Oil Transportation by Tankers: An Analysis of Marine Pollution and Safety Measures

July 1975

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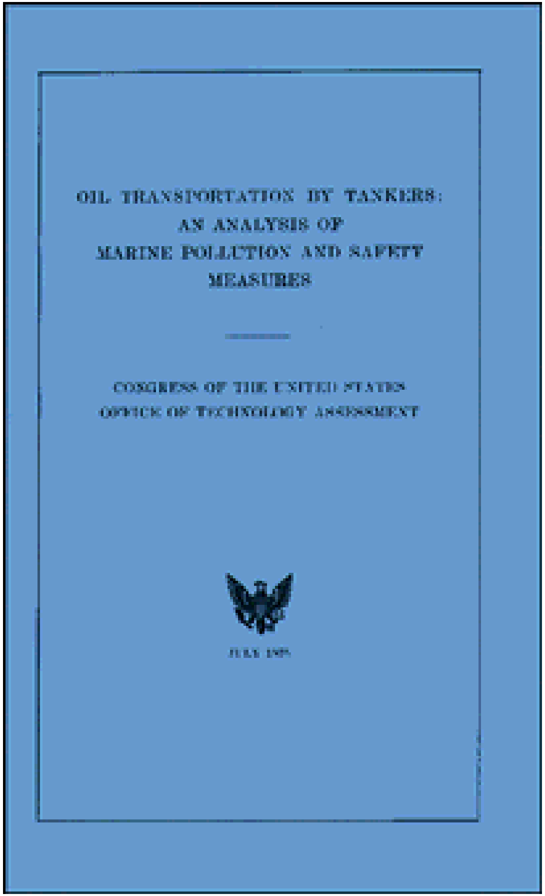

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LETTER OF SUBMITTAL

JULY 23, 1975.

Hon. OLIN E. TEAGUE,
Chairman of the Board, Office of Technology Assessment, U.S.. Congress, Washington, D.C.

DEAR MR. CHAIRMAN: I am pleased to submit this report entitled: "Oil Transportation by Tankers: An Analysis of Marine Pollution and Safety Measures" which was requested by Senator Warren G. Magnuson, **chairman of the committee on commerce,** U.S. Senate. On July 23, the Technology Assessment Board approved transmittal of the report to the committee.

This report was prepared by the Office of Technology Assessment with the **assistance of an ad hoc panel comprised** of public policy analysts and representatives of tanker operators, insurance underwriters, ship design and construction companies, training groups, and environmental organizations. The report was further reviewed by OTA'S Ocean Advisory Panel and the Technology Assessment Advisor-y Council.

It is anticipated that the data and analysis contained in this report will be of use to the Committee on Commerce, particular y for oversight hearings on the Ports and Waterways Safety Act anticipated in the fall of 1975.

Sincerely,

E ~ILIO Q. DADDARIO,
Director
Office of Technology Assessment.

Enclosure.

LETTER OF TRANSMITTAL

JULY 23, 1975.

Hon. WARREN G. MAaNUSON,
Chairman, Committee on Commerce, U.S. Senate,
Washington, D.C.

DEAR MR. CHAIRMAN: *We* are pleased to transmit the following report on "Oil Transportation by Tankers: An Analysis of Marine Pollution and Safety Measures."

Prepared by the Office of Technology Assessment with the assistance of an ad hoc panel, this report first describes the status and trends of tanker operations and pollution problems and subsequently develops advantages and disadvantages of those technical and administrative improvements which could be made. Substantial data on related subjects is presented in an effort to provide the committee with necessary background for further deliberation on this subject.

The summary of findings contained herein is not intended to reflect the views of individual members of the Technology Assessment Board of OTA.

Sincerely,	Sincerely,
OLIN E. TEAGUE,	CLIFFORD P. CASE,
Chairman of the Board,	*Vice Chairman of the Board,*
Office of Technology Assessment.	*Office of Technology Assessment.*

CONTENTS

	Page
List of tables	xi
List of figures	xiii
Preface	xv
Definition of terms	xvii
I. Summary of Findings	1
A. Pollution Prevention and Safety	9
B. Technical Improvements	s
1. Double Bottoms/Double Hulls	4
2. Controllability	4
3. Inert Gas Systems	5
4. Maintenance	5
5. Personnel Training and Licensing	5
6. Information and Control Systems	5
C. Effectiveness of Regulations	6
11. Background: Tankers	8
A. Waterborne Oil Transportation	8
1. Status	8
2. Projections of Petroleum Movement	14
B. History of Tanker Growth	1Y
C. Status and Trends of Tankers	1;'
D. Supertankers in U.S. Waters	22
III. Oil Pollution and Safety Considerations	26
A. Oil Pollution From Tankers	26
1. Amounts and Sources	26
2. Effects	30
B, Examples of Major Tanker Spills	32
1. Recent Major Spills	32
2. Other Tanker Accidents	34
C. Personnel and Equipment Safety	36
IV. Approaches for Reducing Pollution and Improving Safety	38
A. Introduction	38
B. Ship Improvements	38
1. Nature of the Problem	38
2. Utilization of Segregated Ballast Spaces for Accident Protection	38
3. Controllability Aspects	48
4. Cargo Tank Atmosphere Control	52
C. Maintenance	.54
D. Personnel Training and Licensing	57
1. Training	58
2. Licensing	59
3. Captain/Pilot Operations	62

