CANDIDATE ENVIRONMENTAL

IMPACT STATEMENT

DISCHARGING AQUEOUS FILM FORMING FOAM (AFFF)

TO HARBOR WATERS DURING TESTS OF

MACHINERY SPACE FIRE-FIGHTING FOAM SYSTEMS

ABOARD U.S. NAVY SHIPS

JANUARY 1978

DEPARTMENT OF THE NAVY
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
HEADQUARTERS
BETHESDA, MARYLAND 20034

ANNAPOLIS LABORATORY
ANNAPOLIS, MD 21402
CARDEROCK LABORATORY
BETHESDA, MD 20034

IN REPLY REFER TO:
286:CSA
9593
2863-515
15 OCT 1976

From: Commander, David W. Taylor Naval Ship R&D Center
To: Commander, Naval Ship Engineering Center (SEC 6159)

Subj: Candidate Environmental Impact Statement (Draft) on Discharging Firefighting System Aqueous Film Forming Foam (AFFF) into Harbors; Status and Synopsis of

Ref: (a) DTNSRDC RDT&E Work Unit Summary 2863-514, AFFF Harbor Dispersion Study, of 1 June 1975

1. Preparation of a draft Candidate Environmental Impact Statement (CEIS) on the discharge of AFFF from naval ships testing their machinery space firefighting foam generating systems in port (the proposed action) will be completed by 30 October 1976. Difficulties obtaining adequate information for the preparation of the CEIS have been encountered. These include the lack of information on components of 3M Company FC206 AFFF concentrate (which is proprietary), the unavailability of data on the quantities of AFFF generated both aboard ships during system testing and in each port facility and the frequency of such generation, the wide variation in the environmental conditions at naval port facilities which makes generalization of existing site characteristics very difficult, and the limited data available for predicting the rates of dispersion and assimilation of AFFF discharges into the harbors.

2. The above problems have been solved on the basis of information obtained from the sources listed below, and of the stated assumptions.

a. As stated, the 3M Company has not provided any useful information about the components of FC206. However, estimates of composition have been made by the U. S. Air Force, and results of various tests indicate that FC206 is nearly 100% biodegradable. Waste streams containing FC206 have also been successfully treated by conventional activated sludge techniques in concentrations of 200 to 1000 mg/l with sewage although foaming problems were not considered.

b. The quantities of AFFF that could be generated in Navy ports were estimated on the basis of operational experience of the Fire Fighting Assistance Team (FFAT), known equipment characteristics, and ship location information. The numbers and types of ships in each Navy homeport were listed. Using the number of AFFF machinery space systems aboard each ship and the conclusion that one-sixth of all system tests are conducted in port, the quantity of AFFF that could be generated per year for each port was calculated. Twelve Navy ports discharge 90% of the potential yearly total (the remaining ports discharge less than 30 gallons of AFFF concentrate per year).

c. The U. S. Navy Hydrographic Office (now NAVOCEANO) from 1959 through 1963 conducted studies of the relative flushing capabilities of eighteen harbors. Nine of these harbors are included in the 12 Navy ports with the highest potential AFFF discharge volume. It was possible to construct hypothetical examples of the worst case AFFF discharge for 9 ports and predict the rate of decrease of AFFF concentration in the discharge area based upon existing data. (Use of these data reduced the estimated project cost from $125K to $60K.)

3. Alternatives to the proposed action were investigated. These included utilization of an alternative nontoxic concentrate for tests; revising or refining test procedures to reduce the volume of discharge; rescheduling tests for discharge to pierside sewers, collection barges or open sea; performing tests with AFFF discharge contained as part of a closed system; redesigning shipboard maintenance plans to eliminate flow test; and enhancement of system component reliability to eliminate requirements for flow test. The alternatives as well as the proposed action were evaluated to determine the operationally and environmentally most acceptable alternatives.

4. A CEIS does not give specific conclusions or recommendations concerning a proposed action. It details the effects on the human environment of an action and of its alternatives. In a draft statement, an alternative may be favored. Also discussed are considerations that offset the adverse environmental effects of the proposed action.

5. The content of the CEIS can be summarized as follows. The preferred approach in the statement in preparation is continuation of current practice: discharging minimum quantities of AFFF into the waters of those harbors where collection and treatment or disposal of test effluent is not now practiced. Procedures are now available and are often used that both minimize the quantity of effluent generated and eliminate foaming of the discharge. Some Navy port facilities, on their own initiative, are evaluating procedures for collecting AFFF discharges in shipboard wastewater collection, holding and transfer (CHT) systems for transfer to pierside sanitary sewers or waste collection barges. A recommended

—049 — Paul Smith

286:CSA
9593
2863-515

minor modification of test procedures and effluent collection equipment, if coinciding with the Ship-to-Shore Sewage Transfer Program, could potentially eliminate AFFF discharges to harbor waters in major ports by calendar year 1981.

H. H. Singerman

H. H. SINGERMAN
By direction

Copy to:
NAVSEA (SEA 0492P)

A003774

CANDIDATE ENVIRONMENTAL IMPACT STATEMENT

DISCHARGING AQUEOUS FILM FORMING FOAM (AFFF) TO HARBOR WATERS DURING TESTS OF MACHINERY SPACE FIRE-FIGHTING FOAM SYSTEMS ABOARD U.S. NAVY SHIPS

January 1978

Prepared by the David W. Taylor Naval Ship Research and Development Center for the Naval Sea Systems Command in accordance with OPNAVINST 6240.3D in compliance with Section 102(2)(c) of the National Environmental Policy Act of 1969

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND SYMBOLS

AFFF - aqueous film forming foam

ASAP - as soon as possible

AvGas - aviation gasoline

BOD - biochemical oxygen demand

BOD_5 - five-day biochemical oxygen demand

BOD_u - ultimate biochemical oxygen demand

°C - degree Celsius

CEIS - candidate environmental impact statement

CHT - collection, holding and transfer (tanks aboard ship)

cm^3 - cubic centimetre

CNM - Chief of Naval Material

COD - chemical oxygen demand

DO - dissolved oxygen

FC-200 - type of "Light water" AFFF, 3M Company

FC-206 - type of "Light water" AFFF, 3M Company

FFAT - fire-fighting assistance team

FP-180 - water motor proportioner for mixing fire fighting foam concentrate with sea water

ft - foot

FWPCA - Federal Water Pollution Control Act

g - gram

gal - gallon

gpm - gallon per minute

HCFF - high capacity fog foam

JP-4	- Navy aircraft fuel
JP-5	- Navy aircraft fuel
ℓ	- litre
LC_{50}	- concentration of a toxic substance that will kill 50 percent of test organisms within a specified time period
ℓ/s	- litre per second
m	- metre
m^3	- cubic metre
mg	- milligram
mg/ℓ	- milligram per litre
NAVFAC	- Naval Facilities Engineering Command
NAVFACWESTDIV	- Naval Facilities Engineering Command, Western Division
NAVOCEANO	- Naval Oceanographic Office
NAVSEA	- Naval Sea Systems Command
NAVSEC	- Naval Ship Engineering Center
NCBC	- Naval Construction Battalion Center
NFPA	- National Fire Protection Association
NPDES	- National Pollution Discharge Elimination System
NRL	- Naval Research Laboratory
NSC	- Naval Safety Center, Norfolk, Virginia
pH	- negative logarithm of the hydrogen ion concentration
PKP	- potassium bicarbonate powder
PMS	- preventive maintenance schedule

ppb	-	part per billion (1×10^{-9})
ppm	-	part per million (1×10^{-6})
SHIPALT	-	ship alteration
SWOB	-	ship waste off-load barge
TC	-	total carbon
TDS	-	total dissolved solids
TSS	-	total suspended solids
3M	-	Minnesota Mining and Manufacturing Company
$\mu\ell/\ell$	-	microlitres per litre

CEIS PREPARATION COST ESTIMATES

The following estimate of preparation costs for this document against the catagories identified below are listed in accordance with OPNAVINST 6240.3D, paragraph 4302b.

1. Salaries of military and civilian personnel. $30K.

2. Associated travel costs. None.

3. Directly associated research costs. $4.4K.

4. Contract and consultant costs directly related. $22.3K.

5. Indirect but related costs. $1.3K.

6. Administrative costs. $2K.

7. Costs of public hearings. None.

SECTION 1

SUMMARY

1. This is a Candidate Environmental Impact Statement (CEIS).

2. Title: Discharging Aqueous Film Forming Foam (AFFF) to Harbor Waters During Tests of Machinery Space Fire-Fighting Foam Systems Aboard U.S. Navy Ships.

Action: Administrative.

3. Action Description: Regular in situ testing of AFFF fire-fighting systems aboard ship is imperative in the interest of personnel safety and material protection. Each test of a machinery space system generates approximately 90 gal (0.34 m^3) of AFFF at a concentration of 3.5 to 6 percent in sea water. Containment and disposal of AFFF test mixtures is difficult due to design configuration, foaming, or the unavailability of containment vessels. Therefore, AFFF is discharged overboard as it is produced.

a. All AFFF fire-fighting equipment that is newly installed, repaired, altered or converted from protein foam by an industrial activity is tested to insure proper operation and required output.

b. All AFFF fire-fighting equipment is tested on a six-month PMS.

Location: AFFF fire-fighting equipment is tested aboard naval ships located in 33 ports in the continental United States and Hawaii and in 6 naval shipyards servicing surface ships. Approximately 90 percent of the AFFF discharged is produced at naval installations in the following 10 locations.

San Diego, California

Norfolk (Naval Base), Virginia

Charleston, South Carolina

Honolulu (Pearl Harbor), Hawaii

Philadelphia, Pennsylvania

Mayport, Florida

Norfolk (Little Creek Amphibious Base), Virginia

Long Beach, California

Bremerton (Puget Sound), Washington

Alameda, California

4. Environmental Impact:

a. Air - no impact.

b. Navigable waters.

(1) Physical, chemical, biological.

(a) Discharge into harbors with inadequate natural mixing may result in localized areas of chemicals concentration - initial dilution and dispersion rapidly reduce chemicals concentration.

(b) Chemicals interaction with other contaminants already in the harbor is unknown - the possible effects of AFFF are reduced by discharging limited quantities and by rapid dilution.

(c) Certain concentrations of AFFF are toxic to marine organisms - the toxicity of AFFF has been determined, and the concentration of AFFF in harbor waters after discharge is well below acute toxic levels.

(d) The BOD of AFFF is very high - the BOD and COD of AFFF are nearly equal, indicating that the substance is nearly 100% biodegradable.

c. Socioeconomic - Port areas are normally associated with industrial activity and are not used for commercial fishing or recreation. The discharge of limited quantities of AFFF will have no socioeconomic affect on the port area.

d. Aesthetic - Testing with the recommended non-foaming nozzles will eliminate unsightly foam on the water surface previously associated with AFFF discharges.

5. Alternatives:

a. Test with substitute concentrate material.

b. Redefine test procedures to reduce discharge volume.

c. Adjust test schedules for discharge only when collection, treatment, and disposal facilities are available.

d. Perform tests with discharge contained as part of a closed system.

e. Eliminate shipboard flow test by redesigning maintenance plan.

f. Eliminate shipboard flow test by enhancing system component performance reliability.

g. Preferred Approach - Discharge minimum quantities of AFFF into harbors where collection and treatment or alternate disposal of test effluent is not now practiced. Gradually eliminate discharge by utilizing collection, treatment, and disposal facilities now being constructed as they become available for service.

6. Environmental Significance

a. This statement concludes that the impact of the proposed action on the environment will not be environmentally significant. Given the low volumes of AFFF discharged, the infrequency of the discharge, and the rapid dilution that takes place in the receiving water, the proposed action should not be environmentally controversial when considered with the criticality of the fire protection function aboard ship. The environmental impact will be further reduced as adequate facilities for collection, treatment, and disposal of AFFF test effluents become available for service.

SECTION 2

INTRODUCTION

1. Project Description

Proposed Action: Discharge Aqueous Film Forming Foam (AFFF) to Harbor Waters During Tests of Machinery Space Fire-Fighting Foam Generation Systems Aboard U.S. Navy Ships.

a. Each surface ship of the Navy is equipped with a fire-fighting system with a capacity and state-of-readiness to combat and extinguish fires within the range of severity which could occur as a result of normal day-to-day operations or offensive or defensive combat incidents.

b. Criticality of the fire protection function dictates that equipment and fire-fighting crews be exercised on a regular basis as part of the maintenance program. A naval message from Commander, NAVSEA 0945D, appendix A, requires, "All AFFF fire-fighting equipment that is newly installed, repaired, altered or converted from protein foam by an industrial activity shall be tested to insure proper operation and required output." The message states that the following procedures be observed when testing AFFF hoses.

(1) The minimum acceptable concentration of AFFF in the output mixture of the system is 3.5 percent.

(2) The foam should be generated for one minute before sampling. After the sample has been taken, the system should be secured ASAP to avoid excessive use of AFFF concentrate.

(3) If the only work done on a system was on the foam generator (proportioner or pump), then only one hose shall be tested with AFFF to verify foam generator performance. One and one-half inch variable flow nozzles shall be tested at 95 gpm (6 ℓ/s) in machinery spaces and 125 gpm (7.9 ℓ/s) in hangar bays or flight decks. Two and one-half inch variable flow nozzles should be tested at 250 gpm (15.8 ℓ/s).

(4) The above requirements apply, and the systems shall be tested and certified in port prior to ship trial runs, for testing of the machinery space AFFF fire-fighting system aboard active ships and new construction.

c. Critical areas of greatest fire potential (such as machinery spaces, hangar and flight decks, weapons elevators, and helicopter landing areas) are protected by fire-fighting foam generation equipment that employ AFFF as the extinguishing agent.

2. Background

a. Many fire-fighting formulations have been evaluated for efficiency and safety. Because oil floats on water, the application of water on an oil fire could spread the flaming oil, but by generating and applying a foam, an oil fire could be extinguished by smothering the flames. A protein-based "mechanical foam" was developed that, when mixed with water and air, would spread over the surface of an oil fire and prevent the vapors from escaping, mixing with air and burning. However, protein foam has the disadvantage of being fragile. If the foam blanket is disturbed and broken, volatile vapors could escape and a flashback could occur. In a congested machinery space, it is likely that with the movement of firefighters and their equipment, this could occur.[1]

b. AFFF was developed in the mid-1960's. It has the advantage of producing a more rugged vapor sealing blanket than protein foam. It can be vigorously sprayed on a fire and a vapor barrier would remain intact in foot traffic. The active ingredient in AFFF is fluorocarbon surfactant. Fluorocarbon surfactants function as effective vapor securing agents based upon their outstanding effect in reducing the surface tension of water and of their controllable oleophobic and hydrophilic properties, and on their chemical stability. Thus, the physical properties of water can be controlled so that it can foam, float, spread across and remain on the surface of a hydrocarbon fuel even though water itself is denser than the fuel. The term "light water" was based upon those properties. "Light water" appeared in several early military specifications defining the properties of this class of agents. The NFPA later adopted the term "aqueous film forming foam" to refer to fluorocarbon surfactant-based fire-fighting agents. The term "light water" has become associated with the fire-fighting products of the 3M Company.[1]

---

[1]Superscripts refer to similarly numbered entries in Section 10, References.

c. To improve shipboard protection against fires, the Navy is converting all protein foam generating fire-fighting equipment aboard ship to AFFF.[2] The AFFF concentrate specified for use in testing fire-fighting systems must conform to MIL-F-24385 (Military Specification Fire Extinguishing Agent, Aqueous Film Forming Foam (AFFF) Liquid Concentrate, Six Percent, for Fresh and Sea Water, Amendment 2, 25 June 1970). Approved AFFF concentrate (Light Water® FC-206, manufactured by 3M Company) is obtained from the Federal Supply under NSN-9C-4210-00-087-4742 for 5 gal (19 ℓ) containers and NSN-9C-4210-00-087-4750 for 50 gal (190 ℓ) drums.

d. A common type of AFFF currently used aboard naval ships is Light Water FC-200 manufactured by 3M Company. The stocks of FC-200 are gradually being replaced by FC-206. A comparison of various parameters of AFFF's are contained in appendix B. The constituents of the AFFF formulas are trade secrets and have not been disclosed to the Navy.

e. By design, the fire-fighting mixture should consist of 94% firemain water and 6% AFFF concentrate. However, acceptance test criteria allow for a mixture to contain, as a minimum, 3 1/2% AFFF concentrate. Considering the test use of a 1 1/2 inch nozzle at 90 gpm (5.7 ℓ/s), an output of from 3.15 gal (11.9 ℓ) to 5.4 gal (20.4 ℓ) of the AFFF concentrate could be discharged overboard during each minute of the test. Since the ship would not be moving at the time of

®Light Water - Registered Trademark, 3M Company.

effluent discharge, its dispersion would be totally dependent upon the initial dilution of the discharge and diffusion due to local tidal movements, current flow, etc.

f. The foam proportioning equipment installed aboard Navy ships for machinery space fire control in most cases is the FP-180 foam proportioner. A description of the FP-180 and a diagram of a typical permanent installation in contained in appendix C.

g. The FP-1000 foam proportioner and the AFFF Two Speed Injection Pump are often installed in ship hanger bays and on flight decks. These highflow systems are not installed in machinery spaces and will not be tested in port (see section 3.a.(2)). Therefore, they will not be discussed further.

3. <u>Site Characteristics</u>

a. Obligatory in-port testing of AFFF fire-fighting systems is required after work on the system and during regular PMS testing:

(1) The message in appendix A states, "All AFFF fire-fighting equipment that is newly installed, repaired, altered or converted from protein foam by an industrial activity shall be tested to insure proper operation and required output." For the purpose of this statement an "industrial activity" is defined as a facility at which the construction, conversion, or repair of ships is accomplished. Most industrial activity aboard Navy surface ships is done at the six naval shipyards listed below:

Activity		City State
Naval Shipyard:	Philadelphia	Philadelphia, PA
Naval Shipyard:	Norfolk	Portsmouth, VA
Naval Shipyard:	Charleston	Charleston, SC
Naval Shipyard:	Long Beach	Long Beach, CA
Naval Shipyard:	Puget Sound	Bremerton, WA
Naval Shipyard:	Pearl Harbor	Honolulu, HI

(2) All AFFF fire-fighting equipment is also tested on a six-month PMS. For the purpose of this CEIS, it is assumed that regular PMS testing of non-machinery room AFFF system can be delayed until the earliest opportunity when a ship is underway in unrestricted waters. AFFF generated by these system tests can then be discharged directly overboard. However, the criticality of machinery room AFFF systems for personnel safety and material protection makes it imperative that these systems be tested at regular intervals (according to ship PMS) even though a ship may be in port. AFFF generated during in-port PMS testing is discharged overboard. Generation rates are based upon unclassified information about U.S. Navy commissioned surface ship inventories on a homport basis.[3] The relative locations of U.S. Navy homeports are shown in figure 2-1. Estimates of the quantity of AFFF discharged overboard in each Navy port are given in table 4-4. The ports are ranked based upon the estimated quantity of AFFF discharged during in-port testing. Estimates of newly installed, repaired, altered or converted AFFF systems

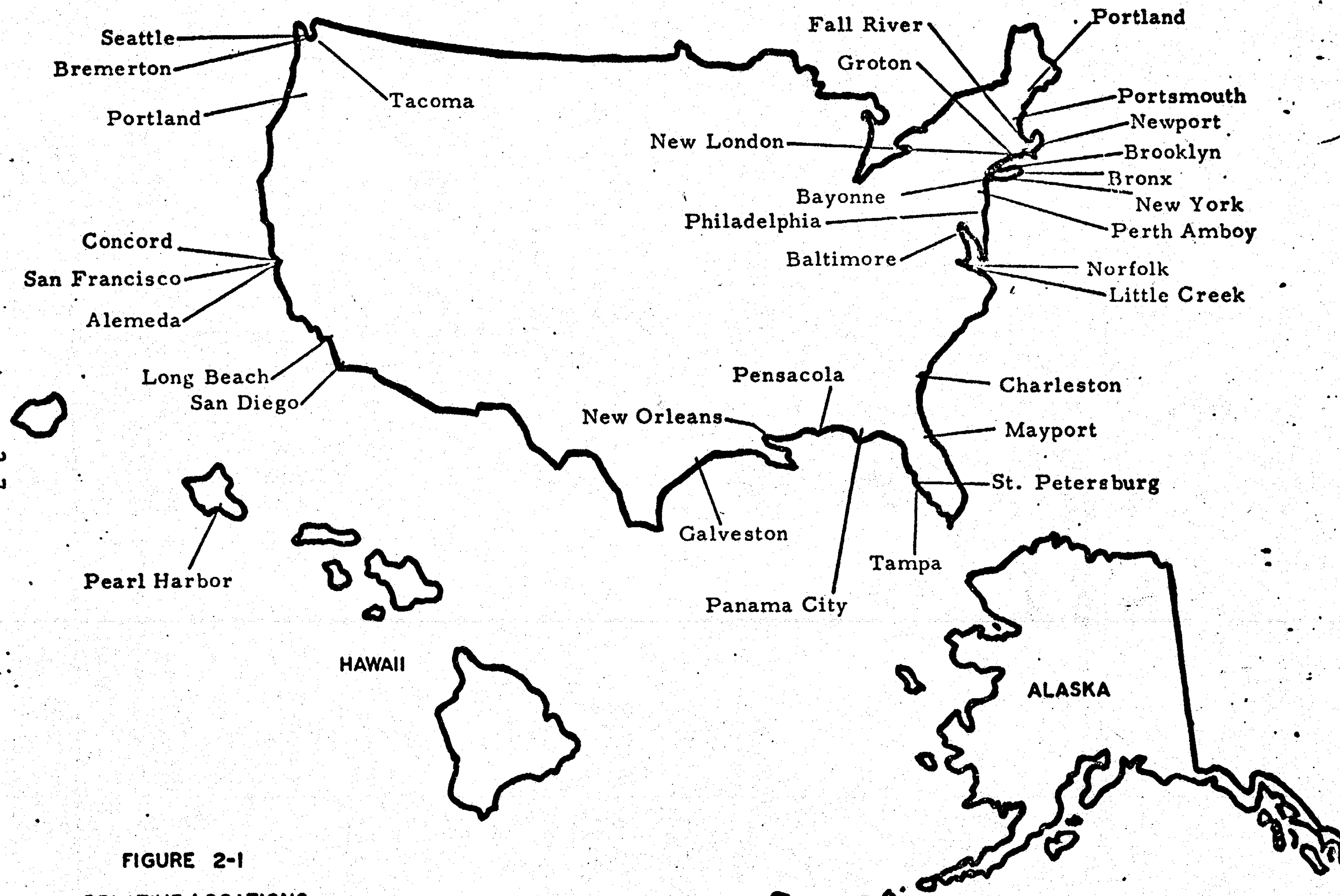


FIGURE 2-1

RELATIVE LOCATIONS OF U.S. NAVY PORTS

are added onto port totals for PMS testing only when alternatives to direct discharge disposal procedures are not practiced (see table 4-2). Approximately 90 percent of the AFFF discharged is generated in the ten ports listed in table 2-1. The annual discharges in each of the remaining ports are estimated at less than 32 gal (0.12 m^3) of AFFF concentrate per year. These quantities can be considered negligible.

Table 2-1
Summary of Estimated Volumes of AFFF
Discharged Overboard in Navy Ports Per Year
During Testing of Machinery Space Fire-Fighting Systems

Port Location	6% AFFF gal (m^3)	Concentrate AFFF gal (m^3)
San Diego, CA	9480 (35.88)	568.8 (2.12)
Norfolk (Naval Station), VA[(a)]	7770 (29.41)	466.2 (1.76)
Charleston, SC[(a)]	3690 (13.84)	221.4 (0.84)
Honolulu (Pearl Harbor), HI[(b)]	3360 (12.72)	201.6 (0.76)
Philadelphia, PA [(b)]	2760 (10.45)	165.6 (0.63)
Mayport, FL	2640 (9.90)	158.4 (0.60)
Little Creek, Norfolk, VA	1950 (7.31)	117 (0.44)
Long Beach, CA[(a)]	1560 (5.85)	93.6 (0.35)
Bremerton (Puget Sound), WA[(b)]	940 (3.56)	56.4 (0.21)
Alameda, CA	660 (2.47)	40 (0.15)
Other Navy Homeports	4163.3 (15.77)	249.8 (0.95)

(a) Excluding shipyard tests.
(b) Including shipyard tests.

b. The information contained in table 2-2 was supplied by the Navy Environmental Support Office, NCBC, Port Hueneme, California. It tabulates the water quality classifications and parameters for which water quality standards have been adopted for each harbor area listed in table 2-1.

Table 2-2
WATER QUALITY REFERENCES FOR SELECTED NAVY PORTS

Harbor Area	Beneficial or Protected Use Classification		Applicable Standards/Objectives		Water Quality References	Interstate/State/Local Water Quality Management Agencies
	Code	Description[a]	Code	Parameter[b]		
San Diego Bay San Diego, CA	Coastal	IND NAV REC-1 REC-2 COMM SAL RARE MAR MIGR SHELL	N/A	COLOR TASTE & ODOR FLOATING SOLIDS TSS SETTLEABLE SOLIDS OIL & GREASE TURBIDITY pH DO BACTERIA TEMP TOXICITY General non-quantified limitations on waste from vessels	• *"Comprehensive Water Quality Control Plan for the San Diego Basin (Abstract), July 1975"* Source: San Diego Regional Water Quality Control Bd. 6154 Mission Gorge Rd. San Diego, CA	• California Water Quality Control Bd., San Diego Region (303 planning)[c] • Comprehensive Planning Organization of the San Diego Region (208 planning)[d]
Long Beach Harbor Long Beach, CA	Coastal	NAV REC-2 COMM RARE MAR SHELL	N/A	COLOR TASTE & ODOR FLOATING MATERIAL TSS SETTLEABLE SOLIDS OIL & GREASE BIOSTIMULANTS TURBIDITY pH DO BACTERIA TEMP TOXICITY PESTICIDES	• *"Water Quality Control Plan for the Los Angeles River Basin, Mar 1975"* Source: Los Angeles Regional Water Quality Control Board 107 S. Broadway, Suite 4027 Los Angeles, CA 90012	• California Water Quality Control Board, Los Angeles Region (303 planning)
San Francisco Bay Alameda, CA		REC-1 REC-2 NAV MAR RARE WILD COMM IND SHELL	N/A	COLOR TASTE & ODOR FLOATING MATERIAL TSS SETTLEABLE SOLIDS OIL & GREASE BIOSTIMULANTS TURBIDITY pH DO BACTERIA TEMP TOXICITY PESTICIDES	• *"Water Quality Control Plan for the San Francisco Bay Basin, July 1975"* Source: Bay Area Regional Water Quality Control Bd. 111 Jackson St. Oakland, CA 94607	• California Water Quality Control Board, Bay Area Region (303 planning) • Association of Bay Area Governments (208 planning) • Bay Conservation District Commission (coastal zone management)

(Continued)

Table 2-2
WATER QUALITY REFERENCES FOR SELECTED NAVY PORTS (CONTINUED)

	Beneficial or Protected Use Classification		Applicable Standards/Objectives		Water Quality References	Interstate/State/Local Water Quality Management Agencies
	Code	Description(a)	Code	Parameter(b)		
Willoughby Bay Norfolk, VA	IIBa	ESTUARINE MUN REC-1 MAR	II	DO pH TEMP	• *"Small Coastal Basins Water Quality Data Report, Oct 76"* Source: Virginia Institute Marine Science Attn: Dr. Bruce Neilson Gloucester Point, VA • *Virginia Water Quality Standards*, amended Nov 74 • *"Water Quality Inventory 305(b) Report, Apr 1976"* • *"Lower James River Basin 303(e) Report (Planning Bulletin 217(3), July 1974"* Source: Virginia Water Control Board P.O. Box 11143 2111 N. Hamilton St. Richmond, VA 23230	• Virginia Water Control Board (303 planning) • Hampton Roads Water Quality Agency (208 planning) • Bureau of Shellfish Sanitation
Little Creek Virginia Beach, VA	IIIB	FREE FLOW STR. MUN REC-1 MAR	III B All Class	DO pH TEMP BACTERIA General non-quantified limitations on floating, toxic, and deleterious substances.		
Cooper River Charleston, SC	SC	TIDAL REC-2 COMM MAR	SC	FLOAT. SOLIDS DO BACTERIA pH General non-quantified limitations on toxic and deleterious substances	• *Stream Classifications for State of South Carolina amended 9/1/72* • *Water Classifications Standards System, amended 1974* • *"Santee-Cooper River Basin Water Quality Management Plan, 1975"* Source: SC Dept of Health and Environmental Control	• South Carolina Dept. Health and Environmental Control (303 planning) • Berkely-Charleston-Dorchester Planning Council (208 planning) • South Carolina Wildlife and Marine Resources Center (coastal zone management)
St. John's River Mayport, FL	III	REC-1 REC-2 MAR WILD		pH DO BACTERIA TURBIDITY TDS FLUORIDES CHLORIDES GROSS BETA CYANIDE COPPER ZINC CHROMIUM PHENOLS LEAD DETERGENTS MERCURY TEMP General non-quantified limitations on toxic and deleterious substances	• *"St. John's River Basin Plan"* Source: Florida Dept. of Environmental Regulations Tallahassee, FL	• Florida Dept. of Environmental Regulation (303 and 208 planning) • Bureau of Coastal Zone Management, Department of Natural Resources (coastal zone management)

(Continued)

Table 2-2
Water Quality References for Selected Navy Ports (Continued)

Harbor Area	Beneficial or Protected Use Classification Code	Beneficial or Protected Use Classification Description[a]	Applicable Standards/Objectives Code	Applicable Standards/Objectives Parameter[b]	Water Quality References	Interstate/State/Local Water Quality Management Agencies
Sinclair Inlet Bremerton, WA	A	MIGR WILD REC-1 REC-2 IND NAV COMM SHELL	A	BACTERIA DO TEMP TOTAL DISSOLVED GAS pH TURBIDITY General non-quantified limitations on toxic and deleterious substances	None available	• State Department of Ecology (303 and 208 planning, coastal zone management)
Delaware estuary (Zone 01.020) Philadelphia, PA	1.2 1.3 2.2 2.4 3.1 3.2 4.1 4.2 4.3	WARM MIGR IND WILD REC-2 boating REC-2 fishing POW NAV WASTE	a_2 b_4 d_7 d_9 e_4 f_4 g_2 i_2 j_2 q_2 w_1 h	pH DO TEMP TEMP TDS BACTERIA TURBIDITY ALKALINITY MBAS PHENOL RADIOACTIVITY TON[e]	• 25 PA Code Chapter 93, *Water Quality Criteria, amended 6/20/74.* • USGS Report *"Water Resources Data for Pennsylvania - Part II Water Quality Records"* Source: District Chief, Water Resources Division Federal Building P.O. Box 1107 Harrisburg, PA 17108	• PA Dept of Environmental Resources (303 planning) • Delaware River Basin Commission (303 coordinator, coastal zone management). • Delaware Valley Regional Planning Commission (208 planning)

(a) The abbreviated descriptions are modeled after the designations used by the Regional Water Quality Control Boards of California. The following description for each abbreviated designation is intended to provide a generalized concept rather than the specific definition offered by each locale.

IND - Includes uses which do not depend primarily on water quality such as mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

NAV - Includes commercial and naval shipping.

POW - Uses for hydropower generation.

