This document is part of Appendix A, and includes the Surface Vessel Bilgewater/Oil Water Separator: Nature of Discharge for the "Phase I Final Rule and Technical Development Document of Uniform National Discharge Standards (UNDS)," published in April 1999. The reference number is EPA-842-R-99-001.

Phase I Final Rule and Technical Development Document of Uniform National Discharge Standards (UNDS)

Surface Vessel Bilgewater/Oil Water Separator: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Surface Vessel Bilgewater/Oil Water Separator (OWS) Discharge

1.0 INTRODUCTION

The National Defense Authorization Act of 1996 amended Section 312 of the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)) to require that the Secretary of Defense and the Administrator of the Environmental Protection Agency (EPA) develop uniform national discharge standards (UNDS) for vessels of the armed forces for "...discharges, other than sewage, incidental to normal operation of a vessel of the Armed Forces, ..." [Section 312(n)(1)]. UNDS is being developed in three phases. The first phase (which this report supports), will determine which discharges will be required to be controlled by marine pollution control devices (MPCDs)—either equipment or management practices. The second phase will develop MPCD performance standards. The final phase will determine the design, construction, installation, and use of MPCDs.

A nature of discharge (NOD) report has been prepared for each of the discharges that have been identified as candidates for regulation under UNDS. The NOD reports were developed based on information obtained from the technical community within the Navy and other branches of the armed services with vessels potentially subject to UNDS, from information available in existing technical reports and documentation, and, when required, from data obtained from discharge samples that were collected under the UNDS program.

The purpose of the NOD report is to describe the discharge in detail, including the system that produces the discharge, the equipment involved, the constituents released to the environment, and the current practice, if any, to prevent or minimize environmental effects. Where existing process information is insufficient to characterize the discharge, the NOD report provides the results of additional sampling or other data gathered on the discharge. Based on above information, the NOD report describes how the estimated constituent concentrations and mass loading to the environment were determined. Finally, the NOD report assesses the potential for environmental effect. The NOD report contain sections on: Discharge Description, Discharge Characteristics, Nature of Discharge Analysis, Conclusions, and Data Sources and References.

2.0 DISCHARGE DESCRIPTION

This section describes the bilgewater/OWS discharge and includes information on: the equipment that is used and its operation (Section 2.1), general description of the constituents of the discharge (Section 2.2), and the vessels that produce this discharge (Section 2.3).

2.1 Equipment Description and Operation

2.1.1 The Bilge Area

The lowest inner part of the hull where liquid drains from the interior spaces and the upper decks of the vessel is referred to as the bilge. The primary sources of drainage into the bilge are the main engine room(s) and the auxiliary machinery room(s), which house the vessel's propulsion system and auxiliary systems (i.e., steam boilers and water purification systems), respectively. Other spaces that collect and contain fluid drainage in their bilge are the shaft alley, steering gear rooms, pump rooms, and air conditioning and refrigeration machinery rooms. Some oil lab sink drains are also directed to the bilge. The liquid collected in the bilge is known as "bilgewater" or "oily wastewater".

2.1.2 Composition of Bilgewater

The composition of bilgewater varies from vessel to vessel; the composition of bilgewater also varies from day to day on the same vessel. Certain wastestreams, including steam condensate, boiler blowdown, drinking fountain water, and sink drainage located in various machinery spaces, can drain to the bilge. The propulsion system and auxiliary systems use fuels, lubricants, hydraulic fluid, antifreeze, solvents, and cleaning chemicals, as part of routine operation and maintenance. Small quantities of these materials enter the bilge as leaks and spills in the engineering spaces. On some older vessels, excess potable water produced by onboard water purification systems is directed to the bilge, although this practice is being phased out.[1] On some Navy and Coast Guard vessels, water from gas turbine washdowns can contribute to bilgewater generation; these washdowns are described in the Gas Turbine Water Wash NOD report.

2.1.3 Bilgewater Treatment and Transfer System

Every surface vessel has an onboard system for collecting and transferring bilgewater. Vessels pump collected bilgewater to a holding tank which the Navy refers to as the oily waste holding tank (OWHT). Some vessels are capable of transferring bilgewater from the OWHT to shore facilities while pierside. OWS systems are installed on vessels, as appropriate, to reduce the oil content of bilgewater prior to overboard discharge. These systems receive bilgewater from the OWHT and use gravity-phase separation, coalescence, centrifugal separation, or combinations of these technologies to treat the waste.

A commonly used Navy OWS is a coalescing plate gravity separator. This type of separator has a horizontal set of oleophilic plates. Oil droplets rise and coalesce as they flow through the plates. The droplets cling to and wet the oleophilic plates once they rise to a plate's underside. When sufficient oil has accumulated, large oil droplets rise through weep holes in the plates and flow to the top of the OWS. The separated oil is then transferred to a waste oil tank (WOT). Figure 1 is a process flow diagram of the standard OWS system used on most Navy vessels.

On some vessels, oil content monitors (OCMs) are installed to prevent the discharge of unacceptable effluent. If the oil content is above the set point limit, the OCM alarms and diverts the OWS effluent back to the OWHT for reprocessing until an acceptable oil concentration reading is obtained.

In addition to the oil removed by the OWS, waste oil from routine maintenance is also collected in the WOT and held for pierside disposal.

Synthetic lubricant oils (SLOs) are not collected in the WOT, and measures are taken to prevent their introduction into the bilge. SLOs have a specific gravity close to that of water and cannot be separated in the OWS. These oils are normally found in engine spaces and are collected in drip pans located underneath the engines. The drip pans drain through segregated piping to dedicated collection tanks. SLOs within these tanks are disposed of on-shore separately from non-synthetic waste oils. Therefore, SLOs, except for tank overflows, are not likely to be in bilgewater at significant levels.

Some ships (e.g., DDG 51 Class destroyers) use non-oily machinery wastewater collection systems that segregate oily wastewater from non-oily wastewater. These ships collect non-oily machinery wastewater in dedicated collection tanks instead of the bilge, and discharge it directly overboard. All oily wastewater collects in OWHTs and is processed by a shipboard OWS or off-loaded for shore facility treatment.

2.2 Releases to the Environment

Untreated bilgewater is expected to contain oil and grease (O&G), an assortment of oxygen-demanding substances, and organic and inorganic materials. These materials include volatile organic compounds (VOCs), semi-volatile organic, inorganic salts, and metals. OWS effluent releases to the environment contain the same constituents present in bilgewater but with lower concentrations of O&G and oil-soluble components.

2.3 Vessels Producing the Discharge

All vessels produce bilgewater. OWS systems have been installed on most vessels of the Armed Forces. Some small boats and craft are not outfitted with OWS systems; thus, bilgewater is stored for shore disposal. Table 1 lists all surface vessels equipped with OWSs. Submarine bilgewater is addressed in the Submarine Bilgewater NOD report.

3.0 DISCHARGE CHARACTERISTICS

This section contains qualitative and quantitative information which characterizes the discharge. Section 3.1 describes where the discharge occurs with respect to harbors and near-shore areas, Section 3.2 describes the rate of the discharge, Section 3.3 lists the constituents in the discharge, and Section 3.4 gives the concentrations of the constituents in the discharge.

3.1 Locality

The Armed Forces do not discharge untreated bilgewater to surface waters. On ships without OWS systems, untreated bilgewater is held for transfer to a shore treatment facility. Bilgewater treated by an OWS can be discharged within or beyond 12 nautical miles (n.m.). On Navy vessels with an OWS and OCM, oil concentrations must be less than 15 parts per million (ppm) prior to discharge. However aboard Navy vessels, discharge of bilgewater with an oil concentration less than 100 ppm is allowed outside 12 n.m. if concentrations less than 15 ppm cannot be achieved because of operating conditions.

