This document is part of Appendix A, and includes the Submarine Bilgewater: 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)

Submarine Bilgewater: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Submarine Bilgewater

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 has been identified as a candidate 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 Forces 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 the 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 contains sections on: Discharge Description, Discharge Characteristics, Nature of Discharge Analysis, Conclusions, and Data Sources and References.

2.0 DISCHARGE DESCRIPTION

This section describes the submarine bilgewater 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

Bilgewater in submarines is a mixture of discharges and leakage from a wide variety of sources, which drain to the lowest compartment (bilge) of the submarine. Bilgewater includes seawater accumulation, normal water leakage from machinery, and fresh water washdowns. It can contain a variety of constituents including cleaning agents, solvents, fuel, lubricating oils, and hydraulic oils.[1]

The submarine's drain system has a series of non-oily bilge collecting tanks, oily bilge collecting tanks, and a waste oil collecting tank or tank complex. The Ohio (SSBN 726) Class ballistic missile submarines and the planned New Attack Submarine (NSSN) use a waste oil collecting tank complex partitioned into oily and clean sides. Los Angeles Class (SSN 688) attack submarines use a waste oil collecting tank without the partitioning, where gravity separation of oil occurs.[1]

Non-oily waste is sent via a segregated drain system to the nonoily bilge collecting tanks, where it is discharged overboard. Waste that is oily or could possibly be oily, goes to the waste oil collecting tank (WOCT) through a separate drain system. Submarine classes with partitioned tanks, as listed above, use gravity separation enhanced by tank baffles to achieve some measure of oil/water separation. The SSN 688 Class submarines use the aft bilge collecting tank (ABCT) to receive and settle the bilgewater and non-oily drainage. The bottom portion of the water as separated in the tank is discharged overboard.[2] The upper portion of the ABCT which would have any potential for containing oily waste is transferred to the WOCT. The lower portion of the WOCT can be pumped overboard outside of 50 nautical miles (n.m.), but the upper portion must be held for future transfer to appropriate shore/disposal facilities.[1]

While most submarines of the U.S. fleet operate as described above, the Sturgeon Class (SSN 637) has bottomless bilge collecting tanks open to the sea, from which water is discharged by displacement whenever bilge pumps are activated. Watches are set to monitor for a sheen whenever oily water is to be pumped to the tank in port; pumping to the bilge collecting tank is to cease if a sheen is reported.[1]

2.2 Releases to the Environment

Onboard SSN 688 Class submarines, clean drains and the lower portion, or water phase, of the separated bilgewater in the ABCT are pumped overboard as necessary regardless of distance from shore. The lower portion of the liquid in the WOCT can be disposed of outside of 50 n.m.[2] The upper portion, or oily waste, from all of the drains, bilge water, and other sources must be held on board until the submarine has access to appropriate shore or disposal facilities.

2.3 Vessels Producing the Discharge

The Navy currently operates five classes of submarines (presented in Table 1) that generate bilgewater. However, not all of these classes discharge bilgewater to the environment. Pierside, submarine bilgewater is transferred to shore facilities. In transit, SSBN submarines do not discharge bilgewater within 12 n.m. SSN 688 Class submarines discharge some of the water phase of the bilgewater collecting tank between 3 and 12 n.m.[3]

3.0 DISCHARGE CHARACTERISTICS

This section contains qualitative and quantitative information that 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

In most submarine classes, submarine drain and plumbing drain systems are used to receive all drains and route them to their respective holding tanks. In these classes, discharges which may contain any oily waste are not to be released within 50 n.m., except in emergencies. Per OPNAVINST 5090.1B, submarines are instructed to: [2]

> *...pump all oily waste to the waste oil collection tank (WOCT). When the tank is full, after allowing for adequate separation time, and the ship is outside 50 n.m. [nautical miles], submarines shall pump the bottom, water phase of the WOCT overboard.*

The upper, oil phase from the WOCT is discharged only to authorized shore facilities.