REC-1 - Includes all recreational uses involving actual body contact with water, such as swimming, wading, waterskiing, skin diving, surfing, sport fishing, uses in therapeutic spas, and other uses where ingestion of water is reasonably possible.

REC-2 - Recreational uses which involve the presence of water but do not require contact with water, such as picnicking, sunbathing, hiking beachcombing, camping, pleasure boating, tidepool and marine life study, hunting, and aesthetic enjoyment in conjunction with the above activities as well as sightseeing.

COMM - The commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in ocean, bays, estuaries and similar non-freshwater areas.

(Continued)

WARM - Provides a warmwater habitat to sustain aquatic resources associated with a warmwater environment.

SAL - Provides an inland saline water habitat for aquatic and wildlife resources.

WILD - Provides a water supply and vegetative habitat for the maintenance of wildlife.

MAR - Provides for the preservation of the marine ecosystem including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl, and vegetation such as kelp.

MIGR - Provides a migration route and temporary aquatic environment for anadromous and other fish species.

RARE - Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species.

SHELL - The collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for either commercial or sport purposes.

MUN - Includes usual uses in community or military water systems and domestic uses from individual water supply systems.

WASTE - A receiving body for treated waste water effluent reflecting levels of treatment necessary to preserve all designated beneficial use categories.

(b) Specific quantified or non-quantified limitations are identified for each parameter in the appropriate area water quality documents.

(c) Planning pursuant to Section 303, PL92-500.

(d) Planning pursuant to Section 208, PL92-500.

(e) Threshold Odor Number.

SECTION 3

RELATIONSHIP OF PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREAS

1. The proposed action relates to the marine environment. There is no direct impingement upon land use plans, policies or controls. A possible indirect effect caused by the implementation of the proposed action would be increased levels of BOD in a localized portion of the harbor water immediately after receiving an AFFF discharge. When considered in combination with the existing (or projected) levels of contamination in the water, the action, if it occurs frequently enough, might prohibit a new land use which would generate a pollution level in excess of allowable limits established for the site by local or federal standards and regulations. However, the limited quantity of AFFF and the infrequency of testing causes an insignificant contribution to water quality degradation in comparison to the highly developed industrialized land uses already associated with surrounding shorelines.

2. The Navy has committed itself to assure that the operation of naval complexes has been reconciled with local land/water use plans, policies and controls.[4] Navy-wide programs to improve ship-to-shore waste collection, handling and disposal will continue to reduce the environmental impact on areas surrounding naval bases and shipyards. The eventual disposal

of shipboard generated AFFF test solution will be incorporated into current environmental enhancement programs for which their relationship to land use plans, policies, and controls has been assessed.

SECTION 4

PROBABLE IMPACT OF THE PROPOSED ACTION

ON THE ENVIRONMENT

1. Introduction

a. It is essential that newly installed and modified AFFF fire-fighting systems be tested prior to ship departure for sea trials. U.S. Navy ships are presently having their protein foam generating fire-fighting equipment aboard surface ships converted to AFFF. The first systems converted were aircraft carrier hangar deck and flight deck equipment. SHIPALT's have been issued to convert aircraft carrier protein foam equipment to AFFF in the HCFF stations, hangar sprinkling systems, machinery spaces, fixed flight deck fire-fighting washdown systems, and hard hoses for hangar space and flight deck. Machinery space protein foam equipment for all other types of surface ships is also being converted by SHIPALT to AFFF use and combined ("twinned") with PKP. PKP is an effective fire-fighting agent for oil fires when the oil is in spray form and burning in space.[5] Figure 4-1 is a diagram of a twin agent (AFFF and PKP) fire extinguishing system. The AFFF system can be operated independently of the PKP units for testing or fire fighting.

b. There are two circumstances when machinery space AFFF systems need to be operated to test the FP-180 foam proportioner:

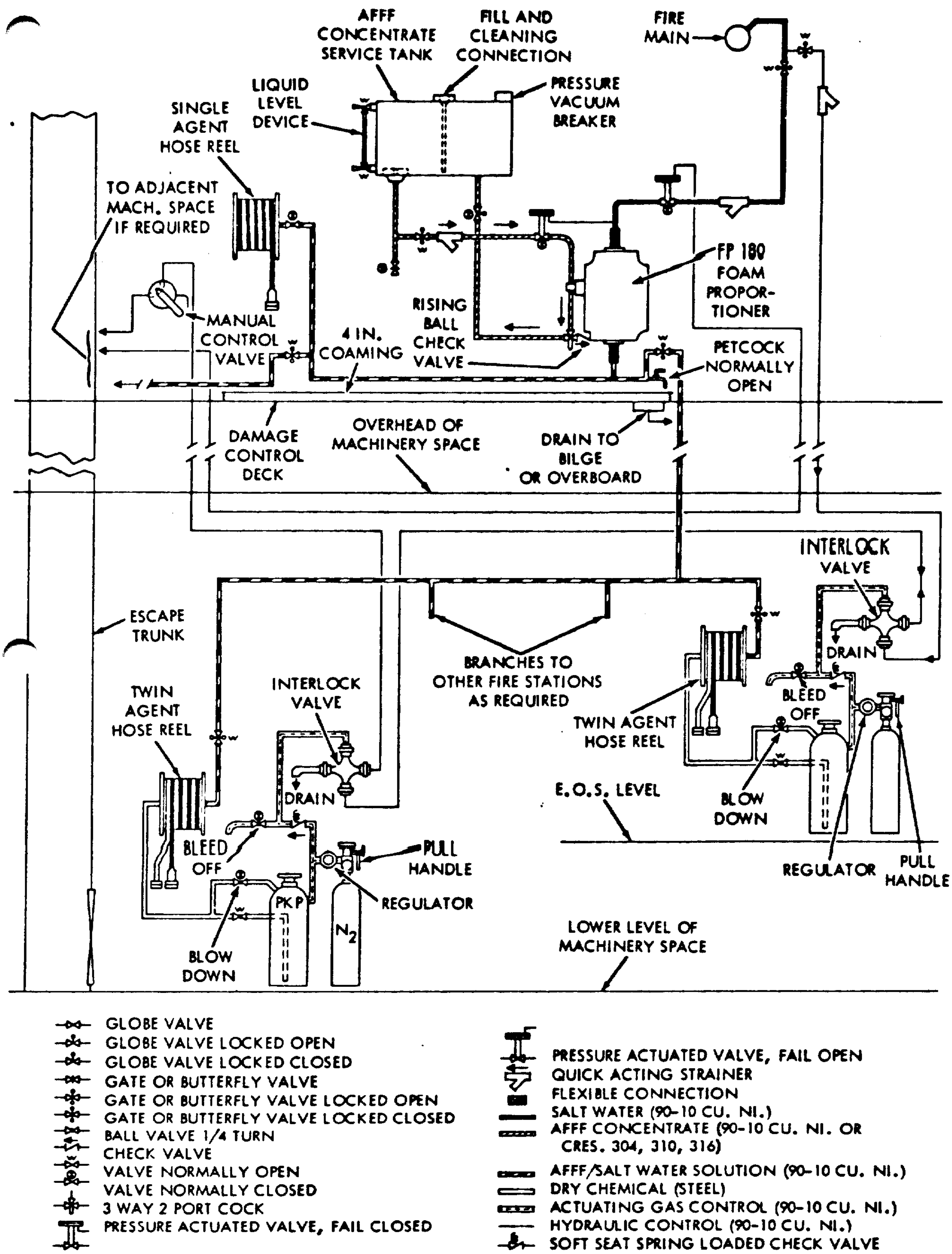


Figure 4-1
Twin Agent (AFFF and PKP) Fire Extinguishing System[5]

the first is after equipment is newly installed, repaired, altered or converted by an industrial activity; the second is scheduled preventive maintenance. NAVSEA 0993-LP-023-6010 technical manual requires preventive maintenance semiannually or more frequently if conditions warrant it.[5] Appendix D contains a copy of the Long Beach Naval Shipyard procedures for testing AFFF/PKP fire-fighting systems. These procedures are representative of those used in other shipyards.

c. The environmental assessment parameters which relate to the proposed action and the appraisals of the magnitude of the resulting impacts are given in table 4-1. There are no apparent air quality impacts of the proposed action.

2. Navigable Waters Impact. The ecological effect of any chemical introduced into a given environment for the first time is a function of many factors. Its physical and chemical structure will determine what physiological influences it could exert on life forms with which it may come into contact. However, its concentration at any point in time is a measure of the probability of such effects occurring. Therefore, an assessment of maximum concentration expected and the speed with which the chemical is purged from the environment are essential elements in the formulation of impact estimates. Since these evaluations must precede a proposed action, direct measurements are not possible. Therefore, the best indirect evidence available has to be applied to the construction of a

Table 4-1
Appraisal of the Proposed Action's Impact Upon
the Environmental Assessment Parameters

Assessment Parameter	Effect of the Proposed Action	Data or Observations for Evaluation of Parameter Impact
Physical/ Chemical/ Biological		
Flow Variations, (concentration - time factors)	The discharge of a quantity of AFFF into harbor waters with inadequate natural mixing capability may result in localized areas of chemical concentration.	Information with regard to tidal, current and wind movements has been acquired in order to calculate the flushing capability of the receiving waters.
Associated Chemical Contaminants	The physical-chemical interaction of AFFF with other major chemical contaminants normally found in a particular harbor could result in altered dispersion, degradation, and toxicological properties of some of the reactants. This could influence the "self purification" capability of the harbor.	Qualitative and quantitative data regarding the major types of contaminants normally found in a particular harbor would determine the degree of chemical interaction with AFFF. Natural mixing in receiving waters and the extremely low concentration of chemicals and AFFF will minimize environmental effects.
Toxicological Properties of AFFF	It is possible that finite concentrations of any chemical will have a detrimental effect on some biological entity in a particular environment. Therefore, the nature of this influence, the spectrum of biological life affected, and the concentration constraints imposed within a particular environment will determine if AFFF and its anticipated usage will constitute an ecological hazard.	The influence of AFFF on marine life in a harbor and contiguous waters must be determined. These effects should be evaluated within the practical range of chemical concentrations anticipated if the proposed action is implemented and should include short-range (acute and sub-acute) and long-range (chronic) toxicity testing. Data currently available (appendix E) supplies the requisite information.

Table 4-1 (cont'd)

Assessment Parameter	Effect of the Proposed Action	Data or Observations for Evaluation of Parameter Impact
pH of AFFF Effluents	The pH of the AFFF product in question, FC-206, is identified at approximately the neutral point, 7.8, in appendix B; therefore, there should be minimal impact on the pH of the harbor waters.	The applicable procurement specification, MIL-F-24385, for the AFFF allows as acceptable a range of pH from 4 to 8. The specification should be changed to conform more closely to the reported control value of pH 7 to 8.
AFFF Pollution Loading Potential	The BOD and COD of FC-206 are very high (appendices B and E). This means that high chemical concentrations could temporarily deplete the DO content of the receiving waters if discharged in large quantities.	The fact that BOD and COD values for FC-206 are relatively the same is indicative that this material is highly biodegradable. The fact that the BOD_5 is 65% of the BOD_u indicates the material is rapidly biodegradable.
<u>Socioeconomic</u>		
Fishing (commercial and recreational) Water Skiing and Swimming	The discharge of AFFF is not expected to affect commercial fishing or recreational use. Harbor areas associated with shipyards are centers of industrial activity and are not used for recreation.	Rapid dilution and biochemical degradation of AFFF within the industrial harbor areas should reduce concentrations to within acceptable limits while within the harbor whereby normal fish feeding or recreational water uses outside harbor areas are not affected.
<u>Aesthetic</u>		
Water Surface	The surfactant and film forming characteristics of the AFFF mixture could result in an unsightly film on the harbor surface.	AFFF testing can be conducted with nonfoaming nozzles. When discharged overboard the AFFF disperses beneath the surface (appendix F).

hypothetical case. Before constructing such a case, the following information must be obtained: (a) the quantity and frequency of potential AFFF discharges; (b) the dilution of a discharge and natural mixing within the harbor; and (c) the rate of removal of the discharge from the receiving waters by natural flushing and by decomposition.

a. While specific data on the generation rates of AFFF from machinery space system testing are not available, it is possible to estimate the quantity of AFFF solution generated per system test and the frequency of those tests using data and information obtained from naval shipyards and experience gained by the FFAT.

(1) Quantities of AFFF generated at naval shipyards as a result of machinery room FP-180 testing are contained in table 4-2. These have been provided by the shipyards cited. They were derived by multiplying the number of ships having their fire-fighting foam systems converted from protein to AFFF by the quantity of foam generated while testing each system. No data are available on the generation rates of AFFF from semiannual PMS maintenance aboard ships in port; however, experience of the FFAT has shown that approximately 90 gal (0.34 m^3) of 6% AFFF solution are generated per test and that ships' operating schedules usually obligate in-port PMS testing at a frequency of about once every three years. Other PMS testing is conducted at sea. The above estimates

are reasonable compared with data in a report on handling ship industrial wastes in San Diego, California. The report is being prepared by contract for NAVFACWESTDIV. The monthly generation rate of AFFF was compiled based on NAVSEC (SEC 6159) survey data from 1972 and on contacts with cognizant commands in the area. Typical AFFF waste generation rates were reported at 530 gal (2.0 m^3) for 40 ships at the Naval Station, 660 gal (2.5 m^3) for 5 ships at North Island, and 30 gal (0.1 m^3) for 4 ships at the Submarine Support Facility.[6] The report estimates include some non-machinery space AFFF equipment testing.

Table 4-2
Quantity of AFFF Generated During
In-Port Fire-Fighting Foam System
Testing at Naval Shipyards (NSY)*

Activity	Number of Ships	AFFF (gal)	AFFF (m^3)	Period (years)	Disposal Procedure
Portsmouth NSY		**	**		
Philadelphia NSY	11	1500	5.7	1	None
Norfolk NSY	-	8000	30.3	1.5	Yes
Charleston NSY	3	225	0.9	1	Yes
Long Beach NSY	9	1100	4.2	1	Yes
Mare Island NSY		**	**		
Puget Sound NSY	1	400	1.5	1	None
Pearl Harbor NSY		***	***		

*Calendar year 1975 estimates.
**No surface ships serviced during CY75.
***Data not available.

(2) The numbers of machinery spaces and proportioners aboard ships with fire-fighting foam systems are given in table 4-3. The quantity of 6% AFFF that could be generated aboard ship per year is estimated for each significant Navy port in table 4-4. Estimates were obtained by multiplying the output

per proportioner by the total number of FP-180 proportioners aboard the ships in the group. The experiences of the FFAT indicate that approximately 90 gal (0.34 m^3) of AFFF are generated during a single test. For in-port PMS testing once every three years, the total quantity of AFFF concentrate generated per port per year is also estimated in table 4-4 assuming maximum generating conditions of 90 gal (0.34 m^3) AFFF solution at 6%.

Table 4-3
FP-180 Proportioners in Machinery Room Spaces Aboard U.S. Navy Ships by Class Grouping

Group	Number FP-180 Proportioners	Ship Classes in Group
1	1	AE, ASR, ARS
2	2	AD, AFS, AG, AO, AOE, AOG, AOR, AR, AS, ATF, FFG, LCC, LKA, LPD, LPH, LPA, LSD, ATS, MSC, MSO, LHA, AF
3	4	CG (DLG), DD, DDG, FF, LST, CGN
4	6	CV, CVN

(3) The AFFF generation estimates from the shipyards given in table 4-2 are included in table 4-4. When a shipyard is in the same harbor area as a homeport (i.e., Norfolk, VA), the shipyard generation rates were combined with those estimates of PMS testing. Shipyards not associated with homeports (i.e., Long Beach, CA) are listed and ranked with those ports in table 4-4.

Table 4-4

Estimated Yearly Quantity of AFFF Generated Aboard Ships In Port Based Upon 90 Gal (0.34 m^3) of 6% Mixture Per Test Once Every Three Years and CY75 Shipyard Generation Estimates

U.S. Navy Port Listing[(a)]	Rank (b)	Number of Ships in Group: Group 1	2	3	4	Total Number of Proportioners In Port	Estimated Gal (m^3) of 6% AFFF Generated: Port	Shipyard	Estimated Total Gal (m^3) of AFFF Concentrate Discharged Per Year
Alameda, CA	10		2		3	22	660 (2.47)		40 (0.15)
Baltimore, MD				1		4	120 (0.45)		7.2 (0.03)
Bayonne, NJ				1		4	120 (0.45)		7.2 (0.03)
Bronx, NY				1		4	120 (0.45)		7.2 (0.03)
Bremerton, WA	9		2	2	1	18	540 (2.02)	400 (1.51)	56.4 (0.21)[(c)]
Brooklyn, NY				1		4	120 (0.45)		7.2 (0.03)
Charleston, SC	3	3	10	25		123	3690 (13.84)	225 (0.85)	221.4 (0.84)[(d)]
Concord, CA		8				8	240 (0.90)		14 (0.05)
Groton, CT		1				1	30 (0.11)		1.8 (0.01)
Fall River, MA			1			2	60 (0.22)		3.6 (0.02)
Galveston, TX				1		4	120 (0.45)		7.2 (0.03)
Pensacola, FL					1	6	180 (0.67)		11 (0.04)
Portland, ME			2			4	120 (0.45)		7.2 (0.03)
Little Creek, VA	7	3	11	10		65	1950 (7.31)		117.0 (0.44)
Long Beach, CA	8		3	10	1	52	1560 (5.85)	1100 (4.16)	93.6 (0.35)[(d)]
Mayport, FL	6	2	7	15	2	88	2640 (9.90)		158.4 (0.60)
New London, CT			1	1		6	180 (0.67)		10.8 (0.04)
New Orleans, LA				1		4	120 (0.45)		7.2 (0.03)
New York, NY				2		8	240 (0.91)		14 (0.05)
Newport, RI			1	4		18	540 (2.04)		32 (0.12)
Norfolk, VA	2	3	29	42	5	259	7770 (29.41)	8000 (30.28)	466.2 (1.76)[(d)]
Panama City, FL			1			2	60 (0.23)		3.6 (0.01)
Pearl Harbor, HI	4	8	13	20		112	3360 (12.72)		201.6 (0.76)[(d)]
Perth Amboy, NJ			2			4	120 (0.45)		7.2 (0.03)
Philadelphia, PA	5		1	10		42	1260 (4.77)	1500 (5.68)	165.6 (0.63)[(c)]
Portland, OR			1	2		10	300 (1.14)		18 (0.07)
Portsmouth, NH			1			2	60 (0.23)		3.6 (0.02)
Tampa, FL				1		4	120 (0.45)		7.2 (0.03)
San Diego, CA	1	2	41	55	2	316	9480 (35.88)		568.8 (2.12)
San Francisco, CA			7	2		18	540 (2.04)		32 (0.12)
Seattle, WA				3		12	360 (1.36)		22 (0.08)
St. Petersburg, FL			2			4	120 (0.45)		7.2 (0.03)
Tacoma, WA			1	1		6	180 (0.68)		11 (0.04)

(a) U.S. homeports for naval surface ships.[3]

(b) Ranked by estimated quantity of AFFF generated per year during testing.

(c) Includes AFFF generated by shipyard tests; no alternate disposal procedure.

(d) Excludes AFFF generated by shipyard tests; alternate disposal procedure practiced.

b. The long-range effect of a contaminant on the harbor environment is dependent on the contaminant's rate of removal. Theoretical analyses of the dilution and flushing capabilities for each of 18 harbors were made by the U.S. Navy Hydrographic Office (now NAVOCEANO) from 1959 through 1963. The analyses were based on available measurements of the physical and dynamic characteristics of the site. The results of each theoretical analysis were reported separately for each port, and the dilution and flushing capabilities of each port were compared in a summary report.[7] The summary report states: "...The major factors, not necessarily in order of importance, which determine the reduction of concentration of an introduced contaminant are: (1) volume of water available for dilution, (2) rate at which the contaminant is dispersed throughout this volume, and (3) rate of advection (i.e., movement by currents)."[7] The methods of investigation and the conclusions of the report are summarized in the following paragraphs.

(1) The Hydrographic Office report states that the volume of water available for dilution is not actually a criterion of flushing capability, although it is of obvious importance since a harbor with poor flushing characteristics still might be safe from contamination if great dilution takes place; a harbor with a small dilution volume and a relatively high rate of flushing might retain a high amount of contamination for a relatively long period of time.

Examples are Long Beach, California which has a large dilution volume and Mare Island Strait, San Francisco, California which has a high flushing rate as shown in figure 4-2.

(2) The amount of turbulence within a water area will determine the rate at which a contaminant is dispersed throughout the dilution volume. For the most part, tidal currents are the source of turbulence. However, horizontal or vertical motion induced through seiches, waves, winds, etc. may serve as a mixing agent. The distribution of conservative physical properties indicates the relative degrees of mixing.

(3) Figure 4-2, Comparison of Dilution Volumes and Flushing Capability of 18 Harbors, taken from this report, was based upon the following assumptions and conclusions.[7]

(a) The initial dilution volume was taken to be the volume of water defined by the length of a flood tidal excursion and the width and depth of the body of water through which the tidal excursion is measured. Where possible this volume was calculated, however where current speed data were not available and the embayment was considered sufficiently small, the volume of the embayment was taken as the dilution volume.

(b) Flushing also affects the concentration of contaminant within a harbor. A contaminant will be removed from an area either by net flow from it or by mixing of the harbor water and the currents passing the entrance of the harbor. These factors were reflected in the exchange ratio

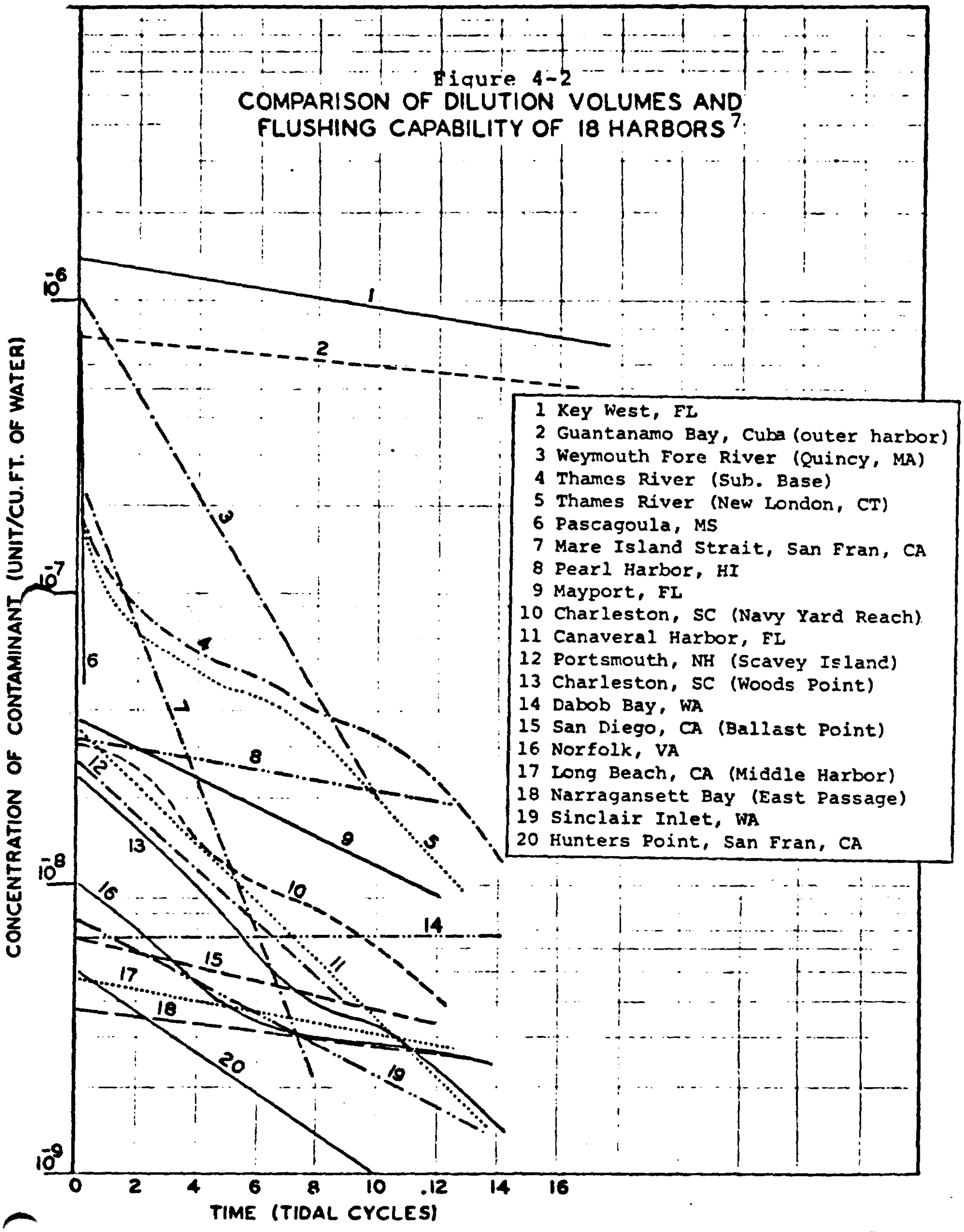


Figure 4-2
COMPARISON OF DILUTION VOLUMES AND FLUSHING CAPABILITY OF 18 HARBORS[7]

for each of these harbors, and this ratio was adjusted to account for the fraction of the tidal prism that is lost during each tidal cycle. It was further assumed that a volume of new uncontaminated water replaces the lost fraction of the tidal prism. These considerations were applied to nonestuarine embayments and to harbors in estuarine embayments in which the point source of contamination was not more than one flood tidal excursion from the entrance. (Flood excursion is defined in the study as the distance traveled by a "particle" of water or of contaminant between one slack before flood and the succeeding slack before ebb.) If the point source was located more than one flood tidal excursion from the harbor entrance, and the harbor was estuarine, the distribution of the contaminant between the point source and the harbor entrance was calculated. It was assumed that the contaminant contained in a segment at a given time was uniformly distributed throughout the high tide volume of that segment. The concentration within the segment was calculated, and the highest concentration found within the estuary at a given time was plotted in figure 4-2. The curves show the rate of decrease of peak concentration within a harbor over 14 tidal cycles. Their relative slopes afford a comparison of the rates of contaminant decrease among the harbors. The position of the curve at time = 0 reflects the amount of dilution that the contaminant would undergo within the first tidal cycle after introduction (assuming that 100 units of contaminant are introduced and the dilution volume is the volume of water defined by the length of a flood tidal excursion and the width and depth of the body of water through which the tidal excursion is measured).

(4) Advection is the true flushing agent as other processes mentioned tend only to reduce the concentration of a contaminant; they do not remove it from the area. Currents immediately offshore from the harbor serve as a mode of transport to oceanic areas where dilution volumes are virtually unlimited.

(5) For analyzing the relative flushing capabilities of the harbors, the data available were inadequate for examining many of the probabilities involved in the event of contamination. In some locations stratification of water results from density differences, and the net inflow in the bottom layer of this type of estuary would be upstream rather than seaward. Should the bottom layer of this type of estuary become contaminated, the flushing time would be prolonged greatly.

(6) The Hydrographic Office summary report cautioned that in light of their information, the flushing analysis for each harbor is believed to be valid insofar as the data available at the time would allow. The limitations imposed by data deficiencies are pointed out in each of the 18 reports for the individual harbors.

c. To verify the results of the theoretical flushing analyses, the Hydrographic Office conducted actual dye tracer field tests for a group of harbors representing the types of harbors studied for their relative flushing capabilities (dye being a conservative substance during the periods observed). The dilution factors measured during five field tests conducted at large Navy ports are summarized in table 4-5. The peak concentration of any conservative contaminant at a time after release can be predicted by multiplying the total amount of contaminant released (concentration x volume) by the dilution factors in the table for that time.

(1) The field test procedures consisted of releasing a quantity of dissolved tracer dye (rhodamine-B, or fluorescein) and monitoring its dilution and dispersion until dye concentrations had decreased below the detection limit of the analytical equipment (two parts of dye per hundred billion parts of water) or until the dye had been transported out of the harbor. Field measurements of the test areas included collection of water samples for analysis of dye concentration and salinity, current and temperature measurements and aerial photographs.

(2) A comparison of the results of the flushing analyses and field tests indicates the usefulness and the limitations of the tidal prism method. One of the basic assumptions of the tidal prism theory is that the contaminating material must be distributed uniformly both horizontally and vertically throughout

Table 4-5
Dilution Factors for Five Navy Harbors Determined from Field Measurements of Dye Dilution and Dispersion

Time After Release		Dilution Factor (per litre)				
Hrs.	Min.	Mayport Basin[8]	Pearl Harbor[9] (Southeast Loch)	San Diego[10] (Ballast Point)	San Francisco[11] (Mare Island Strait)	Norfolk[12] (Hampton Roads)
0	10			6.6E-7*		2.2E-7
0	30			6.6E-9	1.8E-7	7.1E-8
1	0	2.2E-9		9.2E-10	1.2E-7	1.1E-8
2	0	1.2E-9			9.5E-8	
3	0	5.5E-10		1.0E-10	5.7E-8	1.3E-10
4	0		1.2E-7		3.3E-8	
5	0	4.9E-10	1.0E-7		1.6E-8	
6	0		8.0E-8	2.6E-11		2.4E-11
8	0		6.2E-8			
10	0	3.3E-10	4.8E-8			
12	0		4.4E-8	1.3E-11		7.7E-12
15	0	2.2E-10				
24	0	1.1E-10	2.6E-8			2.6E-12
48	0	1.1E-11	9.7E-9			1.5E-12
72	0	3.3E-12	6.6E-9			
96	0		4.4E-9			
120	0		3.2E-9			
240	0		2.9E-9			

Superscripts 8-12 refer to references, Section 10.
*FORTRAN exponent form: 6.6E-7 = 6.6×10^{-7}

the harbor. Thus, valid comparison of the predicted decreasing peak concentration curve and the observed curve cannot be made until the dye is uniformly distributed throughout the basin. For the Mayport Basin field test this occurred within six hours.[8] Application of the tidal prism method to the entire volume of Pearl Harbor failed to give realistic estimates of the decreasing concentration of a contaminant released within the harbor; however, concentration decreases within the Southeast Loch where the shipyard and naval station are located can be estimated fairly accurately after mixing of the dye within the loch is complete at 48 hours after release.[9] A comparison of the other field tests with the theoretical analyses indicated that the predicted reductions in peak contaminant concentrations as shown in figure 4-2 are valid for predicting the flushing rate of a contaminant from a harbor.

(3) In all cases field tested by the Hydrographic Office, the initial dilution rate as seen from peak concentration curves is very rapid. This fact has also been borne out by other dye dispersion studies.[13]

(4) To confirm that a 6% AFFF solution will disperse in a manner similar to that of a dye release, a small scale test was conducted in Dungan Basin at the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory. The experiment involved the release of 20 gal (75.7 ℓ) of 6% AFFF mixture composed of 1.2 gal (4.5 ℓ) of AFFF concentrate

mixed with 18.8 gal (71.2 ℓ) of dilution water and dyed with rhodamine WT dye to an initial concentration of 100 ppm by weight. The experiment proved the applicability of using dye to obtain dilution factors applicable for AFFF. (The experimental procedure and results are contained in appendix F.)

d. The dilution factors contained in the Hydrographic Office field reports can be used to estimate the maximum concentration of AFFF within a harbor after a discharge and to estimate the rates of removal from the harbor by flushing.