3.2 Rate

Bilgewater generation rates vary by vessel and vessel class because of the differences in vessel age, shipboard equipment (e.g., type of propulsion system), operations, and procedures. Vessels with non-oily machinery wastewater collection systems will generate significantly less bilgewater because of their capability to keep non-oily waste streams out of the bilges. The DDG 51 and CVN 68 class ships are two examples of ship classes that have non-oily machinery wastewater collection systems. Other factors influencing bilgewater generation rates are whether a vessel is operating in-port or at-sea, and when in port, whether it is operating in an auxiliary steaming mode or receiving shore electrical/steam power (cold iron mode). In the auxiliary steaming mode, a vessel provides its own services while moored at the pier (i.e., power, freshwater, etc.). In the cold iron mode, a vessel receives these services from shore facilities, minimizing the amount of shipboard equipment in operation. Older vessels without non-oily machinery wastewater collection systems have historically generated more bilgewater while operating in the auxiliary steaming mode than in the cold iron mode because of the discharge of utilities wastewater to the bilge.

Table 2 shows the in-port bilgewater generation rates for certain destroyers (DD 963 and DDG 51 Classes) and aircraft carriers (CVN 68 Class). For the destroyers, bilgewater generation rates were developed by monitoring the levels of bilgewater in the bilges.[1,2] Aircraft carrier class (CVN 68) data was gathered from an analysis of a carrier's (CVN 74) OWS operator log sheets in order to determine the amount of bilgewater that had passed through the OWS over an extended period of time, thus providing an estimate of the bilgewater generation rate.[3]

Table 3 summarizes the bilgewater/OWS flow rates that were developed for an aircraft carrier class (CVN 68), "other ship classes," and the overall fleet based on the average values from Table 2. The assumptions that were made in developing the estimates are summarized as follows:

1. The average and maximum daily bilgewater OWS discharge flow rates for a carrier (CVN 74) of 3,000 and 25,000 gallons per day (gpd), respectively, represents the average and maximum daily bilgewater/OWS flow for all aircraft carriers.

2. The destroyer (DD 963) bilgewater flow estimate of 1,000 to 3,000 gpd represents a typical range of flows for other U.S. Navy surface ship classes. An average of 2,000 gpd is assumed to be the average bilgewater generation rate.

3. Aircraft carriers spend approximately 147 days in port annually.

4. Other ships are in port for approximately 193 days annually.

The calculations used to estimate the total fleet bilgewater OWS effluent discharge to surface waters within 12 n.m. are presented as follows:

CVN 68 Class

$$\mathbf{F_{CVN}(flow\ rate)} = (\mathbf{R_{CVN}})(\mathbf{D_{CVN}})(\mathbf{N_{CVN}})$$

$\mathbf{R_{CVN}}$ = ship flow rate, gpd

$\mathbf{D_{CVN}}$ = days in port annually per ship

$\mathbf{N_{CVN}}$ = number of ships

$\mathbf{F_{CVN}}$ = (3,000) (147) (11) = **4.9 million gallons per year**

Other Ship Classes

$$\mathbf{F_{O}(flow\ rate)} = (\mathbf{R_{O}})(\mathbf{D_{O}})(\mathbf{N_{O}})$$

$\mathbf{F_{O}}$ = (2,000) (193) (220) = **84.9 million gallons per year**

Overall Fleet

$\mathbf{F_{FLEET}}$ = $\mathbf{F_{CVN}}$ (million gals/year) + $\mathbf{F_{O}}$ (million gals/year)

$\mathbf{F_{FLEET}}$ = 4.9 + 84.9 = **89.8 million gallons per year**

It should be noted that bilgewater generation rates are based on data available from existing reports for U.S. Navy ships and does not include "estimates of bilgewater" from ships of other services.

3.3 Constituents

Information about the constituents of bilgewater comes from several studies conducted aboard Navy vessels and at Navy ports, in addition to the UNDS Phase I testing. During these previous studies, samples of bilgewater were collected from a variety of Navy vessels, including aircraft carriers, cruisers, destroyers, dock landing ships, tank landing ships, amphibious assault ships, amphibious transport docks, and submarines. There have been no similar studies or documentation available for the other services.

Bilgewater samples collected in the previous studies were analyzed for a variety of parameters, such as classicals, metals, and organics (including pesticides). Over 25 priority pollutants were identified from these samples, including metals such as arsenic, copper, cadmium, chromium, lead, mercury, selenium, and zinc; and organics such as benzene, the BHC isomers (isomers of hexachlorocyclohexane), ethyl benzene, heptachlor, heptachlor epoxide, naphthalene, phenols, phthalate esters, toluene, trichlorobenzene, and trichloroethane. The bioaccumulators identified in these samples were the BHC isomers and mercury. A variety of substances that are neither priority pollutants nor bioaccumulators were also detected, including metals such as barium and manganese and organics such as chloroform and xylene.

The analytical results from these studies are shown in Tables 4 through 8. The results provide a general overview of the constituents that have historically been detected in bilgewater and the effluent from bilgewater OWS treatment.

3.4 Concentrations

The concentrations of constituents detected during UNDS Phase I testing of bilgewater/OWS effluent samples collected aboard an aircraft carrier (CVN 74) are summarized in Table 9. Many of the same constituents that were detected in the previous studies were also detected in the aircraft carrier samples. This includes classicals, oil & grease as indicated by hexane extractable materials (HEM) or total petroleum hydrocarbons (TPH) as indicated by silica gel treated hexane extractable materials (SGT-HEM), certain metals, and the bioaccumulator, mercury. Neither pesticides nor PCBs were detected in the aircraft carrier bilgewater/OWS samples. Table 10 presents the general statistics of the aircraft carrier data.

Analytical results from previous bilgewater studies are shown in Tables 4 through 8. These tables provide concentrations of constituents that have historically been detected in bilgewater and the effluent from bilgewater OWS treatment.

4.0 NATURE OF DISCHARGE ANALYSIS

Based on the discharge characteristics presented in Section 3.0, the nature of the discharge and its potential impact on the environment can be evaluated. Estimated constituent mass loadings are presented in Section 4.1. In Section 4.2, the available concentration data for the discharge constituents are evaluated, including comparison with federal and state water quality criteria. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loading

Validated bilgewater/OWS constituent concentration data from the aircraft carrier [4] and the flow rate estimates referenced in NOD report Section 3.2 were used to estimate the mass loading of pollutants to the environment. Historical data were not used to estimate mass loadings because these data were not validated.

Table 11 provides a bilgewater/OWS effluent mass loading summary for all constituents detected in the aircraft carrier samples. Sampling data have identified copper, nickel, and zinc as exceeding Federal water quality criteria (in addition to the most stringent state criteria) in the bilgewater/OWS samples analyzed. Also, the concentrations for ammonia, nitrogen (as nitrate/nitrite and total kjeldahl nitrogen), phosphorous, iron, and total petroleum hydrocarbons exceeds the most stringent state water quality criteria.

The constituent loading estimates are based on the assumption that vessels with an on-board OWS system will always process bilgewater through the system and discharge the effluent overboard while in-port, rather than off-loading untreated bilgewater to shore facilities for disposal.

Sample calculations for TPH, as indicated by SGT-HEM, are provided to show how the total fleet constituent discharges to surface waters less than 12 n.m. from shore were calculated. The assumptions and calculations are presented below.