IV. Approaches for Reducing Pollution and Improving Safety--Continued Page
E. Information and Control Systems ---------------------- 63
1. General ---------------------- 63
2. Navigational Aid Systems ---------------------- 63
3. Communication Systems ---------------------- 64
4. Information Systems ---------------------- 65
5. Control Systems ---------------------- 66
6. Vessel Traffic Systems (W'S) ---------------------- 67
7. Collision Avoidance Systems (CAS) ---------------------- 68
F. Local Port Conditions ---------------------- 68
G. Oil Spill Clean-up Approaches ---------------------- 69
V. International and Domestic Regulatory Authority ---------------------- 72
A. Introduction ---------------------- 72
B. International Law and Jurisdiction ---------------------- 72
1, The High Seas ---------------------- 73
2. The Territorial Sea and Contiguous Zone ---------------------- 75
3. The 1973 IMCO Conference on Marine Pollution from Ships ---------------------- 76
4. The Law of the Sea ---------------------- 80
C. Federal Law and Jurisdiction ---------------------- 81
1. Constitutional Authority ---------------------- 81
2. Federal Statutes and Programs ---------------------- 82
D. State Law and Jurisdiction ---------------------- 84
Bibliography ---------------------- 85
Appendix A, Statistics on the World Tanker Fleet ---------------------- 89
Appendix B. Statistics on the U.S. Tanker Fleet ---------------------- 93
Attachment l. Tankship Accidents and Resulting Oil Outflows, 1969-1873-- 97
Attachment. IMCO-Relations with the United Nations and The Specialized Agencies—The Third United Nations Conference on the Law of the Sea—Note by the *Secretariat* ---------------------- 106
Attachment 3.Ports and Waterways Safety Act of 1972 ---------------------- 162
Attachment 4.VLCC Metula Grounding and Refloating Report-Executive Summary—(U.S. Coast Guard) ---------------------- 170
Attachment 5.VLCC Metula Oil Spill (Roy W. Harm) ---------------------- 173
Attachment 6. Collision Involving the SS *Arizona Standard* and SS *Oregon Standard* at the Entrance to San Francisco Bay on February 18, 1971. (NTSB) ---------------------- 242
Attachment 7. Torrey Canyon—A Polar Case in Accidental Oil Pollution-- 285

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The statistical information presented in this report was prepared from current data available in early 1975. The references indicate the dates covered by various sources. The reader may wish to collect more current statistics as they become available. Many of the dated statistical references contained in the bibliography are periodically published and can be checked for this purpose.

LIST OF TABLES

Page

11–1.—Summary of tanker carried U.S. petroleum imports and exports--- 12

11–2.—Principal sources of petroleum imports to the United States—1974 12

II-3.—Destination by district of U.S. imported petroleum by tanker only—1974 13

114.—Major U.S. ports handling tanker imports of crude oil and petroleum products for 1973 13

II-5.—The world tanker fleet-1974 17

II-6.—Summary of tanker's carrying U.S. imports/exports of crude and petroleum products by country of registry 20

II-7.—Major U.S. tanker port capabilities 24

HI-1.-Summary of oil pollution inputs in the world's oceans caused by tankers 27

III-2.—Estimate of oil pollution input to the world's oceans from all sources 27

III-3.-Summary of tankers accidents for the years 1969-73 29

IV-1.-Double bottom tankers in operation or under construction or under contract, January 1975 39

IV-2.—U.S. flag tankers under construction/contract, October 1974 4041

IV–3.—Estimated cost increases (in percent) of double bottom and doubIe hull tanker designs as compared to actual construction or contractual costs 43

IV+.—Effectiveness of double sides and double bottoms according to various sources 44

IV-5.—Distribution of the number of structural failures as a function of tanker age for the period 1969-72 55

IV-6.-Distribution of the oil outflow from structural failures as a function of tanker age for the period 196%72 55

LIST OF FIGURES

Page

11–1.—National summaries—Principal commodities carried by water in United States-l973 ---------- 9

II–2.—World tanker trade routes ---------- 10

II–3.—Growth in tonnage of the world tanker and supertanker fleets, 1960-74, and growth in world and U.S. flag fleet of VLCC's and ULCC'S (over 200,000 dwt) 1967–76 (projected) ---------- 18

114-The largest U.S. Flag Tanker, *Ma8m.chwei%?—265,000* dwt-launched January 1975 ---------- 21

II–5.—A supertanker of 265,000 tons delivered in 1974 ---------- 22

111–1.—The VLCC Metuta grounded and leaking oil in the Strait of Magel-lan, August 1974 ---------- 33

PREFACE

This report has been prepared by the Office of Technology Assessment (OTA) in cooperation with and for use by the Senate Committee on Commerce and by the Congress in general. The report presents a factual background on tankers and a discussion of issues related to the safety of tanker operation and the potential presented by tankers for introducing polluting oil into the marine environment. The report focuses on technical alternatives concerning the design, construction and operation of tankers in U.S. waters as these relate to safety and pollution prevention. Supertanker operations are given emphasis when they present particular or unusual problems.