(1) Based upon the Hydrographic Office dilution factors and the estimated quantity and frequency of potential AFFF discharges, hypothetical cases for an AFFF release can be developed. Each case is hypothetical in the sense that the discharge from a single ship (point source) is used in the calculations whereas it is possible that discharges from additional ships could enter the harbor at the same time. Furthermore, it is assumed that the ship will discharge its AFFF in a harbor location where there is good mixing; it is possible that AFFF would sometimes be discharged in less desirable areas such as those sheltered from the diluting effects of tidal flows. To offset these possibilities, the worst case conditions are assumed: the maximum quantity of AFFF would be discharged per ship and biological decomposition of the AFFF would not occur.

(2) Theoretical peak AFFF concentrations have been calculated in table 4-6 based upon the dilution factors given in table 4-5. Sample calculations for five ports are based on the hypothetical discharge of AFFF from the largest ship likely to be berthed at those locations since it would emit the largest volume of AFFF and would thus provide a more rigorous test. It is recognized that all systems would not be checked simultaneously but would probably be exercised over a period of a few hours. Each test could involve the generation of about 90 gal (0.34 m^3) of maximum 6% concentration AFFF. The system will be secured as soon as possible after sample collection. In order to evaluate the worst possible case, calculations are based on the unlikely assumption that all machinery space FP-180 proportioners are tested simultaneously and the ship represents a single point source.

(3) A sample calculation for determining peak AFFF concentration following testing aboard an AS-type ship berthed at the Submarine Support Facility, Ballast Point, San Diego, follows.

(a) AFFF generated during testing of two FP-180 machinery space proportioners aboard an AS-type ship is 180 gal (0.68 m^3) of 6% solution containing 10.8 gal (40.9 ℓ) of concentrate.

(b) The dilution factor (DF) in San Diego ten minutes after release is 6.6×10^{-7}/litre.[10]

Table 4-6
Peak AFFF Concentrations in Four Navy Harbors
at Intervals After Discharge of 6% AFFF Test Mixture

Time After Discharge		Peak AFFF Concentration in mg/ℓ				
Hrs.	Min.	Mayport Basin*	Pearl Harbor* (Southeast Loch)	San Diego** (Ballast Point)	San Francisco* (Mare Island Strait)	Norfolk* (Hampton Roads)
0	10			28.0		27.0
0	30			0.28	23.0	8.8
1	0	0.27		0.04	15.0	1.4
2	0	0.15			12.0	
3	0	0.07		<0.01	7.1	0.02
4	0		15.0		4.1	
5	0		12.0		2.0	
6	0		10.0			<0.01
8	0		7.8			
10	0	0.06	6.0			
12	0		5.5			
15	0	0.03				
24	0	0.02	3.3			
48	0	<0.01	1.2			
72	0		0.8			

*CV-type ship, six FP-180's tested, 540 gal 6% AFFF (32.4 gal concentrate).
**AS-type ship, two FP-180's tested, 180 gal 6% AFFF (10.8 gal concentrate).

(c) Therefore, the AFFF concentration at that time can be calculated.

$$(40.9 \text{ litre AFFF}) \frac{(10^3 cm^3)}{\text{litre}} \frac{(1.02 \text{ g AFFF})}{cm^3} = 4.2 \times 10^4 \text{g AFFF}$$

$$(4.2 \times 10^4 \text{g AFFF}) \frac{(6.6 \times 10^{-7} DF)}{\text{litre}} \frac{(10^3 mg)}{g} = 28 \text{ mg AFFF per litre}$$

Using the same procedure, the predicted AFFF concentration after one hour is further reduced to 0.04 mg/ℓ.

e. Based upon the results of the Hydrographic Office studies as shown in figure 4-2, it is apparent that there is considerable variability between harbors with regard to the dispersion of substances within harbors and the rate substances will be flushed from harbors. This is due to differences in harbor volumes, tidal flow volumes, eddies, currents, etc. Therefore, it was impractical to experimentally measure actual peak AFFF concentrations in Navy harbors after shipboard AFFF system test effluent discharges. However, from the information presented thusfar on the limited quantity and frequency of AFFF discharges, on the rapid dilution of a discharge, and on the rate of removal of AFFF from a harbor by natural flushing, it is possible to predict concentrations of AFFF after discharge, and the following conclusions can be drawn.

(1) <u>Immediate Effect of an AFFF Discharge</u>. The initial dilution (determined by measuring peak dye concentration immediately after completion of the release) of the dye released during the Hydrographic Office dye dispersal field test for

Key West was approximately 1000 times.[14] Key West had the lowest dilution predicted for the 18 harbors studied, as shown in figure 4-2. During coastal dye dispersion studies using 5000 gal (18.9 m^3) of a seawater-sewage-dye mixture, initial dilutions of 1000 to 2000 times were measured at the point of discharge.[13] The small scale AFFF/dye discharge into Dungan Basin discussed in appendix F indicated initial dilutions of 3200 times. Thus, the initial concentration of AFFF (60,000 ppm maximum) can be expected to be reduced to no more than 60 ppm very soon after impact with the receiving waters. This concentration is only 5% of the 40-hour LC_{50} concentration found toxic to brine shrimp during bioassay tests conducted at the David W. Taylor Naval Ship Research and Development Center. Therefore, the immediate effect of the proposed action, discharging AFFF to harbor waters during in-port testing of machinery space fire-fighting systems, on the environment is considered negligible based upon the dilutions expected during the discharge. Appendix E contains toxicity data on six other representative saltwater organisms tested by the Center as well as tests on additional fresh and saltwater organisms conducted by other laboratories.

(2) Long-Term Effect of AFFF Discharges. The chronic effects of AFFF have not been evaluated and total quantities of chemical discharged during the simultaneous testing of fire-fighting equipment from several ships have not been measured

(although based upon the assumed in-port testing frequency and the relatively small number of machinery space proportioners, the likelihood of multiple tests being conducted at the same time and location is remote). However, it can be concluded from the concentration data in table 4-6 and the toxicity data in appendix E that the dosage of AFFF required to kill 50% of the organisms after 96 hours of exposure (LC_{50}) was considerably higher than the residual AFFF concentration calculated to persist in any of the five selected harbors at the end of that period of time. In fact, for even the largest theoretical AFFF discharge given in table 4-6, the concentration of AFFF in the marine environment will be reduced in minutes to levels well below those acutely toxic to marine organisms. Furthermore, biodegradation data for FC-206 (appendices B and E) indicate that within the accuracy of the BOD and COD tests, AFFF FC-206 is virtually wholly biodegradable.

SECTION 5

ALTERNATIVES TO PROPOSED ACTION

1. The U. S. Navy is committed to providing adequate fire protection for the prevention, containment, and extinguishment of fires. Testing is necessary to verify the readiness of fire-fighting equipment to effectively respond, as called upon, to combat fires. Confidence in both equipment and personnel is achieved by exercising the fire-fighting stations on a regular basis and verifying system performance after alterations or repairs.

a. The need for maintaining a fast, effective system for shipboard fire fighting has been repeatedly demonstrated. Since 1969 alone, over 1100 shipboard fires have been reported to the Naval Safety Center. Major losses in that period of time include the USS KENNEDY/USS BELKNAP collision and fire in 1975 (now estimated at $213M, 8 deaths), USS NEWPORT NEWS in 1972 ($6.5M, 21 deaths), USS FORCE in 1973 (total loss), USS KITTYHAWK in 1973 ($1M, 6 deaths), USS FORRESTAL in 1972 ($20M) and in 1967 ($20M, 133 deaths), USS ENTERPRISE in 1969 ($5M, 27 deaths) and USS ORISKANY ($10M, 43 deaths). NSC reports 106 property damage accidents involving fires in machinery spaces aboard surface ships from July 1974 to January 1977, totalling $5.8M in material damage and 36 casualties.

b. As ships and ships' systems become more sophisticated and the use of aluminum and composite structural materials increases, the vulnerability to fire also increases. To keep pace with the need for more sophisticated fire-fighting strategy, methods for the prevention, containment, and extinguishment of fires have been improving. One such improvement was the development of AFFF in the mid-1960's to replace protein foam.[15]

c. Tests by NRL demonstrated that "light water" was two to three times as effective as protein foam in extinguishing bilge fires and recommended that a dual discharge system of "light water" and PKP be adopted for rapid, improved extinguishment of fuel fires in shipboard engine room spaces.[16] Further testing by NRL, NAVSEC, and NAVSEA continued to demonstrate the superiority of AFFF over protein foam for extinguishing fires involving AvGas, JP-4, and JP-5.[17]

d. The objective of Navy fire protection strategy is to markedly reduce the vulnerability of ships, aircraft, facilities, and personnel to the hazards and damages of fire from both hostile and peacetime action.[15] AFFF systems are an integral part of a ship's fire-fighting capability. The following proposed action and alternatives are analyzed with that objective in mind as well as the environmental impact of AFFF system testing.

2. Proposed Action: Overboard Discharge of Foam. The objective of the proposed action is to dispose of effluent produced by machinery space AFFF fire-fighting foam system testing. The current approach to testing AFFF systems is to generate foam through one nozzle on each proportioner, to quickly sample the discharge for determination of AFFF

concentration in the mixture, and to secure the system as soon as possible to prevent excessive use of AFFF concentrate. The foam is usually discharged directly overboard due to the unavailability of collection and/or treatment facilities.

3. There are six basically different alternative approaches to the proposed action. They are summarized as follows.

a. Alternative (A). Test with Substitute Concentrate Material. Direct research and development efforts toward obtaining a substitute material for fire equipment test use which is more acceptable environmentally and which is functional as AFFF.

b. Alternative (B). Refine Procedures to Reduce Discharge Volume. Refine the test procedures to reduce the volume of the AFFF mixture produced.

c. Alternative (C). Adjust Test Schedules for Discharge Only When Collection, Treatment and Disposal Facilities are Available. Establish that tests only be conducted when the AFFF discharge can be handled in an environmentally acceptable manner. This includes discharge to pier sewers, collection barges or on the open sea while underway.

d. Alternative (D). Perform Tests with Discharge Contained as Part of a Closed System. Provide, as ancillary shipboard equipment, a dedicated holding tank capability to support the AFFF flow test and cause minimal scheduling interference. The AFFF mixture test effluent could be disposed of in accordance with the plan of alternative (C).

The implementation of alternative (B) would improve the feasibility of the portable tankage alternative by reducing the volume to be handled.

e. Alternative (E). Eliminate Shipboard Flow Test by Redesigning Maintenance Plan. Redesign the plan of maintenance for the fire-fighting equipment to eliminate the shipboard flow test requirements.

f. Alternative (F). Eliminate Shipboard Flow Test by Enhancing System Component Performance Reliability. Enhance system reliability by modifying equipment to increase confidence of system performance to an acceptable level without regular flow testing using AFFF.

4. Figures 5-1 through 5-6 summarize the adverse and beneficial effects (including those with cost and risk elements) in flow chart form, and develop the follow-on technical and administrative actions necessary for the conclusive acceptance or rejection of each alternative.

5. When the objective of alternative (A), test with a substitute concentrate material, is considered with regard to the environmental assessment parameters in table 4-1, it is concluded that by the nature of the change to a less harmful material, the potential for harmful impact is measurably reduced.

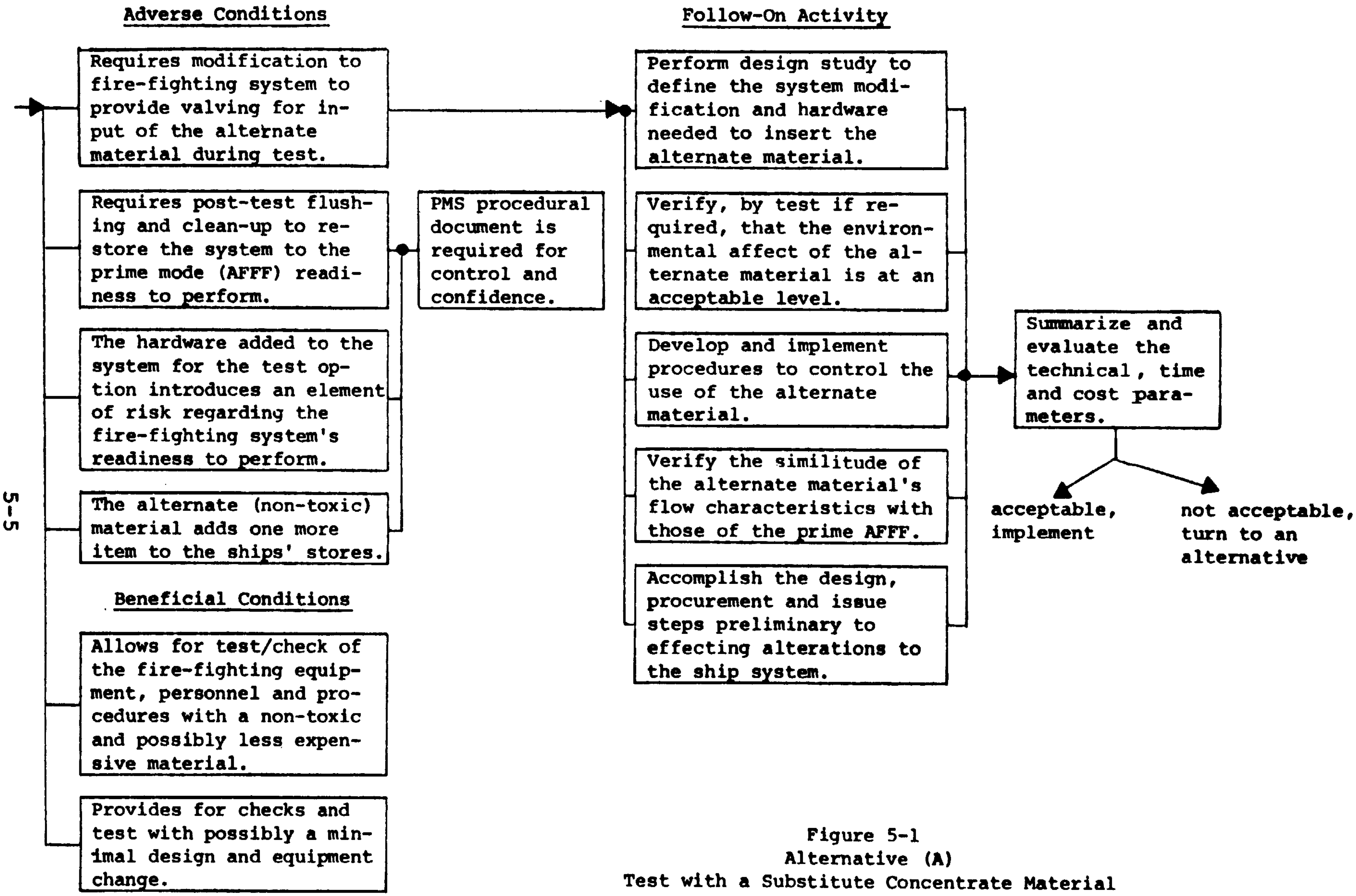


Figure 5-1
Alternative (A)
Test with a Substitute Concentrate Material
Flow Chart

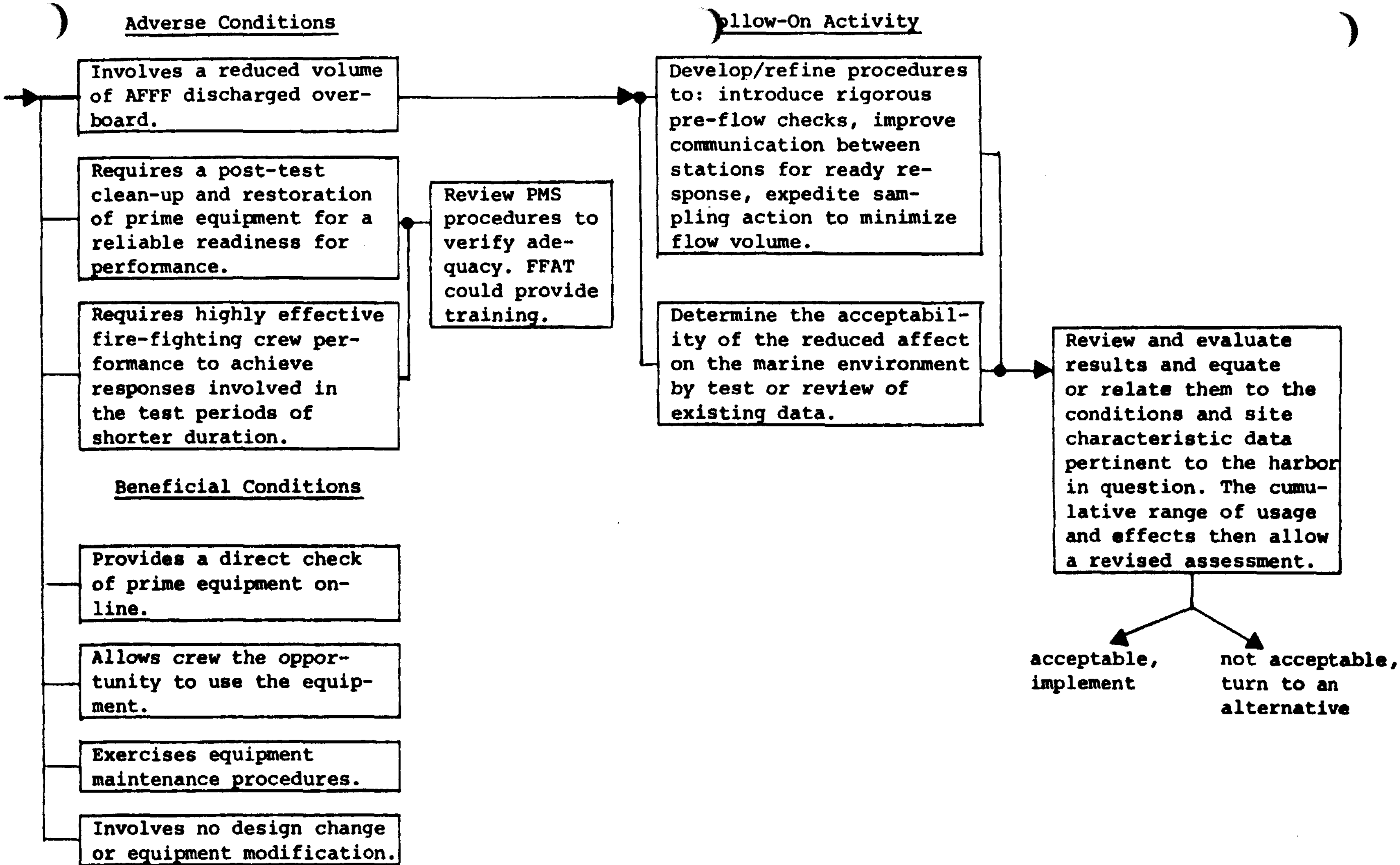


Figure 5-2
Alternative (B)
Refine Procedures to Reduce Discharge Volume
Flow Chart

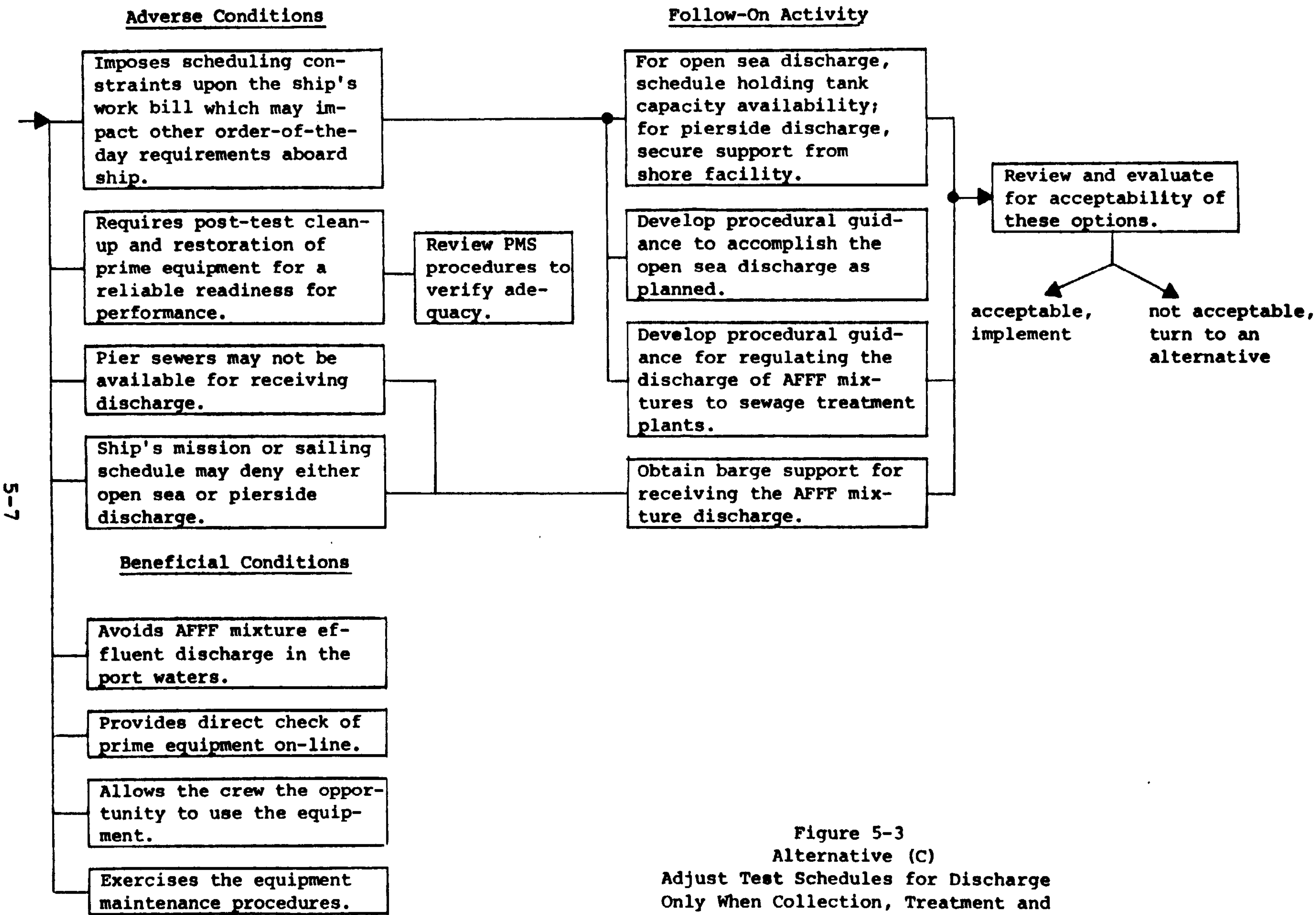


Figure 5-3
Alternative (C)
Adjust Test Schedules for Discharge
Only When Collection, Treatment and
Disposal Facilities are Available
Flow Chart

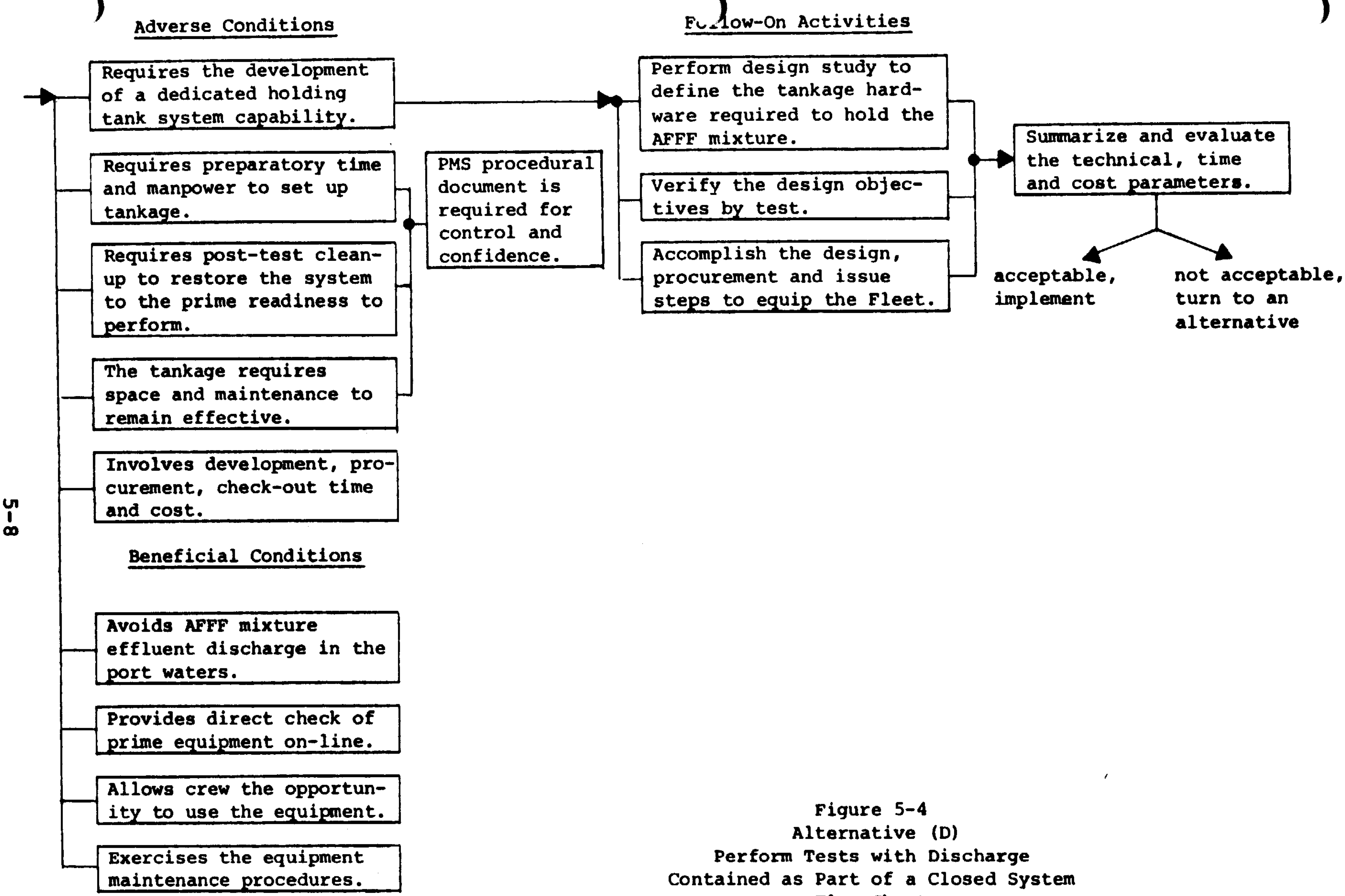


Figure 5-4
Alternative (D)
Perform Tests with Discharge
Contained as Part of a Closed System
Flow Chart

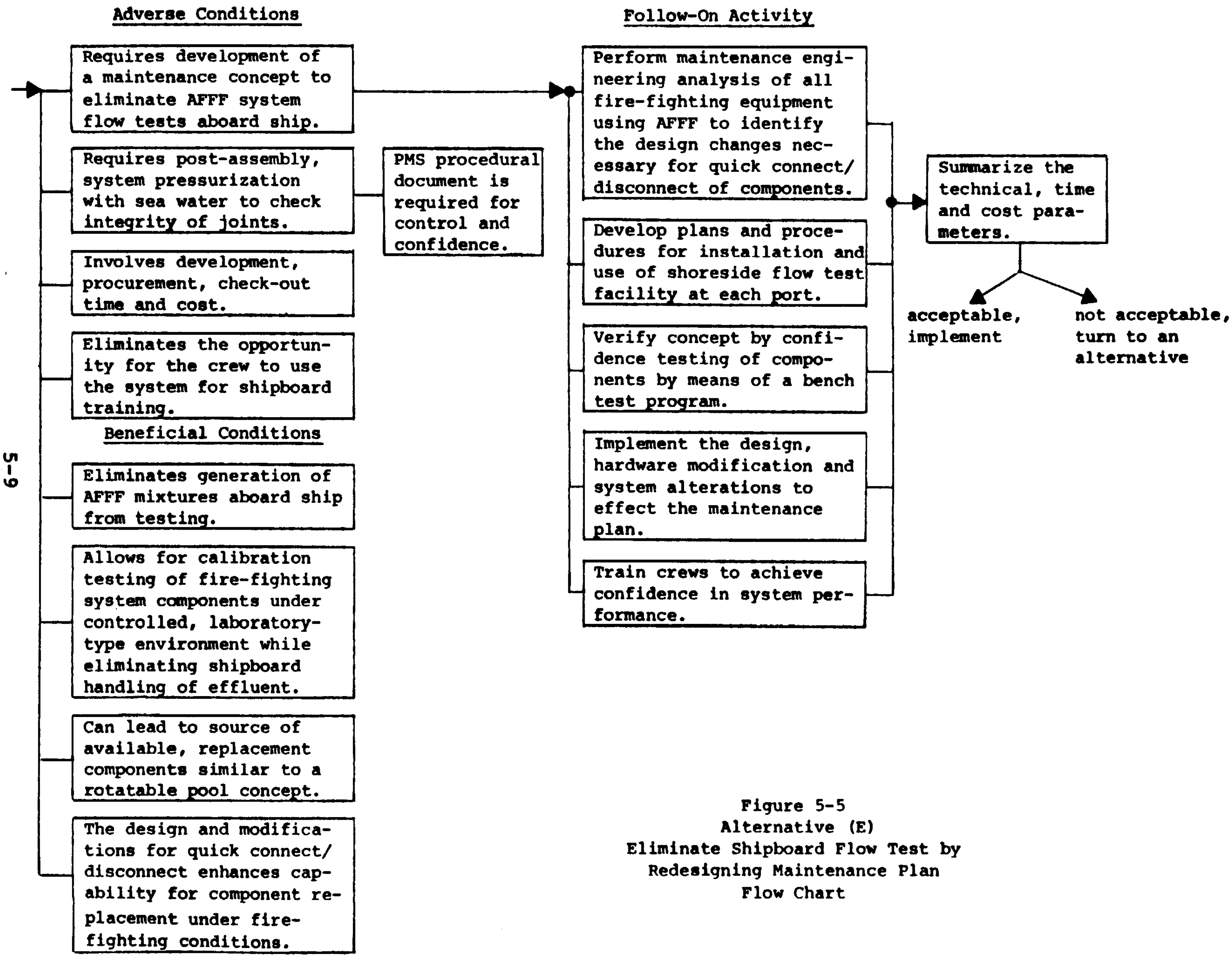


Figure 5-5
Alternative (E)
Eliminate Shipboard Flow Test by Redesigning Maintenance Plan Flow Chart

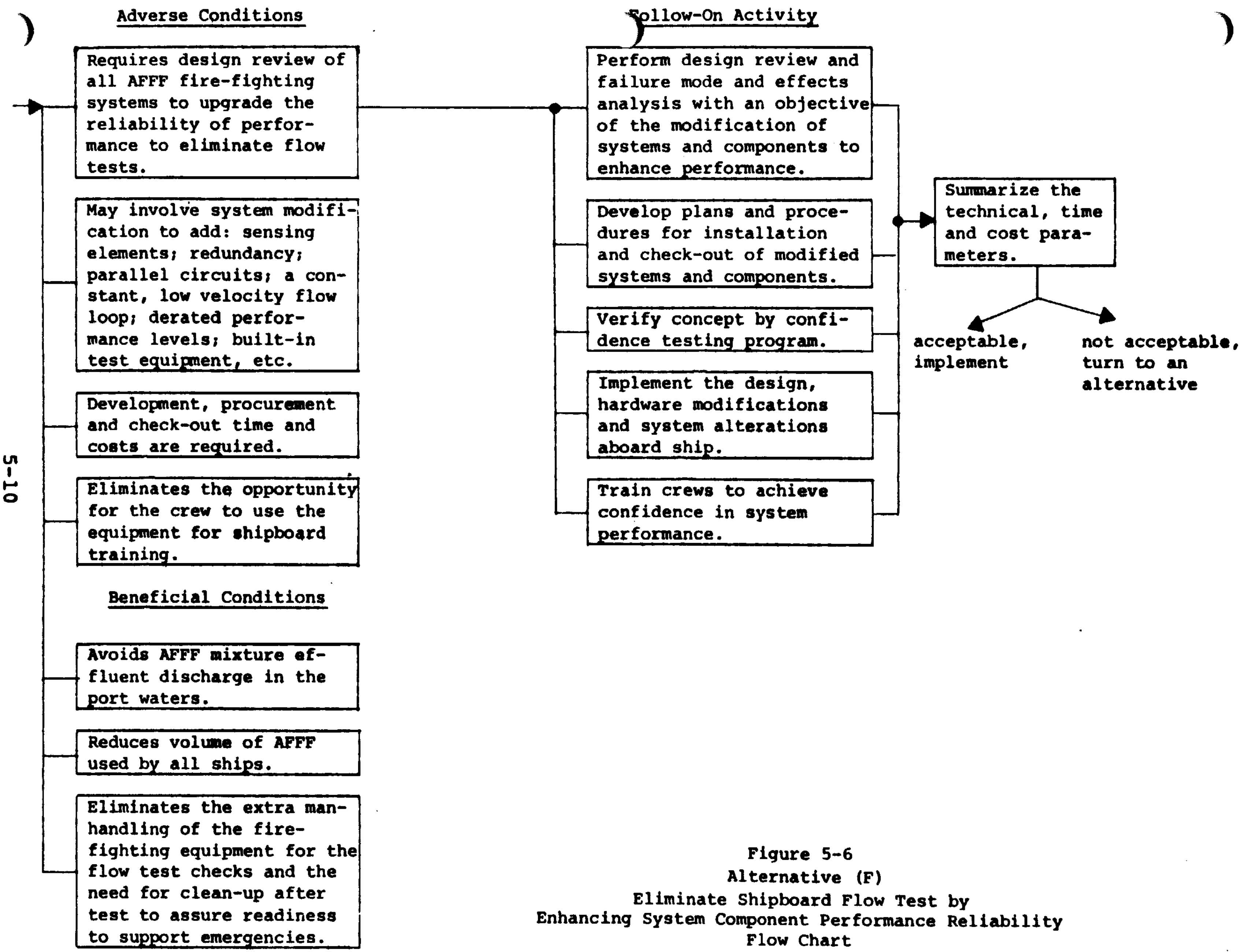


Figure 5-6
Alternative (F)
Eliminate Shipboard Flow Test by
Enhancing System Component Performance Reliability
Flow Chart

a. This alternative has already been investigated by NRL.[18] The NRL report considered several test materials which duplicated AFFF concentrate in viscosity and had a suitable refractive index for analysis using the hand-held refractometer presently used. Glycerin was one of the materials found to give the desired performance, was readily available and was low in cost, and it was therefore evaluated. The NRL study concluded, "It is feasible to simulate AFFF concentrates for proportioner testing by adding appropriate agents to water to give it the proper viscosity and refractive index."[18] However, the use of a substitute material was not recommended. The report further stated, "It is believed that the logistical problem of having a simulated concentrate in the supply system, the operation of change-over from real concentrate to simulant and then back to real concentrate for each test, and the increased potential for introducing errors and confusion would not be justified on the basis of the differential costs per gallon of the simulated and real concentrates."[18]

b. NAVSEC considered glycerin as an AFFF substitute for testing but found it unacceptable from an operational standpoint although glycerin has a lower toxicity than FC-206 (appendix E). They stated the following.

