Chapter III. Oil Pollution and Safety Considerations

A. Oil Pollution From Tankers

1. *Amounts and Sources*

Recent estimates are that one-third of all oil pollution of the world's oceans is caused by activities generally characterized as "marine transportation." [1] Tankers understandably are the single largest contributor of such pollution.

The expected introduction of supertankers in U.S. waters exacerbates public concern about pollution of the oceans. Inherent in this concern are questions of the safety of operation of supertankers, the adequacy of port facilities, the qualifications of the crews that operate them, and various operating practices that cause pollution. Further, the large number of smaller tankers operating in IJ.S. ports, which carry both imported and domestic oil, pose a pollution threat from much the same causes. The overall effect of small tankers in congested ports may be even more extensive than that from supertankers but the relative damage potential has not been substantiated.

Oil pollution from tankers originates from two principal sources: (1) Various types of tanker accidents, and (2) normal tanker operations, such as tank cleaning, ballasting, and other operational reasons for periodically discharging oil overboard. The total of oil spillage into the oceans from tankers of all sizes has been estimated from statistics collected on worldwide operations. Some 1,000,000 tons a year are dumped in standard operations while about 200,000 tons per year of oil is spilled by tanker casualties. [2]

In addition, an added 250,000 tons of oil pollution annually is associated with tanker drydocking activities. Table III–1 summarizes estimates of the worldwide oil pollution inputs to the oceans from all tankers, from all causes, while Table III–2 shows the major sources of all marine pollution to the world's oceans.

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1 "Petroleum in the Marine Environment," National Academy of Sciences, January 1975.

2 USCG, "An Analysis of Oil Outflows Due to Tanker Accidents, 1971–1972" and Charter, Sutherland and Porricelli, "Quantitative Estimates of Petroleum to the oceans," paper presented at the May 1973 workshop on Inputs, Fates and Effects of Petroleum in the Marine Environment. The round numbers are gross estimates since the data is sparce and a range of estimates from a much lower to a much larger number have been made.

TABLE *III-1.-Summary of oil pollution inputs in the world's oceans caused by tankers*

Cause:	197s eatimated annual input (ton8)
Tanker operational spillage caused by tank washing and ballast water discharge: 75 percent by tankers without a load-on-top system and 25 percent by tankers with L. O. T	1, 080, 000
Tanker accidents	200,000
Tanker drydocking	250,000
Tanker terminal operations	3,000
Tanker bilges and lmnkering	50,000
Totall	1,583,000

[1] This total Is equivalent to nearly ½ billion gallons of oil each year.

Source: "Petroleum in the Marine Environment," National Academy of Science8, January 1975.

TABLE *111–2.—Estimate of oil pollution input to the work?8 ocean8 from all sources*

Budget of Petroleum Hydrocarbon Introduced into the Oceans

source	Inputrate (millionsoftons peryear) Best estimate	Probable range	Reference
Natural seeps..	**0.6**	**0. 2-1.0**	**Wilson et al. (1973).**
Offshore production	**. 08**	**.08-.15**	**Do.**
Transportation:			
LOT tankers-;	**.31**	**.15-.4**	**Results of workshop**
Non-LOT tankers-	**. 77**	**.65-LO**	**{ panel deliberations.**
Dry docking-.	**. 25**	**2-.3**	
Terminal operations-	**. 003**	**. 00;5-. 005**	
Bilges bunkering-	**.5**	**.4-.7**	
Tanker accidents-	**. 2**	**.12-.25**	
Nontanker accidents.	**.1**	**.02–.15**	
Coastal refineries-	**. 2**	**.2-.3**	**Brummage (1973a).**
Atmosphere	**. 6**	**.4-.8**	**Feuerstein (1973).**
Coastal municipal wastes-	**. 3**		**Storrs (1973).**
Coastal, nonrefining, industrial wastes.	**. 3**	–	Do.
Urban runoff	**.3**	**.1-.5**	**Storrs (1973), Hallhagen (1973).**
River runoff	**1.6**		**Do.**
Total	6.113		

Reproduced from:" Petroleum in the Marine Environment," National Academy of Sciences, January 1975.

