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**Estimates of Oil Entering the Marine Environment in the Past Decade:
GESAMP Working Group 32 Project**

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Oil Spill Intelligence Report

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Abstract

The Joint Group of Experts on the Scientific Aspects of Marine Protection (GESAMP) Working Group on Estimates of Oil Entering the Marine Environment: Sea Based Activities (Working Group 32), met at International Maritime Organization (IMO) headquarters in London, in November 1997 and May 1998, to discuss a new approach to evaluating all available data sources on the input of oil into the marine environment from sea-based activities. The Working Group will collect and analyze data on oil inputs over the last decade from shipping (tankers and other vessels), offshore and coastal exploration and production, pipelines, atmospheric emissions from sea-based activities, coastal refineries and storage facilities, oil reception facilities, materials disposed of at sea, and natural seepage.

The group, which is sponsored by the United Nations, IMO, United Nations Environment Program, Food and Agriculture Organization, United Nations Educational Scientific and Cultural Organization, World Health Organization, World Meteorological Organization, and International Atomic Energy Agency, will compare its oil input estimate model to estimates made by GESAMP in previous decades in order to evaluate the efficacy of IMO conventions and other

pollution reduction efforts in the past decade. The group will consider the amounts of oil entering the sea through operational and accidental spillage in relation to the quantities of oil transported by ship and through pipelines, and in relation to offshore and coastal oil production. The group will consider temporal and spatial variability in oil inputs, as well as evaluate the accuracy of input estimates.

Introduction

In November 1997 and May 1998, the GESAMP Working Group on Estimates of Oil Entering the Marine Environment: Sea Based Activities met under its chairman, Peter Wells, at IMO Headquarters, London, UK. GESAMP Technical Secretary Manfred Nauke noted that after the publication in 1993 of GESAMP's study, *Impact of Oil and Related Chemicals and Wastes on the Marine Environment*, the Marine Environment Protection Committee (MEPC) of IMO had requested GESAMP: to carefully evaluate all available data sources of input of oil into the marine environment from sea-based activities, i.e., those related to shipping and offshore activities; to develop approaches that might be used for the provision of input data; and to focus particularly on estimates of oil entering the marine environment from transportation sources as a test of the efficacy of IMO conventions on the prevention of marine pollution and safety of life at sea.

Previous estimates made by the United States National Academy of Sciences (see Figures 1 and 2) were based on the assumption that ships flying the flag of or registered in a state party to MARPOL 73/78 do fully comply with the requirements of that Convention and the MEPC was concerned that there was sufficient error inherent in this assumption and in other oil input estimations that the data and data collection methodology should be reevaluated and new estimates of oil input should be calculated.

The Working Group also agreed to consider the amounts of oil entering the sea through operational discharges and accidental spillages in relation to quantities transported by ships, through pipelines, etc., or in relation to offshore and coastal oil production.

Defining the Task of the Working Group

The Working Group reviewed its terms of reference and determined that the overall scope of its task as follows:

- 1.) To estimate current annual inputs of oil entering the marine environment from sea-based activities, taking into account that:
 - a.) Oil would be defined as in Annex I of MARPOL 73/78 Regulation 1 and Appendix 1, i.e., "petroleum in any form including crude oil, fuel oil, sludge, oil refuse, and refined products other than petrochemicals" (see Figure 3);
 - b.) Sea-based activities would include all forms of shipping, especially oil tankers and carriers, other commercial and non-commercial ships, offshore and coastal exploration and production, marine pipelines, atmospheric emissions from such sea-based activities, coastal refineries and storage facilities, materials disposed of at sea; and natural oil seeps;
 - c.) The annual input estimates would consider both historical and extant data, and the measurement and statistical uncertainties of making such estimates; and
 - d.) The annual input estimates would consider the amounts of oil entering the sea through operational discharges and accidental spillages in relation to quantities transported by

ships, through pipelines, etc., or in relation to offshore and coastal oil production, and related industrial operations.

2.) To focus primarily on improving the estimates of oil entering the marine environment from transportation sources, as one test of the efficacy of Annex I of the MARPOL 73/78 Convention, and others where appropriate, pertaining to the prevention of marine pollution from oil, and the safety of life at sea.

In light of the above terms of reference, the Working Group agreed at this stage to:

- 1.) Determine the sources of oil that should be evaluated;
- 2.) Determine the availability of data, information, and expertise needed to carry out quantitative estimations authoritatively;
- 3.) Consider novel approaches (e.g., oil accounting before and after shipment; monitoring of tar balls or dissolved hydrocarbon levels) and models for the estimations;
- 4.) Consider the challenges faced in developing estimates in some input categories (e.g., oil losses during shipment, due to evaporation and measurement technology);
- 5.) Consider specific questions posed by the task, such as:
 - How variable are the oil sources, temporally and spatially?
 - Can trends in oil inputs be reliably determined, particularly from operational discharges and accidents?
 - Are some input types impossible to estimate with accuracy (e.g., discharges from non-tankers, overall losses from tankers)?
 - Can accurate total annual inputs be predicted?