The principal purpose of this report is to provide a broad factual base for use by the Congress in further investigation of major issues and resolution of policy questions. This factual base includes advantages and disvantages of alternatives for reducing tanker pollution and improving safety of operations. It is not the purpose of this report to develop those legislative or regulatory measures which will be necessary to implement the technical alternatives presented.

The study was requested by Senator Magnuson, Chairman of the Senate Committee on Commerce, in order to provide that Committee with the technical background necessary for oversight hearings on regulatory actions resulting from the Ports and Waterways Safety Act of 1972 and other legislation. The study is also an adjunct to a major assessment underway by the Oceans Project Group of OTA related to offshore development of deepwater ports, oil and gas exploration and production, and offshore nuclear power plants.

The Deepwater Ports Act of 1974 provides the legal and jurisdictional framework to proceed with the development of offshore facilities to accommodate even the largest supertanker. The Ports and Waterways Safety Act of 1972 provides regulatory authority for dealing with some of the operational risks and hazards of all tankers. Additional authority through new legislation may be required.

On January 23, 1975, Senator Magnuson introduced a bill to amend the Ports and Waterways Safety Act of 1972 (The Tanker Safety Improvement Act—S. 333), which requires that U.S. flag tankers over 20,000 dwt engaged in trade with U.S. ports which are constructed after June 30, 1975, shall be fitted with double-bottom, segregated-ballast tanks. This bill is now under consideration.

Prepared by OTA staff, this report represents an analysis of available data and recent studies related to design, construction and operation of tankers. The staff was assisted by an Ad Hoc Panel convened to review initial results and make recommendations on the factual background, technical discussions and presentation of material.

OTA is indebted to the members of this Panel who provided the expertise and guidance necessary for consideration of many varied aspects of this subject. These members are: Mr. W. O. Gray, Exxon Corporation; Mr. Eldon V. C. Greenberg, Center for Law and Social Policy; Mr. Virgil F. Keith, Engineering Computer Optecnomics; Mr. Arthur McKenzie, Tanker Advisory Center; Mr. J. D. Porricelli, Engineering Computer Optecnomics Inc.; Mr. Harry S. Townsend, U.S. Salvage Association; Ms. Mary Hope Katsouros, Ocean Affairs Board, National Academy of Sciences; Mr. Robert S. Walters, Department of Political Science, University of Pittsburgh; Mr. Leonard E. Bassil, Maritime Transportation Research Board, National Research Council; Mr. Charles O. Jones, Department of Political Science, University of Pittsburgh, and Mr. James P. Walsh, National Ocean Policy Study.

The OTA Staff on this study are: Mr. Peter A. Johnson, tanker project manager, Mr. Robert W. Niblock, Mr. Charles W. Wixom, and Mrs. JoAnnalynn Fullerton.

While the resulting report contains input from many panel members, the findings should not be construed to be the opinion of any one individual. An effort has been made to present both sides of any controversial subject.

DEFINITION OF TERMS

Technical terms frequently used in this report are defined below. The definitions presented here are intended to increase the clarity and understanding of the material presented in this report and are not intended to be complete technical definitions.

Tanker.—.& self-propelled ship designed for carrying liquid oil cargo in bulk. The tankers described in this report may carry crude petroleum or various pertoleum products such as gasoline, fuel oil, kerosene, etc. (Ships that carry Liquified Natural Gas (LNG) are specifically excluded from the tankers covered by this report.) Some aspects of Combination Carriers ('{Combos") are also covered in this report. These ships are designed to carry either liquid oil or another bulk product, such as ore, the type of product depending on the particular voyage.

Deadweight.-A measure of the total carrying capacity of a tanker (or other ship) in long tons of 2,240 pounds. Deadweight tonnage (dwt) of a tanker includes the weight of all cargo oil plus the weight of fuel, stores, water and crew. In most tankers, the deadweight capacity is within five percent of the actual cargo capacity.

Barrel and Gallon.—Volume measures of cargo oil (or other fluids) carried by tankers. One barrel equals 42 U.S. gallons. One ton of crude oil is equivalent to about '7.4 barrels (or 311 gallons).

Supertanker .—Tankers of great size and carrying capacity; generally considered to be any tanker of over 100,000 deadweight tons.

VLCC and ULCC.—Typical size categories of supertankers. Very large crude carriers (VLCC) are supertankers (for crude oil) of 200,000-400,000 deadweight tons; Ultra large crude carriers (ULCC) are those of greater than 400,000 deadweight tons.

Supertanker Dimensions.—Tankers of about 100,000 deadweight tons are typically more than 1,000 feet in length and 50 feet in draft. The largest supertanker afloat (a 480,000 dwt ULCC) is 1,250 feet long, 203 feet wide and 90 feet in draft. Supertankers are under construction of 533,000 dwt—1,360 feet in length, 208 feet in width, and 93 feet in draft.