1. The total amount of OWS effluent discharged annually from aircraft carriers is 4.9 million gallons (Table 3).

2. The sample data from CVN 74 (Table 10) are assumed to be representative of all aircraft carriers.

$$\mathbf{M(tph)_{CVN}}\text{ (pounds/year)} = (\mathbf{V_{CVN}}\text{ (million gals/year)})\ (\mathbf{C_{CVN}}\text{ (mg/Liter)})\ (\mathbf{CF})$$

where: $\mathbf{V_{CVN}}$ **=** Total bilgewater/OWS generation rate/year

$\mathbf{C_{CVN}}$ = TPH (SGT-HEM) concentration

$$\mathbf{CF} = \text{conversion factor} = 8.34 = \frac{(3.785\text{ liters/gal})\ (1\text{x}10^6\text{ gals/million gals})}{(454\text{ grams/pound})\ (1{,}000\text{ mg/gram})}$$

$$\mathbf{M_{CVN}} = (4.9)\ (9.64)\ (8.34) = \mathbf{394\ pounds/year}$$

The mass loading of constituents for the entire fleet can be estimated by multiplying the estimate for aircraft carriers by a discharge ratio. The discharge ratio is the total fleet discharge rate divided by the total discharge from aircraft carriers. Use of this ratio to estimate fleet mass loadings assumes sample data from CVN 74 (Table 10) is representative of all vessels of the armed forces.

2. Ratioing the total flow for the fleet (89.8 mgd) to the aircraft carrier class (CVN 68) flow for (4.9 mgd) , and multiplying the aircraft carrier loading by the ratio.

$$\mathbf{M_{FLEET} = (F_{FLEET} / F_{cvn}) (M_{CVN})}$$

$$\mathbf{M_{FLEET}} = (89.8/4.9)(394)=7220 \textbf{ pounds/year}$$

4.2 Environmental Concentrations

Table 11 identifies bilgewater OWS effluent constituents in the aircraft carrier samples whose log mean average concentrations (dissolved and/or total) were above Federal water quality criteria, and/or the most stringent state water quality criteria. With regard to oil concentration data, the samples were analyzed for HEM and SGT-HEM. The HEM values correspond to oil and grease and the SGT-HEM values correspond to total petroleum hydrocarbon (TPH) which is a subset of oil and grease.

4.3 Potential for Introducing Non-indigenous Species

There is a low potential for transporting non-indigenous species in this discharge. There is only minor seawater access to bilge compartments, and bilgewater is generally processed before it is transported over long distances.

5.0 CONCLUSIONS

Surface vessel bilgewater and OWS discharges have the potential to cause an adverse environmental effect for the following reasons:

1) Bilgewater, if discharged without treatment, would contribute significant amounts of oil to the environment at concentrations exceeding water quality criteria and discharge standards.

2) OWS effluent contributes significant amounts of oil to the environment at concentrations exceeding water quality criteria and discharge standards.

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. Process information and assumptions were used to estimate the rate of discharge. Based on this estimate and on the reported concentrations of oil and grease constituents, the concentrations of the oil and grease constituents in the environment resulting from this discharge were then estimated.

Table 12 shows the source of the data used to develop this NOD Report.

1. Bilgewater Characterization and Generation Surveys Aboard DD-963 Class Ships. April, 1981. David Taylor Naval Ship Research and Development Center. Report #: DTNSRDC/SME-81/09.

2. In-Port Oily Wastewater Generation on USS ARLEIGH BURKE (DDG 51), NSWCCD-TR-63-96/37. November 1996.

3. USS John C. Stennis (CVN 74) OWS log sheets obtained from CVN 74 by J. Jereb of DLS Engineering Assoc. and submitted to Malcolm-Pirnie via facsimile on February 13, 1997.

4. Correspondence from Commander, Naval Surface Warfare Center, Carderock Division, Philadelphia Site to Commander, Naval Sea Systems Command (Code 03L13), Uniform National Discharge Standards (UNDS) Sampling Program Data, Ser 631/225, 1-6310-280, dated June 19, 1997.

5. The Characterization of Bilgewater Aboard U.S. Navy Ships. October 1992. Naval Surface Warfare Center Carderock Division. Tech. Report #: CDNSWC/SME-CR-10-91.

6. Weaver, George, An Analysis of Bilgewater. Undated, Analytical data for period from 1993 to 1995. Navy Public Works Center Environmental Department, Naval Station San Diego.

7. Wastewater Characterization Data from USS L Y Spear (AS 36) and USS Carney (DDG 64), NSWCCD, 6330-270/KA, February 19, 1997, Enclosures (4) and (6).

General References

USEPA. Toxics Criteria for Those States Not Complying with Clean Water Act Section 303(c)(2)(B). 40 CFR Part 131.36.

USEPA. Interim Final Rule. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Metals Criteria. 60 FR 22230. May 4, 1995.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants. 57 FR 60848. December 22, 1992.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, Proposed Rule under 40 CFR Part 131, Federal Register, Vol. 62, Number 150. August 5, 1997.

Connecticut. Department of Environmental Protection. Water Quality Standards. Surface Water Quality Standards Effective April 8, 1997.

Florida. Department of Environmental Protection. Surface Water Quality Standards, Chapter 62-302. Effective December 26, 1996.

Georgia Final Regulations. Chapter 391-3-6, Water Quality Control, as provided by The Bureau of National Affairs, Inc., 1996.

Hawaii. Hawaiian Water Quality Standards. Section 11, Chapter 54 of the State Code.

Mississippi. Water Quality Criteria for Intrastate, Interstate and Coastal Waters. Mississippi Department of Environmental Quality, Office of Pollution Control. Adopted November 16, 1995.

New Jersey Final Regulations. Surface Water Quality Standards, Section 7:9B-1, as provided by The Bureau of National Affairs, Inc., 1996.

Texas. Texas Surface Water Quality Standards, Sections 307.2 - 307.10. Texas Natural Resource Conservation Commission. Effective July 13, 1995.

Virginia. Water Quality Standards. Chapter 260, Virginia Administrative Code (VAC) , 9 VAC 25-260.

Washington. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A, Washington Administrative Code (WAC).

Navy Small Craft Bilge Generation and Characterization. March, 1987. David W. Taylor Naval Ship Research and Development Center, Report No. DTNSRDC/SME-86/32.

Personal Communication between C. Geiling, Malcolm-Pirnie, and Brian Gordon, NAVSTA San Diego, Week of February 17, 1997, Topic of discussion: bilgewater characterization.

Environmental and Natural Resources Program Manual, OPNAVINST 5090.1B, Department of the Navy, November 1, 1994.

Department of Defense (DoD) Directive 6050.15 of 14 June 1985, Prevention of Oil Pollution from Ships Owned or Operated by the DoD (NOTAL).

Committee Print Number 95-30 of the Committee on Public Works and Transportation of the House of Representatives, Table 1.

The Water Quality Guidance for the Great Lakes System, Table 6A. Volume 60 Federal Register, p. 15366. March 23, 1995.

UNDS Equipment Expert Meeting Minutes. “Surface Vessel Bilgewater and Oily Waste”. July 29, 1996.

Pentagon Ship Movement Data for Years 1991-95, March 4, 1997.

UNDS Phase I Sampling Data Report, Volumes 1-13, October 1997.

UNDS Ship Database, August 1, 1997.