Maritime Transportation Activities

The Working Group agreed that an attempt be made to use the list of transportation sources as set out in the previous evaluation carried out by the United States Academy of Sciences in 1990 (see Figure 4) as follows:

- Operational discharges from oil tankers;
- Dry docking;
- Marine terminals, including bunkering operations (accidental spillages);
- Bilge and fuel oil from all ships;
- Accidental spillages (tanker and non-tanker accidents); and
- Scrapping of ships.

In considering the conclusions of the above study, the Working Group acknowledged the statement that even ships registered in States parties to MARPOL 73/78 face problems in effectively complying with MARPOL 73/78 requirements due to the lack of appropriate reception facilities in many countries, enforcement measures, and adequate training of many ships' crews.

The Working Group also identified a number of assumptions made in evaluating oil discharges, including oil sludges, from tankers and non-tankers into the sea, as these may have changed since 1990. The Working Group further agreed that the amounts of sludges and residues incinerated onboard ships have to be included in its evaluation.

Accidental Spillages

The Working Group noted the variability of spillages in relation to geographical areas, routes, seasons, etc. It was further noted that both the number of spillages and the amounts of oil spilled at sea provided valuable information. A proposal was made to evaluate trends in relation to the introduction of new tanker types (e.g., double bottoms and double hulls).

The Working Group considered available data on accidental spillages of oil into the sea from tankers and non-tankers. The Working Group noted that in previous assessments the amount of oil accidentally spilled from non-tankers was approximately 4 - 6% of that from tankers. Worldwide estimates had then been made using available statistics on annual quantities of oil spilled due to tanker accidents. It was agreed that the relationship of tankers/non-tankers be examined. Extrapolations might be made on the basis of well-documented data from the United States, Europe, and Canada. It was agreed to report the number of spillages together with the amounts of oil entering the marine environment from spillages. In this connection it was agreed to provide data with their confidence limits, thus documenting the level of uncertainties. The Working Group agreed to endeavor to include in its consideration oil amounts contained in sunken ships and whether these are considered incidents (spills) or slow seeps over time. Relevant data might be retrieved from casualty statistics.

Bunkering Operations

Spillages from all types of bunkering operation incidents in marine terminals into the marine environment, e.g., due to tank overflow, hose breaks, fractures, pump, valve and gasket failures, etc., have to be extrapolated from well-documented areas such as the United State, Canada, and/or Europe.

The Working Group noted that accidental spillages from pipelines occur. In addition, releases occur during commissioning processes. Some data are available, predominantly from North America. A survey of areas representing an adequate database was still needed.

Exploration and Production Activities

Input of oil into the marine environment from offshore and coastal activities were due to discharges of cuttings, production water, and accidental spillages. Reliable information on the amount of oil entering the sea from such sources was available for the North Sea and North America and probably for some areas of the Mediterranean, Australia, and South America. The oil industry, as well as nongovernmental regional organizations, will be invited to provide much of the relevant information.

The Working Group was aware that for some regions for which data were not available very careful extrapolations were required, not least because each area has its own geological and production characteristics.

Several members of the Working Group drew attention to discharges from offshore installations, such as sources as input from flaring (often containing up to 30% unburnt residue), drill cuttings dumped at sea in the past, etc.

Air Emissions

Data on atmospheric emissions of hydrocarbons from shipping activities are available.

Data on input into the North Sea of volatile organic compound (VOCs) from offshore activities and coastal refinery and storage facilities can also be provided. Several members of the Working Group undertook to provide relevant information. The Group further noted that data are regularly made available in Japan.

Coastal Refineries and Storage Facilities

Data on oil/hydrocarbon inputs can be made available from a number of sources. Canada, Japan, the Netherlands, Norway, the United Kingdom, et. al., including regional organizations and international bodies such as UNEP will be contacted in this respect.

Reception Facilities

Lists of reception facilities have been prepared by the shipping industry and IMO. However, these do not in general provide any information on adequacy, malfunctions, discharge rates, etc. These limitations will have to be further evaluated. A European Union Directive on reception facilities is in preparation.

Waste Materials Dumped at Sea

The Working Group noted that there are cases where dredged material dumped at sea has been contaminated with oil and oil products. The Secretariat will evaluate this input on the basis of dumping statistics made available by Contracting Parties to the London Convention 1972.

Natural Seepage

The Working Group will obtain estimates of natural seepage from a review of relevant publications.

Conclusion

The GESAMP Working Group on Oil Inputs Into the Sea will collect and analyze data from the various databases, relevant government and industry sources, as well as consider novel approaches, such as oil accounting in shipping, tar ball surveys, and dissolved hydrocarbon levels, to develop models and estimates of the total oil input into the marine environment from sea-based activities. The group will present this information in a report to GESAMP and the various sponsoring UN agencies in the year 2000. At a later date, the same Working Group or another similar group will evaluate the input of oil from land-based sources, including oil that enters rivers and estuaries that eventually run into the marine environment.

