This document is part of Appendix A, Compensated Fuel Ballast: 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)

Appendix A

Compensated Fuel Ballast: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Compensated Fuel Ballast

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 compensated fuel ballast 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

Compensated ballast tanks are used for fuel storage and to maintain stability on some classes of Navy vessels. As fuel is consumed while underway, water is taken in by the vessel to maintain a nearly constant total fluid weight in the vessel. Compensated fuel ballast tanks are maintained full of either fuel, seawater, or a combination of both. When both fuel and seawater are present in the same tank, the fuel floats on top of the seawater because the fuel is less dense. These tanks are only completely emptied of all fluid (seawater and fuel) during in-tank maintenance or modification work that is not part of the ships' normal operation.

In vessels that use compensated fuel ballast systems, several compensated fuel ballast tanks are connected in series to form a tank group. The first tank of the group is called the "receiving tank." Fuel enters and exits the tank group via the receiving tank. The last tank of the group is called the "overflow/expansion tank." Seawater enters and exits the tank group via the overflow/expansion tank from the ship's firemain. Compensating water is introduced into the overboard discharge pipe of the overflow/expansion tank through a level control valve. This valve maintains a constant pressure within the compensated fuel tanks. The compensated ballast/fuel storage tanks are in between the receiving and the overflow/expansion tanks. All the tanks in the group are connected by sluice pipes. Each tank in the group has an upper and lower sluice pipe. The lower sluice pipe in the first tank of the group is connected to the upper sluice pipe of the next tank in the series. The upper sluice pipe in the receiving tank connects to the ship's fill and transfer fuel piping and allows fuel to enter and leave the tank group. The lower sluice pipe of the overflow/expansion tank allows seawater to enter and leave the tank group. Figure 1 shows a schematic diagram of the tank group interconnection pipes.

Each Navy surface vessel using a compensated fuel ballast system has six tank groups in adjacent tank group pairs; two tank groups forward, two tank groups midship, and two tank groups aft. Figure 2 shows the general layout of the six tank groups. For each adjacent tank group pair, there is one port tank group and one starboard tank group. Each tank group consists of three to six tanks connected in a series: a receiving tank, one to four storage tanks, and an overflow/expansion tank. The overboard discharge from each adjacent port and starboard tank group are cross-connected resulting in a port-starboard pair of overboard discharges forward, midship, and aft. Figure 3 illustrates a typical fuel oil tank layout for pair of port and starboard tank groups with cross-connected overflow piping on a surface vessel.

During a fueling operation, fuel enters the receiving tank via the inlet sluice pipe and pushes seawater through the rest of the tanks in the group via the sluice pipes. By simple displacement, an equal amount of seawater is discharged overboard from the overflow/expansion tank. Each tank in the group fills in sequence since fuel cannot get into the next tank in the series until the fuel level reaches the lower sluice pipe of the tank being filled. When the fuel level reaches the lower sluice pipe in a tank the fuel starts to flow into the next tank in the series via the sluice pipe. Operating procedures dictate that the fueling process be stopped prior to fuel entering the overflow/expansion tank.[1] The overflow/expansion tank is intended to hold only seawater, acting as a buffer between the fuel storage tanks and the overboard discharge. This tank is used to prevent the accidental discharge of fuel overboard due to overfilling of the tank group, or due to the thermal expansion of the fuel when ambient temperatures increase.

Fuel is transferred via purifiers to uncompensated fuel service tanks prior to use by ship's propulsion and electrical generating plants. Only fuel from the service tanks is used to power the ship's propulsion and electrical generating plants, fuel is not taken directly from the compensated fuel ballast tanks to the engines. Therefore, compensating water is not taken on when the ship's engines are operating in port.

Non-conventional submarines have a compensated fuel ballast system to provide fuel for the emergency diesel generator. This compensated fuel ballast system consists of a Normal Fuel Oil (NFO) tank and a seawater expansion tank. Compensating water is not discharged to the surrounding water under any normal operating condition. When fueling, the displaced seawater is removed from the NFO tank via the seawater compensating line and is transferred via a hose connection to a port collection facility for treatment and disposal.[2] While operating at sea, compensating seawater is not discharged from the NFO tank because an air charge in the expansion tank compresses to account for volumetric changes due to hull compression during changes in ship depth or as a result of tank liquid temperature changes.

Mixing of the fuel into seawater discharged from the overflow/expansion tank is believed to occur via the following mechanisms:

- Fuel and water can be mixed by turbulence in the tank during rapid introduction of fuel or water, or the rolling motion of the ship. The turbulence is caused by fluid flow around internal tank structure and by interfacial shear between the fuel and the water layers.

- Internal tank structure can cause incorrect fuel level readings and inadvertent discharge of fuel with the compensated ballast water by trapping pockets of fuel and seawater.