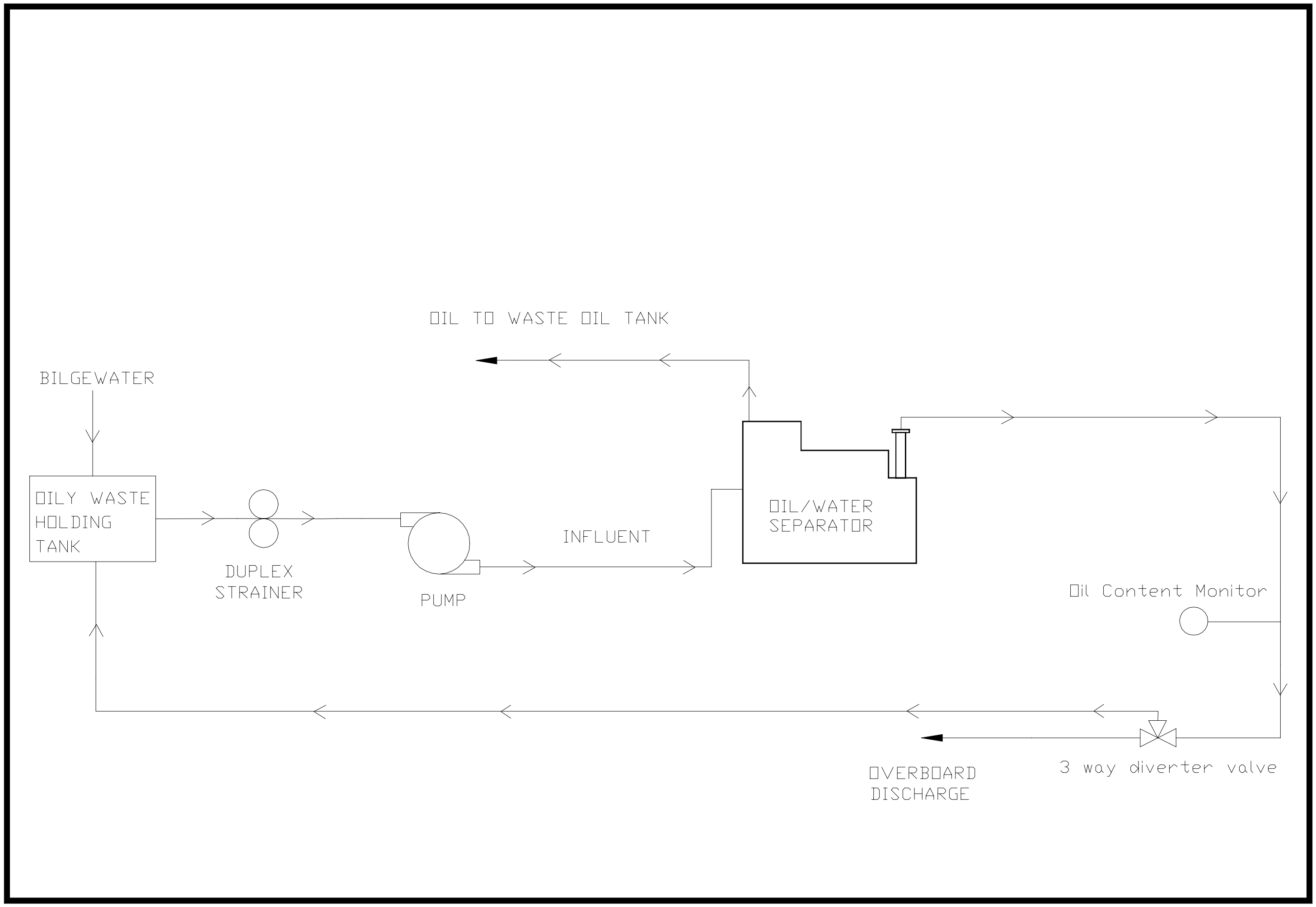

Figure 1. U.S. Navy Oil Water Separator (OWS) Process Flow Diagram (Typical)

Table 1. Vessels Equipped With Oil/Water Separator Systems

SHIP CLASSIFICATION INFORMATION						TRANSIT INFORMATION	
CLASS ID NO.	ARMED SERVICE	CLASS NAME	SHIP TYPE	NO. OF SHIPS	PROPULSION SYSTEM	TRAN-SITS	DAYS IN PORT
AE 26	MSC	Kilauea	Ammunition Ship	8	Steam	4	26
AFS 1	MSC	Mars	Combat Store Ship (ROS)	8	Steam	7	148
AG 194	MSC	Vanguard	Navigation Research Ship	2	Steam	10	151
AGF 3	NAVY	Austin (Converted)	Miscellaneous Command Ship	1	Steam	NA	NA
AGF 11	NAVY	Austin (Converted)	Miscellaneous Command Ship	1	Steam	NA	NA
AGM 22	MSC	Converted Haskell	Missile Range Instrumentation Ship	1	Steam	4	133
AGOS 1	MSC	Stalwart	Ocean Surveillance Ship	5	Diesel	4	70
AGOS 19	MSC	Victorious	Ocean Surveillance Ship	4	Diesel	5	107
AGS 26	MSC	Silas Bent and Wilkes	Surveying Ship	2	Diesel	6	44
AGS 45	MSC	Waters	Surveying Ship	1	Diesel	1	7
AGS 51	MSC	John McDonnell	Surveying Ship	2	Diesel	6	96
AGS 60	MSC	Pathfinder	Surveying Ship	4	Diesel	NA	NA
AH 19	MSC	Mercy	Hospital Ship (ROS)	2	Steam	2	184
AKR 287	MSC	Algol	Vehicle Cargo Ship (ROS)	8	Steam	3	109
AKR 295	MSC	NA	Vehicle Cargo Ship (ROS)	3	Diesel	NA	NA
AO 177	NAVY	Jumboised Cimarron	Oiler	5	Steam	10	188
AO 187	MSC	Henry J. Kaiser	Oiler	12	Diesel	6	78
AOE 1	NAVY	Sacramento	Fast Combat Support Ship	4	Steam	11	183
AOE 6	NAVY	Supply	Fast Combat Support Ship	3	Gas	6	114
AR	NAVY	Vulcan	Repair Ship	6	Steam	8	131
ARC 7	MSC	Zeus	Cable Ship	1	Diesel	2	8
ARS 50	NAVY	Safeguard	Salvage Ships	4	Diesel	22	208
AS 33	NAVY	Simon Lake	Submarine Tender	1	Steam	6	229
AS 39	NAVY	Emory S Land	Submarine Tender	3	Steam	6	293
ATF 166	MSC	Powhatan	Fleet Ocean Tug	7	Diesel	16	127
BD	ARMY	264B	Barge Derrick(Floating Cranes)	12	Diesel	NA	NA
BO	USCG	NA	Buoy Boat	5	Diesel	NA	NA
BOSL	USCG	NA	Stern Loading Buoy Boat	14	Diesel	NA	NA
CG 47	NAVY	Ticonderoga	Guided Missile Cruiser	27	Gas	12	166
CGN 36	NAVY	California	Guided Missile Cruiser	2	Nuclear	11	143
CGN 38	NAVY	Virginia	Guided Missile Cruiser	1	Nuclear	11	161
CV 63	NAVY	Kitty Hawk	Aircraft Carrier	3	Steam	7	137
CVN 65	NAVY	Enterprise	Aircraft Carrier	1	Nuclear	6	76
CVN 68	NAVY	Nimitz	Aircraft Carrier	7	Nuclear	7	147
DD 963	NAVY	Spruance	Destroyer (Typical)	31	Gas	12	178
DDG 51	NAVY	Arleigh Burke	Guided Missile Destroyer	18	Gas	11	101
DDG 993	NAVY	Kidd	Guided Missile Destroyer	4	Gas	12	175
FFG 7	NAVY	Oliver Hazard Perry	Guided Missile Frigate	43	Gas	13	167
LCC 19	NAVY	Blue Ridge	Amphibious Command Ship	2	Steam	8	179
LCU	ARMY	2000	Utility Landing Craft	48	Diesel	NA	NA
LHA 1	NAVY	Tarawa	Amphibious Assault Ship	5	Steam	9	173
LHD 1	NAVY	Wasp	Amphibious Assault Ship	4	Steam	13	185

