This document is part of Appendix A, and includes Motor Gasoline (MOGAS) Compensating Discharge: 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)

Motor Gasoline (MOGAS) Compensating Discharge: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Motor Gasoline (MOGAS) Compensating 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 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 MOGAS 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). This discharge may be referred to as “Motor Gasoline (MOGAS) and Compensating Overboard

2.1 Equipment Description and Operation

MOGAS is commercial gasoline identical to that supplied to gas stations for automobile use. It is carried aboard certain Navy, U.S. Coast Guard (USCG), Military Sealift Command (MSC), and Army vessels as fuel for vehicles, special warfare operational craft, portable bomb hoists, crash saws, and any other gasoline-operated, ship-support equipment.

The USCG, MSC, Air Force, and Army have no vessels with fixed MOGAS storage. Most vehicles and equipment are brought aboard fully loaded with fuel, and additional MOGAS is carried in portable drums or containers. On some Navy vessels, additional MOGAS is stored for replenishment purposes in permanently installed seawater-compensated tanks as shown in Figure 1. Compensating seawater is supplied at a pressure sufficient to force gasoline to the suction side of the gasoline pumps, and keep the tank full to prevent potentially explosive gasoline vapors from forming. Several methods are used to supply seawater to the tanks. Aboard amphibious transport dock (LPD 4 Class) ships, two dedicated seawater pumps take suction directly from the sea chest. On amphibious assault (LHA 1 Class) ships, seawater can be supplied one of two ways: 1) a compensating tank with a capacity of 8,000 to 10,000 gallons of seawater is installed such that water drains by gravity to the fuel tank as necessary; or 2) booster pumps located in the pump room supply seawater to the fuel tanks.

Immediately before a major overhaul, and in accordance with existing management practices, ships with permanently installed seawater-compensated MOGAS tanks will unload any remaining fuel to tanker trucks on the pier and transit out to beyond 50 nautical miles (n.m.). Using seawater pumps, the MOGAS tanks and system piping are flushed with three tank volumes of seawater. Air pressure is used to force the seawater out of the tank, after which steam is used to clean the tank and “cook-off” any remaining fuel remnants. The MOGAS tanks are then filled with seawater and the ship returns to port for the overhaul.

After overhaul and before re-deployment (approximately once a year) the vessel receives MOGAS from pierside tanker trucks. MOGAS that is on-loaded displaces the compensating seawater in the tank, pushing it overboard. Several management practices are in place to ensure that MOGAS is not discharged overboard during refueling operations. Without these management practices, there is a potential to cause an oil sheen in the surrounding waters. First, the MOGAS tanks are filled to no more than 80% of capacity.[1] The amount of fuel needed is calculated before loading, and the tanker truck is only filled with a volume of MOGAS such that completely filling a MOGAS tank with the entire contents of the truck would not cause the tank to overflow. Additionally, watch personnel are stationed at strategic locations on and around the ship and pier to observe refueling operations and report any abnormalities. Containment devices are placed around all refueling hose connections to contain any fuel spills or leaks, and containment booms are placed in the water around the ship being refueled.

An additional management practice controls the rate at which MOGAS is supplied from the tanker trucks. Small-diameter hoses (usually two inches) are used to deliver fuel at a flow rate of 50 gallons per minute (gpm) or less, that, in conjunction with diffusers built into the tank filling system piping, reduces turbulence and minimizes mixing of gasoline and seawater.

2.2 Releases to the Environment

The discharge consists of seawater used to replace, or compensate for, the space created in MOGAS tanks as the fuel is consumed. This seawater is discharged overboard as the MOGAS tank is refilled with gasoline. It is possible that this compensating seawater discharge overboard could contain traces of dissolved gasoline constituents.

2.3 Vessels Producing the Discharge

The USCG, MSC, Air Force, and Army have no vessels with fixed MOGAS storage, and therefore do not contribute to this discharge.[2,3,4] Eight LPD 4 Class, and five LHA 1 Class ships currently have installed MOGAS storage tanks that discharge compensating water during refueling. One LPD and one LHA Class ship are homeported overseas.