- Soluble fuel constituents can be dissolved in seawater.

Some of the design and operational practices used by the Navy to mitigate fuel discharges from compensating ballast systems include:

- Engineering Operating Sequencing Systems (EOSS) fuel filling procedure "Standard Refueling, Fuel Oil" (SRFO) and the Class Advisories (temporary operating instructions and notices) for destroyers and conventional cruisers recommend that fuel storage tanks be refueled to no greater than 85 percent of capacity in port.[1-4] This prevents the fuel/seawater interface from entering the overflow/expansion tank and overboard discharge pipe.

- EOSS fuel filling procedure SRFO and the Class Advisories for the same vessels direct that the in-port flow limiting valves in the supply to each tank group be closed during in-port refueling only (open while refueling at sea). The flow limiting valves restrict the fill rate to each tank group to approximately 400 gallons per minute (gpm) versus 1000 gpm while at sea. This reduces fuel/seawater mixing in the tank.[1-4]

- EOSS fuel filling procedure SRFO requires individuals to stand watch to halt refueling in the event of overboard spills, while others are required to monitor fuel levels in each tank during the refueling operation.[1]

2.2 Releases to the Environment

As discussed in Section 2.1 compensated ballast discharge occurs through the overflow/expansion tank during refueling operations. Compensated ballast discharge consists primarily of seawater containing some fuel constituents. Leaching and corrosion of fuel containment systems are expected to result in the presence of metals.

2.3 Vessels Producing the Discharge

The Navy is the only branch of the Armed Forces whose vessels utilize compensated fuel ballast systems. Compensated fuel ballast systems are used only on CG 47 Class cruisers; DD 963 Class, DDG 993 Class, and DDG 51 Class destroyers; and all non-conventional submarine classes.[2] A total of 75 U.S. based surface vessels generate this discharge. Submarine compensated fuel ballast systems do not discharge to the surrounding water whether in port or at sea. USCG, MSC, Army, Air Force, and Marine Corps vessels do not utilize compensated fuel ballast systems and do not generate this discharge.

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-port refueling of surface ships is the only circumstance during which compensated ballast discharge occurs within 12 nautical miles (n.m.). At-sea refueling operations take place outside of 12 n.m. based on standard operating practice.

3.2 Rate

During in-port refuelings of surface vessels, compensated ballast is discharged at a rate of up to 400 gpm per tank group (2,400 gpm maximum per ship). Based on actual refueling data obtained from Navy personnel, each ship takes on about 200,000 gallons per refueling in port and the refuelings occur on average two times per year per ship.[5]

3.3 Constituents

The Navy has conducted several studies of compensated ballast in the past. These included:

- in-port refueling test of the USS Nicholson (DD 982);[6]
- at-sea refueling testing of the USS Spruance (DD 963);[7]
- in-port and at-sea testing of the USS John Hancock (DD 981);[8] and
- in-port testing of the USS Arleigh Burke (DDG 51).[9,10]

These previous studies have typically measured the oil concentration of the discharge. On the DDG 51, in-line oil content monitors were used in conjunction with standard laboratory analyses to determine the oil concentration in the discharged ballast water. Table 1 summarizes the data for oil concentration in compensated ballast water from the previous Navy studies. The concentration of oil in water varied from below detection levels to 370 milligrams per liter (mg/L).

To further support this NOD report, a sampling effort was conducted. Five samples of compensated ballast discharge, and an additional quality assurance/quality control sample, were taken through the course of an in-port refueling operation from the discharge of a single midship tank group of the USS Arleigh Burke, (DDG 51) on January 27, 1997.[11] Based on previous Navy operational and design experience, midship tank groups on DDG 51 Class vessels are expected to contain the greatest concentration of fuel oil constituents in the ballast water. The samples were analyzed for volatile and semivolatile organics, selected classical pollutants, metals, and mercury using EPA series 1600 protocols. Table 2 presents a summary of the validated analytical data for all detected analytes from the sampling effort that occurred on January 27, 1997. The following priority pollutants were present in measurable amounts: copper, nickel, silver, thallium, zinc, benzene, phenol, and toluene;[12] the only bioaccumulator found was mercury.[13] Also, during the UNDS sampling effort, 8 additional samples were taken and analyzed for TPH by the modified 418-2 method, with results ranging from 11.9 to 108.2 mg/L.[14]

3.4 Concentrations

As mentioned in Section 3.3, Table 2 presents the validated analytical data from the UNDS sampling effort. The table includes metals, volatile organics, semivolatile organics, classicals, and mercury. The table shows the constituents, the log-normal mean, the frequency of detection for each constituent, the minimum and maximum concentrations, and the mass loadings of each constituent. For the purposes of calculating the log-normal mean, a value of one-half the detection limit was used for non-detected results.