Table 1. Vessels Equipped With Oil/Water Separator Systems (cont'd)

SHIP CLASSIFICATION INFORMATION						TRANSIT INFORMATION	
CLASS ID NO.	ARMED SERVICE	CLASS NAME	SHIP TYPE	NO. OF SHIPS	PROPULSION SYSTEM	TRAN-SITS	DAYS IN PORT
LPD 4	NAVY	Austin	Amphibious Transport Dock	3	Steam	11	178
LPD 7	NAVY	Austin	Amphibious Transport Dock	3	Steam	12	188
LPD 14	NAVY	Austin	Amphibious Transport Dock	2	Steam	11	192
LPH 2	NAVY	Iwo Jima	Amphibious Assault Helicopter Carrier	2	Steam	11	186
LSD 36	NAVY	Anchorage	Dock Landing Ship	5	Steam	13	215
LSD 41	NAVY	Whidbey Island	Dock Landing Ship	8	Diesel	13	170
LSD 49	NAVY	Harpers Ferry	Dock Landing Ship	3	Diesel	NA	NA
LST 1179	NAVY	Newport	Tank Landing Ship	3	Diesel	13	191
LSV	ARMY	Frank S Besson	Vehicle Landing Ship	6	Diesel	NA	NA
LT	ARMY	100 / 130	Large Tug	25	Diesel	NA	NA
MCM 1	NAVY	Avenger	Mine Countermeasure Vessel	14	Diesel	28	232
MHC 51	NAVY	Osprey	Minehunters Coastal	12	Diesel	NA	NA
WAGB 290	USCG	Mackinaw	Icebreaker	1	Diesel	NA	NA
WAGB 399	USCG	Polar	Icebreaker	2	Diesel	4	139
WHEC 378	USCG	Hamilton/Hero Class	High Endurance Cutter	12	Diesel	13	151
WIX 295	USCG	Eagle	Sail Training Cutter	1	Diesel	7	188
WLB 180A	USCG	Balsam	Seagoing Tender	8	Diesel	18	190
WLB 180B	USCG	Balsam	Seagoing Tender	2	Diesel	5	120
WLB 180C	USCG	Balsam	Seagoing Tender	13	Diesel	16	123
WLB 225	USCG	Juniper	Seagoing Tender	2	Diesel	NA	NA
WLI 65303	USCG	Blackberry	Buoy Tender, Inland	2	Diesel	NA	NA
WLI 65400	USCG	Bayberry	Buoy Tender, Inland	2	Diesel	NA	NA
WLI 100A	USCG	Blue Bell	Buoy Tender, Inland	1	Diesel	NA	NA
WLI 100C	USCG	Blue Bell	Buoy Tender, Inland	1	Diesel	NA	NA
WLIC 75A	USCG	Anvil/Clamp	Construction Tenders, Inland	2	Diesel	NA	NA
WLIC 75B	USCG	Anvil/Clamp	Construction Tenders, Inland	3	Diesel	NA	NA
WLIC 75D	USCG	Anvil/Clamp	Construction Tenders, Inland	2	Diesel	NA	NA
WLIC 100	USCG	Cosmos	Construction Tenders, Inland	3	Diesel	NA	NA
WLIC 115	USCG	?	Construction Tenders, Inland	1	Diesel	NA	NA
WLIC 160	USCG	Pamlico	Construction Tenders, Inland	4	Diesel	NA	NA
WLM 157	USCG	Red	Buoy Tender, Coastal	9	Diesel	NA	NA
WLM 551	USCG	Keeper	Buoy Tender, Coastal	2	Diesel	NA	NA
WLR 65	USCG	Ouachita	Buoy Tender, River	6	Diesel	NA	NA
WLR 75	USCG	F/Gasconade	Buoy Tender, River	13	Diesel	NA	NA
WLR 115	USCG	Sumac	Buoy Tender, River	1	Diesel	NA	NA
WMEC 210A	USCG	Reliance	Medium Endurance Class	5	Diesel	13	235
WMEC 210B	USCG	Reliance	Medium Endurance Class	11	Diesel	9	149

Table 1. Vessels Equipped With Oil/Water Separator Systems (cont'd)

SHIP CLASSIFICATION INFORMATION						TRANSIT INFORMATION	
CLASS ID NO.	ARMED SERVICE	CLASS NAME	SHIP TYPE	NO. OF SHIPS	PROPULSION SYSTEM	TRAN-SITS	DAYS IN PORT
WMEC 213	USCG	Diver	Medium Endurance Class	1	Diesel	9	98
WMEC 230	USCG	Storis	Medium Endurance Class	1	Diesel	11	167
WMEC 270A	USCG	Bear	Medium Endurance Class	4	Diesel	6	137
WMEC 270B	USCG	Bear	Medium Endurance Class	9	Diesel	7	164
WPB 82C	USCG	Point	Patrol Craft	28	Diesel	NA	NA
WPB 82D	USCG	Point	Patrol Craft	8	Diesel	NA	NA
WPB 110A	USCG	Island	Patrol Craft	16	Diesel	2	72
WPB 110B	USCG	Island	Patrol Craft	21	Diesel	7	137
WPB 110C	USCG	Island	Patrol Craft	12	Diesel	5	157
WTGB 140	USCG	Bay	Icebreaking Tug	9	Diesel	1	8
WYTL 65A	USCG	NA	Harbor Tug	3	Diesel	NA	NA
WYTL 65B	USCG	NA	Harbor Tug	3	Diesel	NA	NA
WYTL 65C	USCG	NA	Harbor Tug	3	Diesel	NA	NA
WYTL 65D	USCG	NA	Harbor Tug	2	Diesel	NA	NA
			TOTAL:	640	AVG:	9	145
			Subtotals:				
			Navy	231		13	197
			MSC	70		5	92
			USCG	248		8	140
			Army	91		NA	NA

Notes:
1. NA = Information not available
2. One transit = travel from one port to another, or from one port to sea and returning back to same port.

Table 2. In-Port Bilgewater Generation Rates[1,2,3]

Ship Class	Gal/Day (Range)	Avg Gal/Day
DD 963	1,000-3,000	2,000
DDG 51	N/A	335
CVN 68*	5,000-25,000	3,000

* Values based on recording information over a 30 day period. All bilgewater was processed by the OWS during six individual days, in volumes ranging from 5,000 to 25,000 gallons per processing event. The total volume processed over 30 days was 91,000 gallons, yielding an average daily processing rate of 3,000 gallons per day.

