: Study of Analysis, C.E.A., Fontenay aux Roses.

Analysis of Loads

Only one type of product was incinerated on each ship concerned, Analysis of the samples collected on the ship gave the following results; (Tables II and III).

The difference in composition of the two products coming, respectively, from the german and the english chemical industry and considered by the manufacturers as representative of the french production of chlorinated industrial wastes should be noted.

Analysis of the effluent of the incinerators

Two quantitative analysis were performed aboard ships: the chlorine and carbonyl chloride (phosgene), Results in p.p.m.

	Matthias II	Vulcanus *	
Chlorine	250	2000	1100
Phosgene	2	< 1	

* 2 measurements

TABLE II

Study of the loads
Physicochemical data

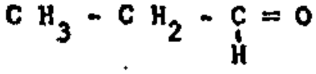
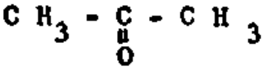
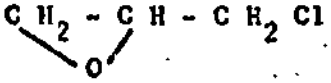
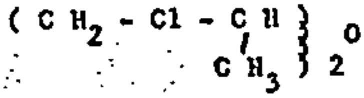
-:-:-:-:-:-:-:-

	Load of the Matthias II	Load of the Vulcanus
Physical measurements		
Density at 20° C.	1.061	1.267
Viscosity at 20° C.	1.085 cs	0.787 cs
Intervals of distillation Between 52 and 190°	97.5 %	97 %
Elementary analysis (% by weight)		
C	43.2	25
H	7.15	4
N	Not detected	Not detected
S	Not detected	Not detected
Cl	47	71
Heavy Metals-(p.p.m.)		
Cr	0.3	0.4
Cu	0.3	0.5
Fe	3	6.5
Hg	0	0
Na	2,5	2
P	7	< 0.3
Pb	3.4	0.9
Si	3	2
Zn	0.3	1.2

TABLE III

STUDY OF THE LOAD - SPECTOGRAPHIC MEASUREMENTS

Load of the MATTHIAS II (in % weight)

Hexanes	$C_6 H_{12}$	2,47
Propanal	 $CH_3 - CH_2 - \underset{H}{C} = O$	14,16
Acetone	 $CH_3 - \underset{O}{\overset{\Vert}{C}} - CH_3$	2,92
1-2 Dichloropropane	$CH_2 01 - CH Cl - CH_3$	28,17
Epichlorhydrine		4,24
2-3 Dichloropropane	$CH_2 = C Cl - CH_2 Cl$	3,02
di (chloroisopropyl) ether	 $(CH_2 - Cl - \underset{CH_3}{CH})_2 O$	28,54
3 chloropropylether	$(CH_2 Cl - CH_2 - CH_2)_2 O$	5,49
2 chloropropylether	$(CH_3 - CH Cl - CH_2)_2 O$	6,47
Other		4,52

Load of the Vulcanus (in % weight)

Chloroform	$CHCl_3$	1,01
+1-1 dichloroethane	$CH_2 Cl - CH_2 Cl$	
Carbon Tet.	CCl_4	2,35
1-2 dichloroethane	$CH_2 Cl - CH_2 Cl$	73,03
Tetrachlorethylene	$CCl_2 = CCl_2$	6,60
1-1-2 trichlorethane	$CH Cl_2 - Cl H_2 Cl$	11,05
other		6,96

These measurements were completed by research on the un-burnt fluids, solids, or gases coming from incomplete combustion of the loads.

The study of the products trapped during the combustion of the chlorinated wastes loaded on the Vulcanus shows only negligible amounts (0.5 p.p.m.) of the compounds corresponding to the heaviest products of the loads in the gas of combustion.

The pyrolysis is then practically complete in the case of the Vulcanus.

Similar studies performed on the products trapped during the combustion of the wastes on the Matthias II gave almost identical results for the unburnt quantities (about 0.5 p.p.m.)

However, one must remark that among those unburnt are:

- light compounds of the type acetone, also present in the load.
- "tars", insoluble in water, of indetermined nature (under study for eventual carcinogens)

The first point implies that in the Matthias II the temperature of combustion is not maintained uniformly at 1000 to 1100°C. as indicated by the temperature recording of the thermo-couples installed on the wall of the furnace, but locally falls below the threshold of dissociation of light compounds (400°C.)

The presence of tars could be worrysome to the extent where carcinogenic elements would be demonstrated. It must be mentioned that taking into consideration the output of gas of combustion (100 - 140,000 m^3/h), 50 to 70 kg of solid wastes or tar are emitted by Matthias II per hour.

Study of the mixture of gas

Hydrochloric acid titration was performed next and in the gas mixture emitted by the two incinerator ships. It must be noted that the maximal concentrations of hydrochloric acid in the air mixture a few meters above the sea water surface are in the same range (a few v.p.m.) for the Matthias and the Vulcanus.

Study of the sea water

The pH measurements performed continuously at the surface of the sea during the experiment could not reveal any variation in the superficial marine media quality.

Analysis of the samples of sea water obtained at the maximal impact point of the gaseous rejects on the marine surface shows no trace of hydrocarbons.

CONCLUSIONS AND AIMS

-:-:-:-:-:-:-:-:-:-:-

From the first results obtained from the experiment, it is concluded that:

1) For the loads to incinerate

- the physico-chemical characteristics of the chemical industry wastes susceptible to be destroyed by incineration are taken into consideration in the first and essentially variable results.

A simple notion of product (s) tested by the experiment and usable as a reference for any eventual permit of incineration released by the Administration must be set aside till more information is provided.

This implies that, though the principle of incineration at sea is accepted by the Administration, all authorizations will be subject to a strict control of the quality of the loads. This control could imply:

- a brief analysis of the loaded products (in order to detect, if necessary, the presence of heavy metals in prohibitive amounts).
- a test of incineration on a small scale in order to determine the quality of the combustion effluents.

2) For the pyrolysis of the loads

- if the pyrolysis seems to be complete in the case of the Vulcanus, a few reservations could be made on the combustion aboard the Matthias II (light unburnt products and tars).

Consequently, the factor "temperature of combustion" must be considered as primordial.

This implies that the control of the temperature during the combustion must be the object of a special attention, and that all the parts of the furnace (s) should be controlled during use to check the temperature.

3) For the incidence of gas of combustion fall-outs

- with the exception of the unburnt solids or tars (in particular of the unburnt not miscible with water of which toxicity still has to be demonstrated [under study]), the release of chlorine and hydrochloric acid seemsto have no impact on the marine life.

In consideration of the facts above, the Ministry in charge of the Environment propdses that.

- an appropriate legislation for the incineration at sea be enacted and that the decrees of application consider the technical point of view, in particular:

  * The necessity of checking the nature of each load before incineration, referring, if necessary, to the indications provided by a test incineration, duplicating in laboratory the actual conditions of the incineration at sea.

  * The necessity of using furnaces and burners performing a complete pyrolysis of the treated products.

  * The necessity of checking continuously and at all points the temperature of the furnace (s) of combustion.

- very soon a number of arrangements will be made so that the incinerator-ships can operate from french ports, and inside a marine zone which will be specially designated for this use, with all precautions concerning the protection of the sea life.

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WITNESS NO. : 4

NAME : H. COMPAAN .

OCEAN INCINERATION HEARING

OCTOBER 4, 1974

I am H. Compaan of the central laboratory TNO. TNO is the National Research Council of the Netherlands. It is a nonprofit, semi-governmental research organization, employing about 4,000 distributed over many laboratories, committees, and working-groups. The Central Laboratory TNO has the special task to carry out multi-disciplinary research. I am heading a research group of 11, working mainly on problems of marine pollution and partly on air pollution.

The department of the Dutch government that is responsible for the environmental control of the Dutch Continental Shelf in the North Sea, gave TNO orders to search for uncombusted organic chlorine compounds in the exhaust gases of the Vulcanus during normal practice.

The investigations on the Vulcanus were carried out on May 29, 1974, on the North Sea, 20 miles northwest of the Hague. During the incineration of VCM - production waste containing approximately 70% combined chlorine, we took a number of stack samples in different ways. The samples were taken by myself and one assistant. The samples were obtained from the top center of the left incinerator by suction through a cooled quartz tube. The exhaust gases were led through:
a) an impinger filled with water (organic free),
b) an impinger filled with 1 N sodium hydroxide (organic free)
c) an absorption tube filled with chromosorb 102.

During the sampling, two colleagues from the Central Technological Institute, TNO were measuring the flame temperatures of the incinerator and the carbon monoxide, carbon dioxide and oxygen contents of the exhaust gases.

The organic chlorine compounds were obtained by extraction of the scrubber liquids with cyclohexane and by thermal desorption from the absorption tubes. The samples were analyzed by gas chromatography with 4 different detection methods:
a) flame ionization detection
b) electron capture detection
c) helium plasma detection
d) mass spectroscopy

Helium plasma detection and mass spectroscopy gave the most conclusive results. The helium plasma detector showed clearly the presence of small amounts of organic chlorine compounds. With the mass spectrometer evidence was obtained for the presence of some organic bromine compounds as well. The total amount of organic chlorine thus found corresponds to a concentration of about 3-5 ppm in the exhaust gases, or not more than 40 ppm on the basis of the feed. This corresponds to a combustion efficiency of 99.996 percent.

During the incineration a sample of the waste was taken at a point near the burners. Gas chromatographic - mass spectroscopic analysis showed that the waste had the usual composition. The samples were taken from 10 A.M. to 2:40 P.M. At 12:30 P.M. the flame temperature was 1200 - 1300ºC. At 2:00 P.M. the flame temperature was 1300 - 1400ºC.

The final report will be ready in October 1974.

[The above complete testimony is retyped from material available during the public hearing conducted by the Environmental Protection Agency in Houston TX on 4 Oct 1974. The hearing was relative to a permit application (No. 730D008C) from Shell Chemical Company to discharge to ocean waters off the coast of Texas]

APPENDIX O

COMMENTS TO:

REVISED DRAFT ENVIRONMENTAL STATEMENT DISPOSITION OF ORANGE HERBICIDE BY INCINERATION

April 1974--AF-ES-72-2D(1)

A. This section presents the letters of comments which were forwarded to the Air Force on the revised Draft Environmental Statement. All comments received are included and the Air Force reply follows each comment.

B. Comments were received from the following:

United States Government Agencies/Departments

- Atomic Energy Commission
- Department of Agriculture
- Department of Commerce
- Department of Defense (Health and Environment)
- Department of Health, Education and Welfare (2 letters of comment)
- Department of Interior
- Department of Transportation
- Environmental Protection Agency

State Governments

- Hawaii (3 letters of comment)
- Mississippi

Other interested Groups

- American Eagle Foundation
- Center for Law and Social Policy (Representing Friends of the Earth and the National Audubon Society)
- The Marquardt Company

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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JUL 5 1974

Dr. Billy E. Welch
Special Assistant for
Environmental Quality
Office of the Assistant Secretary
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

[1] This is in response to your letter dated May 9, 1974, inviting the U. S. Atomic Energy Commission to review and comment on the revised Draft Environmental Statement entitled, "Disposition of Orange Herbicide by Incineration."

[2] We feel that the United States Air Force environmental statement is well prepared in almost all areas. Of particular concern is Johnston Atoll wildlife; however, the statement does elucidate the lack of hazards and adverse effects the proposed action will have on the wildlife. The statement also demonstrates that there should be no adverse environmental effects from incineration either on the special ship or Johnston Island, given proper equipment operation within specified safety constraints.

[3] We do have some concern in areas of the statement which do not seem to be covered with sufficient detail. These are:

1. Transfer of the herbicide to the incinerator, including "de-drumming," bulk storage, control of spills, etc.

2. Clean-up of emptied drums.

3. Disposal of emptied drums.

[4] With respect to item 1, our prime concern is for the health and safety of all involved in or in proximity to the Island operation. This should be the primary consideration in the planning, scheduling, funding, and execution of whatever method is employed. Sufficient advance notice of the method of choice should be provided to field agencies to allow for coordinated and orderly design and construction of the "de-drumming" and transfer facilities. If the schedule for emptying the drums is anticipated to exceed a year, early construction of a bulk storage facility should be considered to minimize re-drumming and expedite the ultimate transfer operation.

[5] As for drum clean-up, the statement documents that even with repeated rinsing of the emptied drum, which is not only expensive and time-consuming, all the residue cannot be removed and that the difference between rinsed and unrinsed drums probably may not be worth the effort.

[6] We presume that the problem of drum disposal is still under study and feel that more consideration should be given to salvaging the drums so they ultimately become ingots. In any event, the crushed drums should be shipped in a sealed container in order to prevent release of any residual herbicide during shipment.

[7] Another area in the statement which we feel has been given marginal consideration is the alternatives to incineration. The alternatives such as "use," "return to industry" are briefly covered and have not been costed out. We should like to suggest that additional review be made of the possibility to return this chemical to the economy, if such can be done. Possibly the chemical processing industry could use this chemical as a raw material in another process. If this alternative is not economically sound nor technically feasible, we feel that such fact should be documented and that incineration is truly the only alternative.

[8] In summary, we feel that this draft statement adequately shows that there will be no adverse environmental impact from proper incineration, if in fact this is the only alternative. We would prefer that the incineration be done at sea since this will minimize exposure of the chemical to the Island personnel and request that as the methods are selected and procedures written, the health and safety of this personnel be of primary concern.

[9] We do object to incineration on Johnston Island for several reasons, but primarily because of the excessive length of time required for construction of a facility for disposal and for the actual disposal. Additionally, incineration on the Island is certain to cause an obstruction to our readiness program that now exists. Our final objection is the high cost of construction and the continuing excessive environmental pollution which could occur by having leaking levels of herbicide around for a much longer period of time.

[10] Since facilities for incineration at sea are in existence (e.g., the ship Vulcanus) and total disposal could be accomplished in less than two months, we prefer this method of incineration. This mode will also eliminate the obstruction to our readiness effort at a minimized cost to the Government.

[11] We have appreciated the opportunity to review and comment on the statement.

Sincerely,

James L. Liverman

James L. Liverman
Assistant General Manager for
Biomedical and Environmental
Research and Safety Programs

cc: Council on Environmental Quality (5)

RESPONSE TO COMMENTS FROM THE ATOMIC ENERGY COMMISSION LETTER (5 Jul 74)

1. (Paragraph 2,3,4 AEC Ltr) A complete dedrumming and transfer operation has been planned and engineered for Johnston Island (Part II.E.) The health and safety of personnel and the maintenance of the environment are prime considerations in this plan. Sufficient notification will be provided for the orderly implementation of the "dedrumming/transfer" project.

2. (Paragraph 3,4,5,6 AEC Ltr) See Part II.E. for drum disposal information.

3. (Paragraph 7 AEC Ltr) See Part I for Air Force action toward EPA registration of Orange herbicide.

4. (Paragraph 7 AEC Ltr) See Part V.C for Air Force action on the return of Orange herbicide to manufacturers.

5. (Paragraph 9,10 AEC Ltr) The proposed disposal action is incineration at sea with incineration on Johnston Island as the principal alternative.

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

June 19, 1974

Dr. Billy E. Welch
Special Assistant for
Environmental Quality
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

We have reviewed the revised draft environmental statement on "Disposition of Orange Herbicide by Incineration"--AF-ES-72-2D (1), April 1974. The statement is well organized, well written, and significant research data are presented to support the effective and safe disposal of orange herbicide by incineration.

We concur in the proposal to dispose of orange herbicide by incineration in a remote area near or on Johnson Island in the Pacific Ocean. With proper concern for the environment as outlined in the revised draft environmental statement, we concur that incineration is the most environmentally safe and most effective method of the alternative procedures that could be considered for the disposal of orange herbicide.