The most significant difference between LPD 4 and LHA 1 Class ships is MOGAS capacity. LPDs have a capacity to carry 26,000 gallons of MOGAS. LHAs have a capacity to carry 11,400 gallons of MOGAS.

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

Refueling always takes place pierside, and compensating seawater is discharged directly overboard as oncoming fuel displaces the seawater.

3.2 Rate

Tanker trucks with small diameter hoses (usually two inches) are used to deliver MOGAS to ships. The fill rate from these trucks is normally limited to 50 gpm or less. With the MOGAS tanks always full of seawater and fuel, compensating water is displaced directly overboard at the same rate as the incoming fuel.

The estimated amounts of compensating seawater discharged annually from ships with MOGAS storage tanks are presented in Table 1. The values in Table 1 are based on the operational experience of one refueling per ship per year, with a maximum of 80% of the tank capacity being displaced overboard by onloaded fuel.[1]

3.3 Constituents

MOGAS is a hydrocarbon based unleaded fuel containing over 150 individual compounds. The types of compounds found in gasoline include alkanes, alkenes, aromatics, metals, and additives. Most of these compounds are a very small fraction (less than 2%) of gasoline. The compounds that individually comprise at least 2% of gasoline include butane, pentane, hexane, isopentane, methylpentane, dimethylpentane, trimethylpentane, trimethylhexane, benzene, toluene, xylene, methyl-3-ethylbenzene, trimethylbenzene, and ethylbenzene. The exact composition of gasoline is unknown because gasoline manufacturers constantly adjust their product to meet performance, emissions, and cost demands.[5] Due to the variable composition and the different water solubilities of the individual components of gasoline, it is difficult to determine the solubility of MOGAS.

To identify the constituents in this discharge, two studies that determined the water soluble components of gasoline, as well as their solubilities, were used. The first study was conducted by the Naval Biosciences Laboratory in 1983, and the second was conducted in 1992 for a workshop on petroleum hydrocarbons.[5,6] Both studies measured the water soluble constituents of gasoline by placing gasoline on top of water, agitating the water, allowing equilibrium to be established, and analyzing the water through gas chromatography. In these analyses, a water fuel interface was established very similar to the interface within MOGAS tanks. In both cases, the water was removed from the bottom of the container to be analyzed, ensuring that emulsified fuel was not being measured. Since gasoline composition has changed over the years, the study performed in 1992 is considered to be more representative of current MOGAS constituents. The constituents identified in this study that are soluble in water are listed in Table 2.[5] Benzene, toluene, ethylbenzene, phenol, and naphthalene are priority pollutants. None of these compounds are bioaccumulators.

3.4 Concentrations

The concentrations of the water soluble gasoline constituents in the MOGAS compensating discharge are estimated from the studies performed to determine the solubility of gasoline components in water. The 1983 study reported a range of constituent concentrations based on the source of the gasoline. Benzene concentrations ranged from 19.1 to 42.5 milligrams per liter (mg/L), toluene from 17.3 to 61.4 mg/L, and xylenes from 9.5 to 27.7 mg/L.[6] The 1992 study provided a more detailed account of the concentrations, which all fell within the ranges reported in the 1983 study.[5] The estimated concentrations of MOGAS components present in the compensating overboard discharge are shown in Table 2.

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 are 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

Using the fleet wide MOGAS compensating water annual discharge volumes presented in Table 1, and the estimated constituent concentrations in Table 2, the total mass loadings for the priority pollutants present in this discharge were calculated using the following formula:

$$\text{Mass Loading (lbs/yr)} = (\text{Concentration (mg/L)})(\text{Volume (gal/yr)})(3.785\ \text{L/gal})(2.2\ \text{lbs/kg})(10^{-6}\ \text{kg/mg})$$

Table 3 provides the resulting mass loadings on a maximum discharge per event basis and on a total annual fleetwide basis.