Table 3. In-Port Bilgewater/OWS Discharge Rates From U.S. Navy Ships

Ship Class	Average Daily Flow per Ship (gals/day)	Annual Flow per Ship (gals/yr)		Total Annual Flow (million gals/yr)	
		Days in Port	Total Flow	No. of Ships	Total Flow
Aircraft Carriers	3,000	147	441,000	11	4.9
All Other Ships (Avg.)	2,000	178	356,000	220	84.9
				Total:	89.8

Table 4. Ship Study Bilgewater Pollutant Summary[5]

	Biddle CG 34	Vincennes CG 49 with OWS	San Jacinto CG 56 with OWS	Roosevelt CVN 71	C. DeGrasse DD 974	H.W. Hill DD 986	Belleau Wood LHA 3	Vancouver LPD 2 with OWS	Pensacola LSD 38 with OWS	Manitowoc LST 1180 with OWS	Louisville SSN 724
TSS (mg/L)	1,440	38	19	519	233	548	1205	62	29	114	169
COD (mg/L)	5,600	530	760	5,400	18,000	11,000	66,000	780	470	1,600	1,100
TOC (mg/L)	644	129	34.6	116	264	4,620	19,040	34	31	224	247
BOD (mg/L)	583	NA	6,740	554	>14,000	842	13,000	<142	98	335	0
O&G (mg/L)	46	27	8	1,550	725	765	5,220	20	4	32	164
Phenols(μg/L)	600	110	30	<5,000	<10	40	2,600	10	10	20	310
Cu (μg/L)	6,400	540	430	1,050	5,320	1,180	1,720	790	300	360	1,450
Fe (μg/L)	46,000	810	260	2,560	28,000	18,900	14,600	1,130	1,620	2,600	1,030
Zn (μg/L)	4,300	810	190	1,900	6,560	1,390	16,200	1,590	410	2.5	2,720
Cd (μg/L)	67	10	5	21	156	44	280	<3	<5	14	82
Ag (μg/L)	10	<10	10	<50	<10	<10	80	10	<10	<10	<10
Ni (μg/L)	3,500	270	130	170	890	550	650	400	210	120	1,590
Mn (μg/L)	3,000	220	20	140	1,350	1,150	370	61	110	210	269
Pb (μg/L)	230	20	<20	<30	2,900	30	270	20	50	<50	60
As (μg/L)	3	6	6	3	7	<4	18	10	4	2	4
Ba (μg/L)	170	63	60	85	<100	60	122	16	40	50	57

Note: Values are not necessarily representative. Concentrations were determined from only one sample per ship class per constituent.

NA : Information not available

< : Less than

Table 5. Ship Study OWS Influent and Effluent Contaminant Concentration Data[5]

		USS VINCENNES (CG 49)		USS SAN JACINTO (CG 56)		USS VANCOUVER (LPD 2)		USS PENSACOLA (LSD 38)		USS MANITOWOC (LST 1180)	
Parameter	**Units**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**	**Influent**	**Effluent**
COD	mg/L	660	530	810	760	900	780	520	470	2,800	1,600
BOD	mg/L	NA	NA	94	6,740	<142	<142	101	98	341	335
TOC	mg/L	145	129	56.8	34.6	42	34	39	31	570	224
TSS	mg/L	34	38	62	19	123	62	41	29	2,684	114
O&G	mg/L	37	27	143	8	47	20	10	4	2,593	32
Ammonia	mg/L	2.2	1.1	<0.10	<0.10	0.18	0.29	<0.10	<0.10	NA	NA
Fecal Coliform	cts/100 ml	NA	NA	49	94	NA	NA	110	49	2	240
Total Phenols	mg/L	130	110	10	30	10	10	20	10	NA	20
Cyanide	mg/L	<10	<10	<10	10	<30	<50	10	40	<10	NA
Arsenic	µg/L	4	6	6	6	8	10	4	4	6	2
Barium	µg/L	59	63	20	60	10	16	30	40	40	50
Cadmium	µg/L	9	10	<5	5	<3	<3	<5	<5	17	14
Chromium	µg/L	<10	<10	<10	<10	<10	<10	<50	<50	770	590
Copper	µg/L	830	540	490	430	2,930	790	560	300	430	360
Iron	µg/L	770	810	280	260	1,240	1,130	2,960	1,620	2,.900	2,600
Lead	µg/L	50	20	<20	<20	40	20	<50	<50	50	<50
Manganese	µg/L	230	220	10	20	51	61	80	110	250	210
Nickel	µg/L	290	270	100	130	310	400	250	210	120	120
Selenium	µg/L	3	<2	12	8	15	17	2	2	40	40
Zinc	µg/L	800	810	80	190	670	1,590	380	410	3,000	2,500
Bis(2-ethylhexyl) phthalate	µg/L	<200	<10	<200	<100	11.2	61.8	<100	<100	<200	<200
4-Nitrophenol	µg/L	<400	<20	<200	<100	10	<20	<100	<100	<200	<200
Phenanthrene	µg/L	<200	23.7	<200	<100	<10	<10	<100	<100	<200	<200
1,2,4-Trichlorobenzene	µg/L	<200	28.3	<200	<100	<10	<10	<100	<100	<200	<200
1,1,1- Trichloroethane	µg/L	<5	<5	<50	<50	NA	<5	<50	<500	45,000	6,000
Alpha-BHC	µg/L	0.047	0.077	<0.05	<0.05	0.02	<0.02	<0.05	<0.05	<0.25	<5
Beta- BHC	µg/L	<0.999	<0.580	<0.5	<0.5	4.45	<0.10	<12	<5	<2.5	<50
Gamma-BHC	µg/L	<0.02	<0.02	16	60	<0.02	<0.02	<0.05	0.5	<0.25	<5
Heptachlor	µg/L	0.460	0.209	<0.05	<0.05	<0.02	<0.02	<0.05	<0.05	<0.25	<5
Heptachlor Epoxide	µg/L	0.379	0.274	<0.05	<0.05	<0.02	<0.02	<0.05	<0.05	<0.25	<5

NA = Data not available

Note: Values are not necessarily representative. Concentrations were determined from only one sample per ship class per constituent.

Table 6. Naval Station San Diego Bilgewater Characterization Data Summary[6] (Calendar Years 1993 through 1995)

Parameter	No. of Analyses	Values Above MDL (units in µg/L)				
		No. Of Values	Min.	Max.	Median	Std. Dev.
Oil & Grease	45	45	5	12,900	146	2,234
Phenols	83	12	15	901	116	0.309
Antimony	(a)	(a)	(a)	80	(a)	(a)
Arsenic	(a)	(a)	(a)	1	(a)	(a)
Cadmium	84	33	10	610	20	118
Chromium	85	31	20	2,320	70	492
Copper	85	84	10	80,400	420	9,250
Lead	85	52	39	3,360	100	509
Nickel	85	83	20	10,300	150	1,590
Selenium	1	0	NA	NA	NA	NA
Silver	84	14	4	1,440	23	398
Thallium	(a)	(a)	(a)	277	(a)	(a)
Zinc	82	80	100	97,000	688	14,500
Benzene	82	29	0.5	179	30	42
Chloroform	81	1	47	47	47	NA
Ethyl Benzene	81	38	6	1,360	50	221
Methylene Chloride	68	18	5	4,220	16	1,000
Tetrachloroethane	82	7	7	74	18	24
Toluene	80	52	5	2,220	77	383
Xylene	17	12	28	9,440	16	2,600
2,4-Dimethyl Phenol	82	14	30	840	89	23
Fluorene	83	41	5	1,890	42	411
Naphthalene	79	37	11	3,070	85	613

NOTES: (a) References contain summary tables and raw data laboratory logs that are incomplete. Summary tables indicate single peak results for antimony, arsenic and thallium in 1993. However, log sheets showing the corresponding data are not included. The above statistical analysis is based on log sheet data that was provided, except for the maximum values shown for the three metals, which were obtained from the PWC summary table for 1993.

(b) NA = Information not available.