Sincerely,

F. H. Tschirley

F. H. Tschirley
Coordinator
Environmental Quality Activities

RESPONSE TO COMMENTS FROM THE DEPARTMENT OF AGRICULTURE LETTER (9 JUN 74)

No reply required.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

July 10, 1974

Dr. Billy E. Welch
Special Assistant
for Environmental Quality
Office of the Assistant Secretary
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

The draft environmental impact statement for the proposed "Revised - Disposition of Orange Herbicide by Incineration," which accompanied your letter of May 9, 1974, has been received by the Department of Commerce for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

The accidental discharge of Orange Herbicide into the air, ground or under "worst case" conditions is discussed under various conditions in the environmental statement. Two "worst case" conditions, that are not discussed, however, are the fate and effect of Orange Herbicide under the "worst case" conditions of either (1) jettisoning of the cargo of the vessel Vulcanus or (2) accidental sinking of the Vulcanus. Consideration should be given to these possibilities, even though they may be remote.

Thank you for giving us an opportunity to provide these comments which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler
by June Lewis
Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

RESPONSE TO COMMENTS FROM THE DEPARTMENT OF COMMERCE LETTER (10 Jul 74)

Information on possible environmental impact resulting from the jettisoning of the Orange cargo or sinkage of the incinerator ship has been included in Part III.C.5.a.

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

HEALTH AND
ENVIRONMENT

1 JUL 1974

MEMORANDUM FOR Special Assistant for Environmental
Quality, SAFILE

SUBJECT: Revised Draft Environmental Statement "Disposition of Orange Herbicide by Incineration"

[1] The following comments on the Draft Environmental Impact Statement, "Disposition of Orange Herbicide by Incineration," are provided in response to your memorandum of May 9, 1974.

[2] In view of EPA withdrawal of its legal motion seeking a ban on the use of 2-4-5-T, further consideration should be given to disposition of that portion of the material which corresponds to current commercial formulation through controlled use by DoD or other governmental agencies.

[3] With respect to disposal via ship incineration, we would suggest that the possibility of accidental release of the material as a result of uncontrolled shipboard fire or natural causes be discussed.

[4] The discussion on incinerating the herbicide on Johnson Island should include the possible effect of the HCl from the exhaust on space tracking equipment and on the aluminum housing of certain of the stored chemical munitions.

[5] The Office of the ASD(I&L) also noted that no fully satisfactory method of disposal of the drained drums is proposed in the statement. Incineration of the drums to remove herbicide residues should be considered. This could be included as a requirement in the service contract. After incineration, disposal of the drums by any number of environmentally acceptable methods is possible including salvage for reuse of the metal.

H. R. Smith
Acting Deputy Asst Secretary of Defense
(Environmental Quality)

RESPONSE TO COMMENTS FROM THE ASSISTANT SECRETARY OF DEFENSE FOR HEALTH AND ENVIRONMENT LETTER (1 Jul 74)

1. (Paragraph 2 SoD for H&E Ltr) See Part I for Air Force action toward EPA registration of Orange herbicide.

2. (Paragraph 3 SoD for H&E Ltr) Information on possible environmental impact resulting from the jettisoning of the Orange cargo or sinkage of the incinerator ship has been included in Part III.C.5.a.

3. (Paragraph 4 SoD for H&E Ltr) If the principal alternative of incineration on Johnston Island were used, meteorological constraints and ambient air monitoring would be utilized to insure that hydrogen chloride does not represent a health hazard to personnel. These precautions would also insure that structures and space tracking equipment are not affected. Additional information on the effects of hydrogen chloride has been included in Part III.B.2.c.

4. (Paragraph 5 SoD for H&E Ltr) See Part II.E. for drum disposal information.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

AUG 23 1974

Dr. Billy E. Welch
Special Assistant for Environmental
Quality
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

[1] We have reviewed the revised draft Environmental Impact Statement concerning the "Disposition of Orange Herbicide by Incineration."

[2] Of vital concern to this Department from the proposed action is the impact to the physical environment and subsequent potential contamination of food for man and animal. A related problem involves the transportation of the phenoxy compounds, the transfer of the chemical to the ship, and one of increasing magnitude is the handling and disposal of wastewater and used containers. The potential seriousness of health and environmental hazards due to accidental causes, improper disposal and handling of the chemical and containers must be treated in the final impact statement, if we are to determine whether or not this project will be fully protective of public health and the environment.

[3] Physical movement of 0.86 million gallons of Orange from its present location in Gulfport, Mississippi, to the ultimate site of disposal is a potentially serious threat to the environment and contributing factor to contamination of food for man and animal use. The draft statement, in our opinion, does not give sufficient information on movement and handling procedures. Another problem exists in the disposal of the empty 55-gallon steel drums. We feel the impacts resulting from container disposal should be discussed in the final statement. Land fill of these drums is questioned since the material can be recycled thereby eliminating any potential hazard once and forever.

[4] The other proposed disposal options are not discussed in the type of detail which would allow conclusions to be drawn about their viability.

[5] We note that incinerating Orange Herbicide at the specified temperature, pressure, dwell-time, combined with high efficiency scrubbing, will provide safeguards against the release of highly toxic dioxins. However, the problem of pyrolytic synthesis of dioxins received minor discussion in this revised statement, depending solely on the use of sufficiently high temperatures to complete the destruction. As stated in the draft statement, the formation of dioxins on pyrolysis can occur at lower temperatures; however, the possibility of cold spots in the furnace or its breakdown have been inadequately considered.

[6] We do not dispute the completeness of the Marquardt Company's land-based incinerator study. The analyses of the exhaust gases are adequate and well discussed. However, it is questionable that under actual operational conditions, sustained combustion efficiencies of 99.999% can be maintained consistently, knowing that incinerator design is not a well defined process.

[7] We could not adequately review the shipboard incinerator concept, since the pilot plant or operational data was not presented. Also, the destruction efficiency of 99.9% for this incinerator was not validated by adequate data; therefore, it can only be concluded that this efficiency was an extrapolation from the Marquardt Company study. In an operation of this magnitude with the potentially serious public health considerations, this type of information should be provided.

[8] Unmonitored incineration on-board the ocean vessel as described in the statement does not provide the safety assurances considered necessary for the disposal of Orange herbicide. Lacking are the high-efficient scrubbing devices and monitoring instrumentation necessary to provide adequate health and environmental safeguards. The statement is silent regarding the potential environmental impacts which would occur in the event an accident should occur on the vessel while loaded with Orange herbicide.

[9] There are no complete comparative cost analyses for the two proposed alternatives presented.

[10] It is our opinion that the "worst case" analysis used in defense of minimal environmental impact can be improved. The dispersion model derived in Appendix K is not complete. This should include general mass transfer equations with supporting simplifying assumptions. Also, in a "worst case" analysis, conversions of less than 99.9% should be used especially since this incineration efficiency is not validated by hard data. For example, if 0.1% conversion corresponds to 0.576 Tons of herbicide/day discharge to the atmosphere, for a conversion of only 90%, this would correspond to about 57.6 Tons of herbicide/day discharged to the atmosphere.

[11] The estimated 22-26 days required to incinerate 2.3 million gallons of Orange herbicide using the vessel does not include in the calculations the volume of drum and other wash water which will result from the disposal operation or the time required to load the chemical into the ship in preparation for incineration. Considering these factors, we estimate that the time required to dispose of 2.3 million gallons of Orange herbicide is underestimated.

[12] In conclusion, it is our considered opinion that:

1. Incineration under tightly controlled parameters is an acceptable method of destroying the Orange herbicide;

2. Prior to use of any incinerator, except the one presently certified by actual pilot testing, the same type and quality of pilot tests with gaseous and liquid effluent analyses must be conducted on said incinerator. This will provide the necessary assurances that the selected disposal method protects the public health and safety, reduces to the maximum the potentially serious threat to the environment and is not a contributing factor to contamination of food for man and animal use;

3. Whatever incineration method is selected, adequate and continuous monitoring of the gaseous and liquid effluents therefrom are required;

4. Transfer and transport of the chemical from Gulfport, Mississippi must be provided with proper safeguards and likewise the chemicals on Johnston Island, if they are to be destroyed by shipboard disposal; and

5. Careful consideration must be given the handling, cleaning and ultimate disposal of the contaminated drums.

[13] We feel that the only positive aspect of the on-board incinerator is that it alleviates the problem in a short period of time. The land-based operation will require seven months on a 24-hour/day operation and will require the Air Force to participate. The on-board incinerator appears to transfer the disposal problem and the potential impacts, public health and environmental to another media. The possibility that it may set a precedent for incineration of all hazardous material at sea cannot be dismissed.

[14] Thank you for the opportunity to comment on this statement.

Sincerely,

Charles Custard

Charles Custard
Director
Office of Environmental Affairs

RESPONSE TO THE COMMENTS FROM THE DEPARTMENT OF HEALTH, EDUCATION AND WELFARE (23 Aug 74)

1. (Paragraph 2,3,11 HEW Ltr) See Part II.E. for drum cleaning/disposal.

2. (Paragraph 2,3 HEW Ltr) An operations plan will be prepared for all handling, transfer and shipments of Orange which are accomplished in support of the incineration project. This plan will stress personnel and environmental safety and include contingency planning for accidents.

3. (Paragraph 4 HEW Ltr) See Part V, Return to Manufacturers, Fractionation, and Chlorinolysis for information on these alternatives.

4. (Paragraph 5 HEW Ltr) The Vulcanus incinerators utilize a vortex circulation to increase the path of combustibles through the incinerator and to minimize the potential for the creation of cold spots. In addition, temperature is measured at different locations in the incinerator. The Air Force will specify contractually for the minimum temperature within the incinerator. Temperature is very important as regards dioxin destruction and is in fact the reason for the high temperature to be specified in the contract (minimum of 1400°C for the Vulcanus). The Orange herbicide combusted in the Marquardt test burn had a high dioxin concentration (~13 mg/kg) compared to the total Orange stock (Part II.F.). No evidence of pyrolytic synthesis was noted in the Marquardt test, see Appendix E.

5. (Paragraph 6,7,8,10 HEW Ltr) The Air Force position is that the environmental impact of the incineration of Orange herbicide can be adequately assessed without further test burns and without monitoring for the proposed action of incineration at sea, see the Air Force response to comments from the EPA, the Marquardt Company, and the Center for Law and Social Policy.

6. (Paragraph 13 HEW Ltr) The Air Force feels that for this project incineration at sea is the more environmentally safe Orange destruction action. Although it is felt that the principal alternative of incineration on Johnston Island can be accomplished in an environmentally safe manner, the potential for damage to the reef and bird communities of the delicate ecosystem of Johnston Atoll warrants concern for any incineration operations on the island. This view is shared in some of the letters of comment to the RDES; see comments from the state of Hawaii and the Center for Law and Social Policy. It is noted that the comments from the State of Hawaii reveal that they are concerned with the negative aspects involved in establishing an incinerator system on Johnston Island; namely, that it could be used for other waste materials in the future.

NOTE: Paragraph 9, HEW Ltr is not within the scope of this environmental statement and paragraph 12 is a restatement of previous paragraphs.

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

mD

SEP 4 1974

Dr. Billy E. Welch
Special Assistant for
Environmental Quality
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

This is an addendum to my letter of August 23, 1974 transmitting this Department's comments on the draft Environmental Impact Statement for the "Disposition of Orange Herbicide by Incineration."

We wish to point out the need for clarifying the fact that Orange, as the n-butyl ester (1:1) 2,4-D and 2,4,5-T is not the same chemically as the commercially available herbicide 2,4-D and 2,4,5-T. The environmental impact statement refers to the later and does not indicate the distinction between the physical properties of this chemical and those of Orange. The anticipated toxicity, stability and other characteristics of Orange are somewhat different, the esters are harder to handle and it does not degrade as easy.

Also, we note that the draft statement fails to address the potential for water pollution and the effects of the impact on the marine physical and biological environment from hydrochloric acid and other by-product emissions resulting from the incineration process.

Sincerely,

Charles Custard

Charles Custard
Director
Office of Environmental Affairs

RESPONSE TO COMMENTS FROM THE DEPARTMENT OF HEALTH, EDUCATION AND WELFARE (4 Sep 74)

1. (Paragraph 2, HEW Ltr) Every effort was made to accurately portray the description and characteristics of Orange herbicide, see Part I.A.1. and Part II.F. Part II.F. includes the procurement specifications, the results of analytical analyses for TCDD, and a table citing the general physical/chemical properties of the herbicide. The rather large number of individuals who have had inputs to the statement may have inadvertently contributed to this situation, i.e., lack of distinction between "commercially available herbicide 2,4-D and 2,4,5-T" and Orange herbicide. Any such lack of distinction between Orange herbicide ard any other pesticide formulations described/referenced in the statement is certainly unintentional. The statement, "Orange herbicide is not a registered herbicide and cannot be used or sold" appears in Part I.C.3. and Part V.C.1. It is noted that Transvall, Inc., Jacksonville, Arkansas advertises for sale a herbicde called Brush-Rhap® which is registered uder EPA Registration No. 11687-11 and which contains 29.0% butyl ester of 2,4-D, 28.2% butyl ester of 2,4,5-T, and 42.8% inert ingredients. In addition, the Pesticide Handbook Entoma, 24th Edition, College Science Publishers, State College, PA (1972) lists a compound called Woodkill manufactured by the Chemical Co,Division of Techne Corp. St. Joseph Mo, as containing 42.67% butyl ester of 2,4-D and 42.20% butyl ester of 2,4,5-T and registered under EPA #449-28. Another product, Line Rider® 22 (EPA #677-95-AA) manufactured by the Diamond Shamrock Co. contains 28% butyl ester of 2,4-D and 27% butyl ester of 2,4,5-T.

2. (Paragraph 3, HEW Ltr) The environmental impact of hydrogen chloride and other by-product emissions resulting from the incineration process is addressed in Part III.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In reply Refer To:
FSF/EA
(ER-74/648)

JUL 9 1974

Dear Dr. Welch:

This is in response to your request of May 9, 1974, for review and comments on the proposed Disposition of Orange Herbicide by Incineration, Johnston Island, Pacific Ocean.

Deep well disposal should be avoided. Development of fissures from seismic vibrations could permit migration of the herbicide to ground water.

The plan, as outlined, for the incineration of Orange Herbicide on Johnston Island or at sea in this general area appears to be an acceptable mode of disposal of this material. Maintenance of high performance by the incinerators and constant monitoring of effluents will be required to minimize environmental impacts.

We are concerned also about disposal of the drums. We suggest that the final statement specify the landfill site to be used, if this is to be the method of disposal, and that there be a discussion of potential leaching of herbicide remnants and resulting environmental impacts.

Sincerely yours,

Stanley D Doremus

Deputy Assistant Secretary of the Interior

Dr. Billy E. Welch
Special Assistant for
  Environmental Quality
Office of the Assistant Secretary
Department of the Air Force
Washington, D.C. 20330

RESPONSE TO COMMENTS FROM THE DEPARTMENT OF THE INTERIOR LETTER (9 Jul 74)

1. (Paragraph 2 DoI Ltr) Deep well injection is not considered as a viable means of Orange disposal, Part V.D.

2. (Paragraph 3 DoI Ltr) See the Air Force response to the letter of comment from the Center for Law and Social Policy relative to monitoring.