"Because glycerin might react with AFFF substances and make AFFF substances ineffective, use of glycerin for testing of foaming stations would require that the tanks be washed out following use of glycerin and refilled with AFFF. The chance of contamination of AFFF tanks by glycerin, which might make AFFF tanks inoperable or reduce the AFFF concentration to unacceptable limits, makes the use of glycerin for testing proportioning pumps less advisable.

In addition, the use of glycerin for testing could allow operational mistakes that affect foam unit performance to occur. If a foam station was accidently left filled with glycerin, the foam unit could be totally ineffective. If a second tank and valving were added, valves could be left set in the wrong position after testing. Any of these occurrences could turn a small fire into a major casualty if the foam unit malfunctioned. The subsequent possible loss of lives therefore makes this alternative unacceptable."[19]

c. AFFF is a highly developed fire-fighting substance. It is unlikely that a substitute substance could be found that is compatible with AFFF such that operational effectiveness is not degraded and a substance that is also environmentally more acceptable for discharge.

d. Therefore, alternative (A), test with substitute concentrate material, has been rejected.

6. When the objective of alternative (B), refine procedures to reduce discharge volume, is considered with regard to the environmental assessment parameters of table 4-1, it is concluded that, by the nature of the change to reduce the volume of the discharge, the potential for harmful impact is reduced.

a. Current testing time is now approximately one minute. Shorter times may be acceptable providing foam is being delivered from the nozzle in a uniform spray pattern and the hose has been previously flushed with salt water to verify that the hose is not clogged. However, if new in-line test devices (as described in section 9) are adopted, observation of nozzle spray pattern will be impossible. Also, even though the test operating time could theoretically be reduced, there is no assurance that the test team could or would minimize generation times. An AFFF discharge would still result.

b. Alternative (B), refine procedures to reduce discharge volume, is rejected.

7. Alternatives (C) and (D) have as an objective, the elimination of untreated AFFF discharges in port while still permitting system testing as currently practiced; therefore, the potential for damaging the environment is eliminated if adequate treatment is provided.

a. Alternative (C), adjust test schedules for discharge only when collection, treatment and disposal facilities are available, relies on direct discharge to waste collection systems other than those specifically for AFFF containment. These waste collection systems include shipboard wastewater CHT systems, SWOB's, donuts and tank trucks. Also included in alternative (C) is discharge to open sea in unrestricted waters directly from AFFF systems undergoing tests or indirectly through CHT systems. Such an alternative is not considered viable, however, as ship safety requires that machinery space AFFF fire fighting systems be tested prior to getting underway.

(1) CHT systems are being installed on ships as part of the Navy program to eliminate the discharge of shipboard sanitary wastes into navigable waters.

(a) CHT systems provide for the collection and transfer of sewage from waste drains as well as soil drains. Waste drains collect wastewater from hotel services such as showers, lavatories, laundries, galleys, sculleries, sinks, etc. Soil drains collect sanitary sewage from water closets and urinals. Separate soil and waste drains transport waste to collection headers for diversion overboard or to the holding tank. The holding tank contains sensing elements to control sewage pumps, a flushing system, and may contain an aeration system. Waste is transferred from the holding tank by sewage pumps, through discharge piping overboard either to the sea or through deck discharge fittings and hose to shore.[20]

(b) The major advantage of utilizing CHT systems for collection of shipboard generated AFFF is that the waste handling system is already aboard, and therefore extensive installation and alteration of a specific AFFF waste handling system is avoided. A lesser advantage from an AFFF waste handling standpoint is the initial dilution with other waste streams that the AFFF will have in the tank prior to pump-out. The degree of dilution will vary from ship class to class based upon the normal working capacity of the tank. Any dilution of AFFF waste prior to handling or treatment will lessen the possible waste handling problems due to foaming and lessen the possible waste treatment problems due to high BOD loading. A tentative installation schedule for CHT's is provided in appendix G.

(2) SWOB's were originally conceived for the collection of oily waste from aircraft carriers, ships at anchor, and ships berthed at remote locations. The SWOB's procured in FY74 and FY75 were outfitted to handle only oily waste. Eighteen will be constructed with FY76 funds; thirteen will handle sewage, five oily waste. A sewage retrofit package developed in FY76 can be used at the discretion of the user activity to convert an oily waste barge to a sewage barge.

(a) SWOB's scheduled for procurement in FY76 are 75,000 gal (284 m^3) barges intended for the collection of sewage from ships at anchor, or berthed at locations where pier sewers are not planned because of high construction costs. The barges would transport the waste collected to available pier sewers or some other discharge location for adequate treatment and disposal. A tentative allocation plan for SWOB's is provided in appendix G.

(b) The advantages of utilizing SWOB's for collection and transport of AFFF wastes are the same as those for CHT systems.

(3) Waste oil rafts, or "donuts" as they are called, are for the collection and transport of oily waste from ships berthed at piers without oily waste collection facilities and from ships at anchor.

(a) A donut is a circular or elliptical cylinder with a flotation collar at the upper open end. The lower end of the cylinder extends several feet beneath the harbor water surface. The bottom is usually closed by baffles (older systems have open bottoms). Waste oil or waste oil-water mixture is discharged from a ship into the top of the donut displacing water within the donut. The water and oil separate gravimetrically within the donut. The floating oil is confined within the donut and any water added flows out of the donut and mixes with the harbor water. A donut can be towed from ship to ship until full, and then it is pumped out to an oil disposal or reclamation facility.

(b) A donut is an unsatisfactory means of collection and transportation for AFFF discharges. The specific gravity of sea water (1.02 - 1.03 at 4°C) and the specific gravity of AFFF (FC-206, 1.020 at 4°C) are nearly identical. Furthermore, they are fully miscible. Therefore, AFFF and sea water will not separate gravimetrically and a donut will have no separation or confining effect.

(4) Liquid wastes are often removed from naval installations by contractors utilizing tank trucks. Wastes can be collected in shoreside tanks which are emptied by a contractor or discharged directly into waiting trucks.

(a) Disposal of AFFF waste discharges by contractor is an acceptable alternative that is practiced in some locations (i.e., Long Beach Naval Shipyard, appendix D). However, disposal by contractor involves additional coordination between ship, shore facility, and contractor, and therefore it involves additional expense and possibly delays.

(b) Collection of AFFF in tanks could be an acceptable alternative until other more efficient alternatives become available.

b. Alternative (D), perform tests with discharge contained as part of a closed system, relies on a designated shipboard holding tank for containing AFFF wastes. Alternative (D) differs from alternative (C) in that specific ancillary shipboard equipment would have to be provided for alternative (D).

(1) Allocating additional space and equipment aboard ship for handling only wastes from AFFF testing is not attractive. A closed test system would only be used during infrequent in-port testing (estimated as once every three years). It would have to be fabricated of materials compatible with AFFF and cleaned and serviced after use. The added benefit derived from dilution with other shipboard waste streams (in CHT system collection alternative (C)) prior to disposal would also be lost. Strict shipboard size and weight limitations would make location of an AFFF collection system difficult. Therefore, the operational and physical disadvantages of providing a separate, closed AFFF test system makes alternative (D) much less attractive than utilizing existing waste handling systems, alternative (C).

(2) Alternative (D), perform tests with AFFF discharge contained as part of a closed system, is rejected.

8. Alternative (E), eliminate shipboard flow test by redesigning maintenance plan, has as an objective the elimination of shipboard flow testing with AFFF and thus the generation of the waste aboard ship.

a. This option recognizes that the fire-fighting systems are comprised of electro/mechanical/hydraulic components connected electrically and/or hydraulically aboard ship. System evaluation could identify the key components requiring AFFF flow test for operational confidence. With some design change, the critical components could be given quick connect/disconnect capability to allow the scene of confidence checks of the components to shift from the ship to shore side where the AFFF discharge could be more easily disposed of without contamination of harbor waters. An overall shipboard fire-fighting system pressure/flow confidence check could be performed using sea water. A program of design, procurement, training and installation is involved. The implementation of this alternative accrues a dividend by increasing the effectiveness of maintenance capabilities.

b. Although alternative (E) eliminates shipboard testing, implementation of a maintenance plan would require time. Shipboard testing would have to continue in the interim period. Alternative (E) is rejected.

9. Alternative (F), eliminate shipboard flow test by enhancing system component performance reliability, has as an objective the elimination of shipboard flow testing with AFFF.

a. A systems analysis could be performed with the objective of changing equipment design to maximize the operational reliability and thereby, by performance, assure confidence in the system without regular flow tests using AFFF. Consideration of the classic paths to increased reliability such as: redundancy, added sensing circuits or parallel circuits, derated performance requirements, built-in test equipment, etc. are warranted.

b. Alternative (F), like alternative (E), also eliminates shipboard testing. However, also like alternative (E), alternative (F) would require time to implement. Thus, alternative (F) is rejected.

10. Table 5-1 summarizes the advantages and disadvantages of the six alternative actions considered. The alternatives are rated satisfactory or unsatisfactory based upon evaluation criteria under the environmental and operational objectives. Each alternative was evaluated based upon the same criteria in table 5-1. Implementation of any of the alternatives would reduce the navigable waters impact of the proposed action; however, alternatives (A), (D), (E), and (F) all have operational disadvantages and were therefore rejected. Alternatives (B) and (C) have been rated most satisfactory based upon the operational objective and are therefore most desirable. However, neither alternative (B) nor (C) can be implemented immediately. Therefore, due to the firm safety requirement for continuing AFFF system testing, the following approach is preferred.

11. Preferred Approach. Considering the proposed action and the alternative actions with a high regard for safety as well as the environment, the preferred approach to testing AFFF fire-fighting systems is continuation of current practice: in port, discharge minimum quantities of AFFF into the waters of those harbors where collection and treatment or alternate disposal of test effluent is not now practiced, and at sea, conduct as many of the necessary tests as possible while a ship is underway in unrestricted waters.

Table 5-1
Comparative Summary of the Affects of the Alternative Actions

Evaluation Criteria	Alternatives					
	(A)	(B)	(C)	(D)	(E)	(F)
Environmental Objective: Reduce Environmental Impact						
1. Navigable waters impact reduction.	S	S	S	S	S	S
2. Lead time to begin implementation of alternative.	U	U	U	U	U	U
Operational Objective: Reliable, Efficient, Simple Operation						
Maximize;						
1. Crew confidence by direct check of equipment on-line.	S	S	S	S	U	U
2. Crew experience through actual equipment use.	S	S	S	S	U	U
Minimize;						
1. AFFF system complexity.	U	S	S	U	S	U
2. AFFF equipment redesign or modification.	S	S	S	S	U	U
3. Ancillary equipment not otherwise available.	U	S	S	U	S	U
4. Logistical support.	U	S	S	U	U	U
5. Maintenance (manpower) requirement.	U	S	U	S	U	S
6. Additional training requirement.	U	U	S	U	S	S
7. Imposition of test scheduling restraints.	S	S	U	S	S	S
S - satisfactory TOTAL S	5	9	8	6	5	4
U - unsatisfactory TOTAL U	6	2	3	5	6	7

a. AFFF system test procedures can be used that both minimize the quantity of effluent generated and eliminate the foaming of the discharge on the harbor surface. Some Navy port facilities, on their own initiative, have implemented procedures for collecting AFFF discharges in portable tanks, pierside sanitary sewers, waste collection barges, or tank trucks (Norfolk Naval Shipyard, Charleston Naval Shipyard, Mayport Naval Station, San Diego Naval Station, and Long Beach Naval Shipyard). Appendix D includes disposal procedures used by Long Beach Naval Shipyard (an example of tank truck disposal) and Norfolk Naval Shipyard (an example of disposal in a sanitary sewer). Until adequate collection and disposal procedures are tested and implemented at other port facilities, direct overboard disposal of AFFF test effluents will be necessary. Adoption of test procedures using the in-line test device recommended by the FFAT, and further development of more environmentally acceptable AFFF formulations would continue to reduce the impact of overboard discharges (see section 9).

b. Table 5-2 shows the capabilities for treating AFFF discharged to the sanitary sewer system at the ten major naval port facilities listed in table 2-1. Estimates of the daily sewage flows from the naval installations and the operating capacities of the listed sewage treatment plants have been

Table 5-2
Treatment Capabilities for AFFF at Major Naval Port Facilities

Naval Port Facility: Location	Naval Port Facility: Approximate Daily Flow in Millions gal (m^3)	Plant Name	Type	Operating Daily Flow in Millions gal (m^3)	Tank Truck Pumpout Rate for 200 µℓ/ℓ Port Facility Discharge gpm (ℓ/m)	Sewage Treatment Plant Influent AFFF Concentration with 200 µℓ/ℓ Port Facility Discharge µℓ/ℓ
San Diego, CA: Naval Station, North Island, Point Loma	 1.0 (0.004) 1.5 (0.006) 0.2 (0.001)	City of San Diego Metropolitan Sewage Treatment Plant, Point Loma	Primary	100 (0.378)	 0.14 (0.53) 0.21 (0.79) 0.03 (0.10)	2.0
Norfolk, VA	4.0 (0.015)	Hampton Roads Sanitary District, Army Base Plant	Primary (E.1979)	16 (0.060)	0.56 (2.1)	50
Charleston, SC	1.4 (0.005)	North Charleston Sewer District Plant	Primary (E.1980)*	11 (0.042)	0.19 (0.74)	25
Pearl Harbor, HI	5.5 (0.021)	Fort Kamehameha Tri-services Treatment Plant	Secondary	5.5 (0.021)	0.76 (2.89)	200
Philadelphia, PA	1.0 (0.004)	City of Philadelphia South East Water Pollution Control Plant	Primary (E.1980)	136 (0.515)	0.14 (0.53)	1.4
Mayport, FL	0.6 (0.002)	Mayport Naval Station Treatment Plant	Secondary	0.6 (0.002)	0.08 (0.32)	200
Little Creek, VA	1.0 (0.004)	Hampton Roads Sanitary District, Elizabeth River Plant	Secondary	16 (0.060)	0.14 (0.53)	12
Long Beach, CA	1.0 (0.004)	Port of Long Beach, City of Los Angeles, Terminal Island Treatment Plant	Secondary	11 (0.042)	0.14 (0.53)	18
Bremerton, WA	0.6 (0.002)	Charleston Treatment Plant	Primary (E.1980)*	6 (0.023)	0.08 (0.32)	20
Alameda, CA	1.1 (0.004)	East Bay Municipal Utilities District Treatment Plant	Primary (E.1977)	80 (0.303)	0.15 (0.58)	2.8

*Estimated completion date of secondary treatment plant.

obtained from the Navy Environmental Support Office (Code 25), Port Hueneme, California, and NAVFAC Engineering Field Divisions. A maximum target AFFF concentration of 200 μℓ/ℓ in the port facility has been selected to minimize foaming in the municipal sewer system. Based upon findings of a USAF study (appendix E), operational problems due to foaming occurred in a bench scale-activated sludge sewage treatment plant at concentrations above 200 μℓ/ℓ. The USAF study concludes that FC-206 can be successfully treated at concentrations of 200 μℓ/ℓ on a continuous basis. Tests reported by the 3M Company (appendix E) showed no microbial inhibition at concentrations less than 1000 mg/ℓ. Therefore, it appears that the degree of foaming and not the treatability of AFFF effluents will determine acceptable discharge concentrations.

c. Dilution of an AFFF test effluent within the port facility will occur in two stages: first, initial dilution in the CHT tank; second, dilution in the port facility sewer system. Figure 5-7 illustrates the initial dilution required in a CHT tank such that, when combined with the dilution in the sewer system, the AFFF concentration leaving the facility does not exceed 200 μℓ/ℓ. Figure 5-7 assumes collection of 90 gal (0.34 m^3) of 6% AFFF solution (5.4 gal [20.4 ℓ] AFFF) per CHT tank discharge. Pumping rates of 100 gpm (6.3 ℓ/s) and 150 gpm (9.5 ℓ/s) are most common; exceptions are 400 gpm (25 ℓ/s) pumps aboard two NIMITZ class ships, 800 gpm (50 ℓ/s) pumps aboard five TARAWA class ships, and 20 gpm (1.3 ℓ/s) pumps aboard one ALBANY class ship.[21] Ships with a combination CHT tank capacity and pumping rate that plots below their facility location line in figure 5-7 would have to find alternative disposal or dilution procedures (i.e., separate holding tank, SWOB barge, etc.).

d. Thus, completion of shipboard CHT tank installation, pier sewer construction, and SWOB delivery could eliminate AFFF system test effluent discharges to harbor waters by calendar year 1981.

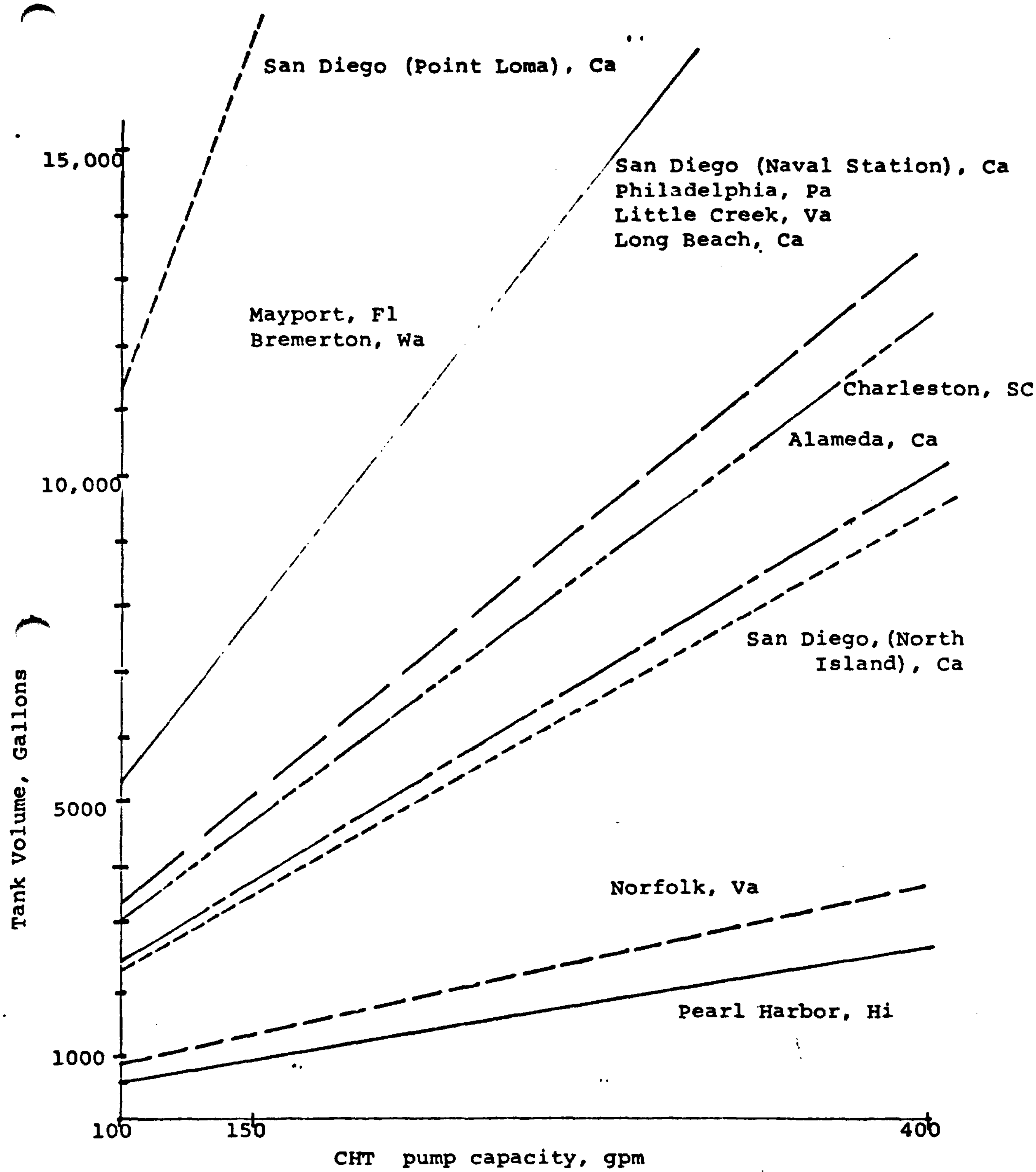


Figure 5-7. CHT Tank Dilution Volumes Required to Maintain AFFF Concentrations at or Below 200 ul/l in the Port Facility Discharge.

SECTION 6

PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

1. Although the quantities of 6% AFFF mixtures that will be discharged are very small compared to other wastes discharged in and around harbor areas, a single assessment of the environmental effects of an action which occurs in many varied locations and under differing circumstances is difficult. Regularly scheduled testing of AFFF fire-fighting systems will occur aboard less than 500 Navy ships scattered in not less than 33 ports.

2. The chronic effects of AFFF chemicals on marine life are as yet unknown. Potential toxicities of residual chemical forms and the possible bioaccumulation of AFFF chemicals in plants or animals has not yet been determined. However, existing evidence on the high degree of biodegradability of AFFF and the treatability of AFFF mixtures by conventional biological treatment plants, provides supportive evidence that AFFF can be assimilated into the environment with little if any harmful effect (appendix E).

SECTION 7

THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

1. The current discharge of AFFF test effluents into harbor waters for disposal should have no immediate or short-term effect upon the use of a harbor area for industrial purposes. It is unlikely that the industrialized uses of port facilities will change in the near future because commerical aquatic or recreational uses of the environment are not currently compatible with an industrialized area. Therefore, long-term productivity of the harbor area as currently defined will not be affected.

SECTION 8

ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES THAT WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

1. The tests and bioassays reported in appendix E are all of a comparatively short-term duration. The long-range impact resulting from the continued use and discharge of AFFF mixtures is not known. It has been recognized that persistent contamination at low levels of toxicity may be more harmful to marine life than sporadic occurrences of higher concentrations.[22] Discharges of AFFF test mixtures into harbors are only avoidable in those ports in which facilities for collection and transfer of liquid waste from ship to shore are operational. Preceding implementation of preferred alternative solutions identified in section 5, water quality in the immediate vicinity of an AFFF discharging vessel will be adversely affected for a short time. There are no corroborating data from long-term tests at low levels of AFFF concentration. The level of any irreversible or irretrievable commitment of natural resources by implementation of the proposed action, if it were to continue unchanged, is not known.

SECTION 9

CONSIDERATIONS THAT OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS

1. The CNM/NAVSEA FFAT has found that many shipboard installed fire-fighting systems and foam proportioners were unreliable for a variety of reasons (i.e., proportioners worn, valving faulty and/or misaligned, electrical circuitry incomplete or otherwise inoperative and piping integrity severely degraded). One of the principal reasons for the conditions found has been attributed to the lack of adequate testing of proportioners and associated systems due to environmental considerations. Because of such considerations, current in-port test procedures require that foam discharges must be collected on board in a tank or discharged to a suitable containment vessel. At-sea test procedures specify that a ship must be underway at 10 knots and be outside the 12-mile limit prior to conducting tests that discharge foam solutions overboard. As a result, when the foregoing requirements cannot be met, many foam proportioners and associated systems are not properly tested prior to a ship getting underway. In event of a shipboard fire such lack of testing presents an undue hazard to the ship as well as to personnel aboard. Together with routine PMS testing requirements, tests are particularly needed after completion of alterations, repairs, or installation of AFFF systems during ship overhauls or after construction. A firm requirement exists to conduct tests in port prior to sea trials.

AFFF discharge from some systems cannot be easily contained due to necessary design configurations and the amount of foam produced. The problem of containment is further complicated in some instances because suitable collection vessels are not readily available, and ship's bilges, tanks and/or barges usually contain small amounts of oil making them unsatisfactory for receiving AFFF mixtures. Disposal of mixtures of oil and AFFF solutions is extremely difficult from a practical standpoint in that AFFF renders the oil unsuitable for disposal by conventional means. It is therefore imperative, in the interest of personnel safety and material protection, that fully operable and reliable fire-fighting systems be maintained aboard ship. This requires regularly scheduled operational PMS testing and operational testing after equipment is newly installed, repaired, altered or converted. Until practical means of collection and alternate means of disposal are developed, it will be necessary to discharge AFFF mixtures overboard.

2. The following actions are currently being undertaken and will directly or indirectly either reduce the volumes of AFFF discharged or lessen the environmental impact of those discharges.

a. In view of the chronological improvement in the toxicological character of AFFF formulations as supported by evidence contained in appendix E, it is reasonable to assume that variants could ultimately become available that would be environmentally even more acceptable than currently available AFFF's. A study has begun to develop new formulations of AFFF material to improve environmental characteristics (Contract No. N00173-76-R-B-039). The development of experimental AFFF formulations that would exhibit a reduced impact on the environment while retaining fire-fighting effectiveness will be explored. The study will examine the effect of AFFF formulation components on the BOD, COD, biodegradability, toxicity toward sewage bacteria, fish toxicity, effect of component concentration on selected environmental/biological parameters, formulation design experiments, and analytical methods evaluation. New AFFF formulas will be selected and screened for fire-fighting performance and physiochemical properties. Alternate analytical methods for determining solution concentration shall be conducted to determine if a simpler method for use in the field is feasible.

b. The Navy has embarked on a program to eliminate the discharge of shipboard sanitary wastes into navigable waters in accordance with PL 92-500, its implementing standards and regulations. To accomplish this program, pier sewers are being constructed to collect ship CHT system discharge for shoreside treatment. Pier sewer construction began in FY73 and is scheduled for completion in FY81. Pier sewers will provide an environmentally acceptable means for disposal of shipboard generated AFFF testing mixtures to sewage treatment plants. The construction schedule for major port wastewater collection facilities ashore as of 15 October 1976 is contained in appendix G.

c. The discharge into a harbor of AFFF solutions through an aeration nozzle has, in the past, produced unsightly expanses of foam floating on the harbor surface. Through the adoption of an in-line foam testing device developed by the FFAT, the aeration nozzle is no longer required for testing and the foaming problem is being eliminated. The device consists of a standard nozzle gauge adapter now required for foam testing, a small drain valve for sample collection, and a selection of interchangeable orifice plates for obtaining desired flow rate. The open end of the hose run from the device may be inserted directly into a tank top or held beneath the surface of a receiving body of water. It prevents the normal 5 to 1 expansion of foam that causes a collecting tank to fill and overflow rapidly or that causes the unsightly foam layer floating on a harbor surface.

SECTION 10

REFERENCES

1. Geyer, G.B., "History, Research, and Foam Developments," Proceedings of a Seminar on Fire Fighting Foams - Their Characteristics and Uses in Fuel Conservation, John Hopkins University, APL/JHU FPP B74-1, December 1974.
2. Chapman, K.H., "Shipboard Foam Fire Fighting Equipment Conversion from Protein Foam to AFFF," NAVSHIPS Tech News, pp. 15-22, February 1974.
3. DTNSRDC Report TM-1863-5-76, "Catalog of U.S. Navy Commissioned Surface Ships and Shipboard Waste Management Systems," December 1976.
4. OPNAVINST 6240.3D of 24 August 1975, Chapter 1, Part 1, Paragraph 1103.
5. NAVSEA 0993-LP-023-6010 Technical Manual, Type 1, Operation and Service Manual with Illustrated Parts List for Fire Extinguishing System, Twin Agent (AFFF and PKP), 10 January 1975.
6. "Ship's Industrial Waste Handling Report," Draft, Prepared by Lowry and Associates, San Diego, for NAVFACWESTDIV, September 1976.
7. Ridley, E.W., "The Relative Flushing Capability of Eighteen Harbors," unpublished manuscript 33-60, U.S. Navy Hydrographic Office, July 1960.