In addition to the oil concentration data collected in previous sampling as described in Table 1, two separate sets of analyses were developed from the UNDS sampling effort to support this NOD report. The samples were analyzed for Hexane Extractable Materials (HEM) and Silica Gel Treated (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. The results varied from 8 to 36.5 mg/L for HEM and from 6 to 12.5 mg/L for SGT-HEM.[11]

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

Based on ship transit data, Navy surface ships with compensated ballast systems are at their homeport (within 12 n.m.) between 101 and 178 days per year, and at sea for the balance of the year.[15] A per-ship total annual discharge of 400,000 gallons per year was calculated based upon the following averages obtained from Navy refueling data:[5]

- 200,000 gallons median discharge per in port refueling; and
- 2 refuelings in port per year.

As mentioned in Section 2.3, 75 surface vessels are homeported in the U.S. and generate compensated ballast within 12 n.m. of the U.S.[16] The majority of these ships' in-port refuelings occur at their homeport. Flow per ship class can be roughly approximated as the product of the number of vessels in a class and 400,000 gallons discharged per ship per year as presented in Table 3. The 75 U.S. based surface vessels discharge 30.0 million gallons within the 12 n.m. zone.

Total mass loading, for in-port discharges, was estimated by multiplying the log-normal mean concentration by the total compensated ballast discharge volume of 30.0 million gallons per year. The generalized equation is shown below:

$$\text{Mass Loading (lbs/yr)} = (\text{Concentration } (\mu g/L))(\text{Volume (gal/yr)})(3.785 \text{ L/gal})(2.2 \text{ lbs/kg})(10^{-9} \text{ kg}/\mu g)$$

Based on the SGT-HEM log-normal mean concentration of 4.65 mg/L the TPH loading could be 1,160 pounds per year (lbs/yr). Based on the HEM log-normal mean concentration of 12.73 mg/L, the total estimated oil & grease loading from in-port discharges could be expected to be 3,180 lbs/yr.

Using the metal log-normal mean concentrations as listed in Table 2; the mass loadings are estimated to be 13.3 lbs/yr for copper; 47.4 lbs/yr for nickel; 2 lbs/yr for thallium; 1,063 lbs/yr for zinc; 0.77 lbs/yr for silver; and 0.00015 lbs/yr for mercury. Using the organic log-normal concentration in Table 2, the mass loading was estimated to be 10.3 lbs/yr for 2-Propenal; and 22 lbs/yr for benzene. Using the log-normal concentration in Table 2, the mass loading was estimated to be 65 lbs/yr for ammonia, 97 lbs/yr for nitrogen, and 15 lbs/yr for phosphorous. These mass loadings are summarized in Table 4. The ratio of the number of vessels in each U.S. homeport to the total of 75 compensated ballast vessels allows the loadings to be proportioned as shown in Table 5.

4.2 Environmental Concentrations

Screening for acute toxicity was accomplished by comparing the log-normal mean resulting from the UNDS sampling to Federal or the most stringent state water quality criteria for these constituents. These data are provided in Table 6. Individual sample concentrations exceed Florida criteria for oil, as indicated by SGT-HEM, but the log-normal mean does not; however, this discharge has demonstrated that potential for causing a sheen when procedural controls are not used.[6,8] *Discharge of Oil*, 40 CFR 110, defines a prohibited discharge of oil as any discharge sufficient to cause a sheen on receiving waters. The Federal discharge standard is 15 mg/L based on *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).

The log-normal mean concentrations for copper, nickel, silver, and zinc samples exceed both Federal and most stringent state water quality criteria (WQC). The most stringent state criteria are exceeded by the log-normal mean concentration for 2-Propenal, ammonia, benzene, HEM, total nitrogen, phosphorous, and thallium. Mercury, a persistent bioaccumulator, was present in three of the four samples, although it did not exceed WQC.

4.3 Potential for Introducing Non-Indigenous Species

Water taken into the fuel tanks during refueling could contain non-indigenous species, but it is unlikely that the organisms will be transferred between ports for the following reasons:

1) Water is not taken into the compensated fuel ballast tanks during refueling operations – water is only discharged during this operation. Water is only taken into the compensated fuel ballast tanks during fuel transfer operations (either between compensated fuel ballast tank groups or from a compensated fuel ballast tank to a fuel service tank). Water could be taken into the compensated fuel ballast tanks prior to a refueling operation because ship's personnel are trying to maximize the fuel storage on board by transferring fuel from the compensated ballast tanks to top off the fuel service tanks. This process is normally done at-sea prior to entering to a port facility. This process also prevents silt and debris from shallow harbors from being introduced into the tanks.