3. (Paragraph 4 DoI Ltr) See Part II.E. for drum disposal information.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS.
U.S. COAST GUARD (G-WS/73)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: (202) 426-2262

JUN 13 1974

Dr. Billy E. Welch
Special Assistant for
Environmental Quality
Office of the Assistant Secretary
Department of the Air Force
Washington, D. C. 20330

Dear Dr. Welch:

This is in response to your letter of 9 May 1974 addressed to the Coast Guard, Office of Marine Environment and Systems, concerning the revised draft environmental impact statement on the Disposition of Orange Herbicide by Incineration.

The Department of Transportation has reviewed the draft statement. The Coast Guard commented as follows:

"The VULCANUS has never demonstrated a 99.9% combustion efficiency for incineration of chlorinated hydrocarbons as indicated on page 16 of subject environmental impact statement. It appears that the agents for the VULCANUS have assumed that the 99.9% combustion efficiency achieved with chlorinated hydrocarbons on another incineration-vessel, the MATHIAS I, also applies to their vessel.

"The Test Facility Schematic on E-7 of subject EIS is not legible even under high magnification.

"It appears safe to conclude that there will be no adverse effect caused by the incineration of Orange Herbicide in a remote area of the Pacific."

The Department of Transportation has no further comments to offer nor do we have any objection to this statement. However, the concern of the Coast Guard should be addressed in the final environmental impact statement.

The opportunity to review this draft statement is appreciated.

Sincerely,

R. I. PRICE
Rear Admiral, U.S. Coast Guard
Chief, [illegible]
and Systems

RESPONSE TO COMMENTS FROM THE DEPARTMENT OF TRANSPORTATION (13 Jun 74)

1. (Paragraph 3 DoT Ltr) The comments on the incineration efficiencies of the Vulcanus are correct. However, information on the incineration of chlorinated hydrocarbons aboard the Vulcanus has been received since the revised draft environmental statement was written. This information is summarized under "hydrocarbons" in Part II.B.2. and presented in Appendix N.

2. (Paragraph 4 DoT Ltr) Although the schematic used for the revised draft environmental statement was legible, clarity was lost in the printing process. An effort was made to improve the clarity of the schematic in the final environmental statement.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 11 1974

OFFICE OF THE
ADMINISTRATOR

Dr. Billy E. Welch
Special Assistant for Environmental
Quality
Office of the Assistant Secretary
(Installations and Logistics)
Department of the Air Force
Washington, D.C. 20330

Dear Dr. Welch:

The Environmental Protection Agency has completed its review of the revised draft environmental impact statement (EIS) for the proposed Disposition of Orange Herbicide by Incineration dated April 1974.

The proposed action surfaces major concerns that need to be documented more fully in the environmental statement.

Four important aspects of this proposed action were not discussed in sufficient detail in this draft EIS: incineration, drum disposal, handling safety, and other alternatives. They should be discussed thoroughly in the final EIS. EPA's concerns with these fours aspects of the proposed action are described in the attached comments.

In light of our review of this revised draft statement and in accordance with EPA procedure, we classified the project as "LO" (Lack of Objections) and rated the draft statement as "Category 2" (Insufficient Information). We would be pleased to discuss our classification or comments with you or members of your staff.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

Introduction

The Environmental Protection Agency has reviewed the revised draft environmental impact statement prepared by the Department of the Air Force for the disposition of Orange herbicide by incineration. The proposed action is the incineration of approximately 2.3 million gallons of Orange herbicide in a remote area near or on Johnston Island in the Pacific Ocean.

Our comments on this administrative action follow.

Incineration

There is no test data on the Vulcanus incinerator. Extrapolation of the Marquardt data to the Vulcanus incinerator operation is not possible because burner design and destruction concepts differ appreciably from the Marquardt process. For example, the high degree of turbulent mixing which allows short dwell times in the Marquardt process may not be achieved by the Vulcanus incinerator. Theoretically, the Vulcanus incinerator should be able to destruct Orange herbicide and dioxin based on temperatures and reported (but unconfirmed) dwell time. To prove this theory, testing should be conducted to determine concentrations of breadown products, unburned Orange herbicide esters, and dioxin.

Sampling during a very extensive test for particulate was not done isokinetically, thus invalidating the emission data presented (Table D-3) on page E(D-21).

Drum Cleaning (Part II.E.)

U.S. Environmental Protection Agency, "Regulations for Acceptance and Recommended Procedures for Disposal and Storage of Pesticides and Pesticide Containers," (40 CFR Part 165, Federal Register, May 1, 1974) are mandatory to Federal agencies for purposes of implementing E.O. 11752. Part 165.9(b) specifies triple rinsing or incineration or specially designated land fill for containers which formerly contained organic pesticides. The environmental statement does not contain a firm commitment to this level of treatment. The implication (page 23) that unrinsed containers will be disposed of at sea is in violation of 40 CFR 165.7. The preferred disposal, in our opinion, would be smelting as scrap metal or salvaging for further shipping uses. Disposal by landfill is the least acceptable alternative. If disposal by landfill is the alternative selected, the landfill site should be located such that there is not a chance of runoff into surface or subsurface waterways. The ultimate disposal of container drums should be specified.

Transportation and Handling Safety (Appendix I)

Transfer operations to and from the rail car and to and from the ship are the most hazardous. Consideration might be given to "containerization" or drums with flat car shipment and, perhaps, containerized loading to avoid individual spill opportunities.

The physical movement of 860,000 gallons of orange from its present location at the Naval Construction Battalion Center, Gulfport, Mississippi to Johnston Island is potentially a serious threat to the environment, and the draft statement does not give sufficient information on movement details, such as mode of transportation, off-loading, storage at disposal site, spill containment, decontamination, etc. We recommend the following: (1) careful observance of Department of Transportation safety requirements in the transport of hazardous materials, (2) spelling out of specific modes and routes of transportation so as to plan for any contingency that might occur, (3) separate and individual contingency plans covering such items as immediate field detoxification, health and safety considerations of personnel who might be involved in cleanup, (4) a firm written commitment from the transportation contractor that containment equipment is located and available to the contractor during transportation, and (5) predesignation of the on-scene coordinator prior to any shipment.

Off-loading areas should be equipped with materials and equipment which should be checked thoroughly before the commencement of each loading or unloading in order to assure safe and dependable operation. Furthermore, responsible persons engaged in off-loading should be given complete instructions in cleanup techniques along with instructions on how to proceed in case of a spill.

While shipment by water is cheaper than land and there has never been a spill during water transport, it might be recognized that material spilled in a waterway would be distributed by the current. A land spill could be much more easily contained. If shipment is made by rail or truck, cleanup teams and equipment should accompany the transport vehicles.

In the matter of storage, whether in bulk or in drums, only those areas especially designed for storage of hazardous materials should be used. Such areas should provide (1) structures to prevent surface water runoff from entering the area, (2) pavement and gutters to collect surface water runoff within the area, (3) drains to channel contaminated runoff to a holding facility, (4) materials and equipment necessary for rapid cleanup of spills, and (5) fencing to control admission to the areas. In addition, storage areas should be located remotely from occupied dwellings.

Alternatives

We must take exception to the statements (page 119) that technology is not currently sufficient to permit the disposal of Orange herbicide by either chlorinolysis or fractionation. Not only are both methods entirely feasible technologically, but they may also offer the most practical means of disposition from the standpoints of economics and resource recovery. These means of disposal deserve much greater consideration than is evident in the EIS.

RESPONSE TO COMMENTS FROM THE ENVIRONMENTAL PROTECTION AGENCY LETTER (11 JULY 1974)

1. INCINERATION: The following is to provide information on the background and purpose of the Marquardt Company test burn of Orange herbicide, see also Part II.C.1. and the Air Force response to the Marquardt Company comments.

a. The Air Force investigated the feasibility of conducting an Orange herbicide test burn at the Rollins Environmental Services industrial waste disposal facilities in New Jersey, Louisiana, and Texas. The Texas site was never considered feasible for a variety of reasons including regulatory agency approval and the potential environmental impact. In addition, the incinerator system was programmed for extensive modification which did not meet the time frame of the disposal project. The Louisiana site, although a candidate for the large scale disposal of Orange, was also programmed for modifications which prohibited it from meeting the test burn schedule. A detailed test burn protocol, including an operational and ecological monitoring program, was prepared for a test burn of Orange herbicide (230 drums) at the New Jersey site. The New Jersey site was undergoing modifications which were acceptable to the test burn schedule. The test burn protocol was presented to representatives of Region II EPA and representatives of the New Jersey Bureau of Air Pollution Control on 4 May 1973. The test burn was tentatively scheduled for Jul 73; however, the following situation developed: comments were not received from the EPA concerning the test burn protocol, the Rollins Environmental Services took longer than anticipated to accomplish the modifications and obtain regulatory agency approval, and the Chairman of the Louisiana Governor's Council on Environmental Quality advised the Air Force that the large scale incineration of Orange in Louisiana would not be welcomed. In addition, an ecological study including aerial infrared photography of the New Jersey site conducted by the Air Force revealed that crops in very close proximity to the incinerator were a species that are very sensitive to chlorophenoxy herbicides; thus, incinerator tests during the growing season involved a possibility for crop damage. The plan for this test burn was, therefore, not concluded and the chance of accomplishing a large scale test burn and subsequent disposal of the entire Orange stock in a conventional commercial incinerator within the U.S. was judged to be very remote. After careful consideration, the Marquardt Company was chosen to conduct a test burn with the SUE® system, see Part II.C.1. for the rationale leading to this selection. The test burn was conducted under Los Angeles Air Pollution Control District Authority to Contract Number A77791. The Marquardt Company test burn was accomplished to obtain data concerning the incineration of Orange under specified incinerator operating conditions to determine contractural specifications to be levied upon any contractor - and not specifically to determine the suitability of the Marquardt system for the large scale disposal of Orange.

b. The Air Force approach to the destruction of Orange via incineration has been to obtain combustion data and incinerator operating conditions which may be applied to a contractor as contract specifications. In this sense, the extrapolation involves a judgment on combustion efficiency for a given incinerator at prescribed incinerator operating conditions rather than an extrapolation of data in a purely technical nature. It is the Air Force position that sufficient data is available on incineration of Orange so that a judgment can be made on the efficiency of treatment to be expected under specified incinerator operating conditions. This data includes five studies concerned with the combustion of Orange (Appendix D and E) and the data on incineration by incinerator ships and at the Rocky Mountain Arsenal, see paragraph c. below. It is emphasized that while the relative pyrolysis efficiencies of the Marquardt test burn ranged from 98.98 percent to 99.999 percent, the efficiency of the Vulcanus for environmental impact analyses was selected at 99.9 percent in the RDES. In the final environmental statement, the analyses were also shown for 99.0 percent and 95.0 percent with the conclusion that even these efficiencies may be deemed environmentally acceptable for a 22-26 day period over the open tropical sea (Part III.B.2. and Part III.C.5.). The 95 percent destruction would not be acceptable to the Air Force; however, it is the Air Force position that an efficiency approaching 99.9 percent can be attained, see paragraph c. below.

c. Since the RDES was published, the Air Force has received information concerning the efficiency of incineration of chlorinated hydrocarbons aboard the Mathias and Vulcanus incinerator ships and on the ecological aspects of incineration at sea (North Sea). This information is included in Appendix N and is summarized in Part III.B. and C. This information, while not on Orange herbicide incineration, attests to the high efficiency attained in chlorinated hydrocarbon incineration (99.9 percent) and to the minimal environmental impact of the incinerator emissions. In addition, essentially complete destruction (>99.9 percent) of mustard agent, a material with similar physical/chemical properties as Orange, is accomplished by incineration at Rocky Mountain Arsenal, see Part V.A.2.

d. The stay time for the Vulcanus incinerator has been recalculated due to receipt of more detailed information from Ocean Combustion Service and is reported in Part II.C.2. as approximately 0.6 seconds instead of the original 0.25 seconds.

e. In view of the above, it is the Air Force position that sufficient information is available to adequately assess the environmental impact of the Orange disposal via incineration and that further test programs are not required.

f. The particulate sampling was done according to established procedures for isokinetic sampling. The results showed that isokinetic conditions were rot always maintained. This problem is discussed in detail on page E(D-22).

2. DRUM CLEANING

a. See Part II.E. for drum cleaning information.

b. This response below is in reference to the following quote from the EPA letter:

> "U.S. Environmental Protection Agency, 'Regulations for Acceptance and Recommended Procedures for Disposal and Storage of Pesticides and Pesticide Containers,' (40 CFR Part 165, Federal Register, May 1, 1974) are mandatory to Federal agencies for purposes of implementing E.O. 11752." (Emphasis added).

(1) Executive Order 11752, 38 FR 34793, dated 19 December 1973, states that it is the responsibility of heads of Federal agencies to "ensure that applicable standards specified in section 4 of the order are met on a continuing basis" (E.O. at Section 3). Section 4 (a) (7) states that "Heads of Federal Agencies shall insure that their facilities conform to requirements of Federal regulations and guidelines respecting manufacture, transportation, purchase, use, storage and disposal of pesticides promulgated pursuant to the provisions of the Federal Insecticide, Fungicide and Rodenticide Act, as amended by the Federal Environmental Pesticide Control Act of 1972." (FIFRA and FEPCA). EPA issued the above-cited "Regulations and Recommended Procedures" on May 1, 1974. The "Regulations" governing acceptance by EPA of compounds whose registration is cancelled are mandatory and minimize EPA's responsibilities. However, the recommended procedures, Title 40 FR §165 <u>et. seq.</u>, are another matter. Note the language employed: "recommended procedures" in Title 40 FR §165.2(c) and §165.8 and "procedures not recommended" in 165.7. Section 165.8 generally states as the standard for agencies to follow, that pesticides ". . . <u>should</u> be disposed of according to the following procedures . . ." (Emphasis added). This language seems to present the procedures for disposal of pesticides as worthy of notice or to attract favorable attention to them. The only "mandatory" reference in the recommended procedures is found at Title 40 FR §165.2(c) which states "These disposal procedures are <u>mandatory only for the Agency</u> in carrying out its pesticide and container disposal operations." (Emphasis added). EPA has, under the Executive Order 11752, authority to establish mandatory guidelines for Federal agencies, but it has chosen not to exercise that authority at this time. The EPA administrator's comments in FR, Vol. 39, No. 85 - Wednesday, May 1, 1974, at page 15237 explains why this choice was made:

> ". . . adequate disposal sites and the necessary facilities are not readily available nationwide, and significant information gaps exist which make it infeasible to write specific criteria for certain disposal methods and procedures. Further, information on the full extent of environmental damages and of the economic impact of such regulations is lacking. Therefore, the Agency has retained the recommended procedures approach. At such time as this information has been obtained and analyzed, consideration will be given to proposing comprehensive regulations relative to storage and disposal."

(2) Since EPA, apparently for sound practical reasons, has not yet chosen to exercise its authority under E.O. 11752, it is our opinion that the recommendatory language of the recommended procedures do not, and were not intended to, establish a Federal regulation or guideline.

(3) Without specific standards binding the agencies, they may use their sound discretion and judgment, within the scope of applicable statutes, in determining the best means of disposing of pesticides.

3. TRANSPORTATION AND HANDLING SAFETY: An Operations Plan will be prepared for handling, transfer, and shipments of Orange which are accomplished in support of the incineration project. This plan will include personnel and environmental safety procedures and describe the monitoring to be accomplished during these operations (see Appendix I. and Part II.E.).