Table 7. Navy Destroyer (DDG 64) OWS Effluent Discharge Data Summary[7]

May to September, 1996						
		Values Above MDL (µg/L)				
Parameter	**No. of Analyses**	**No. Of Values**	**Min.**	**Max.**	**Median**	**Std. Dev.**
Oil in Water (Navy)	28	28	13	670	151	205
Arsenic	11	6	10	70	20	23
Barium	18	18	30	535	118	124
Cadmium	18	3	10	10	10	NA
Chromium	18	10	10	60	20	16
Copper	18	18	430	6,110	1,.410	1,400
Lead	18	15	10	195	40	62
Iron	18	18	300	4,620	1,280	1,210
Manganese	18	18	20	150	48	41
Mercury	18	2	10	10	10	NA
Nickel	18	18	140	1,510	320	317
Selenium	11	11	70	210	100	40
Silver	18	1	10	10	10	NA
Zinc	18	18	480	8,880	2,190	1,930

July 30, 1996 (µg/L)						
	Sample A		Sample B		Sample C	
Parameter	**NRL**	**LLI**	**NRL**	**LLI**	**NRL**	**LLI**
Oil and Grease (EPA 418.1)	---	29	---	70	---	66
Petroleum Hydrocarbons	---	38	---	73	---	70
MBAS	---	0.13	---	0.11	---	0.16
Benzene	79	50	77	49	70	55
Ethylbenzene	71	59	59	54	64	54
Methylene Chloride	<5	64	<5	63	<5	20
Toluene	170	80	170	78	150	81
Xylene (total)	460	289	450	266	410	264
Diethyl Phthalate	---	<10	---	10	---	12
2,4-Dimethylphenol	---	110	---	110	---	110
Dimethyl Phthalate	---	11	---	12	---	13
Fluorene	---	12	---	17	---	20
Naphthalene	---	63	---	61	---	14
Phenanthrene	---	16	---	27	---	30
Phenol	---	46	---	47	---	30

NOTES:
(a) Volatile and semi-volatile analysis performed on random samples collected over two hour period. Sample A during first hour. Samples B and C during second hour.
(b) LLI = Lancaster Labs Inc. NRL = Naval Research Laboratory.
(c) --- = Samples were not analyzed by LLI for the parameters shown.
(d) NA = Information not available
(e) < = less than

Table 8. Auxiliary Ship (AS 36) OWS Effluent Discharge Data Summary[7]
(May 2 through September 12, 1996)

Parameter	Method Detection Level	No. of Analyses	Values Above MDL (μg/L)				
			No. of Values	Min.	Max.	Median	Std. Dev.
Oil in Water	NA	44	44	0.5	93	5.4	20.1
BOD	NA	8	8	1	34	3.5	10.1
COD	NA	14	14	26	260	61	79.5
TSS	NA	10	10	1	57	12.5	16
Antimony	600	14	0	NA	NA	NA	NA
Arsenic	10	14	0	NA	NA	NA	NA
Beryllium	5	14	0	NA	NA	NA	NA
Cadmium	10	14	0	NA	NA	NA	NA
Chromium	20	14	0	NA	NA	NA	NA
Copper	NA	14	14	44	661	257	166
Lead	100	14	0	NA	NA	NA	NA
Iron	NA	11	11	786	2,200	1,050	427
Mercury	0.2	14	1	1.6	1.6	NA	NA
Nickel	NA	14	14	75	471	117	103
Selenium	10/5	14	0	NA	NA	NA	NA
Silver	30	14	0	NA	NA	NA	NA
Thallium	10	14	14	NA	NA	NA	NA
Zinc	NA	14	14	164	1,100	382	283

NOTE: NA = Information not available.

Table 9. Aircraft Carrier (CVN 74) Oil/Water Separator Influent/Effluent Raw Data[4]

		CVN 74-OWSI-01		CVN 74-OWSI-02		CVN 74-OWSI-03		CVN 74-OWSI-04	
Parameter	Units	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
COD	mg/L	132	179	258	258	86	148	195	148
BOD	mg/L	31	5	17	11	18	18	22	10
TOC	mg/L	28	9	24	21	26	20	19	11
TSS	mg/L	38	64	38	46	36	48	70	23
O&G	mg/L	50	22	269	17	42	36	122	27
TKN	mg/L	1.6	1.7	2.0	1.7	1.4	1.6	1.2	1.0
Ammonia	mg/L	0.14	<0.10	0.19	0.17	0.15	0.17	<0.10	<0.10
Nitrate + Nitrite (As N)	mg/L	054	0.20	0.44	0.30	0.50	0.40	0.62	0.0
Total Phosphorous	mg/L	3.2	1.2	3.7	2.7	3.9	2.2	3.1	2.0
TDS	mg/L	7,360	16,620	5,570	9,720	5,920	10,260	8,970	13,320
Chloride	mg/L	4,126	9,742	3,616	7,359	3,531	8,125	3,956	8,040
Sulfate	mg/L	498	1,290	411	643	446	780	643	958
Sulfide	mg/L	5	2	10	8	10	8	10	5
Total Alkalinity	mg/L	36	64	40	46	40	48	48	58
Cyanide	µg/L	<10	<10	<10	<10	<10	<10	NA	<10
Aluminum	µg/L	69(B)	229	74(B)	108(B)	83(B)	104(B)	143(B)	220
Antimony	µg/L	<20	<2	<20	2.6(B)	5.6(B)	<20	<20	<10
Arsenic	µg/L	<10	33	<1	3(C)	<1	33(B)	<1	<1
Barium	µg/L	49	32	50(B)	43(B)	55(B)	40(B)	44(B)	34(B)
Beryllium	µg/L	1(B)	<1	<1	<1	<1	<1	<1	<1
Cadmium	µg/L	6	<5	5.7	<5	5.1	5.6	<5	<5
Chromium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10
Copper	µg/L	581	284	567	426	554	363	574	316
Iron	µg/L	455	482	471	442	560	432	610	531
Lead	µg/L	<46	<46	<46	<46	<46	<46	<46	<46
Manganese	µg/L	34	29	34	33	37	30	35	31
Nickel	µg/L	304	98	318	245	321	208	277	162
Selenium	µg/L	<20	<20	<31.5	41(C)	<20	<20	26(C)	<20
Silver	µg/L	5(B)	<5	<5	5(B)	<5	<5	<5	<5
Thallium	µg/L	<10	<10	<10	<10	<10	<10	<10	<10
Zinc	µg/L	1,590	519	1,760	1,330	1,840	1,110	1,350	786
Bis(2-ethylhexyl) phthalate	µg/L	<10	<10	30	<10	22	<10	38	<10
N,N-Dimethylformamide	µg/L	99	33	124	88	102	65	85	58
Toluene	µg/L	14	<10	12	<10	13	<10	12	<10
Xylene (o+p)	µg/L	24	<10	20	13	19	<10	19	12

Note: (a) < = less than

Table 10. Summary of Detected Analytes: Oil/Water Separator Effluent Data

Constituent	Log Normal Mean	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mass Loading
					(lbs/yr)
Oil Water Separator Effluent					
Classicals (mg/L)					
ALKALINITY	53.51	4 of 4	46	64	40,013
AMMONIA AS NITROGEN	0.09	2 of 4	BDL	0.17	67
BIOCHEMICAL OXYGEN DEMAND	8.78	3 of 4	BDL	18	6,565
CHEMICAL OXYGEN DEMAND (COD)	178.34	4 of 4	148	258	133,356
CHLORIDE	8273.63	4 of 4	7360	9740	6,186,728
HEXANE EXTRACTABLE MATERIAL	23.54	4 of 4	17.5	27	17,602
NITRATE/NITRITE	0.27	4 of 4	0.2	0.4	202
SGT-HEM	9.64	4 of 4	6	16	7,208
SULFATE	887.29	4 of 4	643	1290	663,484
TOTAL DISSOLVED SOLIDS	13238.57	4 of 4	9720	21600	9,899,334
TOTAL KJELDAHL NITROGEN	1.5	4 of 4	1.1	1.7	1,122
TOTAL ORGANIC CARBON (TOC)	14.53	4 of 4	9.3	21	10,865
TOTAL PHOSPHOROUS	1.81	4 of 4	1.2	2.7	1,353
TOTAL RECOVERABLE OIL AND GREASE	39.96	4 of 4	15.05	173	29,881
TOTAL SULFIDE (IODOMETRIC)	5.03	4 of 4	2	8	3,761
TOTAL SUSPENDED SOLIDS	42.46	4 of 4	23	64	31,750
VOLATILE RESIDUE	13285.59	4 of 4	9770	21600	9,934,494
Hydrazine (mg/L)					
HYDRAZINE	0.15	4 of 4	0.095	0.2	112
Mercury (ng/L)					
MERCURY	51.8	4 of 4	32.05	79.8	0.04
Metals (μg/L)					
ALUMINUM					
Total	154.49	4 of 4	104	230.5	116
ANTIMONY					
Total	6.15	1 of 4	BDL	2.6	5
ARSENIC					
Total	6.09	2 of 4	BDL	33	5
BARIUM					
Dissolved	34.98	4 of 4	27.8	41.8	26
Total	36.58	4 of 4	30.65	42.9	27
BORON					
Dissolved	1562.43	4 of 4	1280	2030	1,168
Total	1505.6	4 of 4	1240	1945	1,126