It is obvious from these estimates that a large portion of the total of tanker pollution is due to tanker "operational discharge." This operational discharge has become standard operating practice with tankers. On return voyages, aftir discharging cargo, tankers usually fill some of their cargo tanks with salt-water ballast to keep the ship at reasonable operating draft. This ballast water, which is consequently mixed with some of the residual cargo oil in the tanks, is pumped overboard prior to arriving in a port if Load on Top practices are not adopted. These residues from crude oil commonly amount to about 0.2 to 0.5 percent of the total cargo in a fully loaded tanker. Much of this is discharged overboard with ballast water unless precautions are taken, such as the Load on Top (L.O.T.) operation (see definitions).[3]

In addition to oil and residues contained in ballast water discharges, oil may also be pumped overboard in water used for tank cleaning. Cargo tanks are cleaned by means of spraying the interior with high velocity jets of salt-water. This mixture of oil and water is then discharged overboard unless special precautions are taken. These special precautions may include a slop tank for settling oily water and following LOT procedures. During preparation for drydocking, all tanks are usually cleaned as described above. (The category thus designated in Table III–1 results from such tank cleaning operations.)

New methods have been proposed for tank cleaning and are in use by some tanker operators. Such new methods include spray jet washing with crude oil simultaneously with the discharge of cargo, resulting in the elimination of most of the oil residues in the tanks. While several solutions are available (they are discussed in the next chapter) to reduce tanker operations discharge, many tanker operators continue ta follow practices that do not limit the oil input to the world's oceans. It has been estimated that 80 percent of tanker operators follow L.O.T. practices and 20 percent do not.

It should also be noted that tanker operational discharge estimates may not be very accurate since they are merely extrapolations to the world fleet of records kept for individual ships in certain tanker fleets. There is considerable debate as to whether the world fleet may not, on the whole, be following the best practics, and some estimates have been made which are much higher than those published to date.

Tanker operational discharge has not been estimated in this report for U.S. waters alone, but such discharge probably relates somewhat to the total time each tanker spends in U.S. coastal areas (see chart of world tanker trade, Fig. II–2.).

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[3] The significance of this technique is apparent from estimates that 80 percent of tankers use **L.O.T.** and contribute only 25 percent of the operational spillage while the remaining 20 percent do not use **L.O.** T. and contribute 75 percent. At present, 80 percent of the world's tankers use a "load-on-top" system.

Increases in estimates of tanker operational oil discharges-now some one million tons annually—may follow roughly the rate of growth of tanker tonnage of petroleum shipped by water, assuming no change in operating practices. The rate could change, rising with increases in the proportions of tankers which are older or do not have segregated ballast, or declining as various regulatory measures come into force. At present there is very little data on the history or trendc of the operational source of pollution.

Table III–3 summarizes the causes, and resulting pollution, from tanker accidents both worldwide and within the United States for the past five years. As previously noted, tanker casualties contribute 200,000 tons per year of oil input to the oceans worldwide. Tanker casualties within 50 miles of the U.S. coast have been estimated to contribute spillage of over 12,000 tons per year during the past five years.

TABLE~ *IH-3.-h'ummary of tanker accidents for the years 1969-73*

[All vessels larger than 3,000 DWT]

WORLD ACCIDENTS

Total number of accidents	3, 183
Total number of accidents causing pollution	452
Total oil spilled in these accidents (tons)	1 951, 317

IAbOut 7,1~,000 b~eh.

ACCIDENTS IN U.S. WATERS WITHIN 50 MILES FROM SHORE

Total number of accidents	1, 106
Total number of accidents causing pollution	91
Total oil spilled in these accidents (tons)	[2] 63, 147

~ About 470,000 barrels.