4. ALTERNATIVES: See Part V.I. and V.J. for information on chlorinolysis and fractionation.

JOHN A. BURNS
GOVERNOR

RICHARD E. MARLAND, Ph.D
INTERIM DIRECTOR

TELEPHONE NO
548 6915

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
OFFICE OF THE GOVERNOR
550 HALEKAUWILA ST
ROOM 301
HONOLULU, HAWAII 96813

July 9, 1974

Billy E. Welch, Ph.D
Special Assistant for Environmental Quality
Department of Air Force
Office of the Assistant Secretary
Washington, D.C. 20330

SUBJECT: Disposition of Orange Herbicide by Incineration

Dear Dr. Welch,

[1] As of this date, this Office has received two comments on the subject project. An attached sheet lists the responding agencies. We hope that these comments are helpful to you. We also thank you for giving this Office an opportunity to review the draft environmental statement, particularly in view of the deadline extension you granted.

Although this Office finds the draft environmental statement adequate in most areas, we offer the following comments:

[2] Option I (Incineration at sea)

1. Although burning Orange Herbicide at sea away from civilization and marine life may not have any harmful effect, air pollution still exists as an environmental problem. We should be concerned with limiting the problem of air pollution through the use of a scrubber system with constant monitoring of air emissions throughout the process of incineration instead of an uncontrolled burning operation. Thus, the conclusion in the draft environmental statement that monitoring is unnecessary (p. 64) should be reconsidered. One must not conclude that the environmental impact of air pollution in a populated area is in any way different from the impact in desolate surrounding.

2. A scrubber system in the gas effluent stack would minimize the pollutants in the air. A monitoring system would be able to keep an accurate account of the emissions and any unanticipated high level readings from the stack during the burning of Orange Herbicide.

3. There is little mention of the exhaust from the fuels for the burners. Would the exhaust react with the products emitted from the incineration?

[3] Option II

For incineration at Johnson Island (Option II), there is one area of great concern. One of the waste effluents without the scrubber in the stack is HCl gas (about 18.5 tons daily or 25 ppmv/v). If HCl gas comes in contact with moisture, it converts into hydrochloric acid. Since the relative mean humidity is 75%, the HCl gas could possibly convert to HCl acid. Thus, the offshore waters and the surrounding areas would be contaminated. Marine life may be harmed by the change in pH of the ocean or the acidic aerobic state. Any metal equipment nearby may be damaged by corrosion. Rain is another factor that must be considered since acid-rain may result.

One feasible idea that was briefly mentioned but should be considered in more detail is photodecomposition. Photodecomposition has the advantage of being economical, non-polluting to the air, and recyclable to useful chemicals. Although it is stated on page 84 that 2,3,7,8-tetrachlorodibenzo-p-dioxin is neglible in aqueous suspensions and wet and dry soil, another solvent can be used, like alcohol, where photodecomposition does occur.

The Environmental Center at the University of Hawaii has a major criticism. It is felt that there is insufficient data on the ecology of terrestrial and aquatic biota of Johnson Atoll. Appendix A needs to be expanded to include data describing the species present, their geographical distribution and density, and behavioral characteristics. Although there are detailed data of physical and technological information, the biological aspects are almost ignored. Thus, on that basis the Environmental Center recommends the shipboard alternative for disposition of the Orange Herbicide.

[4] We hope that the final statement will be available for our review, and that it will address the comments presented here.

[5] Thank you very much for the opportunity to review your environmental statement.

Sincerely,

Richard E. Marland

Richard E. Marland
Interim Director

Attachment

LIST OF RESPONDING AGENCIES

State

1. Department of Planning & Economical Development (June 19, 1974)
2. Environmental Center (July 3, 1974)

DEPARTMENT OF PLANNING
AND ECONOMIC DEVELOPMENT

JOHN A. BURNS
Governor

SHELLEY M. MARK
Director

EDWARD J. GREANEY, JR.
Deputy Director

250 South King St. / Honolulu, Hawaii 96813 / P. O. Box 2359 / Honolulu, Hawaii 96804

June 19, 1974

Ref. No. 1057

MEMORANDUM

TO: Dr. Richard E. Marland, Interim Dirdctor
Office of Environmental Quality Control

FROM: Shelley M. Mark, Director
Shelley Mark

SUBJECT: Review of Revised Draft Environmental Statement for Disposition of Orange Herbicide by Incineration

We have reviewed the above subject draft. It appears to be a very detailed and conscientious appraisal of the environmental impacts which may be expected. However, since the subject matter is of a very scientific nature and may be of direct concern to the State of Hawaii due to our geographical position, it is recommended that detailed comments be sought from other State agencies that have the necessary expertise to adequately evaluate this proposal.

University of Hawaii at Manoa

Environmental Center
Maile Bldg. 10 • 2540 Maile Way
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

July 3, 1974

MEMORANDUM

TO: Richard Marland

FROM: Jerry M. Johnson, Acting Director

SUBJECT: Revised Draft Environmental Impact Statement for Disposition of Orange Herbicide by Incineration, April 1974

[1] I have reviewed the subject EIS and have the following comments to offer.

[2] I find the statement to be adequate in most aspects. In fact I believe the Department of the Air Force, except for the one major exception delineated below, should be commended for the overall quality of the document.

[3] My only major criticism is that insufficient data are provided on the ecology of terrestrial and aquatic biota of Johnston Atoll. Appendix A is a very brief and unsatisfactory summarization of what appears to be a comprehensive baseline ecological survey of the biota of concern. Without data describing the species present, their geographical distribution and density and their major behavioral characteristics, the reviewer is able to neither assess the significance of the individual species and their communities nor the possible impact on them of the on-land incineration alternatives. I can understand the reluctance of the U.S. Department of the Air Force to reproduce the entire document summarized in Appendix A for each copy of the final draft EIS. However, it is impossible for the reviewer to obtain a copy of the document from the Department of the Air Force, if at all, within the time constraints placed on the review process. I believe the originating agency could have

done a much better job of summarizing. The Department went to great detail and cost in presenting other aspects (Appendices D, E and K). Thus I find the almost complete lack of biological data somewhat of an enigma. This lack appears to be a cavalier disregard for the biological aspects and a somewhat enthusiastic and overriding concern for the physical and technological considerations.

[4] On the basis of the data provided in the Final Draft, I can only recommend the shipboard alternative as a reasonable mode for orange herbicide disposal. I foresee the deleterious consequences of this alternative as being minimal. Furthermore, the ship could possibly be used for future disposal of chemicals as well. If a permanent incineration structure were placed on the Island, a tremendous economic pressure would be created for disposal thereon of future military wastes and mistakes. It is not only the incinerator effluents that would be of concern on land. The stresses created on the biota by the logistical aspects alone could be serious.

Jerry M. Johnson

JOHN A BURNS
GOVERNOR

RICHARD E MARLAND, PH D
INTERIM DIRECTOR

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STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
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550 HALEKAUWILA ST
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HONOLULU HAWAII 96813

July 11, 1974

Billy E. Welch, Ph.D.
Special Assistant for Environmental Quality
Department of the Air Force SAG/ILE
Office of the Assistant Secretary
Washington, D.C. 20330

SUBJECT: Draft Environmental Statement on Disposition of Orange Herbicide By Incineration

Dear Dr. Welch,

This Office had received an additional comment from Dr. John L. T. Waugh, Chemistry Department at the University of Hawaii on the subject above. We are forwarding the comment to you in order for it to be reviewed. Please append it to our correspondence dated July 9, 1974.

We hope that this has not been a great inconvenience to you. Thank you for your cooperation in this matter.

Sincerely,

Richard E. Marland

Richard E. Marland
Interim Director

Attachment

1st July, 1974.

To: Dr. Jerry M. Johnson,
Environmental Center.

From: John L.T. Waugh,
Chemistry Department.

Air Force Proposal on ORANGE Herbicide Disposal

This is a lengthy and annoying report, which illustrates in many places, the ridiculous wastefulness, the enormous expense, the uncontrolled planning, the limited thinking, and the casual disregard for areas remote from Washington, associated with Defense Department operations. It is pointed out on the inside of the cover of this several-hundred-page report that it is economically printed on recycled paper, although the subject matter involves the single-minded topic of destroying an accumulation of 2.3 million gallons of herbicide, on which apparently millions of dollars have already been spent on shipping it back and forth around the world, storing and re-drumming, apart from the initial manufacturing cost. It is most difficult to believe that one or more of the seven manufacturers of this material could not devise a method of converting the ORANGE herbicide into useful industrial chemicals such as carbon tetrachloride, carbonyl chloride, hydrogen chloride, and chlorine, for a fraction of the cost already involved for shipping and storage, and in a fraction of the 3-year period which has now elapsed since the Department of Defense stopped using this material in Vietnam. Why should one or more of the original manufacturers not put some research effort into developing the necessary technology at whatever capital expense is necessary, rather than compounding the problem by erecting facilities simply for the destruction of this massive amount of material, at a site which is only 717 miles southwest of Hawaii?

The above question is based on the assumption that the sea-going incineration plan, even aboard a special ship such as the VULCANUS, will hopefully be abandoned; the lack of abilty of any person, technical department, or governmental agency of any country, to accurately forecast ocean and climatic conditions during the period of injecting many thousands of tons of hydrogen chloride, carbon monoxide and dioxide, particulate carbon, into the environment during the incineration of such large amounts of material, especially under conditions where access to technical advice, control, monitoring, is remote, would appear to make this mode of destruction a very risky and ill-advised venture. At least, in a land-based operation, a reasonable degree of control can be excercised and the number of possibly indeterminate hazards greatly reduced. Since the herbicide is apparently all contained in 55-gallon drums, the emptying, decontamination, and disposal of these 40,000-odd drums alone is a major problem. Incidentally, the MARQUARDT COMPANY report, appears to be the only part of this whole document which gives some detailed consideration to this aspect of the overall disposal problem.

It would seem reasonably sensible to suggest that instead of shipping the 0.86 million gallons of herbicide from Gulfport, Mississippi, to Johnson Island, at the estimated cost of $450,000, constructing incineration facilities there, remote from the technical and manufacturing centres in the country, that Dow, Hercules, or one of the other 5 original manufactures of the ORANGE herbicide, should be contracted to utilize, further develop if necessary, their present technolgy, with a view to recovering the chlorine content of these 2,300,000 gallons of material in some industrially useful form.

JOHN A. BURNS
GOVERNOR

RICHARD E. MARLAND, Ph.D.
INTERIM DIRECTOR

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OFFICE OF ENVIRONMENTAL QUALITY CONTROL
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HONOLULU, HAWAII 96813

July 15, 1974

Dr. Billy E. Welch
Special Assistant for Environmental Quality
Department of Air Force SAG/ILE
Office of the Assistant Secretary
Washington, D.C. 20330

SUBJECT: Draft Environmental Statement on Disposition of Orange Herbicide by Incineration

Dear Dr. Welch,

This Office has received an additional late comment from the Department of Agriculture (State of Hawaii) dated July 10, 1974 on the above subject. We are forwarding the comment in hopes that it may be reviewed even at this late date. Please append it to our correspondence dated July 9, 1974.

We apologize for the inconvenience created by this comment. We look forward to the final environmental statement.

Thank you for your cooperation in this matter.

Sincerely,

Richard E. Marland

Richard E. Marland
Interim Director

Attachment

JOHN A. BURNS
GOVERNOR

FREDERICK C. ERSKINE
CHAIRMAN, BOARD OF AGRICULTURE

WILLIAM E. FERNANDES
DEPUTY TO THE CHAIRMAN

STATE OF HAWAII
DEPARTMENT OF AGRICULTURE
1428 SO KING STREET
HONOLULU, HAWAII 96814

July 10, 1974

MEMORANDUM

TO: Dr. Richard E. Marland, Interim Director
Office of Environmental Quality Control

SUBJECT: Draft Environmental Impact Statement
Incineration of Orange Herbicide
Department of the Air Force - Johnston Island

This draft environmental impact statement addresses concerns relating to disposal of Orange herbicide. Orange herbicide contains approximately equal parts by volume of the normal butyl ester of 2,4-dichlorophenoxyacetic (2,4-D) and the normal butylester of 2,4,5-trichlorophenoxyacetic (2,4,5-T) acid. A small quantity, known as Orange II, contains the isooctyl ester of 2,4,5-T instead of the normal butylester. No direct agricultural impact is anticipated.

Herbicidal formulations containing 2,4-D or 2,4,5-T are used for control of plant pests in agricultural operations in Hawaii. In 1968 197,227 pounds of 2,4-D and 6,128 pounds of 2,4,5-T were used in sugar cane plant pest management. Other operations used about 1,400 pounds 2,4-D and 14,000 pounds 2,4,5-T. Control of plant pests in pastures depends upon the continued use of 2,4,5-T although this use is declining as better control is achieved.

An impurity, 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD), in some lots of Orange herbicide is teratogenic (malformed fetuses and living offspring) in experimental animals. For this reason military and certain other uses of 2,4,5-T ceased in 1970. There are approximately 860,000 gallons and 1,400,000 gallons in storage at Gulf Port, Mississippi and Johnston Island, Pacific Ocean, respectively.

Controlled incineration at high temperature is recommended for disposal. Two alternative controlled incineration methods described are for either units mounted on a vessel designed specifically for disposal of toxic combustible wastes or located at a leeward site on Johnston Island. Regardless of the choice of system, Johnston Island will be the site for storage and handling as part of the disposal system.

The environmental impact statement provides an adequate assessment of the technology of Orange herbicide incineration. Option 1, incineration at sea is preferred. No significant detrimental environmental effects can be expected from this method of disposal.

Analysis of risks from adoption of Option 2, incineration on Johnston Island, are less well defined. Use of coral rock or sea water scrubbers would create disposal problems. Direct atmospheric discharge of combustion products with due consideration of wind directions and velocities would be preferred.

Biological monitoring was described. There are some concerns for the adequacy of the monitoring protocol. Baseline sampling was limited to a few days in October 1973. The choice of top predatory animals and the dominant plant (coral) species would appear to be adequate for monitoring. However, frequency of sampling, number of sample per site and species were inadequately described for evaluation. A detailed sampling protocol keyed to operational schedules is lacking. It is recommended that such a protocol be provided for review prior to any Johnston Island operations. Such a sampling protocol should be developed showing relation to shoreside handling and storage operations even though incineration at sea is practiced.

Thank you for the opportunity to review this document as it relates to our concerns.

FREDERICK C. ERSKINE
Chairman, Board of Agriculture

RESPONSE TO COMMENTS FROM THE STATE OF HAWAII LETTERS (9,11 and 15 Jul 74)

1. (Paragraph 2-1 S of Hawaii 9 Jul 74 Ltr) Installation of an acidic gas scrubber on the incinerator ship is not practical. Such a system would require considerable energy for operation. And unless a caustic scrubber was used (requires cargo space for alkaline chemical), the liquid discharge from the scrubber would result in localized water pollution. The stack discharge of combustion gases into the atmosphere actually provides for dispersion of the material into the atmosphere rather than concentrating possible impurities into liquid scrubber discharges. The bulk of the incinerator discharges is non-persistent and non-reactive, or subject to photodecomposition and/or hydrolysis. The discharge of such material into a desolate ecosystem for a short period of time should result in a negligible impact. The position that "air pollution" may occur during this period is appreciated; however, it is deemed acceptable since it has minimal impact on the ecosystem.

2. (Paragraph 2-3 S of Hawaii 9 Jul 74 Ltr) No auxiliary fuel is used for the "burners" during the incineration of Orange herbicide. However, auxiliary fuel is used to bring the incinerator to operating temperature prior to injecting the herbicide which is capable of sustaining the necessary incineration temperature.

3. (Paragraph 2-2 S of Hawaii 9 Jul 74 Ltr) See the response to the letter of comment from the Center for Law and Social Policy relative to monitoring.