Double Bottom.—A ship construction term referring to two separate but continuous and watertight plating structures along some length and width of a ship's bottom. Double bottoms are frequently fitted on general cargo ships and passenger ships but rarely have been

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fitted on tankers except for specialized carriers (i.e., chemical tankers) and combinations carriers (i.e., ore/bulk/oil carriers). Double bottoms usually enclose a compartmented space of up to 10 feet in height along the ship's bottom.

Double Side.—.4 ship construction term, like "double bottom," denoting an added side-shell plating structure fitted within the ship. Such double sides may form enclosed compartrnented spaces, which offer some protection against spillage in collisions that rupture the outer shell.

Double HuII.—A method of ship construction incorporating both double bottoms and double sides.

Load-on-Top (LOT).—A method devised to limit the discharge of oil from tankers caused by pumping oily ballast water and oily tank washin=% overboard. In the LOT system, ballast water carried in cargo tanks is first allowed to settle to the bottom and then most of it is pumped overboard. The remainder of the oily ballast and washwater is transferred to a "slop tank" which provides further settling of the water from the oil before the separated water is discharged. Fresh cargo oil is always loaded on top of residual oil left in the slop tank.

Segregated Ballast.—A term describing the provision of separate tanks for ballast water only, thus eliminating the need to carry ballast in cargo oil tanks. Tankers must carry about one-third or more of their total capacity in ballast when on a return (empty) leg of a voyage. Usually sea water is used for ballast. This may be loaded into cargo tanks, or when segregated ballast is provided, into separate ballast tanks. A segregated ballast provision thus adds to the total volume required in a tanker.

Inert Gas System.—A method of filling empty space in cargo tanks on a tanker with an inert gas in order to eliminate danger of an explosive atmosphere created by petroleum fumes mixing with air. The "inert" gas used is usually boiler exhaust gas which contains only insignificant amounts of the free oxygen necessary for an explosive mixture.

Lightering.—A method of offloading tankers at sea or outside of ports, usually from large tankers to smaller ones which, in turn, continue into a discharge port. Lightering is a common practice at entrances to certain ports which cannot handle the deep drafts of large tankers. The large tankers can thus be partially unloaded, permitting them to ride at lightened drafts so they can enter the restricted draft harbor.

Flag State.-The state (or nation) in which a ship is registered and which has legal jurisdiction over the operation of that ship, regardless of where the ship is operating.

Flag of Registry.—The flag indicating the nation under whose jurisdiction a ship is registered. Ships are always registered under the law of one nation. In registering, they designate a port of that nation as the “Home Port.” The ship itself is not required to use that port, but most countries require the owner to maintain a place of business within the country. The ship is thus considered to “fly the flag” of that country. Many companies establish subsidiaries in countries other than their home location :incl register ships under the flag of that country.

Port State.—The state (nation) in which is located the port of use of a ship, and which has legal jurisdiction over those ships which enter the port, irrespective of the flag of registry.

Coastal State.—The state (nation) whose coast is adjacent to the zone of use (contiguous or extended) of a ship and which may have legal jurisdiction over tile operation of that ship entering the zone, whether or not it is destined for a port of the state, and regardless of the flag of registry.

Chapter I. Summary of Findings

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

The pollution damage threat from any vessel to ocean ecosystems and surrounding environments is serious and substantial. Both short term and long term effects of oil pollution have been assessed, resulting in general agreement that oil spills must be reduced from their present level.

The world tanker fleet has greatly expanded in recent years principally through a major use of supertankers which now number 623 ships totaling 127 million dwt or over one half of the world tanker tonnage. An equivalent number of supertankers are now under construction throughout the world.

The expected introduction of supertankers into 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 their 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 U.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, and the relative damage potential needs clarification.

Oil pollution from tankers originates from two principal sources: (1) tanker accidents, and (2) normal tanker operations, such as tank cleaning, de-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. In addition, an added 250,000 tons of oil pollution annually is associated with tanker drydocking activities.

There are numerous improvements that could be made to reduce oil pollution from tankers and to increase the safety of their operations. .Some of these improvements have been proposed in the past, some have been adopted in practice by certain segments of the industry, and some are new proposals by either industry or government. The improvements highlighted in this report relate to those subjects covered by oversight jurisdiction under the Ports and Waterways Safety Act of 1972, which provides the basic U.S. authority for tanker regulations.

Tanker pollution and safety must also be considered in light of the overall need for efficient and effective methods of transportation of petroleum to the United States (imports) and within the United States (domestic). While supertankers appear to offer one of the most efficient and economical means of transporting oil over long distances, these mammoth ships may also present risks to coastal areas and possible adverse impacts which should receive careful consideration.

Pollution and safety issues are often subject to considerable debate regarding accuracy and extent of data, understanding of the effects of pollution, the evaluation of hazards and impacts, the effectiveness of various technical improvements, and the resolution of conflicting expert views on the effectiveness of regulations.