2) If the ship has been generating its own electrical power for an extended period while in-port then the fuel transfer may take place in the harbor prior to the refueling in order to maximize the fuel stored on-board the vessel. However, the refueling that takes place immediately after the fuel transfer will discharge the compensating water back into the same harbor.

3) Compensating water from the fuel storage tanks is frequently flushed while the ship is at sea due to frequent refuelings. Navy surface ships with compensated ballast systems normally refuel every three to four days while out at sea to prevent fuel levels from dropping below 70% capacity. Based on ship transit data, these ships are at sea between 187 and 264 days per year.[11] Using the minimum number of days at sea (187), and assuming that the ship is refueled at-sea every 4 days, results in an estimate of approximately 46 at-sea refuelings per year compared to two in-port refuelings per year. Therefore, there is little chance for compensating water that may have been taken on in one port to be discharged in another port.

5.0 CONCLUSIONS

Uncontrolled, compensated ballast discharge has the potential to cause an adverse environmental effect because significant amounts of oil are discharged during a short duration at concentrations that exceed discharge standards and water quality criteria. This discharge has been reported to cause an oil sheen when procedural controls are not applied.[6,8]

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 the constituents, the concentrations of the constituents in the environment resulting from this discharge were compared with relevant water quality criteria. Table 7 shows the sources of data used to develop this NOD report.

Specific References

1. Naval Sea Systems Command, Engineering Operating Sequencing System (EOSS), Operational Procedure Fuel Oil Refueling, Code SRFO/0319/032596.

2. UNDS Equipment Expert Meeting Minutes - Compensated Fuel Ballast. July 24, 1996.

3. Naval Sea Systems Command, DD 963 - DDG 993 Class Advisory NR 04-94, Inport Refueling / Operational Procedures, 2 May 1994.

4. Naval Sea Systems Command, DDG 51 Class Advisory NR 22-95, Fuel Tank Level Indicator Alignment Procedures, 21 December 1995.

5. Report of Travel, Compensated Fuel Ballast System NCCOSC-NRaD, San Diego, 12 March 1997.

6. Oil Concentrations in Ballast Water During In-Port Refueling of USS Nicholson (DD 982). DTNSRDC Report TM-28-81-145 (December 1981).

7. Oil Concentrations in Ballast Water During At-Sea Refueling of USS Nicholson (DD 982). DTNSRDC Report TM-28-82-158 (December 1982).

8. Evaluation of DD-963 Class Fuel/Ballast Expansion Tank Modifications Aboard USS JOHN HANCOCK (DD 981). DTNSRDC Report TM-28-83-171 (May 1984).

9. SEA 05Y32 Preliminary Trip Report/Test Brief. DDG 51 In-Port Refueling Test, August 12-14, 1992.

10. SEA 05Y32 DDG 51 Post-PSA In-Port Fueling Test. August 4, 1992.

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

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

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

14. Compensated Ballast Sample Analysis Results from DDG 51 In-port Refueling, 27 January 97, Commanding Officer, Naval Surface Warfare Center, Carderock Division, Philadelphia Site, Philadelphia, PA, letter 9593, Ser 631/63 of 14 February 1997.

15. UNDS Ship Database, August 1, 1997.

16. The United States Navy, List of Homeports, Homeports and the Ships Assigned, Effective May 22, 1997.

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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).