8. Fisher, L.J., "Field Report, Mayport Basin, Florida, Dye Dispersal Tests," unpublished manuscript 38-63, U.S. Naval Oceanographic Office, August 1963.

9. Fisher, L.J., "Field Report, Pearl Harbor Dye Dispersal Tests," unpublished manuscript 102-61, U.S. Navy Hydrographic Office, July 1961.

10. Cline, C.H. and Ridley, E.L., "Field Report, San Diego, Dye Dispersal Tests," unpublished manuscript 14-60, U.S. Navy Hydrographic Office, May 1960.

11. Fisher, L.J., "Field Report, Mare Island Strait Dye Dispersal Tests," unpublished manuscript 0-26-62, U.S. Navy Hydrographic Office, April 1962.

12. Cline, C.H. and Maloney, W.E., "Field Report, James River Dye Dispersal Tests," unpublished manuscript 1-60, U.S. Navy Hydrographic Office, February 1960.

13. "Dispersion of Sanitary Wastewater Discharges from Navy Ships," NSRDC Report 4194, August 1974.

14. Fisher, L.J., "Field Report, Key West Harbor Dye Dispersal Test," unpublished manuscript 13-61, U.S. Navy Hydrographic Office, May 1961.

15. "Strategy on Fire Protection," NRL Memorandum 6180-428:HWC: pij to NAVMAT 03T, 12 August 1976.

16. Jablonski, E.J., Peterson, H.B., and Tuve, R.L., "A Comparative Testing Study of Fire Extinguishing Agents for Shipboard Machinery Spaces," NRL Memorandum Report 1696, 15 April 1966.

17. Darwin, R.L. and Jablonski, E.J., "Full Scale Fire Test Studies of Sea Water Compatible 'Light Water' as Related to Shipboard Fire Protection," GPO 1969-394-017/S109, 25 August 1969.

18. Gipe, R.L., Butler, C.S., and Peterson, H.B., "A Substitute Liquid for AFFF Concentrate for Checking Proportioners," NRL Memorandum Report 2733, February 1974.

19. Environmental Impact Assessment/Report, "The Effect of Discharging Aqueous Film Forming Foam (AFFF) to the Sea," NAVSEC 6159, July 1974.

20. NAVSEA 0901-005-0002 Technical Manual, Chapter 9005, Section V - Sewage, 1976.

21. Rice, M.S., Liu, H., and McClellan, G.E., "CHT Ship/Shore Interface Information Book," Hydronautics Technical Report 7607.41-1, Prepared for NAVSEC 6159, October 1976.

22. Warren, C.E., "Problems of Toxic Substances in Biology and Water Pollution Control," W.B. Saunders Co., Philadelphia, 1971.

APPENDIX A

EXCERPT FROM

NAVSEA MESSAGE 191523Z FEB 1975

AFFF TESTING

FM COMNAVSEASYSCOM WASHINGTON DC

TO (SHIPYARDS)

A. COMNAVSHIPSYSCOM WASHINGTON DC 230053Z FEB 74 (NOTAL)

B. COMNAVSHIPSYSCOM WASHINGTON DC 010005Z NOV 74 (NOTAL)

1. The requirements of ref A are superseded by this message. Naval industrial activities must test each shipboard AFFF fire fighting system that has been newly installed, modified or repaired by the activity prior to ship departure. The tests shall be conducted using only approved AFFF concentrate solutions and results certified to the ship's commanding officer. If the test solutions must be collected, they shall be clearly identified and disposed of in accordance with local regulations. End of summary.

2. All AFFF fire fighting equipment that is newly installed, repaired, altered or converted from protein foam by an industrial activity shall be tested to insure proper operation and required output. It is recommended that ship's force verify proper lineup and operational integrity of all other fire fighting systems not included in the foregoing. The following shall be observed when testing AFFF hoses:

a. The minimum acceptable concentration of AFFF in the output mixture of the system is 3.5 percent.

b. Allow foam to be generated for one minute before taking a sample. After the sample has been taken the system should be secured ASAP to avoid excessive use of AFFF concentrate.

c. If the only work done on a system was on the foam generator, (proportioner or pump), then only one hose shall be tested with AFFF to verify the foam generator performance. It is recommended, however, that all other hose lines be tested by use of salt water to verify system line up.

d. All systems shall be tested with the installed nozzle at maximum trigger depression or maximum handle throw. 1 and 1/2 inch variable flow nozzles shall be set at 95 gallons per minute, (gpm), in machinery spaces, and 125 gpm in hangar bays or flight decks. Set 2 and 1/2 inch var. flow nozzles at 250 gpm.

e. Output concentration shall be determined by refractometer analysis, using American Optical Inst. Co. Refractometer No. 10402 or 10430 or equal, NSN 1H 6650-00-107-8509, estimated unit price is $83.00. Samples for refractometer analysis shall be taken at the discharge of the nozzle and analyzed IAW MRC 13 C33R or 24 D82U within two hours after collection. Results of refractometer analysis shall be certified in writing from the industrial activity to the ship commanding officer prior to ship departure.

3. After extensive investigation and tests, it has been determined that AFFF fire fighting systems must be tested with AFFF concentrate to confirm specified system operation and concentration output. No substitute testing liquid is acceptable. The AFFF concentrate shall conform to MIL-F-24385 as identified

in ref B. Approved AFFF concentrate is available in the supply system under NSN 9C-4210-00-087-4742 for 5 gal. containers and NSN 90-4210-00-087-4750 for 50 gal. drums. Direct proprietary purchase of AFFF from any other source rather than the Navy Supply System shall not be made without prior approval of NAVSEA. Some previous 3-M products not on the qualified products list (QPL) that may be found aboard ship are still acceptable for Navy shipboard use. These formulations are the 3-M Co. formulations FC 195 and FC 199. These formulations are compatible with currently stocked QPL concentrates. 3-M formulation FC 196 should not be used due to its high free chlorine ion content which promotes pitting and corrosion of stainless steel.

4. For testing of the machinery space AFFF fire fighting systems the following requirements are applicable for active ships and new construction:

a. The requirements of paras 2 and 3 apply.

b. The systems shall be tested and certified in port prior to ship trial runs.

c. When testing in port AFFF/water foam shall not be discharged into harbor water since such discharge may be harmful to marine life. The AFFF/water foam can be either collected and contained in drums, tanks, tank trucks, sludge barges, closed bottom donuts, YO's or other suitable containers, or the foam can be discharged into the machinery space bilge.

If the AFFF/water foam is tested by discharging into the bilge, then bilge discharging shall be deferred until the ship is outside the 50-mile limit.

d. The AFFF/water foam should not be commingled with reclaimable waste oil products.

e. In port disposal of collected foam shall be governed by local regulations. Guidance information for in port disposal is available from the Environmental Branch of the cognizant NAVFAC Engineering Field Divisions.

5. For testing of AFFF fire fighting systems other than machinery space AFFF fire fighting system, the following requirements are applicable for active and new construction ships:

a. The requirements of paras 2 and 3 apply.

b. The required tests may be conducted while ship is at dockside, when the ship is outside the 3 mile limit and underway at a speed of at least ten knots or when the ship is outside the 12 mile limit, whichever is the most practical.

c. If the tests are conducted at dockside, the requirements of paragraph 4.c to 4.f apply.

d. If conducted while ship is outside the 3 mile limit and underway at ten knots or when ship is outside the 12 mile limit the AFFF/water foam may be discharged overboard as they are discharged from the system.

e. Aircraft carrier flight deck washdown systems (flush deck and deck edge nozzles) shall be tested outside the 12 mile limit. It is recommended that prior to AFFF/water foam testing the flight deck washdown system be thoroughly flushed with salt water to remove any oil and dirt that may have drained through the nozzles into the system.

6. NAVSEA is to be notified in the event that local authority prohibitions or other circumstances preclude testing and certification of shipboard AFFF systems as required by this msg. The point of contact at NAVSEA is Mr. P. Hans, SEA 0495D, Autovon 222-8504.

7. This msg does not authorize the expenditure of customer funds nor does it authorize change orders without prior NAVSEA or TYCOM approval.

APPENDIX B

COMPARISONS OF THE VARIOUS PARAMETERS OF AFFF'S

Comparison of Various Parameters of AFFF's*

Parameter	3M - Light Water			National Foam Systems	
	FC199	FC200	FC206	AOW 3	AOW 6
pH	4.6	7.6	7.8	7.8	7.9
Specific Gravity	1.02	0.989	1.020	1.062	1.031
Water		59%	70%	72%	72%
Diethylene Glycol Monobutyl Ether		39%	27%	10%	10%
COD $(X10^3)$	550 mg/ℓ	730 mg/ℓ	500 mg/ℓ	500 mg/ℓ	350 mg/ℓ
TOC $(X10^3)$		235 mg/ℓ	96 mg/ℓ	130 mg/ℓ	100 mg/ℓ
BOD_u $(X10^3)$	18 mg/ℓ	450 mg/ℓ	411 mg/ℓ	354 mg/ℓ	300 mg/ℓ
BOD_5 (% BOD_u)	37	2	65	45	45

*USAF EHL(K) Rept. 74-26, November 1974. (FOUO)

APPENDIX C

FP-180 WATER MOTOR PROPORTIONER

Naval Ships Technical Manual, Chapter 9930, Fire Fighting - Ship, Articles 9930.120 to 9930.123, September 1967 edition. (FOUO)

9930.120 FP-180 WATER MOTOR PROPORTIONER

1. The FP-180 water motor proportioner has 2½-inch connections at both the inlet and outlet sides and two ½-inch foam pickup tubes. It is a positive displacement foam liquid pump driven by a positive displacement water motor. Flow through the water motor causes the foam pump to inject a metered amount of foam into the fire stream, depending on the position of the foam valve. (See figure 9930-39.)

2. The foam valve has 3 positions, 1 for each of the 2 pickup tubes and an "off" position. A plexi-glass sight tube enables the operator to determine when to shift from 1 pickup tube to the other as a foam can becomes empty, thus ensuring a continuous supply of foam. In the "off" position, with flow through the fire line, water is delivered through the foam pump under pressure, and both water-motor and pump "float" on the line making the fire line available for conventional fire fighting.

3. The FP-180 may be permanently installed for some applications. In this case flexible couplings must be attached to the water motor inlet and outlet and a fixed pipe leading from an installed foam tank will be attached to one pickup tube inlet and the other inlet will be plugged. The foam valve is placed in one position only.

4. The water motor proportioner is designed to proportion 6 percent foam liquid into the fire lines at inlet pressures of 75 to 175 psi and with flows of 60 to 180 g.p.m.

5. Foam can be dispensed by any of the four following combinations:

a. One 1½-inch line equipped with foam nozzle and proportioner supplied by either a 1½- or 2½-inch hose line.

b. Two 1½-inch lines wyed off from the 2½-inch outlet. Both lines equipped with foam nozzles.

c. Three 1½-inch lines with foam nozzles.

d. One 2½-inch line equipped with foam nozzle.

9930.121 OPERATION OF THE PORTABLE FP-180 PROPORTIONER

1. Connect inlet to 2½-inch hose line and connect discharge lines, within capacity of proportioner and as needed. (On ships having 1½-inch fireplugs single 1½-inch inlet and outlet lines can be used.)

2. Set foam valve to "off" position. Foam valve should always be in "off" position except when actually drafting foam.

(61)

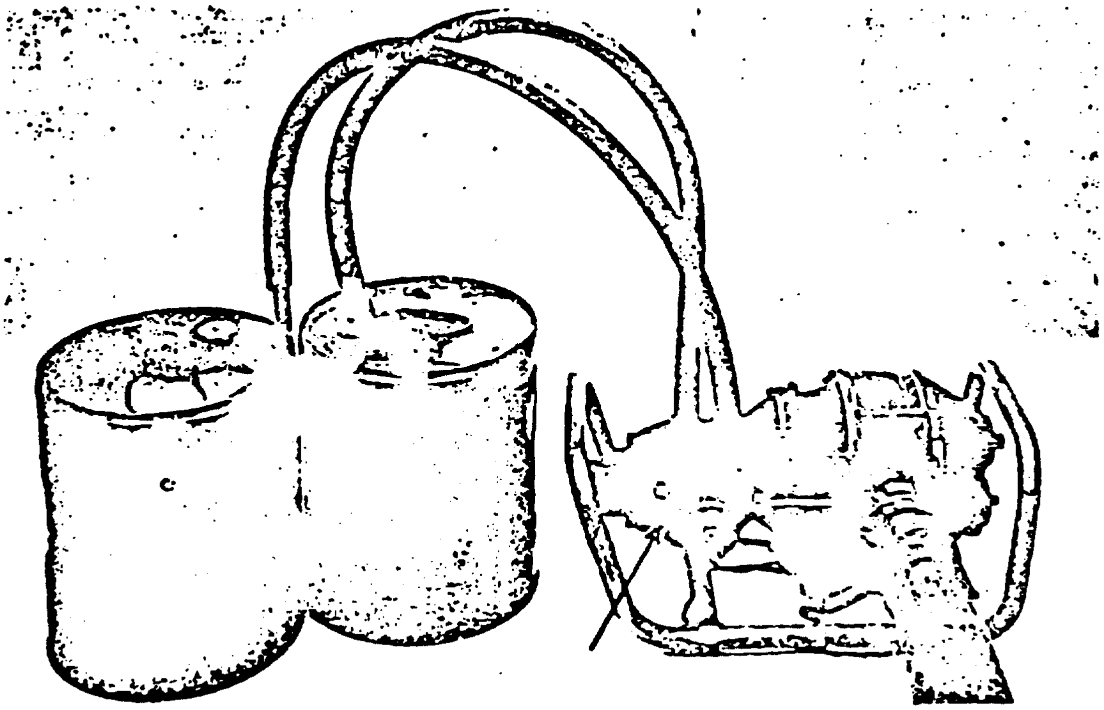


Figure 9930-39. Incoming, or upstream side, arrow points to handle in a foam position.

3. Insert each pickup tube in full foam can.

4. Actuate hose line. To start proportioning foam, shift : to "foam" position. The valve is so designed that, in intermediate positions, a jet of water flows through the pickup tube, purging air and ensuring an immediate prime of the foam pump. No noticeable dwell at intermediate positions is necessary to complete the action. If foam liquid color does not show in the plexiglass tube within a few seconds, shift to the other foam position and check for a blocked pickup tube or an air leak in the line. (1,2)

5. When a foam can is almost empty, shift to other "foam" position and replace empty can.

6. After proportioning foam, always flush the foam pump by running the proportioner two or three minutes in the "off" position, then work the valves two or three times when the unit is running. Return valve handle to "off" position when finished.

9930.122 OPERATION OF PERMANENTLY INSTALLED FP-180 FOAM PROPORTIONER

1. Installed FP-180 foam stations are arranged the same on all ships but may differ in type of controls used to actuate the system. Controls may consist of local manual control valves or remote hydraulic control valves.

2. The station will be composed of an FP-180, 50-gallon foam tank and associated piping and valves. The foam tank is arranged for quick filling from 5-gallon cans. Fitted with a vent, drain connection gage glass and access plates for cleaning.

3. The stations are installed to supply foam for machinery spaces and helicopter landing platforms. Proportioners for landing platforms are arranged for local manual control at the station. Those for machinery spaces may be arranged remote control from the foam hose outlets in the machinery and/or local manual control at the station. Figure 9930-40 shows the latest machinery space foam installation. The system is activated by turning the control cock to "drain", relieving pressure on value 1 which opens admitting seawater. Valve 2 is then opened by firemain pressure admitting foam liquid to the proportioner. This type system fails open, that is, any breech of control lines actuates the foam proportioner. The foam outlet valves still have to be opened to supply the hose lines.

4. On older installations, valve 1 is similar to valve 2 and is opened by turning the control cock to a position which admits firemain pressure to the valve bonnet, opening the valve. This type system fails closed when the control lines are breeched.

5. On still older installations the foam outlets are located outside the space on damage control deck with the foam station. In this case, one must leave the space to obtain the hose line and activate the station

9930.123 CARE AND MAINTENANCE OF THE FP-180 WATER-MOTOR PROPORTIONER

1. Foam liquid dries into a hard-surfaced sticky film that may prevent operation of the proportioner. It is therefore important that the pump and water motor be carefully flushed after each use. The unit should be thoroughly drained after flushing. Stand the unit on the water motor discharge and turn the extended shaft clockwise with a wrench applied to the milled flats on the end of the shaft.

2. After draining, a few ounces of light lubricating oil should be squirted into the motor through the suction and discharge openings. Oil should also be squirted into the foam valve and foam pump. To get oil into the foam pump, place the foam valve in a "foam" position and pour oil into the corresponding pickup tube opening. Turn the extended shaft several revolutions by hand to distribute the oil within the proportioner.

3. The proportioner should periodically be checked for free turning. Always replace the cover over the extended motor shaft to prevent oil leakage or entrance of foreign matter.

4. If the unit fails to turn freely and there are no foreign objects in the water motor visible through inlet or outlet connections, look for dried foam liquid or foreign matter in the foam pump. Have the foam valve in one of the "foam" positions. Pour water through the corresponding inlet connection and turn the rotors first one way then the other. Hot water dissolves caked foam liquid deposits faster than cold water. Never use gasoline or any solvent to wash out dried foam liquid. It may be necessary to remove the foam valve and accessory piping from the pump and pour water directly into the pump ports. At any time that this is done, it is well to clean all foam-carrying accessories before they are replaced on the unit.

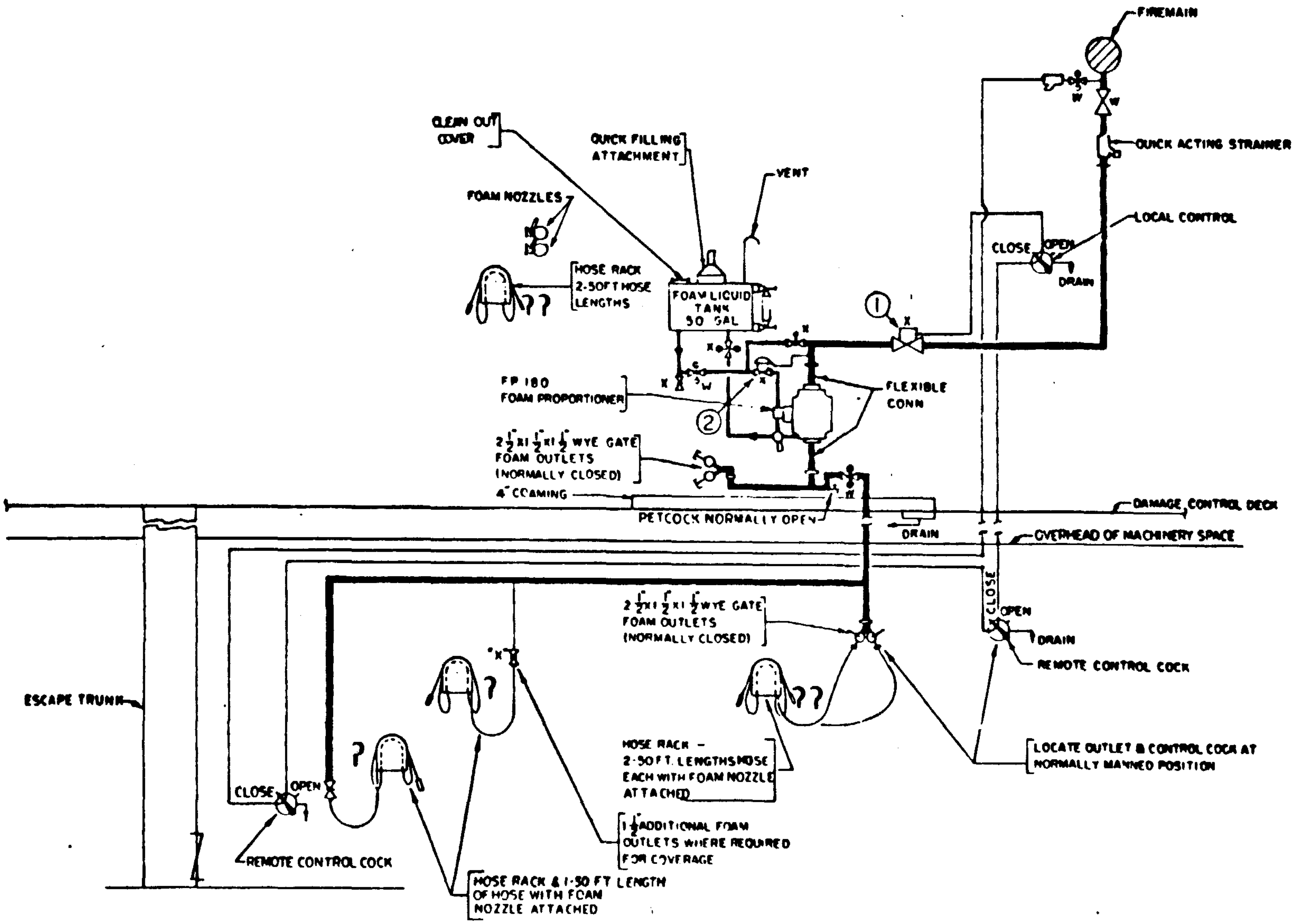


Figure 9930-40. Diagrammatic arrangement of foam hose system.

FOR OFFICIAL USE ONLY

APPENDIX D

AFFF SYSTEM TEST AND WASTE DISPOSAL PROCEDURES

1. AFFF/PKP Fire-Fighting System Test Procedures for Long Beach Naval Shipyard (18 pages)
2. Hazardous Waste Disposal Procedure No. 10 from Norfolk Naval Shipyard (1 page)
3. "Disposal of Aqueous Film Forming Foam (AFFF) Wastes," Pollution Solution, Naval Environmental Protection Support Service, PS-003A, 18 September 1975 (4 pages)

WRP:nn(303)
2 April 1976

MEMORANDUM

From: W. R. Prince, Operational Safety Advisor, LBNS

To: Craig Alig, Code 2863, Naval Ship R. and D. Center

Subj: Disposal of AFFF

1. Craig, below is the information you requested:

a. Based on nine regular overhauls per year, we dispose of approximately 1100 gallons of AFFF per year.

b. It is off loaded into a 2500 gallon sludge tank, transported to a holding area, picked up by an outside contractor, and dumped in a Class I Sanitation dump.

2. Hope this information will be of some benifit to you.

Bill Prince

Bill Prince

STATUS OF SHEETS	REV			
	SHEET	1	2	3
REV.				
SHEET				

SHIP	PLAN REV.	BY DESIGN CODE	P & E NO.	SHIPALT	P & E LEAD CODE	APPROVED	DATE

PLAN ISSUED FOR

EXAMINED	
OFFICIAL	NAME
CHIEF ENGR.	
ASST. CH. ENGR.	
BRANCH HD.	
SECTION HD.	
REVIEWED	
DRAWN	

APPD. DATE

DATE

LONG BEACH NAVAL SHIPYARD

LONG BEACH, CALIFORNIA 90801

AFFF/PKP FIRE FIGHTING SYSTEM
TEST PROCEDURES

AFFF/PKP TEST PROCEDURES

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219 D-2		
SCALE		SHEET OF	

US00006936

AFFF SYSTEM
TEST PROCEDURE

1.0 PURPOSE:

To verify and determine strength and tightness of newly installed twin agent fire extinguishing system and to demonstrate satisfactory operation of system.

2.0 REFERENCES:

2.1 OPNAV INST 6240.3C of 20 Apr 1973

2.2 NAVSEA Notice 9930 of 13 Sep 1973

2.3 NAVSEA MESG R 2300537 Feb 74

2.4 NAVSEA Technical Manual 0993-023-6010 Fire Extinguishing System Twin Agent (AFFF and PKP)

2.5 Type-507-450663 - C1 FP180 - Foam Liquid Proportioner Modifications

2.6 Type-507-4506918 - Operating Diagram Machinery Spaces Fire Fighting System

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

3.0 PREREQUISITES

PIPING

3.1 All existing piping not removed by conversion shall be inspected for presence of protein foam deposits, if found, clean as follows:

3.2 (a) One flushing with hot water for period of 15 minutes.

(b) One flushing with solution of hot water and 10% AFFF.

PROPORTIONER

3.3 The existing FP180 proportioner/s (total to be tested ( )) shall be tested for proper operation.

3.4 Proper operation of the proportioner is determined by color-comparison analysis of the protein-salt water mixture with known admixtures of 2, 4, 6, and 8 percent or by measurement of the mixture using a refractometer. Five percent protein in the mixture is the minimum allowed and indicates proper proportioner operation. For operation of the refractometer, see Maintenance Requirement Cards (MRC) 92 BS8V Q for the procedure of AFFF systems in machinery space of MRC 13 C33R A for AFFF/HCFF Stations.

3.5 Proportioners failing to pass the refractometer test shall be replaced with new FP180 proportioners.

3.6 Proportioners which pass refractometer test shall be flushed in accordance with paragraph 3.2.(a) and 3.2.(b).

4.0 TEST EQUIPMENT

4.1 Supply of small containers

4.2 1-1/2" firehose (sufficient length)

5.0 SERVICES REQUIRED

5.1 Salt water services

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

7.0 PRECAUTIONS

7.1 In compliance with the environmental protection policies of reference (2.1), Aqueous Film Forming Foam (AFFF) may be harmful to marine life and shall not be discharged into navigable waters. Despite this restriction, it is essential that newly installed and modified AFFF fire fighting systems be tested prior to ship departure for sea trials as specified in reference (2.3).

7.2 Therefore, all AFFF fire fighting equipment newly installed, repaired, altered, or converted from protein foam, by industrial activites, shall be tested to insure design operability and output. These tests shall be conducted and the results returned to Design Code 260.15 for written certification to the commanding officer prior to trials or departure.

7.3 Test requirements shall include verification that the system output contains a minimum AFFF concentration of 3.5 percent as specified in reference (2.2). Output concentration shall be determined by refractometer in accordance with applicable MRC cards. Samples for refractometer analysis shall be taken at the discharge of a hose nozzle and analyzed within 2 hours after collection.

7.4 An exception is granted for sample testing of aircraft carrier flight deck washdown fire fighting systems while in port. Verification of output concentration of these systems may be deferred for performance beyond the 12-mile limit because of the impracticability of collecting AFFF foam discharge from slush deck nozzles. All other washdown systems tests shall be conducted prior to getting under way.

7.5 Mixtures containing AFFF, produced by these tests, must be contained in drums, tanks, sludge barges or closed bottom donuts as required for oil disposal in reference (2.1). However, AFFF should not be co-mingled with reclaimable waste oil products. The mixture shall not be discharged into harbor waters since AFFF could produce concentrations affecting marine life. Disposal, including introduction into municipal sewer systems, shall be governed by local regulations.

7.6 Report immediately to the Ship's Superintendent any defects which may delay completion of test.

7.7 List the locations of blanks, etc., used during the conduct of tightness test on Sheet No.

7.8 Observe normal safe working practices in accordance with LBNSY Instruction 5100.27C.

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

8.0 SHIP/SYSTEM/PLANT CONDITIONS:

8.1 Ship - dockside

8.2 System - modifications complete and ready for testing.

9.0 TEST PROCEDURE/TEST SPECIFICATIONS:

9.1 PRELIMINARY VISUAL INSPECTION - PHASE I

9.1.1 Inspect the entire installation for satisfactory workmanship and agreement with references.

9.1.2 Ascertain instruction and label plates are properly located and correctly inscribed.

9.1.3 Determine that foam liquid tank has been tested for tightness prior to installation.

9.1.4 Check that foam proportioners have been filled to the proper level with correct grade of new oil.

9.1.5 Ascertain that 100 ft. of 1-1/2" hose and an AFFF nozzle are provided with each new hose reel on the

9.1.6 Ascertain that 50 ft. of 3/4" hose, 50 ft. of 1-1/2" hose and twin agent nozzle are provided with each new hose reel in the machinery spaces.

9.1.7 Remove cover over the extended motor shaft and check each proportioner for free turning. Replace cover.

9.1.8 Record data as required on Sheets

9.1.9 REPORT

The twin agent fire extinguishing system was visually inspected and found satisfactory on the date indicated.

C/260.15 Test Engr./Tech. ______________ Date ________

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

9.2 HYDROSTATIC TEST - PHASE II

9.2.1 At each foam station with the foam proportioner and AFFF tank isolated, test new firemain and foam concentrate piping hydrostatically to 150 PSIG.

9.2.2 At each foam station with the dry chemical and nitrogen tanks and the dry chemical portion of the machinery space hose reels isolated, test PKP supply piping to hose reels hydrostatically to 330 PSIG for 30 minutes minimum and examine piping, valves, and fittings for tightness. After satisfactory completion of this test, drain water from piping and thoroughly dry out by blowing through with warm, dry air.

9.2.3 At each foam station with the new nitrogen piping between the 3-way hytrol valve and nitrogen-PKP tank assembly isolated, test this piping hydrostatically to 330 PSIG. After satisfactory completion of this test, drain water from piping and thoroughly dry out by blowing through with warm, dry air.

9.2.4 REPORT

The AFFF piping system was given a hydrostatic test and was found satisfactory on the date indicated.

C/260.15 Test Engr/Tech ____________________ Date ______________

Shop Personnel ______________________________ Date ______________

Ship's Representative ______________________ Date ______________

9.3 PRE-OPERATIONAL TEST - PHASE III (PKP SYSTEM ONLY)

9.3.1 Make sure all nozzles are closed.

9.3.2 Close black ball valve.

9.3.3 Remove the safety clip from the nitrogen cylinder valve and pull the quick opening "pull" handle.

9.3.4 Observe the opening of the powertrol and hytrol valves and the flow of AFFF solution from the normally open petcock.

9.3.5 Close the nitrogen cylinder valve, and install the safety clip and lead and wire seal.

9.3.6 Open the blue ball valve.

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

9.3.7 Open the dry chemical nozzle and hold open until evidence of flow ceases.

9.3.8 Close blue ball valve and replace pin and lead and wire seal.

9.3.9 Open green ball valve. Powertrol and hytrol valves should close immediately and flow from the petcock should gradually decrease to zero.

9.3.10 Wait 5 minutes. Close green ball valve.

NOTE: If powertrol and hytrol valves close before green ball valve is opened probable cause is faulty check valve.

9.3.11 Open black ball valve.

9.3.12 Check nitrogen cylinder pressure. If over 1500 PSI, system is ready for use. If under 1500 PSI, replace with spare cylinder.

9.3.13 Repeat steps 9.3.1 through 9.3.12 for remaining PKP units.

9.3.14 Return to each PKP unit in the previous order and open and close green ball valves to check for pressure build-up.

NOTE: When shutting down the system after test or use leave the green ball valve open for 5 minutes to insure that N_2 pressure is relieved.

9.3.15 REPORT

The PKP units were pre-operated and where found satisfactory on the date indicated.

C/260.15 Test Engr/Tech ____________________ Date __________

Ship's Representative ______________________ Date __________

9.4 OPERATIONAL TEST - PHASE IV

9.4.1 Fill the AFFF supply tank with fresh water.

9.4.2 From each foam station operate the AFFF system using the local control valve as per operating chart of reference (2.6), discharging overboard through hose station on DC deck and using additional 1-1/2" fire hose as required.

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE			SHEET

9.4.3 Observe that the water level in the AFFF tank falls at a normal rate. (Approximately 5 GPM when discharging through a 1-1/2" nozzle).