CADMIUM					
Total	3.06	1 of 4	BDL	5.6	2
CALCIUM					
Dissolved	135123.39	4 of 4	105000	184000	101,040
Total	129848.08	4 of 4	104000	172500	97,096
COPPER					
Dissolved	162.56	4 of 4	116	201	122
Total	341.25	4 of 4	277.5	426	255
IRON					
Total	472.36	4 of 4	432	531	353
MAGNESIUM					
Dissolved	392878.32	4 of 4	262000	486000	293,780
Total	423465.92	4 of 4	333000	593500	316,653
MANGANESE					
Dissolved	26.21	4 of 4	22.2	31.1	20
Total	30.35	4 of 4	28.25	32.5	23
MOLYBDENUM					
Dissolved	21.29	4 of 4	18.6	24.3	16
Total	9.29	2 of 4	BDL	28.1	7
NICKEL					
Dissolved	176.4	4 of 4	109	247	132
Total	168.54	4 of 4	97.75	245	126
SODIUM					
Dissolved	3606853.89	4 of 4	2680000	5200000	2,697,078
Total	3585080.31	4 of 4	2770000	5000000	2,680,796
TIN					
Total	16.59	1 of 4	BDL	41.2	12
TITANIUM					
Total	4.5	2 of 4	BDL	9.2	3
ZINC					
Dissolved	855.7	4 of 4	511	1260	640
Total	878.8	4 of 4	514	1330	657
Organics (µg/L)					
N,N-DIMETHYLFORMAMIDE	57.3	4 of 4	32.5	88	43
O+P XYLENE	7.9	2 of 4	BDL	13	6
Pesticides (µg/L)					
2,4-DB	1.66	2 of 4	BDL	2.88	1
DICAMBA	0.29	3 of 4	BDL	0.48	0.2
MCPA	28.45	1 of 4	BDL	58.9	21
MCPP	113.25	4 of 4	41.3	167	85
PYRETHRIN I	183	1 of 1	183	183	137

Log normal means were calculated using measured analyte concentrations. When a sample set contained one or more samples with the analyte below detection levels (i.e., "non-detect" samples), estimated analyte concentrations equivalent to one-half of the detection levels were used to calculate the mean. For example, if a "non-detect" sample was analyzed using a technique with a detection level of 20 mg/L, 10 mg/L was used in the log normal mean calculation.

Table 10 a. Estimated Annual Mass Loadings of Constituents

Constituent	Log Normal Mean	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mass Loading (lbs/yr)
Classicals (mg/L)					
AMMONIA AS NITROGEN	0.09	2 of 4	BDL	0.17	67
NITRATE/NIRITE	0.27	4 of 4	0.2	0.4	202
TOTAL KJELDAHL NITROGEN	1.5	4 of 4	1.1	1.7	1,122
TOTAL NITROGEN[A]	1.77				1,304
TOTAL PHOSPHOROUS	1.81	4 of 4	1.2	2.7	1,353
SGT-HEM	9.64	4 of 4	6	16	7,208
Mercury (ng/L)					
MERCURY	51.8	4 of 4	32.05	79.8	0.04
Metals (µg/L)					
COPPER					
Dissolved	162.56	4 of 4	116	201	122
Total	341.25	4 of 4	277.5	426	255
IRON					
Total	472.36	4 of 4	432	531	353
NICKEL					
Dissolved	176.4	4 of 4	109	247	132
Total	168.54	4 of 4	97.75	245	126
ZINC					
Dissolved	855.7	4 of 4	511	1260	640
Total	878.8	4 of 4	514	1330	657

Notes:
A - Total Nitrogen is the sum of Nitrate/Nitrite and Total Kjeldahl Nitrogen.

Table 11. Mean Concentrations of Constituents that Exceed Water Quality Criteria

Constituent	Log Normal Mean	Minimum Concentration	Maximum Concentration	Federal Acute Water Quality Criteria	Most Stringent State Acute Water Quality Criteria
Classicals (mg/L)					
AMMONIA AS NITROGEN	0.09	BDL	0.17	None	0.006 (HI)[A]
NITRATE/NITRITE	0.27	0.2	0.4	None	0.008 (HI)[A]
TOTAL KJELDAHL NITROGEN	1.5	1.1	1.7	None	-
TOTAL NITROGEN[B]	1.77			None	0.2 (HI)[A]
TOTAL PHOSPHOROUS	1.81	1.2	2.7	None	0.025 (HI)[A]
TPH (SGT-HEM)	9.64	6	16	visible sheen[a] / 15[b]	5 (FL)
Mercury (ng/L)					
MERCURY[*]	51.8	32.05	79.8	1800	25 (FL, GA)
Metals (µg/L)					
COPPER					
Dissolved	162.56	116	201	2.4	2.4 (CT, MS)
Total	341.25	277.5	426	2.9	2.5 (WA)
IRON					
Total	472.36	432	531	None	300 (FL)
NICKEL					
Dissolved	176.4	109	247	74	74 (CA, CT)
Total	168.54	97.75	245	74.6	8.3 (FL, GA)
ZINC					
Dissolved	855.7	511	1260	90	90 (CA, CT, MS)
Total	878.8	514	1330	95.1	84.6 (WA)

Refer to federal criteria promulgated by EPA in its National Toxics Rule, 40 CFR 131.36 (57 FR 60848; Dec. 22, 1992 and 60 FR 22230; May 4, 1995)
A - Nutrient criteria are not specified as acute or chronic values.
B - Total Nitrogen is the sum of Nitrate/Nitrite and Total Kjeldahl Nitrogen.
* - Mercury was not found in excess of WQC; concentration is shown only because it is a bioaccumulator.

CA= California
CT = Connecticut
FL = Florida
GA = Georgia
HI = Hawaii
MS = Mississippi
WA = Washington

[a] *Discharge of Oil*, 40 CFR 110, defines a prohibited discharge of oil as any discharge sufficient to cause a sheen on receiving waters.

[b] *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78). MARPOL 73/78 as implemented by the *Act to Prevent Pollution from Ships* (APPS)

Table 12. Data Sources

	Data Source			
NOD Section	**Reported**	**Sampling**	**Estimated**	**Equipment Expert**
2.1 Equipment Description and Operation	Equipment Literature			X
2.2 Releases to the Environment	OPNAVINST 5090.1B			X
2.3 Vessels Producing the Discharge	UNDS Database			X
3.1 Locality				X
3.2 Rate	X		X	X
3.3 Constituents	X	X		X
3.4 Concentrations	X	X		
4.1 Mass Loading	X		X	
4.2 Environmental Concentrations	X		X	
4.3 Potential for Introducing Non-Indigenous Species				X