CAUSES OF TANKER ACCIDENTS CAUSING POLLUTION WORLDWIDE

	Percent of involvements	Percent of oil spilled
Collisions	28	19
Groundings	27	24
Structural failure	21	36
Other	24	21

Source: U.S. Co@ C3uard, November 1974, and March 1975; also see attachment 1.

Separate U.S. Coast Guard estimates of tanker accidents for 1969-'70, 19'71-72, and 1969–73 show remarkably little change in annual averages over these five years.[4] Historically, a few major accidents each year have been the principal contributors to oil outflow. Future projections

~ See Attachment 1 for an analysis of worldwide tanker accidents over the past five years.

canfiot be made with great assurance, but it would appear that a catastrophic supertanker accident is one major threat. Section III-B describes some major tanker accidents and resulting pollution damage.

As defined, tanker accidents include collisions with other vessels or shore facilities, grounding, structural failures, breakdown, fires, etc. The relative importance of these is discussed in Chapter IV and Attachment 1. Proposed means of reducing these accidents are in Chapter IV.

It should be noted not only that all of the above input rates are estimates, but further that only within recent years have enough data been collected to make such estimates. In fact, some data banks on the subject, such as that of the Smithsonian Center for Short-Lived Phenomena, have not yet been either completely cataloged or published. Present estimates may be too low, and more complete information may indicate problems which as yet are not verified. This was indicated by Mr. Robert Citron of the Smithsonian Center for Short-Lived Phenomena in recent testimony before the Senate Committee on Commerce.[5]

9. *Efect8*

The pollution damage threat from any vessel tu ocean ecosystems and surrounding environments is serious and substantial. Both short-term and long-term effects of oil pollution have been assessed, such assessments leading to general agreement that oil spills must be reduced from their present level.[8]

The environmental deterioration caused by oil spills has been documented in many cases, while specific oil spills have been studied to document significant pollution damage. This damage has included fish kills, bird kills, other biological losses, and damage to recreational beaches and other coastal areas.[7]

Numerous factors determine the extent of damage to be expected from any spill. These include:

1. Type of oil spilled;
2. The dose or amount of oil spilled;
3. The physical features of the region of the spill;
4* The biota of the region;
5. The season of year;
The previous exposure of the region to oil spills;
;: The present exposure of the region to other pollutants; and
8. The treatment that was given to the spill.

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6 Tankers and the Marine Environment, Hearings before the National Ocean Policy Study of the Committee on Commerce, January 29, and 30, 1975.

e ~cpetroleum in the Marine Environment," National Academy of Sciences, January 1975.

7 *Ibid.*

While it is generally agreed that all of these interact in any individual spill, certain factors sometimes predominate. Certainly, knowledge of t}~e effects of petroleum spills is incomplete. Further, no agreement has been reached on that quantity of hydrocarbons that the oceans can assimilate without threat to various ecosystems. Many of those concerned with the quality of the environment stress that because the ocean ecosystem is finite, its assimilative capacity is limited.

Many professionals have studied the major, short-term effects of acute oil spills in coastal areas. Among these, an analysis of 100 spills revealed that the most significant damage occurred in this order:

1. Mortalities to seabirds;
2. Damage to benthic and intertidal organisms; and
3. Damage to plant life, algae and salt marshes.[8]

While short-term effects have been carefully studied, the long-term pollution effects are less well-known. Among the more comprehensive studies, however, is the National Academy of Sciences report. ‘Petroleum in the Marine Environment.” It estimates that about one year's input of oil is continuously contained in the oceans. The significance of this arises from the effects of chronic oil pollution, considered by some to have a more deleterious effect to coastal and estuarine area biota than acute dosing.[9]

After extensive studies of oil pollution effects, Dr. B. Ketchum of the Woods Hole Oceanographic Institl~te makes the following recommendation:

> *No oil or petrolewn products should be disclmrged into estuaw"ne or coa8tal waters that:*
>
> *Can be detected aa a visable film, sheen, or discoloration of the surface or by odor;*
>
> *Can cause tainting of @h or edible invertebrates or damage to the biota;*
>
> *Can fom an oil deposit on the ~hore~ or bottom of the receiving body of water.~"*