4. (Paragraph 3-1 S of Hawaii 9 Jul 74 Ltr) The Air Force does not presently plan to incinerate the Orange herbicide at Johnston Island. However, if the principal alternative of incineration on Johnston Island is initiated, the environmental impact upon the ocean adjacent to Johnston Island associated with the discharge of hydrogen chloride from an incinerator stack on Johnston Island is discussed in Part III.C.5.c., Reef Area. A "worst case" analyses revealed that any damage to the reef on an acute basis would be minimal and that the long term chronic effects can not be predicted. Meterological constraints and ambient air monitoring would be utilized to insure that hydrogen chloride would not adversely affect personnel, structures, or the environment. Information or the reaction of hydrogen chloride in air and effects on structures is included in Part III B.2.c.

5. (Paragraph 3-2 S of Hawaii 9 Jul 74 Ltr) Sufficient data is not available to appraise the removal of TCDD from Orange via photodecomposition.

6. (Paragraph 3-3 S of Hawaii 9 Jul 74 Ltr) As stated on the initial page of Appendix A, the document "Ecological Baseline Survey of Johnston Atoll Central Pacific Ocean" was not included for the sake of space conservation but was availabe by request from the USAF EHL, Kelly AFB, TX. It is interesting to note that only one request for Appendix A was received, and they were provided a copy.

7. (Paragraph 4 U of Hawaii, Manoa 3 Jul 74 Ltr) There are no present interests for establishment of a permanent incinerator on Johnston Island. In fact, the Air Force intends to incinerate at sea.

8. (Paragraph 1 & 3, Atch to S of Hawaii, 11 Jul 74) Efforts to return the Orange herbicide to manufacturers for reprocessing have been explored and they are described in Part V.

9. (Paragraph 2, Atch to S of Hawaii, 11 Jul 74) "Worst Case" analyses are presented for decomposition compounds resulting from incineration at sea and at Johnston Island (Part II.B. and II.C.). The distruction of Orange herbicide in "land based" incinerators was also considered, but they were not viable alternatives for reasons presented in Part II.A., II.B. and V.A.

10. (Paragraph 2, Atch to S of Hawaii, 11 Jul 74) The section on drum cleaning and disposal in the Marquardt Co. report was written by Air Force personnel. However, a new section on the disposal of drums has been included in the final environmental statement (Part II.E.).

11. (Paragraph 7 D of Agriculture, Hawaii 10 Jul 74 Ltr) The comments on biological sampling and concern for the adequacy of sampling protocol are appreciated. It is realized that the data from samples collected in Oct 1973 is somewhat meager. This data has been updated and is presented in Part III. C.1. A detailed protocol of sampling, including biological sampling, would be implemented if any Orange herbicide is incinerated on Johnston Island.

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STATE OF MISSISSIPPI
OFFICE OF THE GOVERNOR

WILLIAM L. WALLER
GOVERNOR

WM. M. HEADRICK
COORDINATOR OF FEDERAL-STATE PROGRAMS

STATE CLEARINGHOUSE FOR FEDERAL PROGRAMS

TO: Dr. Billy E. Welch, Special Assistant for
Environmental Quality
Office of the Assistant Secretary
Department of the Air Force
Washington, D. C. 20330

State Clearinghouse Number 74051501

Date: May 15, 1974

PROJECT DESCRIPTION: Draft Environmental Statement -- Disposition of Orange Herbicide by Incineration -- Revision of January 1972 Statement.

(x) 1. The State Clearinghouse has received notification of intent to apply for Federal assistance as described above.

(x) 2. The State Clearinghouse has reviewed the application(s) for Federal assistance described above.

(--) 3. After proper notification, no State agency has expressed an interest in conferring with the applicant(s) or commenting on the proposed project.

(--) 4. The proposed project is: ( ) consistent ( ) inconsistent with an applicable State plan for Mississippi.

(--) 5. Although there is no applicable State plan for Mississippi, the proposed project appears to be: ( ) consistent ( ) inconsistent with present State goals and policies.

COMMENTS: The attached comments represent the review of this project when disposition by incineration within the Continental United States was proposed. By conferring with all participants, these comments are validated for this statement. Each item in the summary letter of the Air and Water Pollution Control Commission applies whether incineration takes place on this Continent or at sea. The urgency of moving this to a safer storage place is increased due to the passage of more than two years.

This notice constitutes FINAL STATE CLEARINGHOUSE REVIEW AND COMMENT. The requirements of Office of Management and Budget Circular No. A-95 have been met at the State level.

Edward A. May, Jr.
Assistant to the Coordinator

SUITE 400, WATKINS BLDG. • 510 GEORGE STREET • JACKSON 39201 • (601) 354-7570

STATE OF MISSISSIPPI
EXECUTIVE CHAMBER
JACKSON

WILLIAM LOWE WALLER
GOVERNOR

February 11, 1972

Honorable Aaron J. Racusin
Acting Assistant Secretary of the Air Force
Installation and Logistics
Office of the Secretary
Department of the Air Force
Washington, D. C. 20330

Re: Draft Environmental Statement-Disposition of Orange Herbicide by Incineration - January 1972--AF-ES-72-2D

Dear Mr. Racusin:

In compliance with applicable regulations, the above captioned environmental statement has been reviewed by appropriate State agencies concerned with various aspects of the disposition. Comments from State agencies are summarized in the latter prepared by the Air and Water Pollution Control Commission, and are enclosed herewith.

It is my opinion that the attached environmental statement is satisfactory.

I recommend that full consideration be given to the comments of our agencies in the final review.

Sincerely,

Bill Waller

BILL WALLER
GOVERNOR

STATE CLEARINGHOUSE FOR FEDERAL PROGRAMS

Federal-State Programs
Office of the Governor
510 Lamar Life Bldg.
Jackson, Mississippi 39201
Telephone 354-7570

State Clearinghouse No.
72020901

Date: February 9, 1972

TO: Aaron J. Racusin
Acting Assistant Secretary of the Air Force
Installation and Logistics
Office of the Secretary
Department of the Air Force
Washington, D. C. 20330

PROJECT DESCRIPTION: Department of the Air Force Draft Environmental Statement -- Disposition of Orange Herbicide by Incineration - January 1972
AF-ES-72-2D

(x) 1. The State Clearinghouse has received notification of intent to apply for Federal assistance as described above.

(--) 2. The State Clearinghouse has reviewed the application(s) for Federal assistance described above.

(--) 3. After proper notification, no State agency has expressed an interest in conferring with the applicant(s) or commenting on the proposed project.

(--) 4. The proposed project is (   ) consistent (   ) inconsistent with an applicable State Plan for Mississippi.

(--) 5. Although there is no applicable State Plan for Mississippi, the proposed project appears to be (   ) consistent (   ) inconsistent with present State goals and policies.

COMMENTS: The summary of comments from all State agencies concerned is included in the attached letter from the Air and Water Pollution Control Commission. This completes the review.

This notice constitutes FINAL STATE CLEARINGHOUSE REVIEW AND COMMENT. The requirements of U.S. Office of Management and Budget Circular No. A-95 have been met at the State level.

David R. Bowen

David R. Bowen
Coordinator of Federal State Programs

Air & Water Pollution Control Commission

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W. H. MOORE

February 8, 1972

FEB 9 - '72

Mr. Edward A. May, Jr.
Assistant to the Coordinator
Federal-State Programs
Office of the Governor
510 Lamar Life Building
Jackson, Mississippi

Dear Mr. May:

This letter is in reference to yours of January 26, concerning the draft environmental impact statement entitled "Disposition of Orange Herbicide by Incineration". A meeting was held in our office with concerned agencies of the State on February 3, to conduct a technical review of this statement and to coordinate the state's position in this matter. Copies of the impact statement had previously been forwarded to these agencies.

The consensus of this meeting is enumerated below:

1. Department of the Air Force should explore further possibilities for use of the material under adequate control measures, preferably by the federal government, as in national and state forests or by returning to commercial use through some acceptable channel. Apparently the alternative of giving this material away was not explored. It is felt that destruction of the material would be a needless waste and would create further expense. It is recognized that such action as suggested might require some emergency authority from Environmental Protection Agency but this should pose no great difficulty since a similar material is in everyday use.

2. In the event incineration is taken as the alternative, it is requested that the federal government assume the responsibility for all transportion of the material to the point of incineration and provide all necessary safety measures, such as, but not limited to, shipping materials in small quantities and providing the necessary absorbents at the convenient locations if shipped by rail.

3. It is requested that the material be removed from its present location at Keesler Air Force Base beginning immediately and without regard to the final disposition of the material. It is felt this is absolutely essential because of the proximity of the material to recreational and shellfish waters, as well as large densely populated areas, and further because of the history of hurricanes and tornadoes in that particular section of the country. It is our feeling there are many other areas in the continental United States which would provide a much safer depository for this material.

4. The Mississippi Air and Water Pollution Control Commission should be notified in advance of any proposed movement of the material, of the routes to be taken, and of the safety precautions.

Copies of this statement are being forwarded to all of the involved agencies, as noted on the attached sheet.

Yours very truly,

Glen Wood, Jr.
Executive Director

GWjr:js

Copies furnished:

Mr. Billy Joe Cross, Director
Mississippi Game & Fish Commission
Post Office Box 451
Jackson, Mississippi

Mr. Joe D. Brown, Director
Division of Sanitary Engineering
State Board of Health
Post Office Box 1700
Jackson, Mississippi 39205

Mr. Jack W. Pepper, Water Engineer
Mississippi Board of Water Commissioners
416 North State Street
Jackson, Mississippi 39201

Dr. R. A. McLemore, Director
Mississippi Department of Archives and History
Post Office Box 571
Jackson, Mississippi 39205

Attention: Mr. Elbert Hilliard

Colonel Wendell D. Lack, State Forester
Mississippi Forestry Commission
1106 Woolfolk State Office Building
Jackson, Mississippi 39205

Mr. O. T. Guice, Jr., Director
Division of Plant Industry
P. O. Box 5207
State College, Mississippi 39762

Mr. William H. Moore
Director and State Geologist
Mississippi Geological Survey
Post Office Box 4915
Jackson, Mississippi 39216

Mr. Spencer E. Medlin, Comptroller
Mississippi Park System
717 Robert E. Lee Building
Jackson, Mississippi

Mr. William J. Demoran
Marine Biologist
Gulf Coast Research Lab
Post Office Box AG
Ocean Springs, Miss. 39654

Mr. Bobby R. Tramel
Bureau of Sport Fisheries
and Wildlife
Post Office Drawer FW
State College, Miss. 39762

RESPONSE TO COMMENTS FROM THE STATE OF MISSISSIPPI LETTER (15 May 74)

1. See Part I for Air Force action toward EPA registration of Orange herbicide.

2. The Mississippi Air and Water Pollution Control Commission will be notified of any proposed large scale movement of the herbicide in Mississippi. In addition, the Commission will be apprised of plans for dedrumming and transfer of the herbicide from the NCBC, Gulfport to the incineration ship.

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THE AMERICAN EAGLE FOUNDATION
SUITE 300 · 1729 H STREET, NW WASHINGTON, DC 20006 · A/C 202·298·6605

DONALD D. CARRUTH
PRESIDENT

WILLIAM G. ALLEN
VICE PRESIDENT

June 25, 1974

Dr. Billy E. Welch
Special Assistant For Environmental Quality (SAFILE)
Office of the Secretary
U.S. Department of the Air Force
Room 4D873, The Pentagon
Washington, D.C. 20330

Dear Dr. Welch:

[1] This office has reviewed with great interest the "Revised Draft Environmental Statement -- Disposition of Orange Herbicide by Incineration, April 1974, AF-ES-2D(1)".

[2] The February and March 1972 responses to the January 1972 draft environmental statement made available to the Council on Envirormental Quality and the public gives strong support to not allowing residual stocks of Orange Herbicide to be disposed of in any of the fifty states of the United States. Further research on the disposition of this herbicide by government, private and educational organizations,at the request of the Air Force, gives additional support to the need for destroying this chemical waste by high-temperature incineration through the use of the M/V Vulcanus -- a specially equipped and designed vessel which has been used in North Sea waters for destroying hazardous/toxic chemical wastes for the past 22 months.

[3] Since the European generated industrial chemical waste is not of the same chemical-mix as that of Orange Herbicide, and since the February 15, 1974 letter of transmittal by the President, National Academy of Sciences to the President of the Senate, Speaker of the House of Representatives, and the Secretary of Defense, of the report: "The Effects of Herbicides in South Vietnam, Part A -- Summary and Conclusions", we feel that the national as well as the international interests surrounding the actual destruction of residual stores of Orange Herbicide would be best served by a monitoring of the vessel's incineration process.

[4] The monitoring project should include the taking of necessary samples of stack emissions and the product being incinerated, under varying burner and firing conditions, fluid

feed and air flow rates and combustion temperatures; and determine by methods to be prescribed, the parameters of fallout patterns and rates of salt water assimulation of such fallout to a depth of at least two meters below the water surface.

[5] We appreciate your consideration in making available to our national environmental organization copies of the Air Force's revised draft EIS of April 1974.

Sincerely yours,

Donald D. Carruth

Donald D. Carruth
President

THE AMERICAN EAGLE FOUNDATION

RESPONSE TO COMMENTS FROM THE AMERICAN EAGLE FOUNDATION LETTER (25 Jun 74)

1. (Paragraph 2 AEF Ltr) The Final Environmental Statement proposes the destruction of Orange herbicide by incineration under a proposed action of incineration at sea on a specially equipped vessel or as the principal alternative of incineration on Johnston Island. In addition, it is also felt that the herbicide could be incinerated in an environmentally safe manner at the U.S. Army Rocky Mountain Arsenal (RMA), CO, see Part V.A.2.

2. (Paragraph 3,4, AEF Ltr) The monitoring project described in the American Eagle letter as regards incineration on board a vessel at sea is very comprehensive and represents quite a formidable task. The disposal of Orange seems to become a vehicle by which extensive data would be obtained on the incineration process. The fact that the Vulcanus has been "used in North Sea waters for destroying harardous/toxic chemical waste for the past 22 months" seems to refute the need for extensive monitoring of a one time (26 day) incineration of Orange in the Pacific Ocean. The environmental assessment of the proposed action of incineration at sea (Part III) and the information available on the efficiency of incineration of chlorinated hydrocarbons at sea and their associated environmental impact (see Parts III.B.2. and III.C.5.) also minimize the need for stack and ecological monitoring. The Air Force position is that operational monitoring of the Vulcanus incinerators (temperature, fuel/air flow, pressure, etc.) is adequate for the proposed action of incineration at sea and that stack sampling and analyses is not required. See also the Air Force response to the comments from the Center for Law and Social Policy and the EPA.

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Attorneys at Law

June 26, 1974

Dr. Billy E. Welch
Special Assistant for
Environmental Quality
The Pentagon
Room 4 D 873
Washington, D.C. 20330

Dear Dr. Welch:

Revised Draft Environmental Statement on Disposition of Orange Herbicide by Incineration

[1] On May 13, 1974, the Department of the Air Force published a notice (39 Fed. Reg. 17120) soliciting comments on the Department's Revised Draft Environmental Impact Statement on Disposition of Orange Herbicide by Incineration [AF-ES-72-2D(1)]. The following comments on that impact statement are submitted on behalf of the Friends of the Earth and the National Audubon Society (hereafter "the environmental organizations"), two environmental organizations with a worldwide membership of more than 350,000 persons and an established history of concern about pollution of the marine environment. The environmental organizations have undertaken numerous efforts to improve the quality of the marine and coastal environment by means of testimony, policy analysis, educational programs and litigation.