The location of this discharge varies by class and the activities of the submarine. The operational factors that affect the location of bilgewater discharge include the operating depth, type of operations, the submarine's requirement for quiet operations, and the duration of the operations.

SSBN 726 Class submarines discharge all bilgewater either to shore facilities when pierside, or hold bilgewater for discharge when outside 50 n.m. The SSN 688 Class discharges some of the water phase of the bilgewater collecting tank between 3 and 12 n.m. due to the limited size of the holding tank.[3] For the SSN 637 Class submarines, discharges of bilgewater can occur at any location when the bilge pumps are activated.[1]

3.2 Rate

The rate of this discharge varies considerably by class and with the submarine activities. The volume of bilgewater generated can depend on the crew size, operating depth, the submarine's requirement for quiet operations, the type of operations, the duration of operations, and their location.

As shown in Table 1, there are three major submarine classes which generate bilgewater. These are the SSBN 726 Class, the SSN 688 Class, and the SSN 637 Class. The SSN 637 Class submarines are currently being phased out of service. At the present time, the entire class is expected to be retired by the year 2001.[4] Because of this, total discharge rates for SSN 637 Class submarines will not be estimated.

Pearl Harbor Naval Station estimates that 2,000 to 3,000 gallons of bilgewater are generated per submarine per day when pierside; the classes of vessels were not specified.[5] For the SSBN 726 and SSN 688 Class submarines, the following annual per-vessel flow estimates were provided:[3]

SSBN 726	31,500 gallons to shore facilities
	0 gallons while transiting within 12 n.m.
	300,000 gallons outside 12 n.m.
SSN 688	54,000 gallons to shore facilities
	80,540 gallons while transiting within 12 n.m.
	400,200 gallons outside 12 n.m.

Available data indicate that for the other submarine classes, no bilgewater is discharged within 50 n.m. Since bilgewater transferred to shore facilities is not released to the environment, the above information indicates that only the SSN 688 Class submarines actually discharge submarine bilgewater within 12 n.m. from shore.

Based on the value of 80,540 gallons per submarine per year discharged from the SSN 688 Class vessels between 3 and 12 n.m., a total flow was calculated as follows:

(80,540 gal/vessel/year) (56 SSN 688 Class subs) = 4.5 million gallons/year

3.3 Constituents

Potential constituents which have been detected in previous studies include oil and grease, copper, cadmium, lead, nickel, iron, zinc, mercury, lithium bromide, citric acid, chlorine, phenol, cyanide, sodium bisulfite, and the pesticides heptachlor and heptachlor epoxide. Submarine bilgewater could possibly have high levels of total suspended solids (TSS) and chemical oxygen demand (COD).[6,7]

Heptachlor, heptachlor epoxide, phenol, cyanide, copper, cadmium, lead, nickel, silver, and zinc are priority pollutants. Mercury is the only bioaccumulator.

3.4 Concentrations

Table 2 summarizes concentration data from a sampling effort involving 10 submarines. Samples in that program were analyzed for oil, 13 metals, pesticides, PCBs, and 46 organics (vinyl chloride and 45 semivolatile organics).[6,7] The sampling involved four SSBN 726 Class submarines, four SSN 688 Class submarines, and two SSN 637 Class submarines. Samples were taken from submarines that held their bilgewater while operating. Samples are representative of discharges normally made outside 12 n.m.

Samples from open bilge compartments on all three classes of submarines were found to contain an average of 20 parts per million (ppm) oil; bilgewater tanks averaged 76 ppm oil. In calculating arithmetic averages, six samples having values of greater than 1,000 ppm oil were excluded. These were considered not representative of bilgewater discharged within 12 n.m. and would be handled normally as waste oil and retained for shore disposal. These six samples ranged from 1,030 to 820,000 ppm of oil. The arithmetic average of the 52 oil samples, ranging between the detection limit of 5 ppm and 1,000 ppm, is 30 ppm. Including the 23 nondetects, the result would be an arithmetic mean of 22.3 ppm when each non-detect sample was set equal to the detect limit of 5 ppm.