In summary, it appears that tankers which spill oil present a significant environmental hazard to both the total marine life system in the world's oceans and to local coastal and estuarine ecosystems. While merely keeping the tankers away from populated areas will not provide all needed improvements, it would allow for greater dispersal of the pollution and better protection of the benthic communities. Weather, winds and currents, as well as migratory habits of marine life can also spread and propagate initial damages. Many argue that

s Ottaway, S., '{The Comparative Toxicities of Crude Oil, Field Studies, " Oil Pollution Re~~a:ec~@hUnit, CMienton, 1970.

"Biological EtTects of Chronic Oil Pollutlon on Coastal Ecosystems," NAS Workshop,' MaY 1973.

10 Ketchum, "Oil in the Marine Environment," WHOI, 1973.

the ideal situation would be to assure that pollution be kept at least at present levels (or below, if possible) while efforts to assess the dangers are accelerated. They contend that all efforts should be directed toward a significant reduction in the present level of oil outflows.

There are some who maintain that tanker-caused oil pollution may be decreasing relative to all oil pollution. However, there is no general agreement on this subject, and many argue that the situation is deteriorating. Whichever is the cam, there is no doubt that more data on the history and trends of oil spills is greatly needed, as is an accurate determination of the damage to be expected to result from any spill.

B. Examples of Major Tanker Spills

The results of significant tanker accidents, including the accompanying oil pollution damage, are illustrated in the following brief accounts of several notable spills. These incidents were selected for illustrative purposes and do not represent either the most severe cases or the most likely results of all cases. They are, however, representative of recent accidents and have been investigated to one degree or another as to their consequent effects.

1. Recent Major Spills

A. THE “METULA” ACCIDENT

On August 9,1974, at 10 p.m., the VLCC *Metula*, laden with 194,000 tons of crude oil, sailing from the Arabian Gulf to Chile, ran aground at full speed at the end of the first narrows in the Strait of Megellan. After initially leaking about 6,000 tons of her cargo, additional damage to the ship was caused by stormy weather and strong currents. Consequently, a long, difficult salvage operation ensued, during which the oil spilled ultimately exceeded 50,000 tons and substantially damaged beaches, birds and marine life in the Strait.

The *Metula is* a supertanker of 206,000 dwt owned by Curacao Tankers, N.V., a subsidiary of Shell, and flying the flag of the Netherlands Antilles. Built in Japan in 1969, the *MetuZa is* 1067 feet long, 155 feet in breadth, and has a loaded draft of 62 feet.

FIGURE 111–1.—The VLCC *Metula(?a* Grounded and Leaking Oil *in* the **Strait of Magellan, August 1974.**

—(Photo Credit—U. S. Coast Guard).—

Shell Tankers N.V., Rotterdam, operator of the Metula, made salvage arrangements with SMIT International, which provided tugs and equipment. Shell dispatched two smaller tankers to offload cargo. The Chilean government requested assistance from the U.S. Coast Guarcl but did not actively participate in the salvage effort. The results of a Chilean Board of Inquiry on the cause of this accident have not yet been released.11

B. THE "SHOWA MARU" ACCIDENT

The supertanker A'howa *Maru,* carrying *237,000* tons of crude oil from the Arabian Gulf to Japan, went aground in Malacca Strait near Singapore in the early morning of January 6, 1975. About 4,500 tons of oil cargo were spilled from the three tanks damaged during the accident. The Ilhowa Maru was refloated on January 15 after offloading enough cargo to lighten the ship and without significant additional spillage.

[11] U.S. Coast Guard, "Report of the VLCC *Metula* Grounding, Polluting and Refloating in the Strait of Magellan in 1974" ; and, Harm, ROY W., "VLCC *Metula* Oil Spill," Final Report to the Coast Guard, December 1974. (Attachments 4 & 5).