[2] The issue addressed in the impact statement is the disposition of 2.3 million gallons of Orange herbicide presently stored at Johnston Island and in Gulfport, Mississippi. The herbicide is highly toxic as are some of its components, e.g., dioxin. The impact statement thoroughly examines several alternative means of disposing of the Orange herbicide, including the possibility of returning the herbicide to the manufacturers, deep

(injection) well disposal, burial in underground nuclear test cavities, sludge burial, microbial reduction, chlorinolysis, soil biodegradation, and incineration. The impact statement proposes the incineration method, rejecting the others as being either inadequate to destroy the dioxin, otherwise environmentally unsound, or only in the developmental stage and thus unavailable for present use. The impact statement recommends that incineration take place either on board a specially designed vessel in the open tropical ocean west of Johnston Island or in a facility constructed on Johnston Island.

[3] The environmental organizations concur that the only reasonable method of disposal is incineration. We strongly urge the adoption of incineration at sea. Incineration at sea, as the impact statement clearly reveals, is the most environmentally sound of the two methods for the following reasons.

[4] The most toxic and environmentally hazardous byproduct of incineration is hydrogen chloride. The best means of minimizing the potential hazards of hydrogen chloride is to disperse the gas over the widest possible surface area. To achieve this end, incineration aboard a moving vessel is clearly preferable to incineration on Johnston Island. If the incineration occurs on Johnston Island, the hydrogen chloride will drain off the land and will collect in the waters adjacent to the Island. Since the hydrogen chloride would disperse over a smaller surface area, concentration levels could be significantly higher and the environmental impact more severe.

[5] Incineration at sea, west of Johnston Island is far preferable. These waters are generally poor in nutrients, and marine life is scarce when compared to that found in coastal areas or near island dwellings. Furthermore, if incineration occurs on Johnston Island, the human inhabitants and flora and fauna might be adversely affected by the combustion gases, as might the ecologically important bird community located on nearby Sand Island. By incinerating at sea, the Orange herbicide can be disposed of at a down-wind location sufficiently distant from both Johnston and Sand Islands.

[6] Our support for incineration is based on several assumptions. First, the combustion temperatures must remain at least 1400°C throughout the entire operation. This requirement must be met to destroy all of the toxic components of the herbicide. Second, the impact statement mentions that incineration operations are subject to mechanical malfunctions and outlines failsafe measures required to protect the environment and provide safety of personnel. These recommended safeguards range from procedures to preclude and contain any spillage of Orange herbicide during transportation to the incineration site to installation of mechanized devices which prevent the feeding of herbicide into the incinerator's burners if combustion chamber temperatures fall below 1400°C. We assume that these suggested failsafe procedures will be utilized. As an added precautionary measure, we recommend that stack samples be collected periodically and held for analysis, in order to demonstrate, if necessary, that the toxic components of the Orange herbicide were, in fact, destroyed.

[7] Finally, the impact statement does not indicate whether the 45,000 storage drums would be cleaned before disposal, nor does it propose a method of drum disposal. We suggest the drums be cleaned with a light petroleum in order to remove as much herbicide as possible. The cleaning fluid should then be incinerated in the same manner as the Orange herbicide. Although the impact statement finds this process to be expensive, it appears to be the only means of destroying substantially all of the Orange herbicide. After cleaning, the drums should be smelted.

[8] A major omission of the impact statement is its failure to relate the disposition to the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. §1401), and the Convention on Marine Pollution by Dumping of Wastes and Other Matter (London, 1972). The Marine Protection, Research, and Sanctuaries Act prohibits "transporting from the United States...except as authorized by permit...any...material for dumping...into ocean waters" (33 U.S.C. §1411(a)).

[9] The act defines dumping as the "disposition of matter of any kind or description" (33 U.S.C. §1422(c),(f)). While incineration is not a normal form of dumping, it does come under the purview of the Act and the safeguards of the Act should be applied.

[10] The Convention on Marine Pollution by Dumping of Wastes and Other Matter prohibits, "any deliberate disposal at sea of wastes and other matter from vessels" without obtaining a dumping permit (Articles III, IV). Although this Convention is not yet in force, the United States has deposited its instrument of ratification, as have others. Because of this and since the Convention may be in force at the time the Orange herbicide is incinerated, the U.S. should comply with at least the objectives and spirits of the Convention. Article VI of the Convention requires that records of the nature and quantities of all matter permitted to be dumped, the location, time, and method of dumping be reported to the new international organization which will be created under the Convention. We suggest that the United States report the required information to all countries who have ratified the Convention. The U.S. would satisfy the permit requirement by complying with the Marine Protection, Research and Sanctuaries Act.

[11] If you have any questions concerning the above, we would be happy to amplify our comments or provide additional information.

Sincerely,

Richard A. Frank

Richard A. Frank

RAF:cl

RESPONSE TO COMMENTS FROM THE CENTER FOR LAW AND SOCIAL POLICY LETTER (26 Jun 74)

1. (Paragraph 4 CL & SP Ltr) The environmental impact upon the ocean associated with the discharge of hydrogen chloride from an incinerator as a result of incineration of Orange on Johnston Island is discussed under "Reef Area," Part III.C.5.a. A worst case analyses reveals that any damage to the reef on an acute basis would be minimal and that any long term chronic effects on the reef could not be predicted. A monitoring plan would be in operation should any Orange be incinerated on Johnston Island. Monitoring stations would be selected to include evaluation of water in the plume fallout area and around the reef. However, the Air Force does not presently plan to install a facility for the incineration of Orange at Johnston Island.

2. (Paragraph 5 CL & SP Ltr) If Orange herbicide is incinerated on Johnston Island meteorological constraints and an ambient air monitoring program will be in operation to insure that personnel, the bird community on Sand Island, and flora and fauna are not affected.

3. (Paragraph 6 CL & SP Ltr) The final contract for any incineration of Orange will include specifications on temperature requirements, operational monitoring and recording (temperature, fuel flow, air flow, operating pressures, etc.) and failsafe procedures.

4. (Paragraph 6 CL & SP Ltr) The desirability of collecting stack samples for subsequent analysis upon completion of the incineration phase of the project (non-real time monitoring) is appreciated. The feasibility and necessity of such action has been studied by the Air Force. The Air Force's position is that neither real time nor non-real time monitoring is required for this disposal project. This position is based on the evaluation of the environmental impact which would result from incineration of Orange at sea. The analysis based on an anticipated Orange destruction of 99.9% reveals that insignificant impact would occur. For perspective, the worst case analyses was also accomplished for Orange destruction efficiencies of 99.0 and 95.0% with the results indicating what is deemed as a minimal and acceptable environmental impact (see Parts III.B.2. and III.C.5.). Information received on incineration of chlorinated hydrocarbons at sea shows that the incinerators utilized by the vessels tested were capable of essentially complete destruction of the hydrocarbons with negligible environment impact. This information is contained in Appendix N and summarized in Part III.B. and III.C. The incineration of mustard agent at Rocky Mountain Arsenal is accomplished by incineration with essentially total destruction of the agent (see Part V.A.2.). In view of the above, it is the Air Force's position that the operational monitoring (temperature, fuel flow, etc.) will be sufficient for this relatively short project and that neither real time nor non-real time monitoring is required.

5. (Paragraph 7 CL & SP Ltr) See Part II.E. for drum disposal information.

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THE Marquardt COMPANY
CCI Corporation 16555 SATICOY STREET • VAN NUYS, CALIFORNIA 91409 • TELEPHONE (213) 781-2121 • TWX 910-495-1710 • CABLE MARQCOR

June 21, 1974
Ref: 2000/115

Department of the Air Force
Office of the Assistant Secretary
Billy E. Welch, Ph.D.
Special Assistant for Environmental Quality
Washington, DC 20330

Dear Dr. Welch:

The following comments are provided in response to the USAF Revised Draft Environmental Impact Statement for the Disposition of Orange Herbicide by Incineration, April 1974, AF-ES-72-2D(1).

We are pleased that our unique SUdden Expansion (SUE®) burner was selected as the incinerator used to perform the only two full-scale test burns of Herbicide Orange and that a copy of our Final Draft Report on the Destruction of Orange Herbicide, February 1974, was included as Appendix E of the Revised Impact Statement. This report documents the 99.998% destruction efficiency of the SUE® incineration system.

1. The SUE incinerator (a commercial incinerator) system tested by the USAF in no way resembles the definition of a "conventional" liquid waste incinerator as defined in Part V.A.1.a. Appendix E of the Revised Draft Impact Statement contains a detailed description of the SUE incinerator system, pages E (B-1) through E (B-10). The combustion efficiency of 99.998% demonstrated in the test program is extremely high for an incineration process, and we know of no other commercial incinerator with documented efficiency approaching 99%.

   Part II C.2.(c)(1) states that the incineration systems installed on the ship Vulcanus are conventional incinerators.

2. Part II C.2.(c)(3) and (4) states that information from Ocean Combustion Service B.V., Rotterdam, The Netherlands, indicated that 99.9% of chlorinated hydrocarbons feed is destroyed. No information, data, test reports, or references are provided to support this claim. Further, no mention of tests or data substantiating the ability to destroy the dioxin (TCDD) is made.

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3. Part II C.2.(c)(3) states that data presented in Appendices D and E indicate that incineration of Herbicide Orange can be successfully accomplished on board the Vulcanus. All referenced test data representative of full-scale incineration of Herbicide Orange was obtained from the SUE® burner incinerator system. As recognized combustion experts, with 29 years of corporate combustion experience, we disagree with this statement for two reasons:

   (a) Data from one type of combustion system cannot be assumed to apply to a different type or size combustion system without extensive testing to validate the assumption. It is only conjecture that the incinerator on the ship Vulcanus would destroy Herbicide Orange at an efficiency of 99.9% since no tests have been run on the ship incinerator. Los Angeles County, for instance, requires afterburners on solid and liquid waste incinerators as a result of testing units with a single chamber like the incinerator on the Vulcanus. Combustion efficiency is closely related to the efficiency of fuel and air mixing in a unit, combustion frequency, combustion stability and stay time. Large-diameter combustion chambers often present mixing problems, combustion frequency problems, and combustion stability problems that result in low combustion efficiency and products of partial combustion. Partial incineration results in destructive distillation and often produces more undesirable products than dumping the raw product into the atmosphere.

   (b) Experience has proven that mixing, burning rates, and efficiencies determined from one size burner cannot be applied to a different size burner of the same type (let alone a different type of burner). One incinerator chamber (three burners of unknown size) on the Vulcanus would incinerate Orange at a rate of 6-2/3 pounds per second (pps) versus .14 pps for a 12-inch-diameter SUE® burner. Scaling is avoided in the Marquardt system by adding additional 12-inch-diameter SUE® burner modules to increase system capacity without changing combustion efficiency.

Mixing of fuel (herbicide) and air is the single most critical parameter in the incineration process. This fact was proven by tests conducted at Marquardt (Appendix E) establishing that the poppet nozzle could not be used above 2/3 of the stoichiometric herbicide/air ratio, whereas the standard SUE slot nozzle injectors could be used with very high overall burning efficiencies. In fact, the poppet nozzle/SUE burner combination somewhat resembles the mixing process in most commercial incinerators. Thus, if an incinerator with burners other than the slot nozzle-equipped SUE type is used to destroy the herbicide, it cannot be assumed that it will operate in the same fashion and with the same efficiency as the SUE system without thorough testing and data analysis. Viscosity of the fuel (Orange Herbicide) directly affects the efficiency of any nozzle. The herbicide had to be heated to a minimum of 90°F (best results at 180°F) to reach efficient destruction. Heating 20 to 24 tons per hour to 90°F+ may present a major problem on board the Vulcanus.

A further complication arises in very large-diameter incinerators because of the potential for stratifying of zones of burning gases which have different fuel/air ratios. It is impossible to detect this improper mixing by measuring the temperature of the gases at various points because the same temperature can be reached by lean (excess air) burning or by overstoichiometric (insufficient air) burning. The combustion products in the two cases are vastly different and in the case of the overstoichiometric mode probably will contain large quantities of raw or partially decomposed herbicide.

Stay time is no cure or substitute for adequate mixing. The combustion process (more properly defined as oxidation) proceeds very slowly after the initial flame front and requires extremely highlevels of turbulence with very short mixing paths. None of these characteristics have been shown to exist in the Vulcanus units. Therefore, it is our opinion that if the mixing in the burners does not approach 100% efficiency, 99.9% destruction efficiency cannot be achieved.

4. The comparison of incineration times of the two proposed systems (22 - 26 days for the Vulcanus vs. 200 days for the land-sited system on Johnston Island) is technically accurate, but misleading from a total-time-required aspect. In order to realistically compare the two options for a time-and-facility cost, the following considerations must be incorporated into the analysis:

    (a) The land-based system can be fabricated at the contractor's plant and shipped in easily assembled modules. Fabrication and installation time of a SUE liquid incineration system on Johnston Island would be equivalent to availability of the Vulcanus.

    (b) A SUE burner system consisting of 10 burner cans equivalent to the land-based Option 2 system would require a small portable 2500-gallon feed tank which would be continuously charged by the drum-emptying facility (1 drum/5 minutes = 12 drums/hour X 55 gallons = 600 gallons/hour). Such a 10-can SUE® burner system would consume the Orange Herbicide at a rate of 600 gallons/hour. System capacity can be increased by adding additional 12-inch-diameter SUE burner modules which incinerate the herbicide at a rate of 60 gallons/hour each.

    (c) Appendix I 4.a. and Part II E. indicate that all drum emptying will be conducted on Johnston Island. Drums would be shipped from Gulfport to Johnston Island via rail and ship. This implies that the Vulcanus would steam to Johnston Island, berth, load 925,493 gallons of Orange Herbicide, and then steam to the burn area for incineration at sea. No time estimate for this operation is included.

    (d) No POL storage tanks approaching 1,000,000-gallons capacity are shown on Johnston Island. In order to obtain efficient utilization of the Vulcanus incineration capacity, 950,000 gallons of Orange Herbicide would have to be available for loading when the ship berthed. At the rate of 12 drums/hour (660 gallons) it would take 60 working days (24 hours per day) to fill the 1,000,000-gallon tank to the required 950,000 gallons.

At the stated rate, the Vulcanus can incinerate its complete capacity of 925,493 gallons in 8.6 days. Allowing 3 days from its berth at Johnston Island to the incineration area and the same time to return to berth, the total voyage would take 15 days. Thus, the ship would either sit idle for 45 days or cycle to an alternate assignment.

(e) The cost, time, and environmental impact of building a 1,000,000-gallon tank on Johnston Island has not been addressed.

(f) If the drum-emptying operation is to be performed in Mississippi, a separate impact statement should be prepared or the subject impact statement expanded to include this additional operation.

(g) Use of a portion of the existing POL storage tanks on Johnston Island would provide a tank capacity of approximately 50,000 gallons (the assumption is made that two 25,000-gallon diesel tanks would be made available; the remaining tanks would be required for normal operations). Therefore, the Vulcanus would have to stay in port 55 days to take on a complete load. Allowing 1/2 day to load each 50,000 gallons (9 X 1/2 = 4.5 days), the total cycle time per voyage would be 74 days (4.5 + 3 + 3 + 8.6 + 55).