The following principal findings are related to reducing tanker-caused pollution of the oceans and improving the safety of tanker operations:

Pollution Prevention and Safety Data

More, and more accurate, worldwide data are urgently needed on tanker-caused oil spills and accidents in general.

- Additional research is needed on the environmental effects of various levels of oil pollution.

Technical Improvements

- It is necessary to treat the oil pollution problem on a total systems basis in order to make meaningful improvement.
- Fitting double bottoms or double hulls on tankers offer a significant degree of protection from oil pollution in the event of grounding and/or collision accidents.
- Inert gas systems can substantially reduce risks of tank explosions and resulting major casualties.

Improved maintenance, inspection and survey procedures can help alleviate tanker structural failure problems.

. A substantial portion of tanker accidents are caused by human error and improvements in the training and licensing of shipboard personnel are greatly needed.

- Vessel traffic systems and other navigational aids are also in need of continual upgrading and improvement.

Regulations

- The International Pollution Convention of 1973 provides some major improvements in the regulation of tanker-caused pollution worldwide and deserves U.S. efforts to ratify.
- The Ports and Waterways Safety Act of 1972 provides authority to the U.S. Coast Guard for certain regulatory action independent of international treaty, if necessary.
- The National Transportation Safety Board needs to have more autonomous investigative authority than now exists in the case of marine accidents.

* * *

The following discussion expands on the major points highlighted above and presents some of the conflicting views; the subsequent chapters of this report will further develop detailed background information on tankers, the bases for concern on pollution and safety issues, a range of technical approaches for making improvements and the basic international and domestic regulatory authority.

A. Pollution Prevention and Safety

The lack of quantity and accuracy of oil spill data is especially true of oil discharges caused by normal ship operations, for which estimates have been made by extrapolating from that small sample of ships which report their activities. An effort to accurately identify sources, locations and amounts of tanker-caused oil spills would be of significant benefit to all.

Another finding is that more research is needed *on* the environmental effects of various levels of oil pollution. Coupled with an accurate assessment of status and trends of spills, a more complete analysis of the pollution damage to be expected from various spills could also clarify the issue. The long term effects of pollution on the marine environment have been widely debated but with only limited specific investigations as references. Chapter III discusses the issues of pollution and effects in some detail as well as general safety requirements.

B. Technical Improvements

The improvements which could be effected in the tanker transportation system can be categorized in relation to (1) the ship, (2) the crew who operates the ship, (3) the information and control systems, and (4) the environmental influences. These are discussed in detail in Chapter IV. A series of such technical improvements may, in total, provide the measures needed to significantly reduce tanker-caused oil spills. The following improvements are proposed:

1. Double Bottoms/DOuble Hulls

Many previous investigations have provided a background of varying results regarding the absolute pollution prevention effectiveness of double bottoms or double hulls on tankers. From a technical standpoint, however, it is generally accepted that double bottoms will prevent most oil spillage which results from limited intensity hull ruptures due to grounding, such as those which may occur within harbors or other areas where tankers normally operate at reduced speeds. For double hull tankers, the same may apply for collisions as well as grounding.

This report supports the finding that double bottoms offer a significant degree of protection from oil pollution in the event of a grounding accident.

The added costs and extra safety of tankers fitted with double bottoms are also discussed. It was found from the construction of several new double-bottom oil tankers that the added cost of the double bottom is in the range of 2.54.0 percent-significantly less than previous estimates—and that the presumed associated safety problems either do not exist or can be alleviated with proper design.

This report also recognizes that other locations of segregated ballast tanks, when properly designed to act as defensive spaces, may also offer degrees of protection from oil pollution. In the case of double sides, only collision protection is provided; however, this may be of special value where there is a low grounding potential but a high risk of collision. Double hulls, which incorporate both double bottoms and double sides, offer protection from oil pollution from both grounding and collisions.

2. *Controllability*

Controllability problems associated with tankers (especially supertankers) are discussed in Chapter IV. It is generally accepted that the need for attention to control problems! especially for ship operation in confined waters, rises as the size of ship increases. Stopping and low speed maneuvering of supertankers require both a better understanding of ship control characteristics and better knowledge of local port conditions. It appears that the use of tugboats and auxiliary maneuvering devices could be more carefully designed into all tanker operations. Another finding supported by this report is that additional research into large ship controllability would be most desirable.

3. *Inert Gas Systems*

It is generally agreed that the use of inert gas systems to substantially reduce the risk of tank explosions is an extremely beneficial design feature for tankers. Chapter IV discusses the need for and use of these systems. Many tankers are now fitted with these. The finding is supported that inert gas systems are of substantial benefit in large tankers and may be of significant benefit in smaller crude and product tankers as well.

4. *Maintenance*

This study supports the finding that hull structural failures in some tankers-especially those over ten years old and those which may not have been carefully maintained—are the cause of a substantial amount of oil spilled each year. In addition, many of these hull failures result in complete break-up of the ship and the loss of many lives as well as the cargo. It is suggested that special inspection procedures for older tankers may alleviate some of these problems. It is also suggested that converting conventional tankers to segregated ballast tankers with a resulting decrease in cargo capacity may offer several advantages.