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Table 1 Estimated Relative Inputs From All Sources

Source	1973 Amount Percentage ¹	1981 Amount Percentage ²	1990 Amount Percentage ³
Municipal/Industrial	2,700,000 tonnes 44.2%	1,230,000 tonnes 38.4%	1,175,000 tonnes 50.0%
Transportation	2,130,000 tonnes 34.9%	1,420,000 tonnes 44.4%	564,000 tonnes 24.0%
Atmosphere	600,000 tonnes 9.8%	300,000 tonnes 9.4%	305,000 tonnes 13.0%
Natural Source (Seeps)	600,000 tonnes 9.8%	200,000 tonnes 6.4%	258,500 tonnes 11.0%
Offshore Production/Exploration	80,000 tonnes 1.3%	50,000 tonnes 1.6%	47,000 tonnes 2.0%
Total	6,100,000 tonnes	3,200,000 tonnes	2,350,000 tonnes
¹ Based on National Research Council 1975			
² Based on National Research Council 1985			
³ Based on GESAMP 1993			

Table 2 Estimates of Inputs of Petroleum Hydrocarbons Per Year To the World's Oceans

Source	Annual Input in Tonnes			
	1973 ¹	1979 ²	1981 ³	1981 ⁴
Urban runoff/discharges	2,500,000	2,100,000	1,430,000 (700,000 – 2,800,000)	1,080,000 (500,000 – 2,500,000)
Operational tanker discharges	1,080,000	600,000	710,000 (440,000 – 1,450,000)	700,000 (400,000 – 1,500,000)
Tanker accidents at sea	300,000	300,000	390,000 (350,000 – 430,000)	400,000 (300,000 – 400,000)
Losses from non- tanker shipping	750,000	200,000	340,000 (160,000 – 640,000)	320,000 (200,000 – 600,000)
Atmospheric	600,000	600,000	300,000	300,000

deposition			(50,000 – 500,000)	(50,000 – 500,000)
Natural seeps	600,000	600,000	300,000 (30,000 – 2,600,000)	200,000 (20,000 – 2,000,000)
Coastal refineries	200,000	60,000	--	100,000 (60,000 – 600,000)
Other coastal effluents	--	150,000	50,000 (30,000 – 80,000)	50,000 (50,000 – 200,000)
Offshore production losses	80,000	60,000	50,000 (40,000 – 70,000)	50,000 (40,000 – 70,000)
Total discharges	6,100,000	4,670,000	3,570,000	3,200,000
Source: Adapted from Freedman 1989 and GESAMP 1993 ¹ NRC 1975; ² Kornberg 1981; ³ Baker 1983; ⁴ NRC 1985				

Table 3 Annex I of MARPOL 73/78: List of Oils

<i>Asphalt Solutions</i>	<i>Gasoline Blending Stocks</i>
Blending stocks	Akylates – fuel
Roofers flux	Reformats
<i>Oils</i>	Polymer – fuel
Clarified oil	<i>Gasolines</i>
Crude oil	Casinghead (natural)
Crude oil mixtures	Automotive
Diesel oil	Aviation
Fuel No. 4 (Bunker A)	Straight run
Fuel No. 5 (Bunker B)	Fuel oil No. 1 (Kerosene)
Fuel No. 6 (Bunker C)	Fuel oil No. 1-D
Residual fuel oil	Fuel oil No. 2
Road oil	Fuel oil No. 2-D
Transformer oil	<i>Jet Fuels</i>
Aromatic oil (excluding vegetable oil)	JP-1 (Kerosene)
Lubricating oils/blending stocks	JP-3
Mineral oil	JP-4
Motor oil	JP-5 (Kerosene, Heavy)
Penetrating oil	Turbo fuel
Spindle oil	Kerosene
Turbine oil	Mineral spirit
Distillates	<i>Naphtha</i>
Straight run	Solvent
Flashed feed stocks	Petroleum
<i>Gas Oil</i>	Heartcut distillate oil
Cracked gas oil	

Table 4 Estimated Inputs of Petroleum Hydrocarbons into the Oceans Due to Marine Transportation Activities (US National Academy of Sciences Study)

Sources	1981 Estimate	1989 Estimate
Tanker operations	700,000 tonnes	159,000 tonnes

Tanker accidents	400,000 tonnes	114,000 tonnes
Bilge/fuel oil discharges	300,000 tonnes	253,000 tonnes
Dry-docking	30,000 tonnes	4,000 tonnes
Marine terminals (including bunkering operations)	22,000 tonnes	30,000 tonnes
Non-tanker accidents	20,000 tonnes	7,000 tonnes
Scrapping of ships	--	3,000 tonnes
Total	1,470,000 tonnes	570,000 tonnes
Source: National Research Council 1985; IMO 1990.		