(925,493 gallons - 50,000 gallons available at start = 875,493 gallons

$$\frac{875{,}493 \text{ gallons}}{50{,}000 \text{ gallons/tank}} = 17.5 \text{ tanks}$$

$$\frac{50{,}000 \text{ gallons/tank}}{15{,}840 \text{ gallons/day}} = 3.16 \text{ days/tank}$$

3.16 days/tank X 17.5 tanks = 55 working days @ 24 hours/day)

In view of the above-mentioned facts, it appears that the time required for Option I and Option II is similar. If a 1,000,000-gallon tank were constructed, Option I would be approximately 180 days plus tank construction time plus tank flushing and flush fluid incineration time plus tank dismantling and removal. If an existing 50,000-gallon storage tank capacity is assumed, Option I becomes 220 days.

5. Part II D.1.C states that the cargo (Orange) can be discharged directly into the sea in the event that the safety of the Vulcanus and her crew is threatened. Discharge of 925,000 gallons of Herbicide Orange into the Johnston Island area, open tropical ocean, or long-range effects on the Hawaiian Islands is not considered or included in the "worst case" evaluations.

We appreciate the opportunity to review and comment on this Draft Environmental Impact Statement. We respectfully request copies of other comments when received and a copy of the final Impact Statement when it is released.

Very truly yours,

THE MARQUARDT COMPANY

R J Haas

R. J. Haas, General Manager
Environmental Systems Division

RESPONSE TO COMMENTS FROM THE MARQUARDT COMPANY LETTER (21 Jun 74)

1. (Paragraph 1 TMC Ltr) The revised draft environmental statement did not state that the SUE® incinerator is a conventional incinerator. The flame and fuel/air characteristics of the SUE® system are felt to be very important in the acquisition of data on Orange combustion from which judgments can be made concerning overall requirements for efficient combustion. Undoubtedly such a judgment can be made with better validity than had another specialized incinerator system such as molten salt, fluidized bed, or a system which utilizes pure oxygen as the oxidizer been selected for the test incineration. It is noted the Air Force initially intended to perform a test burn in a conventional incinerator but opted for the SUE® when plans for the conventional incinerator could not be concluded (see Part II C.1.).

2. (Paragraph 2 TMC Ltr) Neither the Vulcanus nor any other incinerator vessel has been used for the destruction of Orange and its TCDD contents. Some information on the incineration of chlorinated hydrocarbons on incinerator ships has been submitted to the Air Force (see Appendix N). This information reports incinerator efficiencies greater than 99.9% and attest to the negligible short term environmental impact associated with incineration at sea. Information from Rocky Mountain Arsenal also reports a high efficiency of destruction of mustard agent, 99.9% (see Part V.A.2.).

3. (Paragraph 3 TMC Ltr) The Marquardt Company has taken exception to the following statement on page 15 of the revised draft environmental statement: "A comparison of incineration characteristics of the 'Vulcanus' versus those known to be acceptable based on the data presented in Appendices D and E indicated that Orange herbicide can be successfully incinerated on board the 'Vulcanus'." The company's position is stated in the following quote from paragraph 3 of their letter: "Data from one type of combustion system cannot be assumed to apply to a different type or size combustion system without extensive testing to validate the assumption." There is no basic disagreement with this statement as regards the direct extrapolation of data. The question is --- can a judgment be made on the probable destruction of Orange herbicide via incineration with the data that is presently available? Such data includes five studies concerned with the combustion of Orange and the data on the incinerator ships and Rocky Mountain Arsenal. The Air Force's position is that such a judgment can be made in fact, this position was the underlying reason for the course of action which resulted in the test burn at the Marquardt Company. That is, the Marquardt test burn was designed to obtain data on overall incinerator operation/efficiency which could be used for contractural purposes (see Part II.C.1.).

4. (Paragraph 3 TMC Ltr) The following comments are concerned with the need for an efficient injection system and mixing in the incinerator. The Marquardt system was proven to be extremely efficient for both the poppet nozzle and the slot nozzle and for all fuel feed temperatures(viscosity). Table I-6, page E(I-13) and Table 2, page E-35 show that the relative pyrolysis efficiency is 99.99 percent for both Run I (poppet nozzle, Orange feed temperature 66-63°F, W_f/W_a 0.086) and Run III (poppet Nozzle,

Orange feed temperature 92-90°F, W_f/W_a 0.106). Run II was conducted under the same conditions as Run I except that the feed temperature was 98/96°F and had a relative pyrolysis efficiency of 99.98 percent. The shift to the slot nozzle allowed a higher fuel flow rate and higher efficiencies of 99.998-99.999 percent were attained. The flow rate increase is attributed to the hydraulic characteristics of the nozzle; the higher combustion efficiency is attributed to the greater efficiency of the slot nozzle as an injection system. The Marquardt system was extremely efficient for all test runs and the slot injection system was responsible for the highest destruction rate and efficiency. It is emphasized that the effiencies with the poppet nozzle were quite high and that as the Marquardt Company letter states "...the poppet nozzle/SUE® burner combination somewhat resembles the mixing process in most commercial incinerators." It is the Air Force's position that a properly engineered incinerator system which can operate under specified overall combustion conditions, and is equipped with a well designed injection system and a turbulent combustion space would be an acceptable incineration system.

5. (Paragraph 4 TMC Ltr) Both incineration at sea and on Johnston Island have been programmed to PERT Charts and the project times are not similar. The present plan for incineration at sea does not include the construction and use of large volume storage tanks. When the incinerator ship is loaded at Gulfport, railroad cars will be utilized to transfer the Orange (dedrummed) from NCBC to the dock. On Johnston Island aircraft refuelers will be utilized to transfer the Orange from a dedrumming facility to the ship. A dedrumming/loading rate of 1,000 drums per day is planned. These transfer systems are readily attainable for scheduling purposes, easily managed and controlled, and very satisfactory from an environmental impact standpoint. The activities conducted at both Mississippi and Johnston Island will be well planned and include complete environmental and industrial hygiene considerations.

6. (Paragraph 5 TMC Ltr) Information on possible environmental impact resulting from the jettisoning of the Orange cargo or sinkage of the incinerator ship has been included in Part III.C.5.a.

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LITERATURE CITED

Abend, H.E. 1942. Ramparts of the Pacific. Doubleday, Garden City, N.Y.

Advisory Committee on 2,4,5-T. 1971. Report of the Advisory Committee on 2,4,5-T to the Administrator of the Environmental Protection Agency.

AEC/DOD--Atomic Energy Commission/Dept of Defense. 1971. Johnston Atoll Facilities Brochure.

AEC/DOD--Atomic Energy Commission/Dept of Defense. n.d. Master Site Plans, Johnston Atoll.

AEC/DOD--Atomic Energy Commission/Dept of Defense. n.d. Facilities and support requirements plan--Pacific Area.

Air pollution--Niagara County. 1964. Comprehensive Area Survey Report No. 3. New York State Air Pollution Control Board, Albany, New York.

Air Pollution Control Association. 1970. Recognition of air pollution injury to vegetation. APCA, Pittsburgh, Pa.

Aly, O.M. and S.D. Faust. 1964. Studies on the fate of 2,4-D and ester Derivatives in natural surface waters. J.Agr. Food Chem. 12:541.

Amerson, A.B., Jr. 1973. Ecological baseline survey of Johnston Atoll, central Pacific Ocean. Smithsonian Institution, Washington, D.C. (USAF Contract F-44620-67-C-0063).

Ashmore, S.A. 1973. The geomorphology of Johnston Atoll. Naval Ocean. Off., Tech. Rep. 237:1-27.

Audus, L.G. 1960. Microbiological breakdown of herbicides in soils. In Herbicides and the soil. Blackwell, London.

Bamesberger, W.L. and D.F. Adams. 1966. An atmospheric survey for aerosol and gaseous 2,4-D compounds. In Organic pesticides in the environment, Advances in Chemistry No. 60. American Chemical Society, Washington, D.C.

Bauer, L.R. 1965. Historical report of Johnston Atoll. Joint Task Force Eight.

Baughman, R. and M. Meselson, a. 1973. An analytical method for detecting TCDD (Dioxin): Levels of TCDD in samples from Vietnam. Environ. Health Perspect. No. 5:27.

Baughman, R.W. and M. Meselson. b. 1973. Memorandum on TCDD production by pyrolysis of sodium 2,4,5-T. Harvard Univ., Cambridge, Mass.

Berndt, W.O. and F. Koschier. *In vitro* uptake of 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) by renal cortical tissue and rabbits and rats. Toxicol. Appl. Pharmacol. 26:559.

Besselievre, E.B. 1969. The treatment of industrial wastes. McGraw-Hill, New York, N.Y.

Bjorklund, N.E. and K. Erne. 1966. Toxicological studies of phenoxyacetic acid in animals. Acta Vet. Scand. 7:364.

Bleiberg, J.M. et al. 1964. Industrially acquired porphyria. Arch. Derm. 89:793.

Brock, V.E., W.V. Heukelem, and P. Helfrich. 1966. An ecological reconnaissance of Johnston Island and the effects of dredging.

Brock, V.E., R.S. Jones, and P. Helfrich. 1965. An ecological reconnaissance of Johnston Island and the effects of dredging. Annual report. Hawaii Inst. Marine Biol., Tech. Rep. 5:1-90.

Brown, E. and Y.A. Nishioka. 1967. Pesticides in selected western streams--a contribution to the national program. Pestic. Monit. J. 1(2):38.

Brown, K.S., M.C. Johnston and J.D. Niswander. 1972. Isolated cleft palate in mice after transportation during gestation. Teratology 5:119.

Bryan, E.H., Jr. 1942. American Polynesia and the Hawaiian Chain. Tongg Pub. Co., Honolulu, HI.

Bureau of Sport Fisheries and Wildlife. 1972. Handbook of procedures for pesticide residue analysis. Govt. Printing Office, Washington, D.C.

Byerly, T.C. 1970. Letter to Sen. Hart and Magnuson.

Cheng, K.W. and W.W. Kilgore. 1966. Gas chromatographic determination of pentachlorophenol and sodium pentachlorophenate residue in fruits. J. Food Sci. 31:259.

Christensen, H.E., ed. 1971. Toxic substances. U.S. Govt Printing Office, Washington, D.C.

Clark, D.E. et al. 1964. The fate of 2,4-dichlorophenoxyacetic acid in sheep. J. Agr. Food Chem. 12:43.

Collins, T.F.X. and C.H. Williams. 1971. Teratogenic studies with 2,4,5-T and 2,4-D in the hamster. Bull. Environ. Contam. Toxicol. 6:559.

Colmer, A.R. 1953. The action of 2,4-D upon Azobacter of some sugarcane soils. Appl. Microbiol. 1:184.

Cope, O.B., E.M. Wood and G.H. Wallen. 1970. Some chronic effects of 2,4-D on the Bluegill (*Lepomis macrochirus*). Trans. Amer. Fish. Soc. 99:1.

Courtney, K.D. and J.A. Moore. 1971. Teratology studies with 2,4,5-trichlorophenoxyacetic acid and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. Toxicol. Appl. Pharmacol. 20:396.

Crosby, D.G. and Tutass, H.O. 1966. Photodecomposition of 2,4-dichlorophenoxyacetic acid. J. Agr. Food Chem. 14:596.

Crosby, D.G. et al. 1971. Photodecomposition of chlorinated dibenzo-*p*-dioxins. Science. 173(3998):748.

DAF/DNA--Dept. of the Air Force/Defense Nuclear Agency. 1973. Memorandum of agreement concerning the transfer of host-manager responsibility at Johnston Atoll. (Effective 1 Jul 73).

DeRose, H.R. and A.S. Newman. 1947. Persistence of growth regulators in the soil. Soil Sci. Soc. Amer. Proc. 12:222.

DNA--Defense Nuclear Agency. 1972. Summary report of conference on compatibilit of RED HAT and Herbicide Orange with readiness activities on Johnston Island. Hq Field Command, DNA, Kirtland AFB N.M., 14-16 Nov 72.

DNA/AEC--Defense Nuclear Agency/Atomic Energy Commission. 1973. Memorandum of agreement betweer Field Command DNA and AEC Nevada Operations Office regarding contractual arrangements at Johnston Atoll. (1 Jul 73).

DNA/PACAF--Defense Nuclear Agency (CJTF-8)/15th Air Base Wing (PACAF). 1971. Support agreement concerning USAF/DNA responsibilities of Johnston Island Readiness Facilities. (1 Nov 1971).

DNA/PACAF--Defense Nuclear Agency/Pacific Air Forces. 1973. Support agreement between Pacific Air Forces and Field Command, Defense Nuclear Agency. (Effective 1 Jul 73).

DOD/AEC--Dept. of Defense/Atomic Energy Commission. a. 1965. Agreement on responsibilites for planning for the support of readiness and conduct of atomic test operations outside North American Continental limits and related budgeting and funding. (September, 1965).

DOD/AEC--Dept. of Defense/Atomic Energy Commission. b. 1965. Memorandum of agreement regarding contractual arrangements at Johnston Atoll. (18 Feb 65).

Dow Chemical Co. 1970. Petition, Part IV, Item 3.

EIS-OR--Forest Service. 1973. Environmental impact statement--The 1973 herbicide use on the Deschutes, Winema, Ochoco, and Fremont National Forest, Oregon. Forest Svc., USDA, Pacific Northwest Region, Portland, Oregon. [EIS-OR-124C-F].

Emerson, J.L. et al. 1970. Teratogenic study of 2,4,5-trichlorophenoxyacetic acid in the rat. Toxicol. Appl. Pharmacol. 17:317.

Emery, K.O. 1956. Marine geology of Johnston Island and its surrounding shallows, central Pacific Ocean. Geol. Soc. Amer. Bull. 67:1505.

Emery, K.O. 1955. Transportation of rocks by driftwood. J. Sediment. Peterology. 25:51.

Environmental Protection Agency. 1972. Water Quality Standards. Criteria Digest (August), Washington, D.C.

Environmental Protection Agency. 1973. Guidelines for preparation of environmental statements. EPA Region X, Seattle, Wash.

Erne, K. 1966. Distribution and elimination of chlorinated phenoxyacetic acids in animals. Acta. Vet. Scand. 7:240.

Food and Drug Administration. 1972. Pesticide Analytical Manual, V.I, Methods Which Detect Multiple Residues. FDA, U.S. Dept. of HEW, Washington, D.C.

Fosberg, F.R. 1949. Flora of Johnston Island, central Pacific. Pac. Sci. 3:338.

Fox, A.S. et al. 1970. Restricting the use of phenoxy herbicides USDA Agricultural Economic Rept. No. 194.

Gehring, P.J. et al. 1973. The fate of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) following oral administration. Toxicol. Appl. Pharmacol. 26:352.

Gleason, M.N. et al. 1969. Clinical toxicology of commercial products. 3rd ed. Williams & Wilkins, Baltimore, Md.

Goelitz, D.F. and W.L. Lamar. n.d. Determination of phenoxy acid herbicides in water by electron capture and microcoulometric gas chromatography. USGS WSP-1817-C. Draft copy. U.S. Geological Survey, Washington, D.C.

Goldberg, L. 1971. Trace chemical contaminants in food: Potential for harm. Food Cosmet. Toxicol. 9:65.

Gosline, W.A. 1955. The inshore fish fauna of Johnston Island, a central Pacific atoll. Pac. Sci. 9:442.

Goulding, R.L. 1973. Waste pesticide management. Final Narrative Report. Environmental Health Sciences Center. Oregon State Univ., Corvallis.

Gratkowski, H., D. Hopkins, and P. Lauterbach. 1973. The Pacific Northwest region. J. Forestry. 71:318.

Henderson, R.S. and E.C. Evans, III. 1973. Continuous flow marine organism holding tanks: A proposed joint NUC/HIMB project for marine biological and environmental studies. NUC TN 1123. Naval Undersea Center, San Diego, Calif.