9.4.4 Demonstrate foam recirculation using the FP180 test procedure on operating chart of reference (2.6).

9.4.5 Perform the following operational test on the dry chemical extinguisher set:

(1) Remove safety clip from nitrogen cylinder valve and pull lever.

(2) Check that sea water and AFFF concentrate valves are in open position.

(3) Close cylinder valve and replace safety clip.

(4) Seal cylinder valve with lead and wire seals.

(5) Open and close dry chemical nozzles quickly and observe discharge of "Purple-K" dry chemical.

(6) Open and close AFFF nozzles in the machinery space hose reels quickly and observe discharge.

(7) Close black dry chemical valve.

(8) Open blue hose clean out valve.

(9) Open dry chemical nozzle to clear all dry chemical from hose line and relieve all pressure from tank.

(10) Close blue hose clean out valve.

(11) Replace ring pin and seal with lead and wire seal.

(12) Open black dry chemical valve.

(13) Open green vent valve and check that sea water and AFFF concentrate valves close.

(14) Close green vent valve.

(15) Remove fill cap and replace "Purple-K" which was used, approximately 15 pounds.

(16) Replace fill cap, hand tighten.

(17) Replace nitrogen cylinder if pressure is less than 1500 PSI at 70°F.

(18) Replace any missing lead and wires.

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

9.4.6 During the operation of AFFF system, take one (1) sample of the foam solution and submit to the lab, Code 134.1, for refractometer analysis.

> NOTE: After completion of the refractometer analysis, the lab should submit results to Code 260.15.

9.5 <u>REFRACTOMETER ANALYSIS - PHASE V (Lab only)</u>

9.5.1 A refractometer analysis shall be accomplished by the Industrial Lab to determine the AFFF concentration of the AFFF solution.

> NOTE: This procedure has been incorporated into the Maintenance Requirement Cards (MRC) for the AFFF system for machinery spaces (performed every six months) and the AFFF high capacity fog foam (AFFF/HCFF) stations (performed annually) to ensure an adequate as well as an efficient amount of concentrate (3.5 to 6 percent) is available.
>
> During test operation of a foam-proportioning system, the pollution-control requirement must be adhered to; that is, foam generating tests of foam equipment must be conducted when the foam generated is retained in a tank or barge.

9.5.2 To perform the refractomer analysis, the following equipment is required: -3-

12-inch ruler
Data sheet and graph paper
Eye dropper
Light water (AFFF concentrate)
Clean bucket
100-ml beaker
50-ml beaker
Sample bottles
Lens tissue, 100 sheets
100-cc volumetric flasks (3), marked 2%, 4%, and 6% and glass flask stoppers
Funnel
1.3330-1.3700 angstrom optical refractometer, American Optical Instrument Company No. 10420 or 0-30 scale AOIC No. 10430 or equal, No. 10430 is available from SPCC under FSN No. 1H6650-600-6154
10-ml measuring pipette

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

9.5.3 PREPARATION OF CALIBRATION CURVE

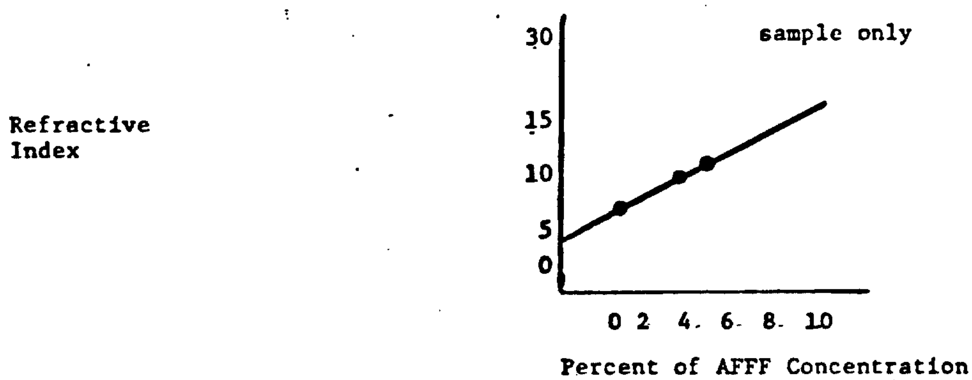
9.5.3.1 Since the concentration of sea water varies depending on the area or region where the ship is operating, a new calibration curve must be developed for each refractometer analysis. Obtain about 50-ml of AFFF concentrate from the storage tank; this can be drawn from the gauge glass drain. To ensure that no sediment is drawn out, drain and refill the gauge glass before taking the test sample. Next obtain from the firemain about a gallon of sea water. First, clean and dry three 100-cc volumetric flasks and designate 2, 4, and 6 percent respectively. Then fill these flasks approximately 3/4 full with the sea water; into the flask marked 2 percent, pipette 2-cc of the collected AFFF concentrate; into the flask marked 4 percent, pipette 4-cc of AFFF concentrate; into the flask marked 6 percent, pipette 6-cc of concentrate. Next fill the volumetric flasks up to the 100-cc line with water, insert the glass stopper, and invert each flask several times to mix thoroughly. The next step is determining the refractive index of the sea water sample and the 2-, 4-, and 6-percent samples. With the aid of an eye dropper, place a few drops of the sea water sample on the glass surface of the refractometer. Make sure all air bubbles are expelled when the top prism plate is moved into its closed position against the bottom glass surface. Best readings are obtained when the refractometer is held level, pointed toward an overhead light source and a slight finger pressure is applied on the upper prism. Read the number from the left-hand scale where the horizontal line appears between the dark and light fields and record the value of the data sheet (See Table I). This value is the refractive index of the sea water sample and will be the concentration "0 percent" value. Special care should be observed in cleaning the glass surface of the prism. The fluid should be removed by lightly blotting and wiping with lens tissue. A dry lens tissue should then be dipped in clean fresh water and the glass surface should be lightly wiped with the wet tissue and then dried with a dry lens tissue. Using the same method as for "0 percent" concentration, obtain refractive index values for the 2, 4, and 6 percent standard solutions and record the readings on the data sheet. Special care should be taken to clean the refractometer's glass surface and rinse out the eye dropper with fresh water after each reading. A calibration curve can now be plotted using the refractive index as the vertical values and horizontal values increasing from 0 to 10 percent (See Table 2).

9.5.3.2 Plot the values from Table 1 for the "0 percent" water sample and the 2, 4, and 6 percent standard solutions on the graph paper and draw a straight line through the four points; this will be the calibration curve for the particular station where the concentration sample was taken. If a straight line is not obtained, discard the samples and start again with fresh samples. This completes the preparation for analysis of the test samples.

Table 1

Concentration % Concentrate	% Water	Refractive index from scale readings
1.0	100 (Water sample)	1.
2.2	98 (Standard solution)	2.
3.4	96 (Standard solution)	3.
4.6	94 (Standard solution)	4.
5.-	--- (System test sample)	5.

Table 2



SIZE	CODE IDENT. NO.	NAVSHIPS DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

9.5.4 FOAM SOLUTION TEST

9.5.4.1 Samples of foam solution may be collected wherever it can be certain that the sample is a true representation of the system output. After allowing sufficient time to elapse after start up to ensure that the system has come to equilibrium (about one minute), a sample may be obtained by holding a container with a handle into the edge of the handline stream (or from a pan set on the deck to catch some of the foam discharge from a flight deck fire fighting system flush deck nozzle.)

9.5.4.2 Now place a few drops of foam solution from the system test sample on the refractometer and obtain its refractive index (samples should be analyzed within two hours after the system test run). Using the refractive index, the concentration of the sample can be obtained from the calibration curve. Record the concentration on the data sheet. If the test samples read less than 3.5 percent, attempt the following corrections and retest the system: Inspect foam concentrate tank supply lines to AFFF/HCFF FP1000 proportioner of AFFF injection pump for obstructions and closed valves; clean the AFFF supply line strainer; inspect foam or flight deck flush deck nozzles for obstructions; increase firemain pressure, inspect FP1000 proportioner foam pump for seizure or binding; check proportioner foam pump rotor clearances; using one and two hoselines respectively, compare the proportioner RPM with that in the proportioner manual. If RPM is not up to specification, the proportioner should be repaired. If unable to obtain 3.5 to 6 percent station operating concentration, report deficiency to D.C. Central, and retain data sheets and graphs for comparison against future tests.

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

REPORT

	AFFF STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION
1. Workmanship					
2. Agreement with ref. dwgs.					
3. Instruction and label plates					
4. Tightness of foam liquid tank		NA	NA	NA	NA
5. Proportioner oil level		NA	NA	NA	NA
6. Were the following provided at foam outlet on D.C. deck?					
(a) 1 foam nozzle		NA	NA	NA	NA
(b) 125' of 1-1/2 hose		NA	NA	NA	NA
7. Were the following provided at each hose outlet in the machinery space?					
(a) 50' length 1-1/2" hose	NA				
(b) 50' length 3/4 hose	NA				
(c) 1 twin agent nozzle	NA				
8. Hydrostatic Test					
(a) 150 PSI held for 30 minutes for SW piping		NA	NA	NA	NA
(b) 330 PSI held for 30 minutes for nitrogen piping	NA				

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

REPORT

	AFFF STATION	AFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION
(c) 330 PSI held for 30 minutes for PKP supply piping	NA				
9. Operational Test performed					
10. Was dry chemical nozzle opened to clear all dry chemical from hose line and relieve all pressure from tank?	NA				
11. Were green vent valve and blue valve closed at end of test on dry chemical extinguisher set?	NA				
12. Was black valve open at end of test on dry chemical extinguishing set?	NA				
13. Was "Purple-K" which was used replaced?	NA				
14. Was foam pump flushed and drained?		NA	NA	NA	NA
15. Refractometer tests results		NA	NA	NA	NA

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

US00006949

REPORT

	AFFF STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION
1. Workmanship					
2. Agreement with ref. dwgs.					
3. Instruction and label plates					
4. Tightness of foam liquid tank		NA	NA	NA	NA
5. Proportioner oil level		NA	NA	NA	NA
6. Were the following provided at foam outlet on D.C. deck?					
(a) 1 foam nozzle		NA	NA	NA	NA
(b) 125' of 1½ hose		NA	NA	NA	NA
7. Were the following provided at each hose outlet in the machinery space?					
(a) 50' length	NA				
(b) 50' length 3/4 hose	NA				
(c) 1 twin agent nozzle	NA				
8. Hydrostatic Test					
(a) 150 PSI held for 30 minutes for SW piping		NA	NA	NA	NA
(b) 330 PSI held for 30 minutes for nitrogen piping	NA				

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

REPORT

	AFFF STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION	AFFF/PKP STATION
(c) 330 PSI held for 30 minutes for PKP supply piping	NA				
9. Operational Test performed					
10. Was dry chemical nozzle opened to clear all dry chemical from hose line and relieve all pressure from tank?	NA				
11. Were green vent valve and blue valve closed at end of test on dry chemical extinguisher set?	NA				
12. Was black valve open at end of test on dry chemical extinguishing set?	NA				
13. Was "Purple-K" which was used replaced?	NA				
14. Was foam pump flushed and drained		NA	NA	NA	NA
15. Refractometer test results		NA	NA	NA	NA

SIZE	CODE IDENT. NO.	NAVSEA DRAWING NO.	REV.
A	89219		
SCALE		SHEET	

11ND-NSYLB-9673/86 (4-73)

TEST EQUIPMENT CALIBRATION VERIFICATION TABLE

THE TABLE BELOW IS TO BE FILLED IN BY THE SHOP REPRESENTATIVE TO SUBSTANTIATE THAT THE STATUS OF TEST EQUIPMENT UTILIZED IN CONJUNCTION WITH THIS TEST MEMO IS PROPERLY CALIBRATED. IF TEST EQUIPMENT IS NOT OF REQUIRED CURRENT CALIBRATION, DISCONTINUE TEST UNTIL PROPERLY CALIBRATED EQUIPMENT IS AVAILABLE.

TYPE OF EQUIPMENT	MANUFACTURER	LBNS SER. NO.	DATE CALIB	EXPIRATION DATE	REPRESENTATIVE
13330-1.3700 angstrom optical refractometer, American Optical Instrument Company No. 10420 or 0-30 scale AOIC No. 10430 or equal, No. 10430 is available from SPCC under FSN. No. 1H6650-600-6154.					

T________________ SHEET ______ OF ______

HAZARDOUS WASTE DISPOSAL PROCEDURE NO. 10

DATE ISSUED: 11 APR 1975

HAZARDOUS MATERIAL COVERED: Aqueous Film Forming Foam (AFFF) Wastes

FSN 4210-00-087-4742 FSN 4210-00-087-4750

SPECIAL HANDLING INSTRUCTIONS: Collect AFFF wastes in containers of suitable size to permit easy handling. Containers may be flushed and reused.

DISPOSAL INSTRUCTIONS: Discharge to the Yard sanitary sewerage system at a controlled rate not to exceed 10 gallons of undiluted AFFF per hour.

Prepared by: Lt. C. V. Cecil, CEC, USN, Code 403

Concurrence: Code 730 William J. Marr

PS-003A
(Rev. 18 Sep 1975)

POLLUTION SOLUTION

NAVAL ENVIRONMENTAL PROTECTION SUPPORT SERVICE

NEPSS

NAVY ENVIRONMENTAL SUPPORT OFFICE
Naval Construction Battalion Center, Port Hueneme, California 93043

DISPOSAL OF AQUEOUS FILMFORMING FOAM (AFFF) WASTES

I PROBLEM

AFFF products are fluorocarbon surfactants used for fire fighting. AFFF wastes from firefighting system tests and training exercises must be disposed of in accordance with local and federal guidelines.

<u>More Details of the Problem</u>: Naval industrial activities must test each shipboard AFFF firefighting system that has been installed, modified, or repaired to encure that the minimum concentration of AFFF in the output mixture is 3.5% (the optimum is 6%). The foam is generated for one minute at flow rates of 95 to 250 gpm before the sample is taken to measure AFFF concentration.

In-port and under certain circumstances at sea, the effluent containing AFFF must be collected and clearly identified for other than direct disposal to the ocean.

AFFF wastewaters containing petroleum are produced from training operations at firefighting schools. For additional guidance in handling these wastes, see Reference 2.

II SOLUTIONS

The acceptable procedures for shore disposal of AFFF wastes are summarized from References 2 and 3 as follows:

A. <u>Discharge Wastes to Sewage Treatment Plant</u>: AFFF wastes free from oil can be discharged to free flowing sanitary sewers at controlled rates. Safe discharge concentrations to a secondary sewage treatment plant (STP) depend upon the specific AFFF used and the average flow rate of the plant. If the AFFF is identified, the safe discharge concentration listed in the table below can be used to determine the discharge rate. It is advisable to discharge at the recommended concentration or at a concentration which will allow acclimation until it is certain that the plant is adapted to this type of waste. Conditions in some localities might allow discharge up to or exceeding the maximum.

If the AFFF concentrate in the waste cannot be identified but is known to be on the AFFF specifications[3] qualified products list, the lowest discharge limit should be assumed (10 μl/l recommended to 100 μl/l maximum).

TABLE 1
COMPARISON OF CONCENTRATIONS OF AFFF IN SYNTHETIC SEWAGE AMENABLE TO BIOLOGICAL TREATMENT
(Data from Table 8, Reference 4)

Manufacturer's AFFF Concentrate Label	Recommended[a] for Treatment μl/l (ppm)	Maximum to[b] Sewage Treatment Plant μl/l (ppm)
	(gal per million gal of secondary STP flow)	
FC-199	25	250
FC-200	10	10
FC-206	20	200
Aer-O-Water 3	150	1700
Aer-O-Water 6	150	1700
K74-100	25	250

[a] Based on reactions to microorganisms, aquatic life, and safety factors

[b] Based on activated sludge pilot plant studies using a synthetic sewage consisting of glucose (160 mg/ℓ), peptone (160 mg/ℓ), urea (28.6 mg/ℓ), sodium bicarbonate (102 mg/ℓ), potassium phosphate (32.5 mg/ℓ), and tap water

B. Discharge Wastes to Receiving Body of Water

Wastes can be discharged to a stream containing aquatic life within the following limits:

RECOMMENDED MAXIMUM CONCENTRATION OF AFFF FOR DIRECT DISCHARGE TO STREAM
(From Reference 4)

AFFF CONCENTRATE	MAXIMUM CONCENTRATION μl/l (ppm)
FC-199	20
FC-200	5
FC-206	54
Aer-O-Water 3	60
Aer-O-Water 6	22
K74-100	55

C. Filter Waste Through Activated Carbon: AFFF products can be adsorbed on carbon[5]. The efficiency depends upon the particular AFFF concentrate, e.g., 100 percent removal of FC-200 and 70-75 percent removal of Aer-O-Water 6 within 5 minutes of contact time. The effluent may be suitable for discharge to a stream or it can be discharged into a sanitary sewer at an appropriate rate. Pending development of techniques for recovering the adsorbed chemicals, the used carbon can be disposed of in incinerators, mixed with coal for coal-burning furnaces, or disposed of in landfill sites which accept household wastes.

D. The attached flow diagram, Figure 1, can be used to determine the options and restrictions of disposal methods, including disposal at sea.

III RECOMMENDATIONS

The preferred method for disposal of AFFF wastes is discharging to a biological sewage treatment plant under controlled conditions.

IV BENEFITS

Disposal by controlled rate of discharge to a biological treatment plant is a simple and safe procedure which can be accomplished at most naval activities. This method reduces the possibility of environmental damage and eliminates costs of storage and special handling.

V CONTACT

Additional details regarding these disposal methods may be obtained from NAVFAC, Code 0451E, or by contacting NESO, Code 2522, Autovon 360-5071.

VI REFERENCES

1. Naval Message 191523Z Feb 75 COMNAVSEASYSCOM, Washington, D.C.

2. NAVFACENGCOM letter 1042/WEG of 13 May 1975, to: NCBC Port Hueneme, Subj: Aqueous Filmforming Foam; revised disposal guidance.

3. Military Specifications, MIL-F-24385 (NAVY), 21 Nov 1969.

4. E. E. Lefebvre and R. C. Inman, "Biodegradability and Toxicity of Ansul K74-100, Aqueous Film Forming Foam," U.S.A.F. Environmental Health Laboratory, EHL (k) 75-3, Jan 1975.

5. R. K. Kroop and J. E. Martin, Treatability of Aqueous Film-Forming Foams Used for Fire Fighting, Air Force Weapons Laboratory, Kirkland Air Force Base, AFWL-TR, 73-279, February, 1974.

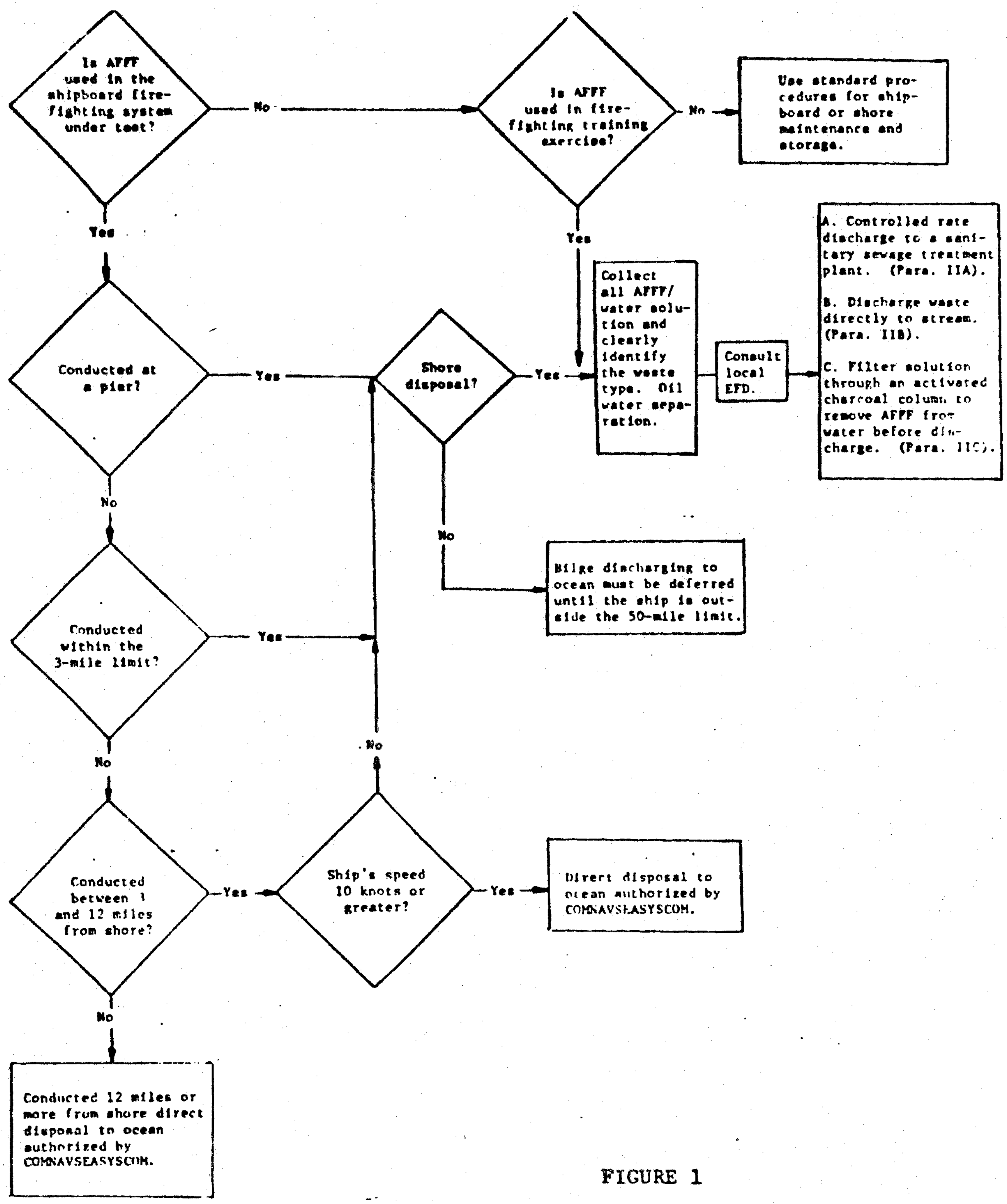


FIGURE 1

Flow Diagram for Disposal of Waste From AFFF Firefighting Tests

APPENDIX E

BIODEGRADABILITY AND TOXICITY OF FC-206

1. 3M Company letter to Mr. C. Alig, Subject: FC-206, dtd 25 June 1976 (3 pages)
2. NAVSEC letter to NAVSEA, 6159C/SD, 9360/593.344, ETA 4088025, Ser 270, dtd 3 July 1974, enclosure (1), Bioassay Data (excerpt) (5 pages)
3. USAF Environmental Health Laboratory Report EHL(K) 74-26, November 1974 (21 pages)

GENERAL OFFICES • 3M CENTER • SAINT PAUL, MINNESOTA 55101 • TEL. (612) 733-1110

ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL
3M COMPANY
P.O. BOX 33331 • 900 BUSH AVENUE • SAINT PAUL, MINNESOTA 55133

TEL. (612) 733-6033

June 25, 1976

Subject: FC-206

Mr. Craig Alig
Naval Ship R & D
Code 2863
Annapolis, MD 21402

Dear Mr. Alig:

This is in response to your request regarding the environmental effects of "LIGHT WATER" Brand Aqueous Film Forming Foam Concentrate FC-206.

The 3M Company is conducting an ongoing program to evaluate and assess the environmental impact of its new and existing products. In accordance with this program, FC-206 has been subjected to a testing schedule designed to evaluate the product's overall environmental impact. Where possible, this product has been tested utilizing those existing methods and procedures which are outlined in "Standard Methods for the Examination of Water and Wastewater," 13th Edition, 1971.

Due to the basic nature and function of FC-206, the wastewater discharge from its use in either an actual or simulated situation, is most likely to find its way to an aquatic ecosystem, usually being first conveyed to a wastewater treatment system. For this reason, the information presented in this letter will be directed toward the aquatic toxicity and biological treatability characteristics of FC-206.

The freshwater aquatic toxicity studies which have been conducted on FC-206 have utilized a warm water and cold water fish (Pimephales promelas and Salmo gairdneri). The results of the studies on the concentrate as sold are as follows:

Species	
Fish	96-Hr. LC_{50}
Fathead minnow (Pimephales promelas)	3000 mg/l Continuous Flow Test
Rainbow trout (Salmo gairdneri)	1800 mg/l Static Test

MINNESOTA MINING AND MANUFACTURING COMPANY

Invertebrate aquatic toxicity studies have been conducted on FC-206. The species tested and their toxicity responses are as follows:

Species	48-Hr. LC_{50}
Water flea (Daphnia Magna)	5850 mg/l
Scud (Gammarus fasciatus)	5170 mg/l

Marine aquatic toxicity studies have been conducted on FC-206. The species tested and their toxicity responses are as follows:

Species	96-Hr. LC_{50}
Mummichog (Fundulus heteroclitus)	1820 mg/l Static Test
Grass shrimp (Palaemonetes vulgaris)	280 mg/l Static Test
Fiddler crab (Uca pugilator)	3260 mg/l Static Test
	48-Hr. LC_{50}
Atlantic oyster larvae (Crassostrea virginica)	>100 <240 mg/l

The ability of an FC-206 wastewater discharge to be stabilized in a biological wastewater treatment system has been evaluated in accordance with parameters such as the biochemical and chemical oxygen uptake rate which are normally used in treatability studies. The biochemical and chemical oxygen demand test results are as follows:

BOD_5	210,000 mg/l
BOD_{ult}	420,000 mg/l
COD	420,000 mg/l

The oxygen uptake tests by the dissolved oxygen probe method have shown that no microbial inhibition will occur at FC-206 concentrations less than 1000 mg/l. This concentration level has also been confirmed through tests which measure activity of microorganisms by the TTC* reduction in an activated sludge biological population.

*TTC (2,3,5-Triphenyltetrazolium Chloride) Re: "Dehydrogenase Enzyme as a Parameter of Activated Sludge Activities," Ford, et al. Proceedings of the 21st Industrial Waste Conference, Purdue, May 3, 4, and 5, 1966.

In addition, a conventional activated sludge pilot plant was successfully operated using a feed source which consisted of a mixture of settled domestic sewage and FC-206. At an FC-206 concentration of 1000 mg/1, the average reductions in COD and BOD levels were 73% and 86%, respectively. When operating at an FC-206 level of 1000 mg/1, the average BOD_5 concentration in the effluent from the pilot plant was 18 mg/1.

In general, it is advisable to treat FC-206 wastewater discharges in combination with either domestic or industrial wastewater in a biological or physiochemical wastewater treatment system. A combined raw wastewater discharge providing a maximum concentration of 1000 mg/1 FC-206 concentrate would permit satisfactory treatment.

All statements, technical information and recommendations contained herein are of a general nature and are based on laboratory tests we believe to be reliable, but the accuracy, completeness or applicability to particular circumstances is not guaranteed. No express warranties are created herein, and implied warranties of merchantability and fitness for a particular purpose are disclaimed.

A more complete evaluation of your specific situation should be based on the particular circumstances and factors involved, including consultation with the appropriate pollution control agencies.

We hope this information will be of value to you. If we can be of further assistance, please contact Mr. D.L. Bacon on (612) 733-5453.

Very truly yours,

R L Bohon

Robert L. Bohon, Manager
Environmental Laboratory

RLB/mab

BIOASSAY DATA EXCERPTED FROM ENCLOSURE (1), NAVSEC LETTER TO NAVSEA, 6159C/SD, 9630/593.344, ETA 4088025, SER 270, DATED 3 JULY 1974.

FC-200 AFFF and FC-206 AFFF toxicities were determined by performing bioassays on seven representative saltwater organisms at the Naval Ship Research and Development Center, Annapolis Division. The seven saltwater organisms tested were carefully selected as representatives of the water column. Bioassays were also performed on two other commercial alternative AFFF substances (Aerowater Number 3 and Aerowater Number 6), (manufactured by the National Foam Corporation) and on glycerine, a substance that was considered as a possible alternative to AFFF for use for pierside testing of foam station units.

The organisms tested are listed in table 1. Because it is a representative marine fish species and can be raised in the laboratory, 2 to 3 inch length Killifish (Fundulus majalus) were used for testing. The two bottom organisms that were used were the common Atlantic Oyster (Crassostrea virginia) and the Ribbed Bay Mussel (Modiolus modiolus). The barnacle used was the common white acorn species (Balanus eburneau). The brine shrimp (Artemia salina) tested was the San Francisco Bay strain. Although it is not found in brackish waters, its inclusion in a bioassay procedure has many advantages: (a) it is a standard bioassay organism used by many biology laboratories; (b) it is a reference organism used by EPA; (c) its life cycle, maintenance and culture conditions are very well documented; and (d) its response to a host of chemicals is known. Cyclotella nanna is a brown centric diatom, fully oceanic, but often found in brackish water. Pseudomonas nigrificans (American Type Cultural Collection No. 19375) is a marine bacteria belonging to that vast group of bacteria (Pseudomonas) which is found in almost all the salt waters of the world. Bacteria are the common denominator in water, so their inclusion in a bioassay is absolutely necessary. These organisms were selected and placed in test tanks or flasks. The desired amounts of the chemicals were added volumetrically, and at the end of 96 hours the LC_{50} (concentration of the chemical which is lethal to 50% of the test organisms) was recorded. (For brine shrimp, a 40 hour LC_{50} was determined.) Table 2 shows the actual number of organisms used for testing of each concentration of any one chemical.

The LC_{50} for these chemicals are listed in table 3. Table 3 shows that the least toxic AFFF compound is FC-206, although glycerine is less toxic than FC-206.