5. *Personnel Training* and *Licensing*

There is substantial agreement that human error is a major factor contributing to all tanker accidents (especially grounding and collisions) and that improvements in this area have the potential of providing the most significant benefits. Chapter IV discusses a broad range of possible improvements in the training and licensing of shipboard personnel. Training and licensing practices appear to be more crucial as the size of a tanker increases because of the increased threat of a major accident.

6. *Information and Control Systems*

A broad range of systems to provide better information for the navigation and control of tankers (and other surrounding ships as well) is considered to be a very beneficial safety feature. The systems available and propcsed are clescribed in Chapter IV. It is noted that navigational aids could be improved in many areas, and that vessel traffic systems, collision avoidance systems, improved communications systems and shipboard control itself are all areas in need of continual upgrading and improvement.

c. *Effectiveness of Regulations*

Chapter V discusses the legal and jurisdictional aspects of tanker regulation and control. Both international and national laws apply to the operations of tankers in U.S. waters. Since 94 percent of the imports of oil to the United States is carried by foreign flag tankers, international regulations are of particular interest. It is also noted that the new regulations for tanker design and construction, proposed to be promulgated soon by the U.S. Coast Guard, are substantially the same as international agreements on the subject. However, the United States possesses sufficient legal authority to set more stringent standards.

In addition to steps which may be necessary to implement the improvements outlined above, this report also supports the finding that the International Pollution Convention of 1973 can enable several major improvements in the regulation of tankers toward substantially reducing worldwide oil pollution. There are conflicting views, however, cm the ability of any international agreements with Flag State enforcement (given the nature of flag and ownership of world tanker fleets) to effectively control tanker operations. Given that fact that many other international treaties have taken many years to be ratified, it is felt that this one may also be delayed beyond a reasonable time. It is generally agreed, however, that U.S. efforts to ratify, and to encourage other nations to ratify, the 1973 Pollution Convention will be of benefit to all. A possible exception to this position has been expressed by some environmental groups who claim that an international agreement may not be desirable if it reduces our ability to make improvements unilaterally.

The Ports and Waterways Safety Act of 1972 provides authority to the U.S. Coast Guard to take certain actions independently of international treaty, if necessary, as well as to develop tanker regulations on the basis of the best available pollution control technology for the protection of U.S. waters.

In conjunction with other subjects studied and presented in this report, the area of accident investigation was reviewed and some possible improvements are suggested here. The National Transportation Safety Board investigates major accidents at the request of the U.S. Coast Guard and makes recommendations regarding problem areas. It should be noted that the 1974 amendments to the Federal Railroad Safety Act, addressing the question of NTSB autonomy, required that it no longer be within the Department of Transportation, but rather be an independent agency by April, 1975. This same act, however, did not change the dual relationship in marine accidents of

NTSB and the USCG. Thus, although the NTSB is established as an independent Federal agency to make unbiased investigations of transportation accidents in all fields which are of significant impact or of national interest, it may investigate marine accidents only upon request of the U.S. Coast Guard—and then only after the Coast Guard has completed an initial inquiry.

The Coast Guard has operational responsibility for traffic control systems, licensing of operators or approval of ship safety standards. Therefore, it is sometimes placed in the position of having to expose deficiencies in its own operations while investigating marine accidents. An agency such as NTSB could relieve the Coast Guard of these "self policing" burdens and provide both the Congress and the Executive branch with findings and recommendations outside of Coast Guard jurisdiction.

It is also recognized that more detailed information on major accidents worldwide could provide valuable data for analysis of causes and effects. NTSB or some other appropriate agency could possibly investigate significant accidents throughout the world as well as within U.S. waters with the objective to develop a better understanding of those factors that contribute to such accidents.

Chapter II. Background: Tankers

A. Waterborne Oil Transportation

1. *Status*

Over the past decade, the world has experienced a major increase in reliance on the use of oil as a principal source of energy. At the same time, a large portion of this oil increasingly has been produced in one part of the world and consumed in another. For the year 1973, the world's petroleum consumption was 2.76 billion tons; of this 1.70 billion tons (62 percent) was recovered in one area and transported to another. Almost all of this was transported by tanker.[1]

Tankers are also used to ship crude oil and refined products within local areas (such as along the coast of the U. S.) and to ship refined products from a major refinery to many areas. In both foreign and domestic shipping, petroleum and related products comprised just over 40 percent of all U.S. water-borne commerce in 1973. (See Figure II-l.)