The Showa *Maru is* owned by the Taiheiyo Shipping Company of Tokyo and flies the Japanese flag. The accident was one of the first major oil spills in the Singapore area, which experiences a large amount of shipping traffic, particularly in supertankers, on this trade route from the Arabian Gulf to ,Japan. Two of the three countries bordering the i.%lacca Strait (Indonesia and Malaysia) have indicated that they are considering a ban on supcrtanker use of this passage, which is claimed in part as territorial waters by Indonesia, Malaysia and Singapore. Indonesia has suggested that giant tankers use the Lombok Strait, which is wider and less congested.[12]

C. THE "JAKOB MAERSK" ACCIDENT

The 88,000 ton tanker *Jakob Maersk* struck a sandbar and exploded on January 29, 1975, while attempting to enter the deepwater harbor at Oporto, Portugal. Four major explosions shook the tanker, six crewmen were killed, and all of the cargo of 85,000 tons of crude oil either spilled in the water or burned in the resulting fire, which raged for days. Local beaches were extensively polluted; 20 miles of coastline were covered by oil.

The *Jakob Maersk* was owned and operated by the A. P. Miller Co., a Copenhagen shipping firm. The oil spill was reported to be second only in magnitude to the. Torrey Canyon loss off the Cornish coast of England. The ship was a total loss aml crude oil continues to leak from the sunken hull at the last report.[13]

2. *Other Tanker Accidents*

A. "TAMPICO) MARU" SPILL

This ship, containing 55,200 barrels of diesel oil, ran aground in the mouth of a small cove in Baja, California during March 195'7. The oil lost was contained in the cove, resulting in an immediate kill of all forms of marine life. Recovery to prespill conditions was estimated to be approximately six years, although sublethal effects may have persisted longer.

B. "TORRIlY CANYON" SPILL

In March 1967, the tanker *Torrey Canyon* ran aground at Seven Stones Reef, about five miles offshore of Cornwall, England. It was carrying 860,000 barrels of Kuwait crude oil. The entire oil cargo was lost and remained at sea from one to three weeks before washing ashore at various locations. Major biological damage from the oil itself ap-

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[12] "Mammoth tankers may be banned from Malacca Strait," *Marine Engineering/Log*, April 1975, p. 10.
[13] The New *York Times*, February 23, 1975.

peared to be confined to waterfowl and the smothering of some intertidal benthic organisms. Toxic emulsifiers used in shore cleaning operations were largely responsible for the mortality of various shoreline organ organisms

C. WEST FALMOUTH SPILL

on September 16, 1969, the oil barge *Florida,* on the way to a power plant on the Cape Cod Canal, came ashore off Fassets Point in Buzzards Bay, near the entrance to West Falmouth Harbor, Massachusetts. h-early 4,500 barrels of No. 2 fuel oil were released into these coastal waters.

Immediately after the spill, massive destruction of marine life occurred offshore. Extensive trawling and dreclging showed that a wide range of fish shellfish, worms, crabs and other invertebrates were affected. Trawls made in 10 feet of water soon after the spill showed that 95 percent of the animals collected were dead. The bottom muds containedmany dead snails? clams, and crustaceans. Similar mortality occurred in the tidal rivers and marshes into which the oil had moved under the combined influence of tide and wind.

Eight months after the spill, the pollution covered an area of approximately 5,000 acres offshore and 500 acres of marshes and tidal rivers-about eleven times the area initially affected. Secondary pollution from heavily affected areas continued after the accident. In heavily polluted marshes, oil penetrated to a depth of at least one to two feet, and in these areas vital bacterial degradation was almost negligible eight months after the spill. Wherever the oil spread? there was concomitant animal mortality, and after nine months the affected areas had not repopulated. A study conducted four years after the spill indicates that some effects still persist.[15]

D. SAN FRANCISCO BAY SPILL

The San Francisco oil spill occurred during the early morning hours of January 18! 1971, when two Standard Oil Company of California tankers, O-regon *Standard* and *Arizona Standard,* collided under the Golden Gate Bridge. The collision dumped 90,000 barrels of Bunker C fuel oil, an asphalt-like material, which then was carried by tidal current to beaches both above and below the entrance to San Francisco Bay.One of these beach areas, a low-profile shale inter-ticlal area named Duxbury Reef, located about, 15 miles north of Golden Gate

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14 See Attachment 7 for a more detailed description of the acciden t and resulting pollution including estimates of inch rred costs.