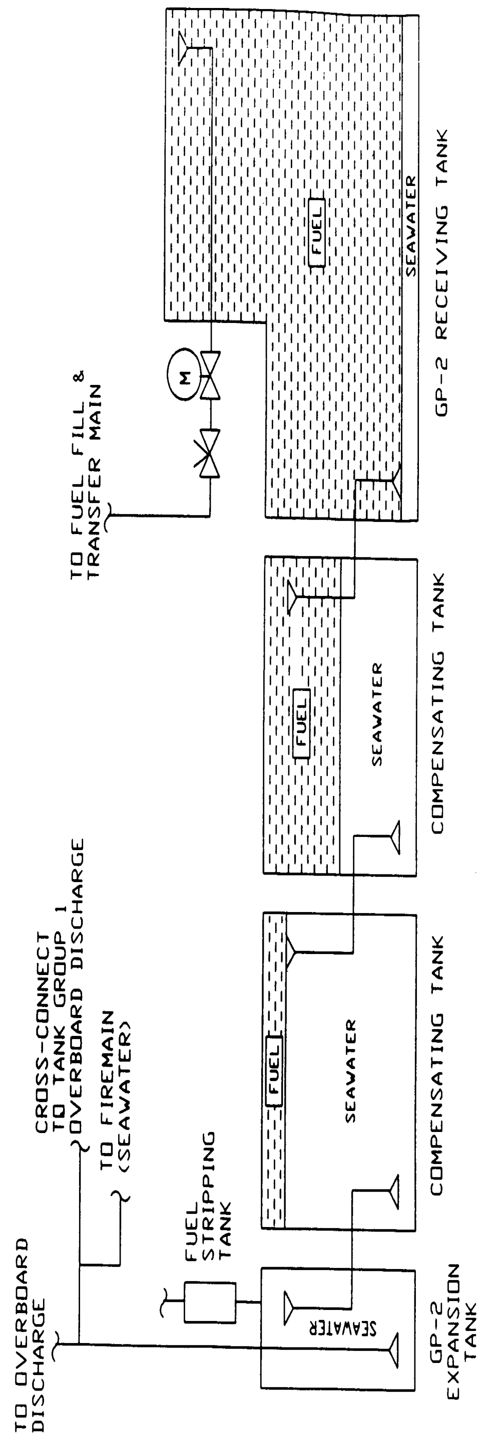

Figure 1. Fuel Tank Group 3 and 4 (Typical) Compensated Seawater Ballast

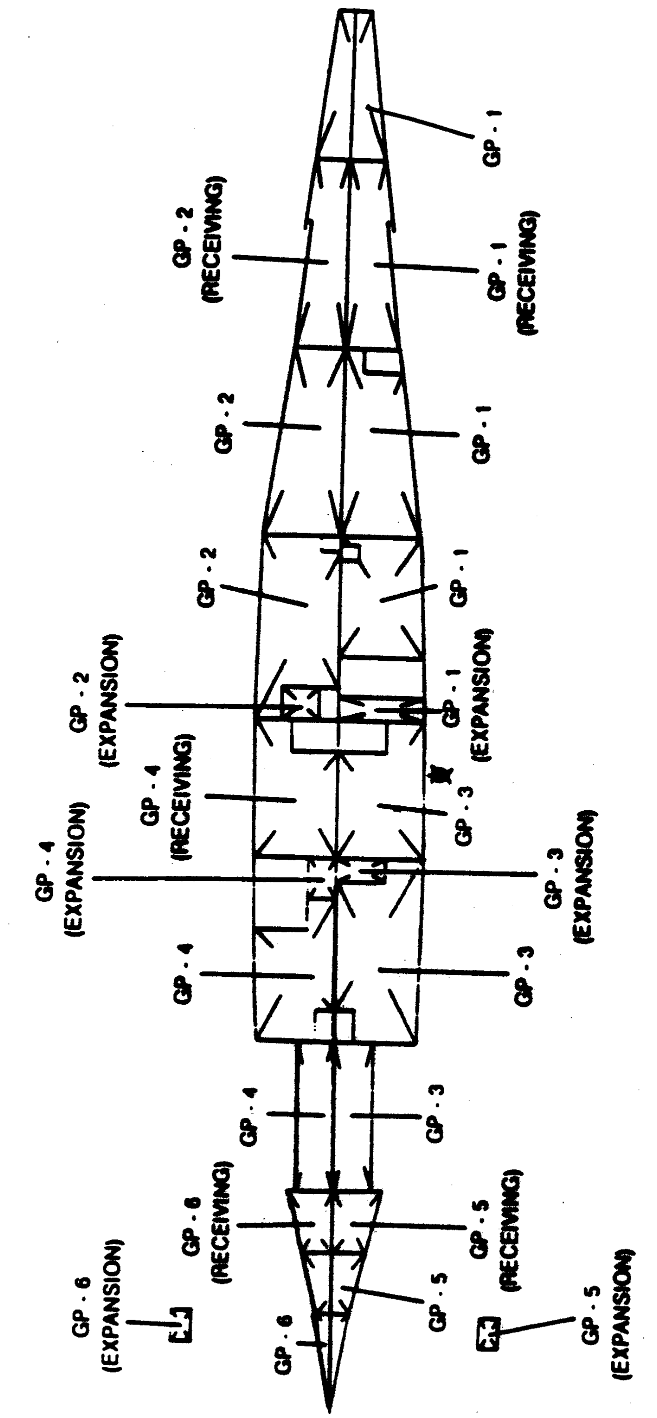

Figure 2. Compensated Fuel Ballast Tank Layout

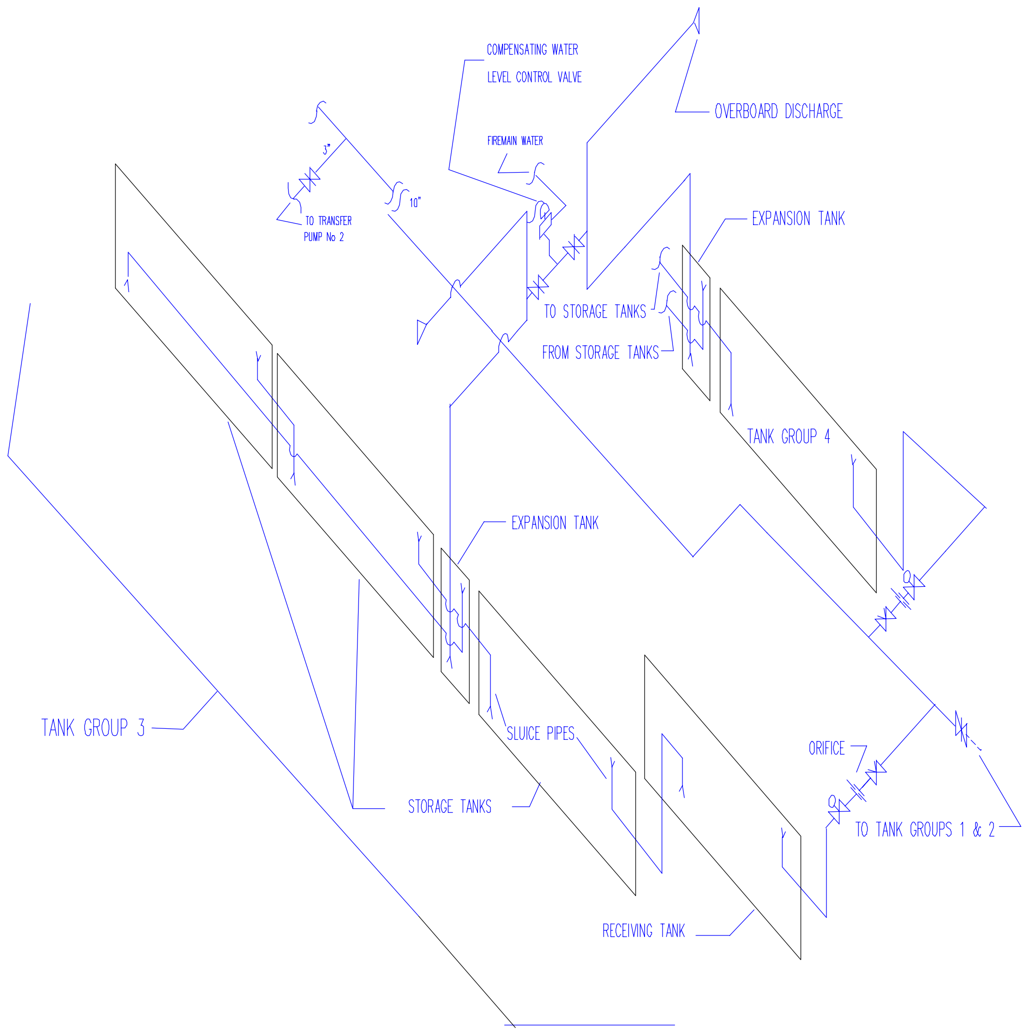

Figure 3. Typical Port and Starboard Tank Groups with Cross-connected Overflow

Table 1. Oil Concentrations in Compensated Ballast Waters (mg/L)

Previous Navy Studies			
USS Nicholson DD 982[6] (in-port)	USS Spruance DD 963[7] (at-sea)	USS John Hancock DD 981[8] (in-port)	USS Arleigh Burke DDG 51[10,11] (in-port)
2 to 149	< 60	<1 to 370	0.0 to 10.35 (lab)

mg/L - milligrams of oil per liter of fluid
(lab) - laboratory analysis results for physical samples taken during testing