Table 1

BIOASSAY ORGANISMS

Name	Type	Stage	Habitat
Killi Fish (Fundulus majalus)	Fish Vertebrate	Young Adult 2-3" long	Estuarine Water Columns
Bay Mussel (Modiolus modiolus)	Mollusc Shelled	Adult 1-2" long	Brackish Bottom
Brine Shrimp (Artemia salina)	Bronchiopod Crustacean	Adult (2 weeks old)	Standard Bioassay
Barnacle (Balanus eburneus)	Cirriped Crustacean	Adult 3/4-1½" base	Brackish Littoral
Oyster (Crassostrea virginia)	Mollusc Shelled	Adult 2" - 4"	Brackish Bottom
Diatom (Cyclotella nana)	Algae Brown Green	$1-2 \times 10^6$ cells/cc	Oceanic
Marine Bacteria (Pseudomonas Nigrificans)	Bacteria	2×10^7 cells/cc	Oceanic to Brackish

Table 2

NUMBER OF ORGANISMS AND CHEMICAL CONCENTRATIONS

Organism	Number of Organisms/ Test Concentration	No. of Concentrations	Total No. of Organisms
Killi Fish	6	(Control & 9) x 3	180
Bay Mussel	6	(Control & 9) x 3	180
Brine Shrimp	20	(Control & 9) x 3	600
Barnacle	10	(Control & 9) x 3	300
Oyster	6	(Control & 9) x 3	180
Algae	2 test tubes each with 10^3 to 10^6 cells/cc	(Control & 9) x 3	60 tubes
Bacteria	2 test tubes each with 10^7 cells/cc	(Control & 9) x 3	60 tubes

Table 3

96 HOUR LC_{50} (40 hour LC_{50} for brine shrimp)

FC-200 AFFF (3M Company)

Organism	96 Hr. LC_{50}
Fish	76 ppm
Brine Shrimp	80 ppm
Oyster	Greater than 60,000 ppm
Mussel	26,530 ppm
Barnacle	283 ppm
Algae	110 ppm
Bacteria	1,000 ppm

FC-206 AFFF (3M Company)

Organism	96 Hr. LC_{50}
Fish	2,679 ppm
Brine Shrimp	1,187 ppm
Oyster	Greater than 60,000 ppm
Mussel	10,000 ppm
Barnacle	10,000 ppm
Algae	1,560 ppm
Bacteria	10,000 ppm

Glycerine

Organism	96 Hr. LC_{50}
Fish	51,870 ppm
Brine Shrimp	17,275 ppm
Oyster	Greater than 60,000 ppm
Mussel	35,660 ppm
Barnacle	45,000 ppm
Algae	33,500 ppm
Bacteria	Greater than 100,000 ppm

National Foam Aerowater Number 3
(National Foam Corporation)

Organism	96 Hr. TC 50
Fish	850 ppm
Brine Shrimp	727 ppm
Oyster	Greater than 60,000 ppm
Mussel	150 ppm
Barnacle	155 ppm
Algae	574 ppm
Bacteria	20,000 ppm

National Foam Aerowater Number 6
(National Foam Corporation)

Organism	96 Hr. TC 50
Fish	900 ppm
Brine Shrimp	8,567 ppm
Oyster	35,000 ppm
Mussel	80 ppm
Barnacle	427 ppm
Algae	980 ppm
Bacteria	20,000 ppm

USAF ENVIRONMENTAL HEALTH LABORATORY (AFLC)

UNITED STATES AIR FORCE

KELLY AFB, TEXAS 78241

BIODEGRADABILITY AND TOXICITY OF LIGHT WATER® FC206, AQUEOUS FILM FORMING FOAM

November 1974

EHL(K) 74-26

Prepared By:

EDWARD E. LeFEBVRE, Maj, USAF, BSC
Consultant, Environmental Chemistry

ROGER C. INMAN, Maj, USAF, VC
Veterinary Ecologist/Toxicologist

Reviewed By:

ALBERT M. ELLIOTT, Lt Col, USAF, BSC
Chief, Special Projects Division

Approved By:

WALTER W. MELVIN, JR., Col, USAF, MC
Commander

FOR OFFICIAL USE ONLY

N O T I C E

This subject report is released by the Air Force for the purpose of aiding future study and research. Release of this material is not intended for promotional or advertising purposes and should in no way be construed as an endorsement of any product. The views expressed herein are those of the author/evaluator and do not necessarily reflect the views of the United States Air Force or the Department of Defense.

TABLE OF CONTENTS

TABLE OF CONTENTS

I. SUMMARY

Light Water®, FC206, is an aqueous film forming foam (AFFF) used for fire fighting. Biodegradability studies show that it can be biologically treated in controlled concentrations up to 200 ul/l in synthetic sewage on a continuous basis. Higher concentration appear amenable to treatment in oxidation ponds over long time periods. Toxicity studies with fathead minnow juveniles and fry indicate that FC206 is less toxic than AFFF's previously tested. The 96-hour LC_{50} for fathead minnow juveniles and fry were 1080 ul/l and 170 ul/l respectively. Using a 0.05 application factor, a concentration unit of 54 ul/l is recommended for discharge to any waters containing aquatic life.

II. INTRODUCTION

This is the fourth report on the biodegradability and toxicity of a commercial aqueous film forming foam used to fight fires by the Air Force. The results of studies of Light Water® (FC206) a product of Minnesota Mining and Manufacturing Co., St Paul, Minn, are presented here. The FC206 is used to make a six percent solution for the fire fighting operations. This study was conducted at the request of Hq USAF/SGPA and Hq USAF/PREE.

III. DISCUSSION

A. Composition

Results of analysis at this laboratory are shown in Table 1. The specific gravity of the concentrate is 1.020 with a pH of 7.8.

Table 1. Composition of FC206.

PARAMETER	QUANTITY
Water	~70%
Diethylene Glycol Monobutyl Ether	~27%
Flurocarbon (Structure not Determined)	~ 2%
Sodium Sulfate	~ 1%
Chemical Oxygen Demand	500,000 mg/l
Total Organic Carbon	96,000 mg/l
Surfactants (MBAS as LAS)	41,000 mg/l
Fluorine	14,000 mg/l

B. Respiration Studies

1. Biochemical Oxygen Demand

The need for measurement of biochemical oxygen demand (BOD) over incubation periods in excess of the standard five days has been pointed out by several investigators and reported previously (5). Additionally, incubation at 25°C rather than the standard 20°C allows determination of the Ultimate BOD in a shorter time period without adverse affects on the micro-organism composition although temperatures in excess of 30°C would alter composition (2). Figure 1 is a curve showing the BOD over a 20-day period as measured with the E/BOD Respirometer as previously reported (13). Table 2 is a summary of these E/BOD measurements.

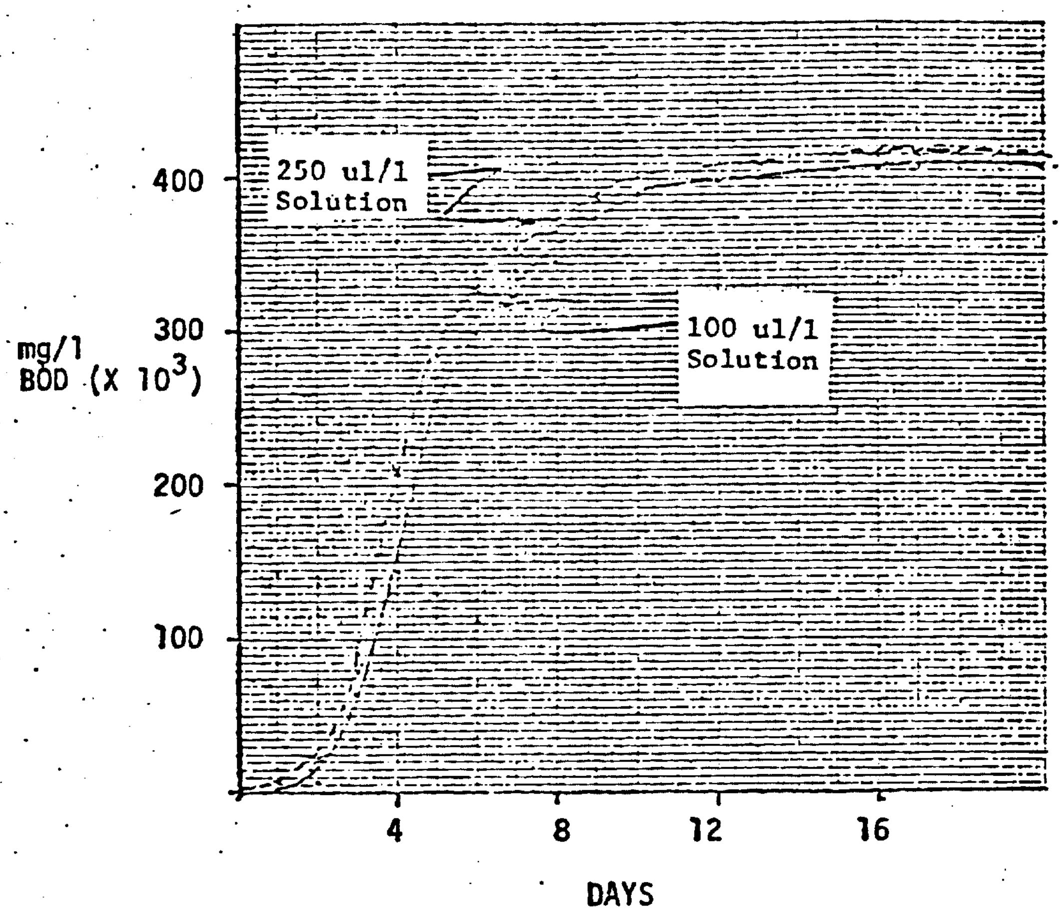


Figure 1. Biological Oxygen Demand as a Function of Time of FC 206 by USAF Environmental Health Laboratory, Kelly AFB TX, 1974.

Table 2. Summary of Data From Measurement of Extended BOD of FC206 at 25°C with the E/BOD Respirometer

	mg/l	Percent of E/BOD_{20}
E/BOD_5	$2.68X10^5$	65.2
E/BOD_{10}	$3.95X10^5$	96.1
E/BOD_{15}	$4.10X10^5$	99.7
E/BOD_{20}	$4.11X10^5$	

2. Warburg Respirometer Studies

Figure 2 shows the variation in oxygen uptake with respect to concentration of the FC206. Acclimation of the microorganisms can be seen by the increase in oxygen uptake rates at the higher concentrations with respect to time. Since the dilution of FC206 from normal usage is to a six percent solution, oxygen up take was not measured beyond the 10 percent solution.

C. Pilot Plant Studies

1. Two bench-scale activated sludge pilot plants were fed increasing concentrations of FC206 in synthetic sewage of composition shown in Table 3. The plants began to show solids loss at an FC206 concentration of 200 to 225 ul/l. Most of the solids loss appeared to be physical in nature from the foaming action forcing the solids over the side of the reactor. Tables 4 and 5 are summaries of the measured parameters for each plant. Table 6 shows the recovery of solids in the first plant when the FC206 concentration was lowered from 500 ul/l to 200 ul/l.

Table 3. Composition of Synthetic Sewage Used in Biodegradability Studies

Glucose	160	mg/l
Peptone	160	mg/l
Urea	28.6	mg/l
Na HCO_3	102	mg/l
KH_2 PO_4	32.5	mg/l
Tap Water		

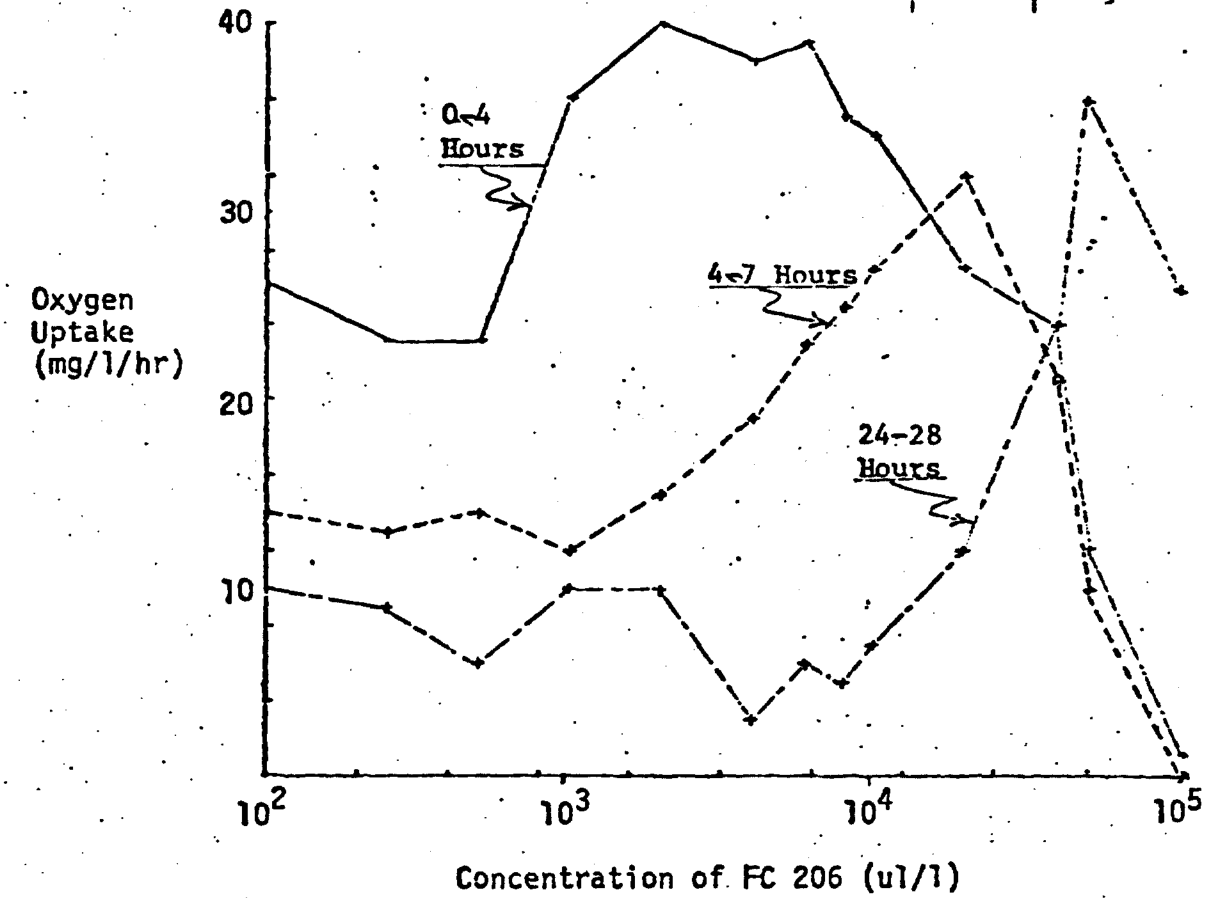


Figure 2. Oxygen Uptake of Varying Concentrations of FC 206 Using the Warburg Respirometer

2. Five Fathead minnows (Pimephales promelas) were placed in each container receiving effluent from each of the plants at the beginning of the study. One fish succumbed in the first plant effluent after 27 days and one in the second plant effluent after 43 days indicating that the effluents were relatively non-toxic. Five giant water fleas (Daphnia magna) were placed in each effluent container on the 36th day and survived to the termination of the study (51 days).

Table 4. Summary of Analysis of Samples From Activated Sludge Pilot Plant No. 1 Receiving FC206 and Synthetic Sewage.

No. of Days	ul/l FC206	mg/l Avg. MLSS	pH Range	D.O. Range mg/l	Percent BOD_5 Removal	Percent TOD Removal
5	50	3045	7.2-7.3	4.0-6.2	97.8	>95.8
3	75	3315	7.1-7.2	4.2-4.4	No Data	>95.4
5	100	3363	7.2-7.3	4.8-5.6	98.9	>95.6
3	200	3587	7.1-7.2	4.0-5.6	98.8	>99
8	300	3016	7.2-7.4	4.0-6.0	92.1	>99
5	400	2685	7.3-7.4	5.8-6.2	97.6	91.5
14	500	1763	7.4-7.8	5.0-7.4	94.8	54.5
1	300	1000	7.7	6.6	17.7	>99
3	200	1513	7.7-8.1	6.0-7.2	85.7	No Data

Table 5. Summary of Analysis of Samples from Activated Sludge Pilot Plant No. 2 Receiving FC206 and Synthetic Sewage.

No. of Days	ul/l FC206	mg/l Avg. MLSS	pH Range	D.O. Range mg/l	Percent BOD_5 Removal	Percent TOD Removal
5	50	2397	7.2-7.5	2.0-6.0	98.0	>96.1
8	75	2648	7.2-7.3	4.8-5.8	98.8	>95.4
3	125	2863	7.3-7.3	4.6-5.6	98.7	>99
8	225	3052	7.2-7.4	4.6-5.4	98.3	>99
5	250	2985	7.0-7.2	4.6-6.0	98.2	>97.9
22	300	2414	7.1-7.4	4.4-7.0	96.5	>98.2

Table 6. Daily Measurement of MLSS in Plant No. 1 From 30th to 51st Days.

Day	ul/1 FC206	mg/1 MLSS
30	500	2810
31	500	2650
32	500	2820
36	500	840
38	500	1020
39	500	1100
43	500	1100
44	300	1000
45	200	1280
46	200	1460
51	200	1800

D. Toxicity Studies

1. METHODS AND MATERIALS

a. Experimental Animals

Toxicity studies used the fathead minnow (Pimephales promelas) to determine the relative toxicity of FC206 solutions -- (Concentrate and pilot plant effluents). Sexually-immature fathead minnows were supplied by the National Fish Hatchery at Uvalde, Texas. The fish were acclimatized to the laboratory conditions and local water for a minimum of 30 days before use. Mean fish weight was 0.913 gm (σ = 0.370). The fish were fed a commercial fish food*. Immature fathead minnow fry used in static bioassays were reared at EHL/K. Age of fry at time of use was 21 days.

b. Exposure Procedure

(1) Continual flow type bioassays used proportional diluting equipment as developed by Mount and Brungs (7) (8). These diluters supplied logarithmic scaled dilutions of the compound being tested to a flow-through chamber for each concentration in which the experimental animals were held. Studies with fry were static bioassays with three fry per each one-liter test concentration.

*Tetramin®, Distributor, Tetra Sales Corp. Heyward, CA 94545.

(2) Bioassays were performed in accordance with principles described in Standard Methods (12) and Sprague (9). Test animals were not fasted prior to testing. They were not fed during the actual assay period. Ten fish were used for each concentration and the control. Exposure chambers were plastic rat cages modified to contain 4 liters of diluted toxicant.

(3) Response of the test animals was recorded throughout a 96-hour test period. Probit analysis was performed on the data recorded at 24, 48, 72 and 96 hours of exposure to evaluate quantal response to graded doses. After the first bioassay, a true 96 hour replicate was performed using the same procedures and concentrations as used in the first run. In all these bioassays the test animals were placed into the exposure chambers in a random order by using a table of random numbers. The chambers themselves were positioned in random order. The control chamber contained water from the same water tank as the water that was used as the diluent in the other test chambers. The flow of diluted toxicant into the chamber was adjusted to a retention time of 2 hours. This is equal to a 6 hour, 95% replacement time and insures adequate maintenance of the dissolved oxygen concentration. 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.

c. Dilution Water

Unchlorinated well water from a deep well was used as the dilution water in these studies. The water was collected in 400 gallon fiberglas trailer-tanks at an on-base well site. The water trailers were hauled to the Laboratory and allowed to sit at least 24 hours before the water was used. Air was bubbled through the water. The water was adjusted by heating or cooling to 24°C before it was run into the proportional diluter. The pH was 7.2 Hardness (EDTA as mg/l $CaCO_3$) was 194. Total alkalinity (as $CaCO_3$) was 160 mg/l.

d. Treatment use of Data

LC_{50}s* or TL_{50}s were determined by the probit analysis method of Litchfield and Wilcoxon. (6) Other statistical treatments such as the $(CHI)^2$ test for "Goodness of Fit" were by standard formulas. (3) To be used in this report and the previous reports on Fire-Fighting foam chemicals, toxicity study results had to fulfill two important criteria. 1) Graded quanted responses had to definitively relate to the logarithms of serial dilutions in each test chamber. 2) the results had to be repli-

*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.

cable. The establishment of dose-effect and time-effect relationships allowed scientifically based predictions of the ecological effects of the tested chemicals on a body of water during use, accidental spillage or disposal. Also the relative toxicity of one material could be compared with another; perhaps with the goal of selecting one that would have the least effect on aquatic biota. Finally, the results could be used to set "allowable" or minimal effect concentrations in bodies of water that may receive these materials as waste.

2. Results of Toxicity Studies

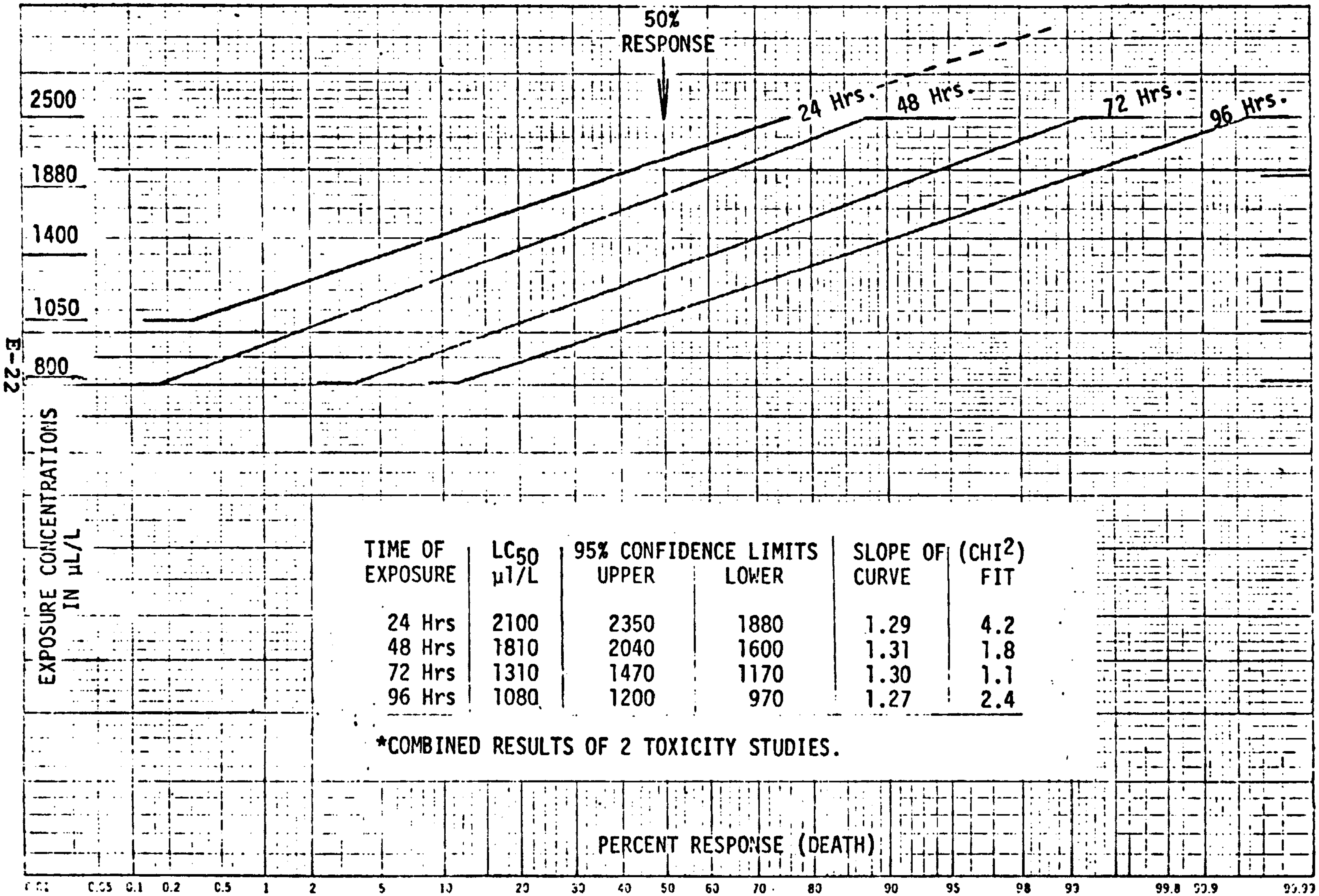
a. The sexually immature minnows were exposed to concentrations of FC206 ranging from 800 ul/l to 2500 ul/l (see Figure 3). At 48, 72 and 96 hours of exposure there was 100 percent death at the 2500 ul/l concentration and no deaths at the 800 ul/l concentration. At 24 hours of exposure there were no deaths in the 1050 ul/l concentration and 75 percent deaths in the 2500 ul/l concentration..

b. Figure 4 illustrates the change in LC_{50} with increasing time of exposure. As the percent of deaths increase with time of exposure (lower LC_{50}s), there is a reduction in the slope of the curve between 72 and 96 hours. The reduction in the slope indicates that the 96 hour value may be approaching the incipient LC_{50} (lethal threshold concentration). Therefore, for FC206, the 96 hour LC_{50} is considered to be an adaquate estimation of the incipient LC_{50} and can be used to set acceptable concentration limits of FC206 for short periods of time.

c. The 96 hour LC_{50} for 3 week old fry was 170 ul/l. The LC_{50} value for fry compared with the 1080 ul/l value for the juvenile fish indicates that the FC206 concentrate is approximately 6 times more toxic to the fry than more mature forms. Thus the increased sensitivity of immature forms indicates that the limits of safety using a 1/10 application factor for short term exposure would provide just adequate protection and that a 1/20 value would be more desirable.

Figure 3

QUANTAL RESPONSE CURVES* OF FISH EXPOSED TO FC 206

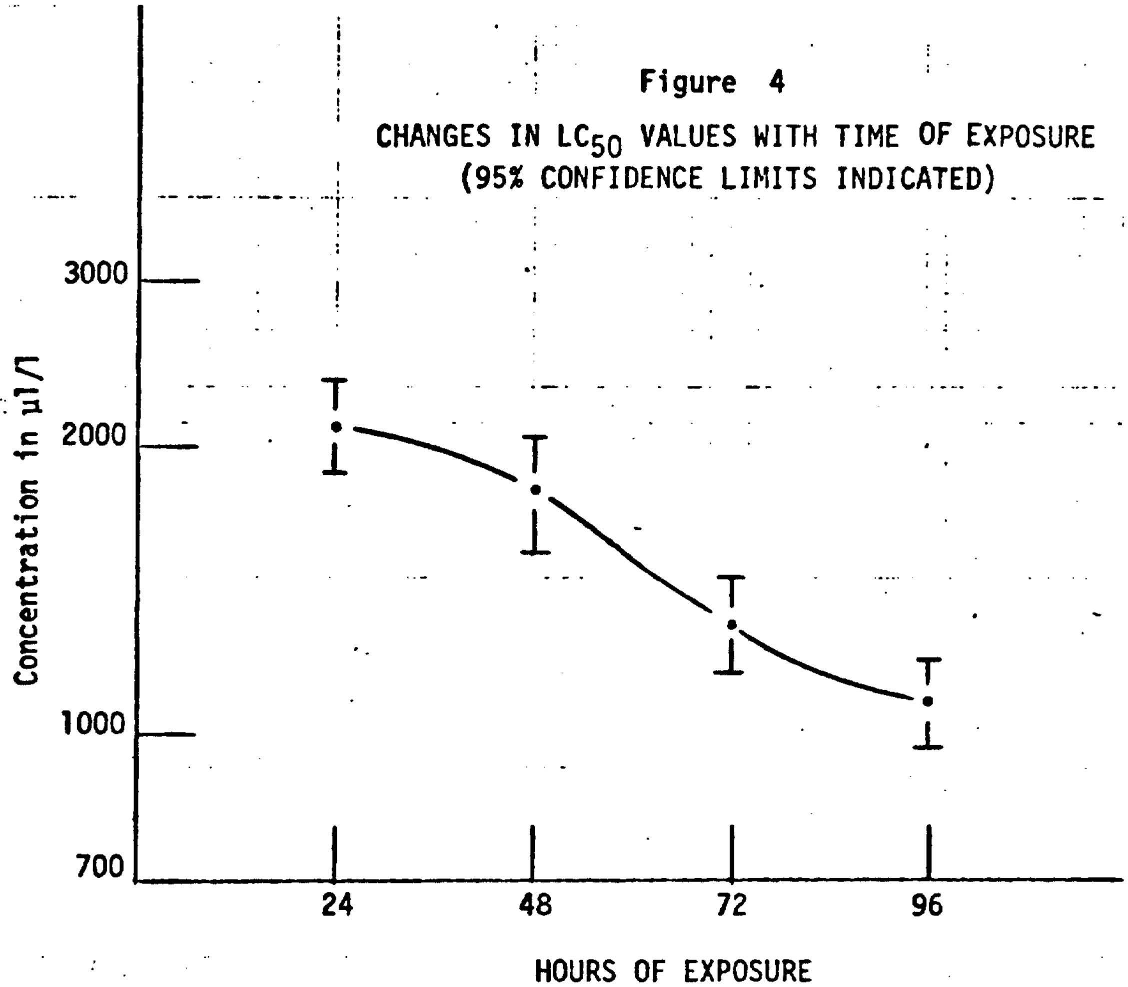


TIME OF EXPOSURE	LC_{50} µl/L	95% CONFIDENCE LIMITS UPPER	LOWER	SLOPE OF CURVE	(CHI^2) FIT
24 Hrs	2100	2350	1880	1.29	4.2
48 Hrs	1810	2040	1600	1.31	1.8
72 Hrs	1310	1470	1170	1.30	1.1
96 Hrs	1080	1200	970	1.27	2.4

*COMBINED RESULTS OF 2 TOXICITY STUDIES.

Figure 4

CHANGES IN LC_{50} VALUES WITH TIME OF EXPOSURE
(95% CONFIDENCE LIMITS INDICATED)



E. Comparison with AFFF's Previously Studies

1. Table 7 is a summary of the various parameters measured for each of the AFFF products studied thus far. (4,5,13). The greater percentage of the ultimate BOD being measured in the first five days on the newer products indicates a more rapid degree of biodegradability.

Table 7. Comparison of Various Parameters of AFFF's

	3M - LIGHT WATER			NAT'L FOAM SYSTEMS	
PARAMETER	FC199	FC200	FC206	AOW 3	AOW 6
pH	4.6	7.6	7.8	7.8	7.9
Specific Gravity	1.02	0.989	1.020	1.062	1.031
Water		59%	70%	72%	72%
Diethylene Glycol Monobutyl Ether		39%	27%	10%	10%
COD $(X10^3)$	550 mg/l	730 mg/l	500 mg/l	500 mg/l	350 mg/l
TOC $(X10^3)$		235 mg/l	96 mg/l	130 mg/l	100 mg/l
BOD_u $(X10^3)$	18 mg/l	450 mg/l	411 mg/l	354 mg/l	300 mg/l
BOD_5 (% BOD_u)	37	2	65	45	45

2. Table 8 summarizes the daily changes in LC_{50}'s during 96-hour bioassays for each of the AFFF concentrates previously studied.

Table 8. Changes in Toxicity of AFFF's to Fathead Minnows with increase in time of exposure.

	LC_{50} (Concentrations in µl/l)				
	3M - LIGHT WATER			NAT'L FOAM SYSTEMS	
	FC199	FC200	FC206	AOW 3	AOW 6
24-Hour	650	*	2100	1030	635
48-Hour	588	135	1810	820	255
72-Hour	450	97	1300	630	245
96-Hour	398	97	1080	600	225

*No mortality in 24 hours in one bioassay but 50% in highest concentration (150 µl/l) in duplicate bioassay.

IV. CONCLUSIONS

A. No acute toxicity to activated sludge microorganims was exhibited by FC206 up to 100,000 ul/l of the concentrate in synthetic sewage/activated sludge. Dilution of the concentrate for fire fighting operations is six percent (60,000 ul/l).

B. Respiration studies indicate that acclimation of microorganisms to concentrations up to 100,000 ul/l could occur and would allow successful waste treatment in oxidation ponds.

C. Bench scale - activated sludge treatment plants effectively treated concentrations of 200 ul/l on a continuous feed basis. Above this concentrations, sludge microorganisms were not able to build rapidly. This was probably due primarily to the physical removal of solids through foaming rather than direct toxicity to the microorganisms. Fathead minnows and daphnia lived in effluent from the plant being fed 500 ul/l.

D. In acute toxicity studies in which the test fish (Pimaphales promelas) were exposed to continously replenished concentrations of FC206, the 96 hour LC_{50} was 1080 ul/l (0.11%). The 96 hour value was considered to be an adequate estimation of the incipient LC_{50} (lethal threshold concentration) and suitable for use with application factors to predict "safe levels" for short-term exposure periods.

E. In comparing toxicities, FC206 concentrate was approximately six times more toxic to fry than the larger juvenile Fathead minnows. Also, FC206 concentrate was less toxic to Fathead minnows than previously tested fire fighting foams.