HAC--Herbicide Assessment Commission. 1972. Background Material Relevant to Presentations at the 1970 Annual Meeting of the AAAS and Preliminary Report of the Herbicide Assessment Commission; both reprinted in Congressional Record 118(32): S3226-3233 March 3, 1972.

Lauterback, P. 1967. Chemical weeding and release of conifers in western Oregon and Washington. Symposium Proceedings: Herbicides and vegetation management, Oregon State Univ. Corvallis, Oreg.

Leopold, A.D., P. Van Schaik, and M. Neal. 1960. Molecular structure and herbicide absorption. Weeds. 8:48.

Lutz, J.F., G.E. Byers, and T.J. Sheets. 1973. The persistence and movement of picloram and 2,4,5-T in soils. J. Environ. Quality. 2:485.

Manigold, D.B. and J.A. Schulze. 1969. Pesticides in selected western streams--a progress report. Pestic. Monit. J. 3:124.

Marshall, J. 1825. Royal Navy biography, V. IV. Gorman Pub. Co., London, England.

Matsumura, F. and J.H. Benezet. 1973. Studies on the bioaccumulation and microbial degradation of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Environ. Health Perspect. No. 5:253.

Metcalf, L.D. and A.A. Schmitz. 1961. The rapid preparation of fatty acid esters for gas chromatographic analysis. Anal. Chem. 33:363.

Miller, S.S. 1974. Emerging technology of chlorinolysis. Environ. Sci. Technol. 8:18.

Mitchell, J.W. et al. 1946. Tolerance of farm animals to feed containing 2,4-D. J. Animal Sci. 5:226.

Montgomery, M.L. and L.A. Norris. 1970. A preliminary evaluation of the hazards of 2,4,5-T in the forest environment. USDA Forest Service Research Note PNW-116.

National Primary and Secondary Ambient Air Quality Standards for Carbon Monoxide. 40 CFR 50.8, 36 FR 22384, 25 Nov 71; as amended by 38 FR 25678, 14 Sep 73.

Navy Hydrographic Office. a. 1959. Johnston Island and Reef. H.O. Chart 5356. U.S. Navy, Washington, D.C.

---- b. 1959. Sailing directions for the Pacific islands, V.III, The south-central groups. 6th ed. H.O. Publn. 80, Change 12. U.S. Navy, Washington, D.C.

Navy Public Works Office. 1964. Long term land management plan, Johnston Island. 14th Naval District, Pearl Harbor, Oahu, Hawaii.

Nishimura, H. and S. Miyamoto. 1969. Teratogenic effects of sodium chloride in mice. Food Cosmet. Toxicol. 7:415.

Norris, L.A. 1970. Degradation of herbicides in the forest floor. P. 527, Tree growth and forest soils. Ed. by C.T. Youngberg and C.B. Davey, Oregon Univ. Press, Corvallis.

O'Connor, G.A. and P.J. Wierenga. 1973. The persistence of 2,4,5-T in greenhouse lysimeter studies. Soil Sci. Soc. Amer. Proc. 37:398.

Odum, E.P. 1971. Fundamentals of ecology. W.B. Saunders, Philadelphia, Pa.

House, W.B. *et al*. 1967. Assessment of ecological effects of extensive or repeated use of herbicides: Final report. Midwest Research Inst., Kansas City, Mo. AD824,314.

---- 1967. Phenoxy herbicide residues and their persistence. Midwest Research Institute, Kansas City, Mo. [AD 726367].

Innes, J.R.M. *et al* 1969. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: A preliminary note. *J. Natl. Cancer Inst.* 42:1101.

Johnson, J.E. 1970. Symposium on possible public health implications of widespread use of pesticides. Amer. Inst. of Biological Sciences, Bloomington, Ind.

Joint Hazards Evaluation Group. 1972. An evaluation of hazards to Island and transient personnel as associated with RED HAT stores and aircraft operations on Johnston Atoll. (Jul 72).

Joint Task Force Seven. 1959. A Johnston Island climatological study. Meteorological Center, Pearl Harbor, Hawaii.

Kalter, H. and J. Warkaney. 1959. Experimental production of malformations in mammals by metabolic procedures. *Physiol. Rev.* 39:69.

Kearney, P.C., E.A. Woolson, and C.P. Ellington, Jr. 1972. Persistence and metabolism of chlorodioxins in soils. *Environ. Sci. Technol.* 6:1017.

Khanna, S. and S.C. Fang. 1966. Metabolism of C^{14}-labeled 2,4-dichlorophenoxyacetic acid in rats. *J. Agr. Food Chem.* 14:500.

King, C.T.G. *et al*. 1971. Screening of the herbicides 2,4,5-T and 2,4-D for cleft palate production. *Teratology*. 4:233.

Kinne, O. 1970. *Marine ecology*, V.1. Wiley-Interscience, New York, N.Y.

Kirch, J.H. 1967. Special herbicide combination for rights-of-way brush control. Symposium Proceedings Herbicides and Vegetation Management, Oregon State Univ., Corvallis, Oreg.

Klingman, D.L. and W.C. Shaw. 1967. Using phenoxy herbicides effectively. USDA Farmer's Bull. No. 2183, GPO, Washington, D.C.

Klingman, D.L. *et al*. 1966. Residues in the forage and in milk from cows grazing forage treated with esters of 2,4-D. *Weeds*. 14:164.

Kopenski, R.P. and M.P. Wennekens. 1966. Circulation patterns Johnston Atoll, winter-summer 1965. Office of Naval Research, Spec. Pub. 93:1-240.

Langer, H.G. 1973. The formation of dibenzodioxins and other condensation products from chlorinated phenols and derivatives. *Environ. Health Perspect.* No. 5:3.

Palm, C.E. et al. 1968. Principles of plant and animal pest control, V.2 Weed control. Natl. Academy of Sciences, Washington, D.C. Publn. 1597.

Palmer, J.S. 1963. Chronic toxicity of 2,4-D alkanolamine salts to cattle. J. Amer. Vet. Med. Ass. 143:398.

Palmer, J.S. and R.D. Radeleff. 1964. The toxicologic effects of certain fungicides and herbicides on sheep and cattle. Ann. N.Y. Acad. Sci. 111:729.

Penfound, W.T. and V. Minyard. 1947. Relation of light intensity to effects of 2,4-dichlorophenoxyacetic acid on water hyacinth and kidney bean plants. Bot. Gaz. 109:231.

Petero, S.U. and M. Strassburg. 1969. Stress als teratogener faktor. Arzeim. Forsch. 19:1106.

Pimentel, D. 1971. Ecological effects of pesticides on non-target species. Govt. Printing Office, Washington, D.C.

POBSP--Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C. [unpublished report]:

1964. Staff. Preliminary biological survey of Sand Island, Johnston Atoll.

Program/Budget Decision 282. 1969. Transfer of Johnston Atoll. (10 Dec 69).

Pursely, P.L. and E.D. Schall. 1965. Gas chromatographic determination of 2,4-D and 2,4,5-T and their derivatives in commercial formulations J. Ass. Offic. Anal. Chem. 48:327.

Radeleff, R.D. 1964. Veterinary toxicology. Lea & Febiger, Philadelphia, Pa., p. 242.

Redfield, A.C. and L.A. Walford. 1951. A study of chemical wastes at sea. Publ. No. 201, National Academy of Science, National Council.

Rowe, V.K. et al. n.d. Toxicology of chlorinated dibenzo-p-dioxins. Biochemical Research Lab, Dow Chemical Co., Midland, Mich.

St. John, L.E., Jr., D.G. Wagner, and D.J. List. 1964. Fate of Atrazine, Kuron, Silvex and 2,4,5-T in the dairy cow. J. Dairy Sci. 47:1267.

Sanders, H.O. 1970. Toxicities of some herbicides to six species of freshwater crustaceans. J. Water Pollut. Contr. Fed. 42:1544.

Schultz, D.P. 1973. Dynamics of a salt of (2,4-dichlorophenoxy)acetic acid in fish, water and hydrosol. J. Agr. Food Chem. 21:186.

Schwetz, B.A. et al. 1973. Toxicology of chlorinated dibenzo-p-dioxins. Environ. Health Perspec. No. 5:87.

Sec Def--Secretary of Defense. 1969. Memorandum for Secreatry of Air Force: Nuclear Readiness to Test. (30 Oct 1969).

---- 1970. Memorandum for Director, Defense Nuclear Agency: Readiness to Test. (27 Apr 1970).

---- 1970. Memorandum for Secretary of the Air Force and Director, Defense Atomic Support Agency: Operation RED HAT, Phase II Johnston Island. (3 Dec 70).

Seckel, G.R. 1962. Atlas of the oceanographic climate of the Hawaiian Islands region. Fishery Bulletin. 193:371.

Shelton, P.C. ms., in prep. The natural history of Johnston Atoll, central Pacific Ocean. Atoll Res. Bull.

Shennan, J.L. and W.W. Fletcher. 1965. The growth *in vitro* of microorganisms in the presence of substituted phenoxyacetic and phenoxybutric acids. Weed Res. 5:226.

Smith, A.E. 1972. The hydrolysis of 2,4-dichlorophenoxyacetate esters to 2,4-dichlorophenoxyacetid acid in Saskatchewan soils. Weed Res. 12:364-372.

Smith, D.D. and R.P. Brown. 1971 Ocean disposal of barge-delivered liquid and solid wastes from U.S. coastal cities. PHS Publn. 2113. Govt. Printing Office, Washington, D.C.

Sorg, T.J. and H.L. Hickman. 1968. Sanitary landfill facts. Public Health Svc. Publn. 1792. Govt. Printing Office, Washington, D.C.

Sparschu, G.L. et al. 1970. Teratogenic study of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin in the rat. Toxicol Appl. Pharmacol. 17:317.

Stahl, Q.R. 1969. Air pollution aspects of hydrochloric acid. Litton Systems, Inc., Bethesda, Maryland. Available from Clearinghouse for Federal Scientific and Technical Information, Springfield, Va, Publication PB188067.

Stanley, C.W. 1966. Derivatization of pesticide-related acids and phenols for gas chromatographic determination. J. Agr. Food Chem. 14:321.

Sterling, T.D. 1971. Difficulty of evaluating the toxicity and teratogenicity of 2,4,5-T from existing animal experiments. Science 174:1358.

Stojanovic, B.J., M.V. Kennedy, and F.L. Shuman. 1972. Edaphic aspects of the disposal of unused pesticides, pesticide wastes, and pesticide containers. J. Environ. Quality. 1:54.

Stojanovic, B.J., M.V. Kennedy, and W.C. Shaw. 1972. Technical report on thermal decomposition of Orange herbicides. Miss. Agricultural and Forestry Exp. Sta. and Plant Science Research Div. of USDA. Miss. State Univ., State College, Miss.

Suskind, Raymond. 1973. Chloroacne and associated problems. Paper presented at Natl. Inst. of Environ. Health Sciences Conf. on Chlorinated Dibenzodioxins and Dibenzodifurans, Research Triangle Park, N.C.

Thiesen, P.A. 1967. Chemical weeding and release of conifers in southwestern Oregon. Symposium Proceedings: Herbicides and vegetation management, Oregon State Univ., Corvallis, Oreg.

Thomas, T.C. and J.N. Seiber. In press. Evaluation of Chromosorb 102 as a medium for trapping pesticides from air. *Bull. Environ. Contam. Toxicol*, accepted for publication August 1973.

Thorp, T.E. 1960. Johnston Island, a library brochure. Prepared for the Pacific Missile Range. Dept. Geog., Univ. Calif., Riverside.

U.S. Air Force. 1968. Purchase Description No. AFPID, 23 Feb 68.

U.S. Air Force. 1968. Purchase Description No. AFPID 6840-1, Amend. 1, 11 Apr 68.

U.S. Army. 1969. Herbicides used in Southeast Asia. Rept. No. SAOQ-TR-69-11078. Plant Sciences Lab, Fort Detrick, Md. (Contract #FD-2050-9-11078).

U.S. Army. 1973. Ocean dumping in the New York bight: an assessment of environmental studies (by George Pararas-Carayannis). Technical Manual No. 39. U.S. Army, Corps of Engineers, Coastal Engineering Research Center.

U.S. Dept. of Agr. 1970. Report and tables on domestic use of a 2,4,5-T, 1964 and 1966. Production Resources Branch, Farm Production Economics Div., USDA.

---- 1972. *Thermal decomposition of Orange herbicides*. Miss. Agricultural and Forestry Experimental Station and Plant Science Research Div, USDA. Cooperative Agreement No. 12-14-100-10, 673(34).

U.S. Dept. of Commerce, Environmental Data Service. 1972. Local climatological data, annual summary with comparative data, Johnston Island, Pacific. National Climatic Center, Asheville, N.C.

USAF EHL(K)--USAF Environmental Health Laboratory, Kelly AFB. a. 1973. Letter regarding ARL analyses for BTU content of Gulfport Orange herbicide stocks. (12 Oct 73).

---- b. 1973. Statistical presentation of the results of analysis for dioxin concentrations found in Orange herbicide analyses performed by Dow Chemical Co. Unpublished data. USAF EHL(K), Kelly AFB Texas.

USAF Histories, Pacific Air Forces Base Command, 1959-1963.

USAF RPL--USAF Rocket Propulsion Lab. 1972. Contract No. F0-4611-72-C-0087.

USDHEW--U.S. Dept. of Health, Education and Welfare. 1969. Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health. Govt. Printing Office, Washington, D.C.

Walker, C.M. 1973. Rehabilitation of forest lands. J. Forestry 71:136.

Walsh, G.E. 1972. Effects of herbicides on photosynthesis and growth of marine unicellular algae. Hyacinth Cont. J. 10:45.

Wennekens, M.P. 1969. Johnston Island regional oceanography, Section 6. Office of Naval Research, San Francisco, Calif.

Wetmore, A. ms. a. Field notes, 1923. Smithsonian Institution, Washington, D.C.

---- b. A scientific survey of Johnston Island, 1923. [prepared in 1963]. Smithsonian Institution, Washington, D.C.

Willis, G.H. et al. 1969. Pesticides in air: A system for monitoring atmospheric concentrations of field-applied pesticides. Pestic. Monit. J. 3:172.

Woolson, E.A. et al. 1972. Survey of polychlorodibenzo-p-dioxin content in selected pesticides. J. Agr. Food Chem. 20:351.

Worne, Howard E. 1972. The activity of mutant microorganisms in the biological treatment of industrial wastes. Paper presented at Aqua Sana Lenebeurs van Vlaanderen, Ghent, Belgium.

WSSA--Weed Science Society of America. 1970. Herbicide handbook of the Weed Science Society of America. 2nd ed. Univ. of Ill., Urbana, Ill.

Young, A.L., ed. 1974. Ecological studies on a herbicide-equipment test area Eglin AFB Reservation, Fla. AFATL-TR-74-12.

Young, A.L. et al. 1974. The ecological consequences of massive quantities of 2,4-D and 2,4,5-T herbicides--summary of a five year field study. Presentation to the Weed Science Society of America, Las Vegas, Nev.

Young, A.L., E.L. Arnold, and A.M. Wachirski. 1974. Field studies on the soil persistence and movement of 2,4-D, 2,4,5-T and TCDD. Presentation to the Weed Science Society of America, Las Vegas, Nev.

Zielinski, W.L., Jr. and L. Fishbein. 1967. Gas chromatographic measurement of disappearance rates of 2,4-D and 2,4,5-T acids and esters in mice. J. Agr. Food Chem. 15:841.

Zinkl, J. et al. 1973. Hematological and clinical chemistry effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin in laboratory animals. Environ. Health Perspect. No. 5:111.