Table 2. Summary of Detected Analytes for Compensated Ballast Discharge

Constituent		Log Normal Mean	Frequency of Detection	Minimum Concentration	Maximum Concentration	Mass Loading (lbs/yr)
Classicals (mg/L)						
ALKALINITY		46.72	4 of 4	45	49	11,671
AMMONIA AS NITROGEN		0.26	4 of 4	0.19	0.3	65
BIOCHEMICAL OXYGEN DEMAND		6.82	1 of 4	BDL	12	1,704
CHEMICAL OXYGEN DEMAND (COD)		429.25	4 of 4	380	490	107,231
CHLORIDE		16042.18	4 of 4	15400	16800	4,007,497
HEXANE EXTRACTABLE MATERIAL		12.73	4 of 4	8	36.5	3,180
SGT-HEM		4.65	2 of 4	BDL	12.5	1,162
SULFATE		2005.74	4 of 4	1900	2120	501,054
TOTAL DISSOLVED SOLIDS		27760.50	4 of 4	27000	29300	6,934,851
TOTAL KJELDAHL NITROGEN		0.39	4 of 4	0.28	0.58	97
TOTAL ORGANIC CARBON (TOC)		28.98	4 of 4	21	40	7,239
TOTAL PHOSPHOROUS		0.06	3 of 4	BDL	0.34	15
TOTAL SULFIDE (IODOMETRIC)		3.94	4 of 4	3	5	984
TOTAL SUSPENDED SOLIDS		9.62	4 of 4	4	18	2,403
VOLATILE RESIDUE		2506.27	4 of 4	1910	3160	626,091
Hydrazine (mg/L)						
HYDRAZINE		0.08	4 of 4	0.0705	0.089	20
Mercury (ng/L)						
MERCURY		0.60	3 of 4	BDL	0.835	0.0001
Metals (µg/L)						
ALUMINUM	Dissolved	52.03	2 of 4	BDL	120	13
	Total	37.00	1 of 4	BDL	135.5	9
BARIUM	Dissolved	11.44	4 of 4	10.35	12	3
	Total	11.24	4 of 4	10.25	11.8	3
BORON	Dissolved	3098.77	4 of 4	2990	3220	774
	Total	3060.48	4 of 4	2990	3175	765
CALCIUM	Dissolved	256841.05	4 of 4	203000	292000	64,161
	Total	291451.71	4 of 4	286000	299000	72,808
COPPER	Total	53.37	4 of 4	43.7	86	13
IRON	Dissolved	99.76	4 of 4	37.45	159	25
	Total	130.50	4 of 4	74.95	202	33
MAGNESIUM	Dissolved	907229.15	4 of 4	881000	923500	226,635
	Total	938389.79	4 of 4	907000	1024500	234,419
MANGANESE	Dissolved	12.13	4 of 4	11.15	13.7	3
	Total	12.13	4 of 4	10.7	13.7	3
NICKEL	Dissolved	184.65	4 of 4	137	263.5	46
	Total	189.72	4 of 4	144	267.5	47
SILVER	Dissolved	3.07	1 of 4	BDL	5.68	1
SODIUM	Dissolved	8225693.86	4 of 4	8040000	8450000	2,054,861
	Total	8039337.04	4 of 4	7740000	8550000	2,008,307

THALLIUM	Dissolved	5.61	1 of 4	BDL	10.8	1
	Total	7.40	1 of 4	BDL	24	2
ZINC	Dissolved	1220.18	4 of 4	173	4330	305
	Total	4256.14	4 of 4	3840	4845	1,063
Organics (µg/L)						
2,3-DICHLOROANILINE		6.09	1 of 4	BDL	11	2
2,4-DIMETHYLPHENOL		312.10	4 of 4	180	430	78
2-METHYLBENZOTHIOAZOLE		8.07	1 of 4	BDL	34	2
2-METHYLNAPHTHALENE		61.34	4 of 4	58	63	15
2-PROPANONE		41.18	2 of 4	BDL	73	10
2-PROPENAL		42.20	1 of 4	BDL	203	11
4-CHLORO-2-NITROANILINE		12.04	1 of 4	BDL	21	3
ACETOPHENONE		21.99	4 of 4	21	23	5
ANILINE		6.58	1 of 4	BDL	15	2
BENZENE		89.99	4 of 4	31	153	22
BENZOIC ACID		75.62	3 of 4	BDL	146	19
BENZYL ALCOHOL		12.16	3 of 4	BDL	24	3
BIPHENYL		9.76	4 of 4	7.5	11	2
ETHYLBENZENE		38.59	4 of 4	20.5	59	10
HEXANOIC ACID		16.93	4 of 4	7.5	28	4
ISOSAFROLE		6.69	1 of 4	BDL	16	2
LONGIFOLENE		54.02	1 of 4	BDL	545	13
M-XYLENE		58.13	4 of 4	41.5	73	15
N-DECANE		7.28	1 of 4	BDL	22.5	2
N-DOCOSANE		7.11	1 of 4	BDL	20.5	2
N-DODECANE		10.01	2 of 4	BDL	36.5	3
N-EICOSANE		20.35	4 of 4	14	51	5
N-HEXADECANE		39.36	4 of 4	26	99.5	10
N-OCTADECANE		24.98	4 of 4	16	64	6
N-TETRADECANE		21.19	4 of 4	14	60	5
NAPHTHALENE		19.54	3 of 4	BDL	47	5
O+P XYLENE		100.66	4 of 4	71	127	25
O-CRESOL		181.10	4 of 4	84.5	296	45
O-TOLUIDINE		40.24	4 of 4	8	95	10
P-CRESOL		110.73	4 of 4	46.5	192	28
P-CYMENE		5.53	1 of 4	BDL	10	1
PHENOL		69.70	4 of 4	59	83	17
THIOACETAMIDE		19.75	1 of 4	BDL	152	5
TOLUENE		164.46	4 of 4	63.5	269	41
TOLUENE,2,4,-DIAMINO-		72.44	1 of 4	BDL	227	18

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 3. Estimated Total U.S. In-port Discharge of Compensated Ballast (millions of gallons/year Fleetwide)