V. RECOMMENDATIONS

A. Wastewater from fire-fighting training operations should be passed through a gravity oil separator. The waste should then be held in a pond for natural oxidation and decomposition or pumped to a secondary sewage treatment facility at a controlled flow rate. Secondary treatment could be provided with the domestic sewage such that the influent to the sewage treatment plant will not contain in excess of 20 ul/l of the FC206. This recommendation is based on training exercises and is not necessarily intended for operational use.

B. Using the 96 hour LC_{50} of 1080 ul/l and an application factor of 0.05, the calculated "safe level" of FC206 concentrate is 54 ul/l for short term exposure. For situations in which the aquatic animals will be exposed more than 4 days, concentration of FC206 should not exceed 20 ul/l in the affected body of water.

VI. REFERENCES

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

2. Caskey, William, Personal Communication, Dept of Microbiology, Texas A & M University, College Station, TX.

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

4. LeFebvre, E.E. 1971. "Biodegradability and Toxicity of Light Water ." Report No. EHL(K) 71-36. USAF Environmental Health Laboratory, Kelly AFB, Tx.

5. LeFebvre, E.E. and J.F. Thomas. 1973. "Biodegradability and Toxicity of AER-O-Water 3 and AER-O-Water 6 Aqueous Film Forming Foam". Report No. EHL(K) 73-22. USAF Environmental Health Laboratory, Kelly AFB, Tx.

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. 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.

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

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

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

11. Sprague, J. B., "Sublethal Effects and "SAFE" Concentrations Water Research, Vol. 5 (1971), pp 245-266.

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

13. Thomas, J. F. and E. E. LeFebvre. 1974 "Biodegradability and Toxicity of FC200 Aqueous Film Forming Foam". Report No. EHL(K) 74-3, USAF Environmental Health Laboratory, Kelly AFB, Tx.

APPENDIX

Participants in Study

PARTICIPANTS

Biodegradability and Toxicity of Light Water, FC206 Aqueous Film Forming Foam

Biodegradability Studies:

Project Officer: Maj Edward E. LeFebvre
Consultant, Environmental Chemistry

1Lt Thomas Doane, Consultant, Environmental Chemistry
TSgt Samuel A. Britt, Laboratory Techician
Mr. Gilbert Valdez, Physical Sciences Aide
A1C Gregory Knerl, Laboratory Techician

Bioassays:

Maj. Roger Inman, Veterniary Ecologist Toxicologist
MSgt Melvin Struck, Laboratory Animal Techician
TSgt Jerold Akey, Laboratory Animal Techician

APPENDIX F

SMALL SCALE AFFF/DYE DISPERSION TEST

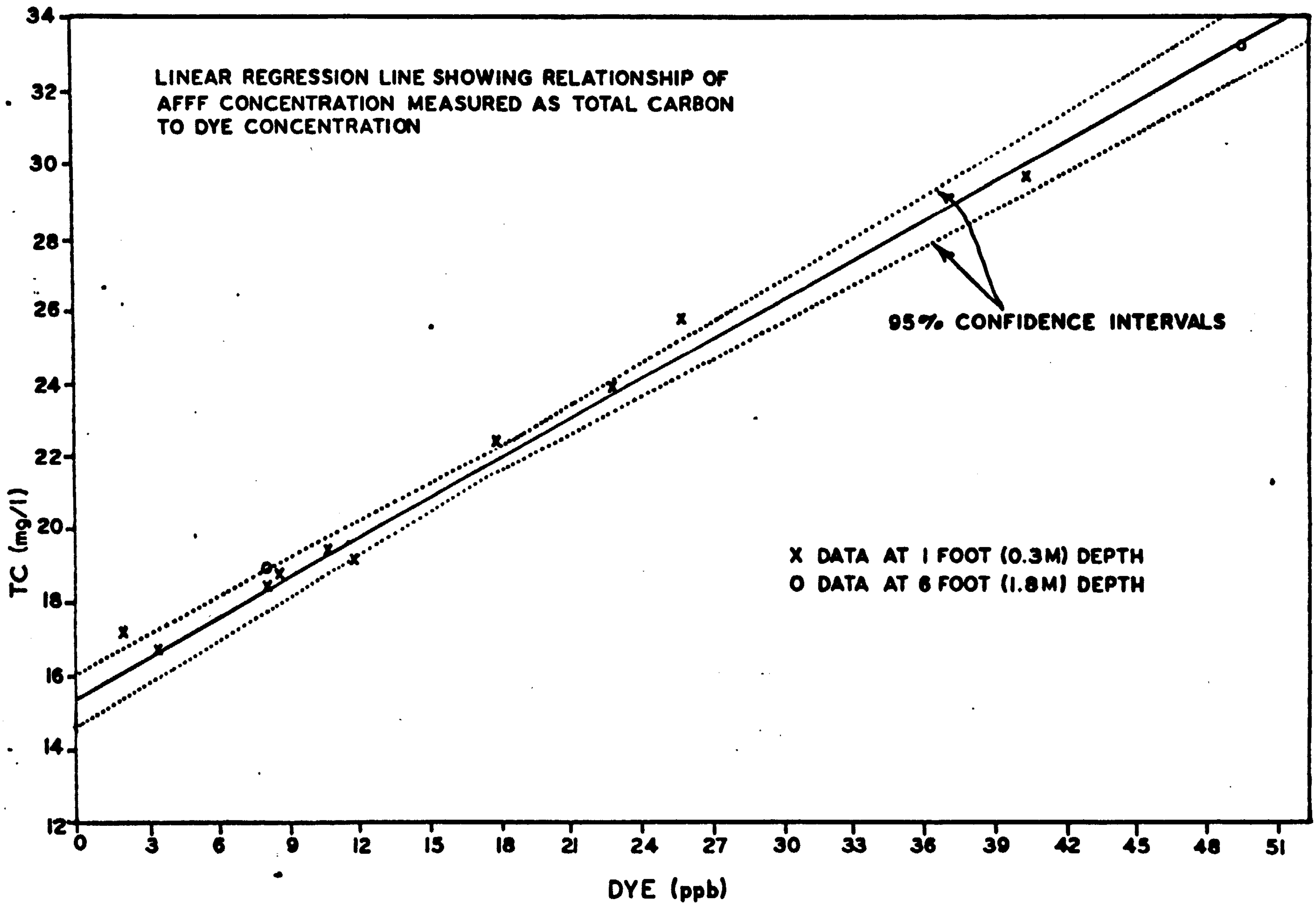
1. A small scale test was conducted in Dungan Basin at the David W. Taylor Naval Ship Research and Development Center, Annapolis Laboratory, on 3 September 1975. Released into the basin was a mixture of 1.2 gal (4.5 ℓ) of AFFF (3M Co. FC-206) and 18.8 gal (71.2 ℓ) of water drawn from the basin. The AFFF/water mixture was dyed to a concentration of 100 ppm (by weight) with rhodamine WT dye. The mixture was poured overboard at 1412 hours from a small boat in the center of the basin. Samples were pumped into collection bottles from depths of one foot (called surface samples, S), six feet, and nine feet from areas within the visible dye patch visually estimated to be those of highest dye concentration. Samples were analyzed for dye concentration, TC, and COD. Results of analyses are contained in table F-1. It was assumed that the increase in TC above background levels was due to the presence of AFFF.

2. Rhodamine dye concentration and TC data for samples collected at the one foot (0.3 m) depth are plotted in figure F-1. The relationship between dye and TC demonstrates that dye can be used to simulate the dispersion of AFFF. Although the rate of change in AFFF and dye was different, the dilution factors remained the same. Therefore, dilution data from an in situ dye dispersion study can be used to develop dilution factors applicable for predicting the decrease in AFFF concentration after release of a known quantity of AFFF under similar conditions in the study area.

Table F-1
Results of Laboratory Analyses of Water Samples from Dungan Basin Before and After the Addition of AFFF and Rhodamine Dye

Time	Depth (ft)	Depth (m)	Dye Concentration (ppb)	TC (mg/ℓ)	COD (mg/ℓ)
Bkgd	1	0.3	<2	15.6	128
Bkgd	1	0.3	<2	13.8	125
Bkgd	6	1.8	<2	14.8	68
Bkgd	6	1.8	<2	13.8	70
1412	-	-	Release dye, 1.0×10^5 ppb	-	2.6×10^4
1415	1	0.3	8.9	18.6	96
1415	6	1.8	8.3	18.7	80
1417	1	0.3	40.6	29.6	150
1417	6	1.8	49.5	33.2	144
1419	1	0.3	25.7	24.8	160
1419	6	1.8	<2	14.6	84
1420	1	0.3	21.8	23.8	184
1420	6	1.8	<2	14.8	104
1422	1	0.3	17.8	22.4	100
1422	6	1.8	<2	14.8	80
1423	1	0.3	10.9	19.4	68
1423	6	1.8	<2	14.1	148
1424	1	0.3	8.5	18.2	76
1424	6	1.8	<2	15.3	64
1425	1	0.3	3.7	16.6	88
1425	6	1.8	<2	14.1	132
1425	9	2.7	<2	14.1	152
1427	1	0.3	11.9	19.2	100
1427	6	1.8	<2	14.6	68
1427	9	2.7	<2	14.1	188
1430	1	0.3	2.1	17.3	64
1430	6	1.8	<2	13.6	48
1430	9	2.7	<2	14.8	96

FIGURE F-1


LINEAR REGRESSION LINE SHOWING RELATIONSHIP OF AFFF CONCENTRATION MEASURED AS TOTAL CARBON TO DYE CONCENTRATION
95% CONFIDENCE INTERVALS
X DATA AT 1 FOOT (0.3M) DEPTH
O DATA AT 6 FOOT (1.8M) DEPTH
TC (mg/l)
DYE (ppb)
12
14
16
18
20
22
24
26
28
30
32
34
0
3
6
9
12
15
18
21
24
27
30
33
36
39
42
45
48
51

F-3

APPENDIX G

TENTATIVE ALLOCATION PLANS AND CONSTRUCTION SCHEDULES FOR SHIP CHT SYSTEMS, SWOBS, AND PIER SEWERS

TABLE G-1
ACTIVITIES WHICH HAVE/PLAN TO HAVE PIERSIDE FACILITIES FOR
SHIP-TO-SHORE SEWAGE TRANSFER TOGETHER WITH FACILITY DESCRIPTION AND STATUS*

15 October 1976

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
NORFOLK COMPLEX				
NAVSTA	P-807	W289D	PIERS 7,12,20,21,22,23	CONST.COMPL. FACILITY OPERATING
			PIER 24	UNDER CONST. UNTIL 6/78
			PIER 25	UNDER CONST. UNTIL 7/77
NAB LITTLE CREEK	P-206	W131J	PIERS 56,57,58,59	CONST.COMPL. FACILITY OPERATING
NAVSTA	P-911	W289E	PIERS 2,3,4,5,10	UNDER CONST. UNTIL 1/77
NSY PORTSMOUTH	P-177	W164G	WHARFS 1-12,15,23-27,29-33 35,36,38,39,41-45	UNDER CONST. UNTIL 4/77
NAB LITTLE CREEK	P-207	W131K	PIERS 1-8,11-15,16-19	UNDER CONST. UNTIL 3/77
NSY PORTSMOUTH	P-999	W164A	PIER C	UNDER CONST. UNTIL 4/77
SAN DIEGO COMPLEX				
NAVSTA	P-176	W027D	PIER 4	CONST.COMPL. FACILITY OPERATING
NSSF	P-036	W304A	PIERS 5000,5002, DEPERMING PIER	CONST.COMPL. FACILITY OPERATING
NAS NORIA	P-313	W018L	WHARFS I,J,K	CONST.COMPL.(MUNICIPAL CONN. COMPL.) Lift Station Pump Prob.
NAVSTA	P-179	W027F	PIERS 5,6,8	UNDER CONST. UNTIL 5/77; PIER 5 CONST.COMPL.
			SMALL CRAFT BASIN	CONST.COMPL.
			MOLE PIER	CONST.COMPL.
			PIERS 1,2,3	UNDER CONST. UNTIL 1/78
			PIER 9	PLANNED EST.COMPLETION 12/78
	P-191	W032j	PIER 10	PLANNED EST.COMPLETION 12/79
	P-198	- -	PIERS 11,12,13	PLANNED EST.COMPLETION 12/80
NSC	P-022	W209K	BROADWAY PIER	UNDER CONST. UNTIL 12/76
	P-023	W209j	FUEL PIER PT.LOMA	UNDER CONST. UNTIL 12/77
NUC	P-059	W028D	PIERS 1,2 PT. LOMA	PLANNED EST. COMPLETION 6/78
	P-057	W028C	SAN CLEMENTE ISLAND	PLANNED EST. COMPLETION 7/79
NAB CORONADO	P-093	W220C	PIERS 3,8,13	UNDER CONST. UNTIL 12/77

*NCBC letter to CNO, 25A1:WLR:hla, Control No. 610-23, Seria 5054 of 16 November 1976, enclosure (1).

TABLE 1 (cont.)

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
CHARLESTON NSC	P-903	W305A	PIER A	UNDER CONST. UNTIL 6/77
NSY			PIERS C,D,F,G,H,J,K,L,M	UNDER CONST. UNTIL 6/77
NAVSTA			PIERS N,P,Q,R,S,T,U	UNDER CONST. UNTIL 6/77
NWS	P-901	W119H	WHARF A, PIERS B,C,	UNDER CONST. UNTIL 11/76
MAYPORT NAVSTA	P-964	W049K	WHARFS B,C,D,A	CONST.COMPL. FACILITY OPERATING
PEARL HARBOR COMPLEX NSB	P-119	W057G	PIERS S1-S5,S8,S9	CONST.COMPL. (awaiting sewage transfer hose)
NAVSTA	P-991	W165G	PIERS B1-B26,	UNDER CONST. UNTIL 2/77
NSY			B1-B21,GD1-GD5,	UNDER CONST. UNTIL 2/77
			O2, MR NO. 2	UNDER CONST. UNTIL 2/77
NAVSTA	P-991A	W165H	PIERS M1-M4,	UNDER CONST. UNTIL 2/77
NSC			H1-H4,	UNDER CONST. UNTIL 2/77
NSB			S10-S14,S20,S21	UNDER CONST. UNTIL 2/77
NAVSTA	P-179	W165I	A1-A7,S15-S19,F1-F5	UNDER CONST. UNTIL 10/77
NSC			V1-V4,K3-K11	UNDER CONST. UNTIL 10/77
NAVSTA	P-179A	W165J	F12,F13	UNDER DESIGN, EST.COMPL. 7/78
NAVMAG	P-179B	W165J	W1-W5	UNDER DESIGN, EST.COMPL. 3/79
SAN FRANCISCO NAS ALAMEDA	P-100	W007M	PIER 3	CONST.COMPL. FACILITY OPERATING
	P-133	W007N	PIERS 1,2	CONST.COMPL. FACILITY OPERATING
NWS CONCORD	P-153	W008F	PIER 2	PLANNED, EST.COMPLETION 6/80
NSY VALLEJO	P-203	W031F	WHARFS 2-20,24	PLANNED, EST.COMPLETION 5/78
			PIERS 21-23	PLANNED, EST.COMPLETION 5/78
NSC OAKLAND	P-002,3,4	W019F	- - - - -	PLANNED, EST.COMPLETION 12/79
PUGET SOUND NTS KEYPORT	P-190	W146J	WHARF	UNDER CONST. UNTIL 1/77
NSY BREMERTON	P-166	W144K	PIERS 3-8	PLANNED, EST. COMPLETION 1/80
NSC BREMERTON	P-038	W147N	FUEL PIER	PLANNED, EST. COMPLETION 5/77

TABLE G-1 (cont.)

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
LONG BEACH				
NAVSTA	P-131	W014F	PIERS 9,11,15	CONST.COMPL.
NSY	P-172	W015I	PIERS 1,2,3,6,E	CONST.COMPL.
NAVSTA	P-133	W014G	PIER 7	UNDER CONST. UNTIL 1/77
NWS SEAL BEACH	P-096	W035C	WHARF	PLANNED, EST. COMPLETION 7/78
GROTON/NEW LONDON				
NSB NEW LONDON	P-157	W040D	PIERS 1-4,6,8-10,12,13,15,17,31	CONST.COMPL.(awaiting sewage transfer hose)
NUSC	P-116	W332A	PIER 7	PLANNED EST. COMPLETION 9/79
PENSACOLA				
NAS	P-999	W051K	PIERS 302,302	CONST.COMPL.(awaiting sewage transfer hose)
WASHINGTON D.C.				
NAVSTA	P-194	W042j	PIERS 1,4	CONST.COMPL. FACILITY OPERATING
PORTSMOUTH N.H.				
NSY	---	---	PIERS 1,2,3	CONST.COMPL. FACILITY OPERATING
ADAK				
NAVSTA	P-834	W002I	PIER 3	PLANNED, EST. COMPLETION 12/79
EARLE				
NWS	P-771	W190A	PIERS 2,3	PLANNED, EST. COMPLETION 6/77
NEW ORLEANS				
NSA	P-047	W063C	PIER 1	PLANNED, EST. COMPLETION 8/79
PANAMA CITY				
NSCL	P-999	W266B	SOUTH DOCK, EAST DOCK	CONST.COMPL (awaiting sewage transfer hose)

TABLE G-1 (cont.)

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
PORT HUENEME				
CBC	P-332	W023K	WHARFS 2-6,A	PLANNED, EST. COMPLETION 9/79
YORKTOWN				
NWS	P-336	W136C	PIER 2	UNDER CONST. UNTIL 1/77
PHILADELPHIA				
NSY	P-451	W106D	PIERS 1,2,4	UNDER CONST. UNTIL 11/76
	P-443	W106B	PIERS 5,6	CONST.COMPL.(awaiting sewage transfer hose)
ROOSEVELT ROADS				
NAVSTA	P-997	W111H	PIERS 1,2,3	UNDER CONST. UNTIL 4/77
GUAM				
NAVSTA	P-094	W064K	A,B & V	UNDER CONST. UNTIL 11/76
NAVSHIPREPFAC			L,M,N,& O	UNDER CONST. UNTIL 11/76
NSD			R,S,T, & U	UNDER CONST. UNTIL 11/76
NAVMAG			H	UNDER CONST. UNTIL 11/76
NAVSTA	P-107	W064R	X	PLANNED, EST. COMPLETION 12/79
PORTLAND, OR				
NAVRESCTR	O&MN	W258C	PIERSEWER	AWAITING AWARD OF CONST.CONTRACT (EST.COMPL. OF CONST. 4/77)
TACOMA, WA				
NAVRESCTR	O&MN	W151C	PIERSEWER	AWAITING AWARD OF CONST.CONTRACT (EST.COMPL. OF CONST. 4/77)
EVERETT, WA				
NAVRESCTR	O&MN		PIERSEWER	UNDER CONST. UNTIL 1/77

TABLE G-1 (cont.)

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
GALVESTON, TX NAVRESCTR	MCNR P-032	W322A	PIERSEWER STRUCT. #11	PLANNED, EST. COMPLETION 7/77
ST. PETERSBURG, FL NAVRESCTR	MCNR P-241	W329A	PIERSEWER STRUCT. #6	PLANNED, EST. COMPLETION 7/77
BRONX, NY (Fort Schyler) NAVRESCTR	MCNR P-315	W324A	PIERSEWER	PLANNED, EST. COMPLETION 1/78
PERTH AMBOY NAVRESCTR	MCNR P-346	W338A	PIERSEWER	PLANNED, EST. COMPLETION 12/78
PORTLAND, ME NAVRESCTR	MCNR P-343	W340A	PIERSEWER	PLANNED, EST. COMPLETION 10/78
BALTIMORE, MD NAVRESCTR	MCNR P-243	W072A	PIERSEWER	PLANNED, EST. COMPLETION 10/77
JACKSONVILLE, FL			NO PIERSEWER PLANNED	
BOSTON, MA			NO PIERSEWER PLANNED	
NEWPORT, RI (NETC) NAVSTA	P-208	W116N	PIERSEWER PLANNED	

TABLE G-1 (cont.)

LOCATION	MCON NO.	PCR NO.	DESCRIPTION	STATUS
GREAT LAKES, IL			NO PIERSEWER PLANNED	
YOKOSUKA, JAPAN				
LA MADDALENA, IT				
HOLY LOCH, SC			WILL USE SWOB	
ROTA, SPAIN			WILL USE SWOB	
BAHRAIN				
GAETA				
NAPLES				
BROOKLYN, NY (Floyd Bennett Field) NAVRESCTR	MCNR P-319	W337B	PIERSEWER PLANNED	

TABLE G-2
SHIPS WASTE OFFLOAD BARGE (SWOB) ALLOCATION PLAN AND DELIVERY SCHEDULE*

	FY74 PROCUREMENT (OIL)		FY75 PROCUREMENT (OIL)			FY76 PROCUREMENT (OIL & SEWAGE)		TOTAL ALLOCATED	
	ALLOCATED	DELIVERED	ALLOCATED	DELIVERED	TO BE DELIVERED	ALLOCATED (OIL)	ALLOCATED (SEWAGE)	OIL	SEWAGE
NAVSHIPYD Portsmouth	0	0	0	0	1	0	0	1	0
WPNSTA Earle	0	0	2	0	1 (Note 1)	1	0	2	0
NAVSHIPYD Phildadelphia	0	0	0	0	0	2	0	2	0
WPNSTA Yorktown	1	1	0	0	0	0	0	1	0
NAVSTA Norfolk	3	3	3	3	0	0	2	6	2
NAVPHIBASE Little Creek	1	1	1	1	0	0	1	2	1
NAVSHIPYD Norfolk	1	1	0	0	0	1	0	2	0
NAVSTA Charleston	2	2	0	0	0	1	0	3	0
NAVSHIPYD Charleston	0	0	0	0	0	0	1	0	1
NAVSHIPYD Puget Sound	2	2	3	3	0	0	0	5	0
NAVSHIPYD Mare Island	1	1	0	0	0	0	0	1	0
NAVFUELDEP Point Molate	0	0	1	0	1-Jan '77	0	1	1	1
NSC Oakland	1	1	0	0	0	0	0	1	0
NAVSHIPYD Long Beach	2	2	0	0	0	0	1	2	1
NAVSTA San Diego	3	3	0	0	0	0	2	3	2
NAS North Island	2	2	0	0	0	0	0	2	0
NAVSHIPYD Pearl Harbor	1	1	0	0	0	0	0	1	0
NAVSTA Pearl Harbor	2	2	1	0	1 (Note 2)	0	3	3	3
NAVSTA Guam	0	0	1	0	1 (Note 2)	0	1	1	1
NAVSTA Subic Bay	0	0	1	0	1 (Note 2)	0	0	1	0
FLEACT Yokosuka	0	0	2	0	2 (Note 3)	0	0	2	0
NAVSTA Rota	0	0	1	0	1 (Note 4)	0	1	1	1
NAVSUPPO La Maddalena	0	0	1	0	1 (Note 4)	0	0	1	0
NAVSTA Roosevelt Roads	0	0	2	0	2-Jan '77	0	0	2	0
NAVSTA Guantanamo Bay	0	0	1	0	1-Jan '77	0	0	1	0
TOTALS	22	22	20	7	13	5	13	47	13

*Information provided by Naval Facilities Engineering Command (NAVFAC 104), 10 January 1977.

Notes:
1. One barge delivered by contractor stored at NAVSHIPYD Puget Sound to be delivered by contractor to final destination.
2. Three barges delivered by contractor in July 1976 to NAVSHIPYD Long Beach to await a Navy tow of opportunity to final destinations.
3. Two barges delivered by contractor in September 1976 to NAVSHIPYD Long Beach to await a Navy tow of opportunity to final destinations.
4. Three barges delivered by contractor in July 1976 to INACTSHIPPAC Portsmouth to await a Navy tow of opportunity to final destinations.

TABLE G-3
CHT COMPLETION SCHEDULE*

1 SEPT'76

FY-73

COMP.

CC-11

AS-11
AS-16
AS-31
AS-32
AS-37
ASR-8 (4)
ASR-9
ASR-14

LPH-3

PART.

LPD-6 (* in 7T)
LSD-32 (* in 7T)
LSD-34 (* in 77)

INCR.

CV-60(6)(8)

FY-74

COMPLETES

CG-10	DDG-37
CG-17	DDG-46
CG-27	FF-1049
DD-945	FF-1053
DDG-11	FF-1054
DDG-33	FFG-1
AD-18	AR-7
AD-37	AS-12
AE-21	ATF-100
AE-22	ATF-101
AFS-6	ATF-161
AO-98	
AO-147	
AOR-1	
LPD-7	
LST-1179	
LST-1182	

PARTIALS

CG-26 (* in '78)
CG-28 (* in '76)
CGN-35 (* in '76
DD-835 Note (5)
DD-839 (* in '78)
DD-862 (* in '78)
DD-863 Note (5)
DD-855 Note (5)
DD-836 (* in '78)
DDG-7 (* in '77)
FF-1056 (* in '78)
FF-1057 (* in '7)
FF-1058 (* in '78)
FF-1060 (* in '7)
FFG-2 (* in '79)

AE-27 (* in '76)
AO-149 (* in '79)
ARS-8 (* in '76)
ARS-23 (* in '76)
ARS-26 Note (5)
ARS-25 (* in '76)
ASR-13 (* in '78)
ASR-15 (* in '78)
ATF-96 (* in '76)
ATF-100 (* in '76)
ATF-110 (* in '76)
ASR-16 Note (4)

LKA-113 (* in '78)
LPD-8 (* in '79)
LPD-13 (* in '78)
LSD-28 (* in '79)
LST-1183(* in '78)
LST-1184(* in '78)

INCREMENTALS

CV-67 (8)

FY-75

COMPLETES

CG-29	DDG-31
CG-36	DDG-36
CGN-25	DDG-45
DD-937	FF-1041
DD-938	FF-1059
DD-941	FF-1066
DD-948	FF-1077
DD-950	FFG-5
DD-763	FFG-6
DD-756	
DD-927	
AD-38	ARS-38
AFS-2	ARS-40
AFS-7	ARS-42
AC-153	
AO-99	
AOR-2	
LKA-116	LSD-37
LPD-1	LST-1180
LPD-10	LST-1185
LPD-11	LST-1186
LPH-7	LST-1187
LPH-10	LST-1191

PARTIALS

LCC-20 (* in '78)

INCREMENTALS

CV-64(8)
CV-66(8)

FY-76-7T

COMPLETES

CG-18	FF-1065
CG-22	FF-1037
DD-931	FF-1050
DD-933	FF-1051
DD-940	FF-1052
DD-943	FF-1062
DD-946	FF-1063
DDG-4	FF-1065
DDG-9	FF-1071
DDG-10	FF-1072
DDG-19	FF-1075
DDG-22	FF-1078
DDG-23	FF-1079
DDG-32	FF-1091
AGFF-1	FFG-3
AD-19	ARS-41
AE-28	AS-34
AE-28	ATS-1
AE-29	ATS-2
AFS-4	ATF-103
AGF-3	ATF-105
AOE-1	ATF-113
AOE-4	ATF-162
AOR-3	
AOR-6	AR-5
LCC-19	LSD-29
LKA-112	LSD-35
LPA-248	LSD-38
LPA-249	LSD-39
LPD-5	LST-1181
LPD-9	LST-1188
LPD-12	LST-1189
LPD-14	LST-1195
LPH-9	
LPH-11	
LPH-12	

COMPLETIONS OF PARTIALS

CG-28	CGN-35
AE-27	ATF-96
ARS-8	ATF-106
ARS-23	ATF-110
ARS-25	
LPD-6	LSD-32

INCREMENTALS

CV-63(8)

FY-77

COMPLETES

CV-67(6)(7)

CG-20	FF-1076
CG-23	FF-1080
CG-26	FF-1082
CG-30	FF-1083
CG-32	FF-1084
DDG-15	FF-1085
DDG-35	FF-1086
DDG-38	FF-1087
DDG-40	FF-1089
FF-1055	
FF-1061	
FF-1070	
FF-1073	
FF-1074	
AD-15	ARS-43
AE-23	AS-33
AE-24	AS-36
AE-32	ATF-160
AE-34	
AE-35	
AFS-1	
AO-51	
AOE-2	
AOR-5	
AR-8	
LPD-15	LST-1193

COMPLETIONS OF PARTIALS

DDG-7

LSD-34

INCREMENTALS

CV-59 (8)
CV-61 (8)

FY-78

COMPLETES

CVT-16(6)(7)(9)

CV-63 (6)(7)(9)

CG-21	FF-1047
CG-33	FF-1049
	FF-1069
DDG-5	FF-1088
DDG-6	FF-1090
DDG-9	FF-1091
DDG-16	FF-1092
DDG-18	FF-1093
DDG-20	FF-1094
DDG-38	FF-1095
DDG-43	FF-1096
DDG-44	DD-962
DD-951	(NRT)
AE-25	AR-6
AE-33	
	AS-19
AFS-5	AS-18
LSD-33	LKA-115
LSD-36	

COMPLETIONS OF PARTIALS

CG-26	FF-1058
DD-886	FF-1060
FF-1056	FFG-2
FF-1057	DD-839
	DD-862
ASR-13	ASR-15
LCC-20	LST-1183
LKA-113	LST-1184
LPD-13	

INCREMENTALS

CV-61(6)
CV-60(8)
CV-62(6)(8)
CV-63(6)
CV-64(6)
CV-66(7)

FY-79

COMPLETES

CV-60 (7)
CV-62 (7)
CV-64 (7)
CVN-65(6)(7)(8)
CV-66 (6)

CG-31	DDG-46
DDG-2	FF-1066
DDG-13	FF-1067
DDG-14	
DDG-17	FF-1097
DDG-24	FF-1038
DDG-39	
DDG-42	
AFS-3	AGDS-2
AGM-6	
ASR-21	
ASR-22	
LKA-117	
LSD-30	
LSD-31	

COMPLETIONS OF PARTIALS

AO-148

LPD-8
LSD-28

INCREMENTALS

CV-61(7)
CV-59(6)

FY-80

COMP.

CV-59(7)

CG-5
DDG-3
DDG-41

ADE-3

INCR.

CV-61(8)

FY-81

COMP.

CV-41(8)
CV-61(7)
CV-63(7)

CG-16
CG-19

DD-944
DDG-12
DDG-21
FFG-4
FF-1048
FF-1063
FF-1064
FF-1052

ATS-3
ARS-39

LPA-116
LPD-2
LPD-4
LPH-2
LSD-40
LST-1190
LST-1192
LST-1194
LST-1196
LST-1197
LST-1129

TOTAL COMPLETIONS (1)

FY	COMP.	COMP. OF PART.	TOT
'73	10		10
'74	28		28
'75	41		41
'76-'7T	68	11	79
'77	41	2	43
'78	35	16	51
'79	26	3	29
'80	5		5
'81	26		26
		GRAND TOTAL	312

Notes: * - Indicates completion to be accomplished in year specified.
(1)- Total completions include completes, completions of partials and completions of incrementals.
(2)- CHT system to be installed, however, not in current overhaul schedules through FY-'81.
(3)- Partial installation - completion undetermined.
(4)- To be stricken in FY-'77.
(5)- Scheduled for decommissioning.
(6)- Fwd. piping portion.
(7)- Aft piping portion.
(8)- Tank portion.

FOR OFFICIAL USE ONLY

*CHT Ship/Shore Interface Information Book, Hydronautics Technical Report 7607.1 prepared for NAVSEC 6159, October 1976.