15 Mich ael, Von Roa l te and Brown "Long-Term Effects of an Oil Spill at West Falmouth, Mass.." 1975 Conference on Prevention and Control of Oil Pollution, API, 1975.

Bridge, was examined extensively to analyze damage caused by the oil, while briefer studies were made at four other locations. Damage was evaluated by direct observation and enumeration of organisms on the reef, along with statistical analysis of the data.[16]

These studies showed that smothering was by far the predominant cause of marine organism mortality.

C. Personnel and Equipment Safety

While any pollution control measure must incorporate provisions for crew and ship safety, steps to protect the lives of crew members, reduce loss of equipment, and protect ports and waterways from disasters are required beyond those necessary to reduce pollution.

If the cargo is excluded from consideration, tankers may be no more or less safe than other ships. However, tankers-and especially very large tankers-do present hazard related to their cargo on a much larger scale. For example, tank explosions have been a problem in many supertankers. As the size of the individual tanker has increased, the incidence of explosions has also risen. A few years ago, serious tank explosions in VLCCS caused the total loss of two of these large ships.[17]

However, because these ships were on a ballast voyage (with tanks empty or containing ballast water) when the accident occurred, very little oil pollution resulted from these explosions and sinkings. These accidents did, however, take a significant toll of lives.

Attachment 1 contains the results of a recent study by the U.S. Coast Guard on worldwide tanker accidents over the past five years. It shows that during 1971–73 there were 83 major tanker accidents, resulting in 381 deaths and 178 injuries. Collisions and explosions caused almost 90 percent of the deaths and injuries. (In such collisions, in fact, the fire or explosion which followed accounted for mos+ of the deaths so attributed.)

Some note that the number of deaths due to tanker accidents is small in relation to the approximately 1500 persons killed in the United States each year in recreational boating accidents. However, if existing measures to reduce explosions were more widely adopted, even this number of deaths and injuries could be reduced.

In addition large clollar losses result from major tanker explosions, because these often destroy the entire ship. A study of total loss ratios indicates a general increase in tanker losses from 1964 to 1973, with fires and explosions accounting for the greatest amount of tonnage

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16 See Attachment 6 for a detailed description of the accident and an analysis of probable cause.

17 Porricelli, Keith and Storch, *Tankers and the Ecology,* Transactions of the Society of Naval Architects and Marine Engineers, 1971, see especially discussion by Harry S. Townsend, pp. 199–201.

lost for any single casualty.[18] At the same time, there are indications that tanker insurance pay outs have been rising recently,[19] which along with forecasts of supertanker loss ratios, may well portend substantial insurance premium increases in the future.

The safety of ports and other ships in congested waters is also of concern to many. The January 1975, collision and fire involving two tankers in the Delaware River at Marcus Hook is a case in point. One of the tankers, carrying light crude oil, exploded and burned, leaving three dead and 27 missing. Flames from the fire reached 500 feet into the air, but favorable winds kept them from reaching the tank storage area near the tanker's berth. Tanker accidents of such magnitude may pose a significant threat to the surrounding port areas in addition to the pollution problem. New deepwater ports for supertankers should also be carefully planned because of such safety considerations. Even though such ports may be far offshore, the fact that they would be servicing large tankers and be subject to possible extreme environmental conditions could present safety problems for the port itself.

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[18] McKenzie, A., "A Study of Tanker Total Losses, 1964-1973," October 1974.
[19] See, for example, "Hull Syndicate Hurting," *Marine Engineering/Log,* April 1975, p. 168.