4.2 Environmental Concentrations

As identified in Section 3.3, the constituents of concern are benzene, toluene, ethylbenzene, xylene isomers, phenol, and naphthalene. The estimated constituent concentrations in MOGAS compensating water discharges, and the corresponding most stringent state water quality criteria (WQC), are presented in Table 4. Benzene, toluene, ethylbenzene, phenol, and naphthalene concentrations exceed the most stringent state WQC. There are no relevant Federal or state WQC for xylene isomers.

4.3 Potential for Introducing Non-Indigenous Species

In those instances where vessels receive MOGAS prior to deployment and no overhaul period is pending, the possibility of non-indigenous species transport exists. Water from different ports could have entered the tanks during the previous deployment to compensate for consumed fuel. When shipboard MOGAS tanks are emptied of fuel, flushed, steam-cleaned, and then filled with seawater while in deep water before returning to port for overhaul, there is no significant possibility of non-indigenous species transport. Therefore, depending on the operational procedures and the deployment of the vessels, there may be a potential for the transfer of non-indigenous species.

5.0 CONCLUSIONS

MOGAS compensating discharge has the potential to cause an adverse environmental effect because there is a potential to cause an oil sheen in the waters surrounding the ship. Additionally, the possibility exists for the transfer of non-indigenous species, depending on the operational procedures of a particular vessel and the deployment schedule.

6.0 DATA SOURCES AND REFERENCES

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

Specific References

1. UNDS Equipment Expert Meeting Minutes. Motor Gasoline (MOGAS) Storage and Compensated Overboard Discharge. October 23, 1996.

2. Personal Communication Between LT Joyce Aivalotis (U.S. Coast Guard) and David Ciscon (M. Rosenblatt & Son). May 28, 1997.

3. Personal Communication Between Penny Weersing (Military Sealift Command Central Technical Activity) and Don Kim (M. Rosenblatt & Son). October 24, 1996.

4. US Army Input to Equipment Expert Meeting, Motor Gasoline (MOGAS) Storage and Compensated Overboard Discharge. February 7, 1997.

5. Bruya, James E., Petroleum Hydrocarbons: What are they? How much is present? Where do they go? Friedman & Bruya, Inc., Seattle, WA. April 1992.

6. Guard, Harold E. and Roy B. Laughlin, Jr., Characterization of Gasolines, Diesel Fuels & Their Water Soluble Fractions. Naval Biosciences Laboratory, Oakland, CA., September 1983.

General References

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

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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.