Each sample was also analyzed for 13 metals. Eighteen pesticides, 7 PCBs, 45 semivolatile organics (base neutral aromatics), and one volatile organic (vinyl chloride) were analyzed for in the 81 samples. Table 2 presents concentration ranges and the average concentration calculated. No PCBs, semivolatiles, or vinyl chloride were detected in any sample. Six of the 81 samples contained detectable levels of the pesticides heptachlor and heptachlor epoxide.[6,7]

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. The estimated mass loadings are presented in Section 4.1. In Section 4.2, the concentrations of discharge constituents after release to the environment are estimated and compared with the water quality criteria. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

The total annual mass loadings were calculated based upon the estimated discharge volume for SSN 688 Class vessels and the average concentrations of constituents in submarine bilgewater. The results are presented in Table 3.

4.2 Environmental Concentrations

Concentration data presented in Table 2 are measured concentrations in the discharge, and do not reflect any dilution afforded by the receiving water.

Table 4 shows the water quality criteria (WQC) that are relevant to submarine bilgewater, and compares measured concentrations of constituents to WQC. Reported levels of oil and grease for bilgewater exceed the Federal and the most stringent state WQC. Mercury, heptachlor, and heptachlor epoxide exceed the most stringent state WQC. Average measurements of constituents in the discharge exceed the Federal and the most stringent state WQC for copper, nickel, silver, and zinc. While there is no relevant Federal WQC, chlorine concentrations exceed the most stringent state WQC. Cadmium concentrations exceed the most stringent state WQC, but do not exceed the Federal WQC.

4.3 Potential for Introducing Non-indigenous Species

Non-indigenous species are not likely to be transported by submarine bilgewater. There is limited seawater access to bilge compartments. Bilgewater storage capacity limitations require processing bilgewater on a frequent basis, resulting in discharge in the same geographic area in which it was generated.

5.0 CONCLUSIONS

Concentration data from submarine bilgewater were used to estimate constituent loadings within 12 n.m. from shore. These data and estimates were based on the existing management practices (i.e. shoreside bilgewater collection, discharging only the water phase, and refraining from discharging within 12 n.m.). Discharges between 3 and 12 n.m. occur while the vessels are underway thereby dispersing the pollutants. Removal of the existing practices could significantly increase amounts of constituents discharged above WQC and discharge standards, especially oil. Submarine bilgewater could potentially be discharged in port if these existing practices were not in place. Therefore, submarine bilgewater, uncontrolled, has the potential to cause an adverse environmental effect.

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. Table 5 shows the sources of data used to develop this NOD report.

Specific References

1. UNDS Equipment Expert Meeting Minutes, Submarine Bilgewater. August 12, 1996.

2. OPNAVINST 5090.1B. Environmental and Natural Resources Program Manual. November 1, 1994.

3. Data Call Response, Commander, Submarine Force, U.S. Atlantic Fleet. Submarine Discharge Questionnaire. December 13, 1996.

4. Personal Communication Between Mr. R.B. Miller (M. Rosenblatt & Son, Inc.) and Mr.

Paul Murphy (NAVSEA PMS 392A33) of October 15, 1997.

5. Data Call Response, Pearl Harbor Naval Station. October 11, 1996.

6. Bilge Water Sampling Study. Final Report. September 30, 1996. Electric Boat Corporation.

7. NSSN Review, June 5, 1996. Subject: Fleet Bilge Water Sampling. Presented by: James Triba, NSSN Seawater Systems, Electric Boat Corporation.

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).

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. 23 March 1995.