Today's total world trade in petroleum shipped by tanker averages 30 to 35 million barrels per day.[2] This is carried by 238 million dead-

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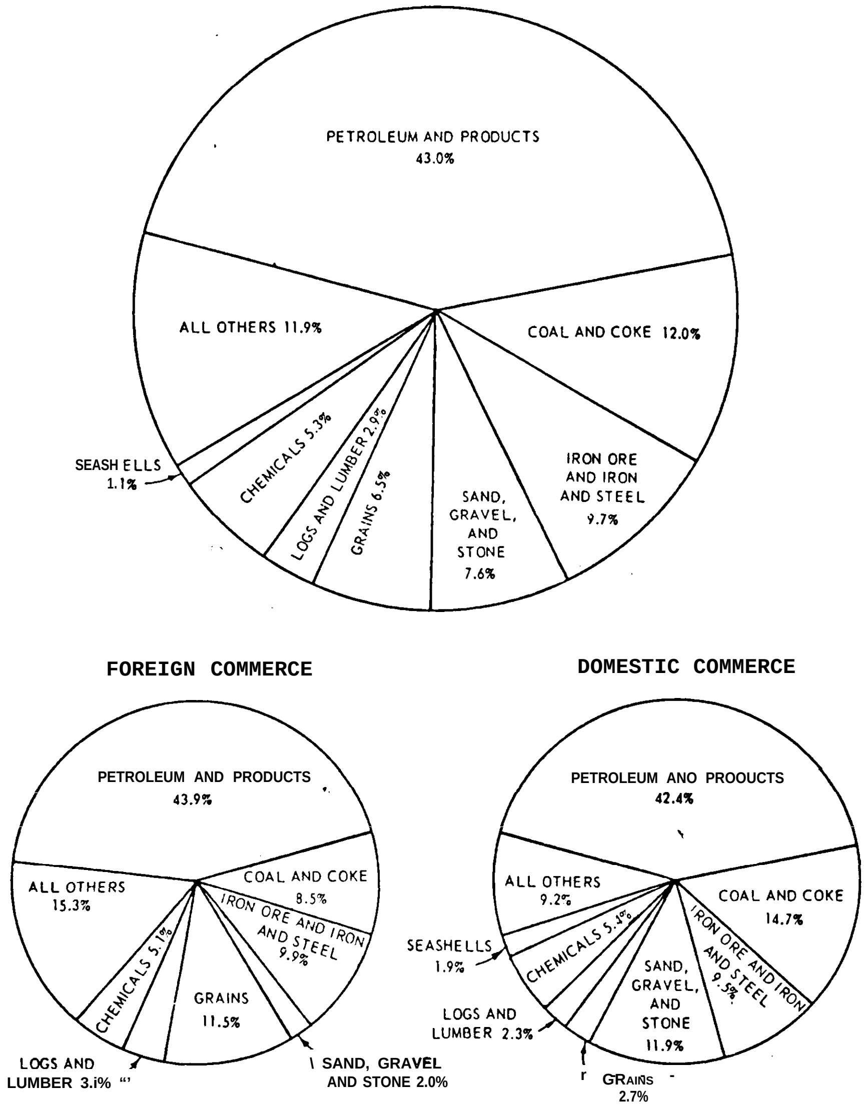
1 *BP Statistical Review of the World Oil Industry, 197S.*
2 *Ibid.*

FIGURE II–1. NATIONAL SUMMARIES.

PRINCIPAL COMMODITIES CARRIED BY WATER IN UNITED STATES—CALENDAR YEAR 1973—TOTAL COMMERCE



Waterborne Commerce of the United States-1973, U.S. Army Corps of Engineers

weight tons of tankers available in the world fleet.[3] In today's world fleet, supertankers are in use principally on two major trade routes-from the Arabian Gulf to Europe around Africa, and from the Arabian Gulf to Japan through the Malacca Straits. These routes also account for one half of the total seaborne tonnage carried throughout the world. Figure II-2 illustrates the major world tanker trade routes and the relative tonnages shipped on each route.

Today the majority of tonnage of tankers (but not individual ships) in the world fleet is comprised of supertankers. This use of supertankers has been stimulated by the economics of petroleum transportation over the two long trade routes noted above, particularly since the closing of the Suez Canal in 1967. The recent opening of the Suez may have some further conflicting implications on the demand for supertankers.

While the world inter-area movement of oil has been growing, imports of petroleum to the United States have been increasing as well. Because domestic production has not been able to keep up with rising U.S. demand, the United States presently is importing over 35 percent of its oil requirements. Except for pipeline imports from Canada, through which some 16 percent of total U.S. imports have been received, all U.S. oil imports are carried by tanker.

In 1974, imports of petroleum by tanker into the United States averaged 5.4 million barrels per day, of which half was crude and half refined products. The refined products were received mainly from Caribbean sources while the crude came from Venezuela, the Arabian Gulf, North and West Africa, and Indonesia.

The major portions of crude imports into the United States are received at the key refining centers located in the New York-New Jersey-Delaware-Pennsylvania area, the Texas-Louisiana area, or the California area. In the recent past (1972-74), two thirds of U.S. petroleum imports have been received on the East Coast.

Table II-1 summarizes petroleum import and exports by tanker over the past four years and projects the current one (1970-'74, and 1975). The data are taken from Bureau of Mines statistics and (for 1975) short-term projections of the Federal Energy Administration. The projected increase in tanker-carried imports for 1975 derives principally from the assumption that pipeline imports from Canada will be reduced by 200,000 barrels per day, requiring a corresponding increase from other sources, using tankers. (Canada has announced that it is reducing petroleum exports to the United States on a graduated basis, toward a goal of eliminating such exports by 1981.)