Ship Class	Number of Ships	Total In-port Discharge
CG 47	25	10.0
DD 963	28	11.2
DD 993	4	1.6
DDG 51	18	7.2

Table 4. 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		0.26	4 of 4	0.19	0.3	65
Hexane Extractable Material		12.73	4 of 4	8	36.5	3,180
Nitrate/ Nitrite		-	-	-	-	-
Total Kjeldahl Nitrogen		0.39	4 of 4	0.28	0.58	97
Total Nitrogen[a]		0.39	4 of 4	0.28	0.58	97
Total Phosphorous		0.06	3 of 4	BDL	0.34	15
Mercury (ng/L)						
Mercury*		0.6	3 of 4	BDL	0.835	0.00015
Metals (μg/L)						
Copper	Total	53.37	4 of 4	43.7	86	13
Nickel	Dissolved	184.65	4 of 4	137	263.5	46
	Total	189.72	4 of 4	144	267.5	47
Silver	Dissolved	3.07	1 of 4	BDL	5.68	0.77
Thallium	Total	7.40	1 of 4	BDL	24	2
Zinc	Dissolved	1220.18	4 of 4	173	4330	305
	Total	4256.14	4 of 4	3840	4845	1,063
Organics (μg/L)						
2-Propenal		42.2	1 of 4	BDL	203	10
Benzene		89.99	4 of 4	31	153	22

* - Mercury was not found in excess of WQC; mass loading is shown only because it is a bioaccumulator.
A - Total Nitrogen is the sum of Nitrate/Nitrite and Total Kjeldahl Nitrogen.

Table 5. Estimated Mass Loadings by Homeport (lbs/yr)

	Total	Everett	Mayport	Norfolk	Pascagoula	Pearl Harbor	San Diego
Ships	75	4	13	27	2	10	19
	Loading Ranges						
HEM	3180	170	551	1145	85	424	805
SGT-HEM	1160	62	201	417	31	155	294
Copper	13.3	0.7	2.3	4.75	0.35	1.8	3.4
Nickel	47.4	2.5	8.25	17.1	1.25	6.3	12
Zinc	1063	56.7	184.25	382.7	28.35	141.7	269.3
Thallium	2	0.11	0.35	0.72	0.05	0.27	0.51
Silver	0.77	0.04	0.135	0.285	0.02	0.1	0.19
2-Propenal	10.3	0.55	1.8	3.7	0.28	1.4	2.6
Ammonia	65	3.5	11.3	23.4	1.75	8.7	16.5
Benzene	22	1.2	3.8	7.9	0.6	2.9	5.6
Nitrogen	97	1.7	17	35	0.84	13	25
Phosphorous	15	0.8	2.6	5.4	0.4	2.0	3.8

Table 6. Mean Concentrations of Constituents Exceeding Water Quality Criteria

Constituent		Log Normal Mean	Minimum Concentration	Maximum Concentration	Federal Acute WQC	Most Stringent State Acute WQC
Classicals (mg/L)						
Ammonia As Nitrogen		0.26	0.19	0.3	None	0.006 (HI)[A]
Nitrate/Nitrite		-	-	-		
Total Kjeldahl Nitrogen		0.39	0.28	0.58	None	-
Total Nitrogen[B]		0.39	0.28	0.58	None	0.2 (HI)[A]
Hexane Extractable Material		12.73	8	36.5	visible sheen[a]/ 15[b]	5 (FL)
Total Phosphorous		0.06	BDL	0.34	None	0.025 (HI)[A]
Mercury (ng/L)						
Mercury*		0.6	BDL	0.835	1800	25 (FL, GA)
Metals (μg/L)						
Copper	Total	53.37	43.7	86	2.9	2.5 (WA)
Nickel	Dissolved	184.65	137	263.5	74	74 (CA, CT)
	Total	189.72	144	267.5	74.6	8.3 (FL, GA)
Silver	Dissolved	3.07	BDL	5.68	1.9	1.9 (CA, MS)
Thallium	Total	7.40	BDL	24	None	6.3 (FL)
Zinc	Dissolved	1220	173	4330	90	90 (CA, CT, MS)
	Total	4256	3840	4845	95.1	84.6 (WA)
Organics (μg/L)						
2-Propenal		42.2	BDL	203	None	18 (HI)
Benzene		89.99	31	153	None	71.28 (FL)

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)
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 7. Data Sources

	Data Source			
NOD Section	**Reported**	**Sampling**	**Estimated**	**Equipment Expert**
2.1 Equipment Description and Operation	Data call responses			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	Data call responses	X		X
3.4 Concentrations	Data call responses	X		X
4.1 Mass Loadings			X	
4.2 Environmental Concentrations	X	X		
4.3 Potential for Introducing Non-Indigenous Species				X