Table 1. Submarines Producing Bilgewater Discharges

Vessel Class	Description of Vessel	Number of Vessels
SSBN 726	Ohio Class Ballistic Missile Submarine	17
SSN 637	Sturgeon Class Attack Submarine	13
SSN 640	Benjamin Franklin Class Attack Submarine	2
SSN 671	Narwhal Class Attack Submarine	1
SSN 688	Los Angeles Class Attack Submarine	56

Table 2. Concentrations of Contaminants in Submarine Bilgewater Discharge (mg/L)[6,7]

Parameter	Range (mg/L)	Arithmetic Mean (mg/L)*
Oil	<5 - 820,000	30 mg/L (note a)
Arsenic	<0.01	<0.01
Barium	<0.01 - 3.3	0.014
Cadmium	<0.005 - 0.2	0.02
Chromium	<0.01 - 1.7	0.050
Copper	0.065- 15	1.42
Iron	<0.2 - 20	1.89
Lead	<0.01 - 0.074	0.01
Manganese	<0.01 - 1.7	0.12
Mercury	<0.0002 - 0.0007	0.00007
Nickel	<0.04 - 11	0.98
Selenium	<0.005 - 0.021	0.005
Silver	<0.01 - 0.035	0.006
Zinc	<0.02 - 11	1.36
Heptachlor		0.000005
17 other pesticides		note b
Heptachlor epoxide		0.000003
PCBs	<0.001	<0.001
1 VOA plus 45 SVOAs [note c]		note b
Ammonia	<0.1 - 68	6.95
Chlorine	0.0 - 1.6	0.21
COD	<15 - 4500	595
Cyanide	<0.01 - 0.03	0.004
pH	2.94 - 8.95	6.9
Phenols	<0.01 - 5.4	0.19
Surfactants	ND - 0.807	0.16
TSS	<7 - 2400	177

Note a - The average of 30 mg/L provided in the primary reference[6] omitted all nondetects and all (six) oil values > 1,000 milligrams per liter (mg/L). The average of the 75 samples less than 1,000 ppm (including nondetects, assumed to equal the detection limit) is 22.3 mg/L.
Note b - No samples had detectable levels.
Note c - VOA is volatile organic analyte; SVOA is semivolatile organic analyte
Values preceded by "<" are non-detects

Table 3. Estimated Mass Loadings of Constituents from Submarine Bilgewater Discharges (lbs/yr)

Pollutant	Concentration (mg/L)	688 Class 3-12 n.m.
Oil	30.01	1130
Copper	1.42	53.4
Lead	0.01	0.38
Nickel	0.98	36.9
Silver	0.006	0.23
Zinc	1.36	51.2
Ammonia	6.95	262
Chlorine	0.21	7.90
Barium	0.014	0.53
Cadmium	0.02	0.75
Chromium	0.05	1.9
Mercury	0.00007	0.0026
Selenium	0.005	0.19
Heptachlor	0.000005	0.00019
Cyanide	0.004	0.15
Phenol	0.19	7.15
Surfactants	0.16	6.02

Table 4. Comparison of Measured Constituent Values and Water Quality Criteria (μg/L)

Constituent	Average Concentration	Federal Acute WQC	Most Stringent State Acute WQC
Mercury*	0.07	1.8	0.025 (FL, GA)
Heptachlor	0.005	0.053	0.00011 (GA)
Heptachlor epoxide	0.003	0.053	0.00021 (FL)
Phenol	190	-	170 (HI)
Cyanide	4	1	1 (CA, CT, FL, GA, HI, MS, NJ, VA, WA)
Oil	3,0010	visible sheen[a] / 15,000[b]	5000 (FL)
Copper	1420	2.4	2.4 (CT, MS)
Nickel	980	74	8.3 (FL, GA)
Silver	6	1.9	1.2 (WA)
Zinc	1360	90	84.6 (WA)
Chlorine	210	-	10 (FL)
Cadmium	20	42	9.3 (FL, GA)

Notes:
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)
Where historical data were not reported as dissolved or total, the metals concentrations were compared to the most stringent (dissolved or total) state water quality criteria.

CA = California
CT = Connecticut
FL = Florida
GA = Georgia
HI = Hawaii
MS = Mississippi
NJ = New Jersey
VA = Virginia
WA = Washington

* Bioaccumulator

[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 5. Data Sources

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