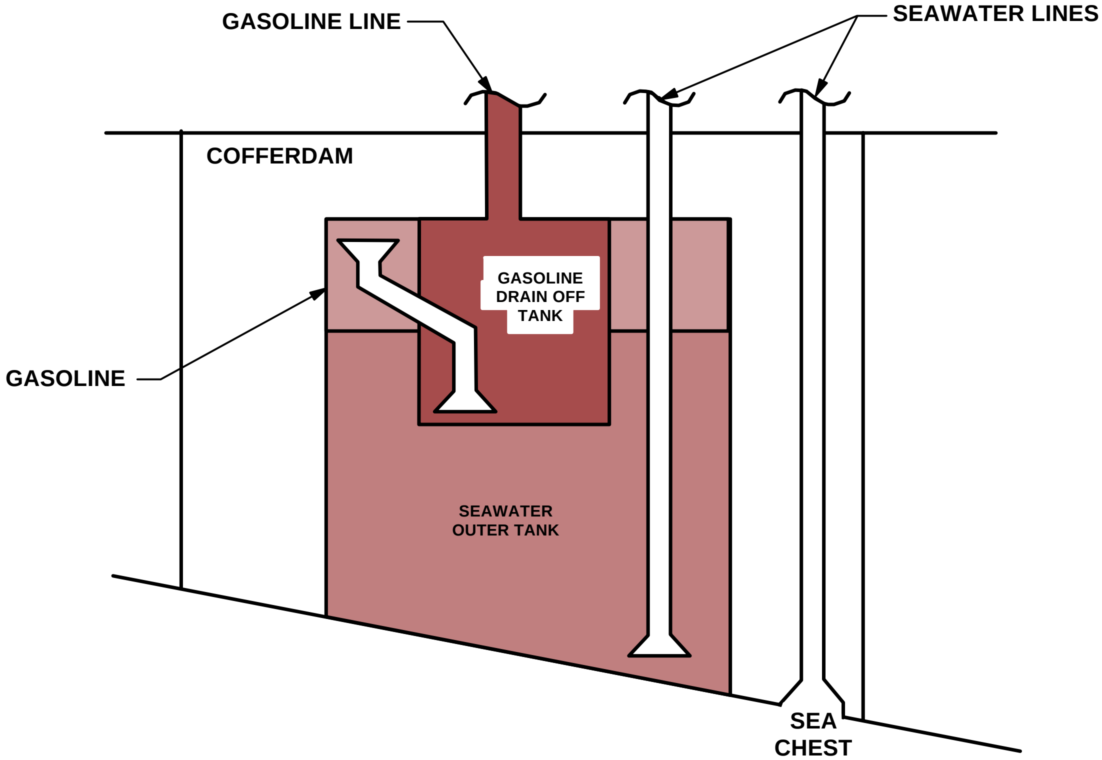

FIGURE 1
SEAWATER COMPENSATED MOGAS STOWAGE TANK

Table 1. Estimated Total Amounts of MOGAS Compensating Seawater Displaced Overboard Annually by Vessel Class in U.S. Ports

Vessel Class	No. of Vessels in U.S.	MOGAS Tank Capacity Per Vessel (gal)	Total Tank Capacity (gal)	Volume of Compensating Seawater Discharged Overboard Per Year[a]
LPD	7	26,000	182,000	145,600
LHA	4	11,400	45,600	36,480
			Estimated Total:	182,080

[a] Based on one complete in-port refueling per year per vessel, and a maximum of 80% of the tank capacity being displaced overboard by onloaded fuel

Table 2. Estimated Constituent Concentrations in MOGAS Compensating Overboard Discharge[5]

Compound	Concentration (mg/L)
Methyl-t-butyl ether (MTBE)	116
Benzene	29.5
Toluene	42.6
Xylene Isomers (3)	14.7
Ethylbenzene	2.4
C_5 and C_6 Alkenes and Alkadienes	0.5
C_1 to C_4 Phenols	1.2
C_3 to C_5 Benzenes	6.8
C_0 to C_3 Anilines	3.7
C_0 to C_2 Thiophenes	1.3
C_0 to C_2 Indanes and Indenes	1.2
C_0 to C_2 Naphthalenes	1.2
C_0 to C_2 Pyridines	0.4
C_0 to C_2 Indoles	0.3

Table 3. Estimated Annual Mass Loadings

Constituent	Estimated Concentration In Discharge (mg/L)	Maximum Discharge Event Mass Loading* (lbs)	Total Fleetwide Mass Loading** (lbs)
Benzene	29.5	5.1	45
Toluene	42.6	7.4	65
Xylene Isomers (3)	14.7	2.5	22
Ethylbenzene	2.4	0.4	4
Phenols	1.2	0.2	2
Naphthalenes	1.2	0.2	2

* Based upon a maximum discharge event volume of 20,800 gallons from an LPD 7 (assuming a maximum of 80% of the 26,000 gallon tank capacity being displaced overboard by onloaded fuel)
** Based upon a total annual discharge volume of 182,080 gallons

Table 4. Comparison of Estimated Discharge Concentrations with Water Quality Criteria

Constituent	Concentration (mg/L)	Federal Acute WQC (mg/L)	Most Stringent State Acute WQC (mg/L)
Benzene	29.5	None	0.07128 (FL)
Toluene	42.6	None	2.1 (HI)
Ethylbenzene	2.4	None	0.14 (HI)
Phenols	1.2	None	0.17 (HI)
Naphthalenes	1.2	None	0.78 (HI)

Notes:
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.

FL = Florida
HI = Hawaii

Table 5. Data Sources

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