[3] *Lloyds Register of Shipping, Statistical Tables,* **1974**; total as of July 1, **1974.** *Clarkson's Tanker Register reports* **296** million **dwt** (including Combos) **as** of January 1,1975.

WORLD TANKER TRADE ROUTES

INTERNATIONAL FLOW OF PETROLEUM 1972

FIQUBE II-2

TABLE *II-1.-Summary of tanker carried U.S. petroleum imports and exports*

	Millions of barrels per day averages over each year				
	Imports				
Year	Crude oil	Petroleum product	Total	Exports (products)	Total imports and exports
1970 ---------------- -	1.0	1.6	2.6	0.1	2.7
1971 ---------------- -	1.2	1.8	3.0	:2	3.2
1972 ----------- _ -_ ---	1.4	2.3	3.7	.2	3.9
1973-----------------	2.2	3.0	5.2	2	5.4
1974- ----------------	2.8	2.6	5.4	:2	5.6
1975-----------------	3.0	2.7	5.7	.2	5.9

Note: Notincludedinthis table is approximately 450,000 barrels per day (1973 average) of crude oil passing through Portland, Maine and shipped by pipeline to Canada. Also excluded is all Canadian crude imports which are by pipeline (1974-75 average S00,000 barrels per day).

Source: Bureau of Mines, Mineral Industry Survey; FEA, Petroleum Supply/Demand Projections for 1975.

The specific source of crude and refined product imports is also of interest when considering tanker traffic. Table II–2 lists the principal sources of petroleum imports to the United States during the second quarter of 1974 (excluding Canada), ranked by percent of total amounts Bureau of Mines statistics indicate that major increases of imports from Iran, Nigeria and Indonesia during 1974 already replaced some of the Canadian imports.

TABLE *H-2.-Principal sources of petroleum imports to the United States—1974*

Rank and mum	Typ+ of oil	Millions of barrelsd~~	Perc8nt total crude and product
1. Venezuela ----- -----------	}6 product, ~$ crude ------	0.9	17
2. Nigeria- -----------------	All crude-_ ------- -_ ----	.7	13
3. Iran ------------- ---- --- -----	-do-- -- _ _ -----------	.6	11
4. Netherland Antilles_ ---- -_	All product -------- -----	.5	9
5. Saudi Arabia ------ -------	All crude ----------- ----	.4	7
6. Virgin Islands- -----------	All product---- ---------	.3	6
7. Indonesia ------- ---------	All crude -------- -------	.3	6

Source: Bureau of Mines, monthly petroleum statement, January-June 1974.

The U.S. destinations of tanker-carried petroleum imports are distributed generally as shown on Table II–3, extrapolated from Bureau of Mines reports for the first half of 1974. Table 114 lists the major U.S. ports handling tanker imports of both crude oil and products.

TABLE II-3.-Destinotion by district of U.S. imported petroleum by tanker on!y—1974

District-destination	Millions of barrels per day average: Crude	Petroleum product	Total	Percentage
East Coast	[a] 1.2	2.5	3.7	68
Gulf Coast	[b] .6	.1	.7	13
West Coast	[c] .6	.2	.8	15
Inland	.1	.1	.2	4
Total	2.5	2.9	5.4	100

[a] Major source: Nigeria, Iran, and Venezuela.
[b] Major source: Nigeria, Saudi Arabia.
[c] Major source: Indonesia, Iran, and Saudi Arabia.

Source: Bureau of Mines, Monthly Petroleum Statements, January-June, 1974.

TABLE II-4..—*Major U.S. ports handling tanker imports of crude oil and petroleum products for 1973*

[Average of millions of barrels/day]

Port	Crude oil	Petroleum products	Total
New York, N.Y	0.41	0.73	1.14
Delaware River Ports	.87	.13	1.00
Portland, Maine	[a] .46	.03	.49
Boston Fall River, Mass	.01	.20	.21
Long Beach, Calif	.14	.03	.17
Galveston, Tax	.16	.01	.17
Rhode Island/Connecticut ports		.13	.13
Los Angeles, Calif	.11	.02	.13
Norfolk and Hampton Roads		.11	.11
Houston, Tex	.09	.02	.11
Baltimore, Md	.02	.08	.10

[a] The Portland trade in crude is all transshipped directly to Canada by pipeline and therefore is not included in statistical import data of Tables II-1 and II-3.

Note: Each 0.10 million barrels per day requires the unloading of one 100,000 dwt tanker per week.

Source: U.S. Army Corps of Engfneers-Waterbome Commerce of the United States-1973.

The foregoing described the sources and destination of petroleum imports; the major exports of petroleum product are from West Coast refineries, with small amounts shipped from the Gulf Coast. (See Table II-l.)

Petroleum tankers engaged in U.S. coastwise trade comprise a large majority of ships of the total U.S. flag fleet. Using smaller tankers, the trade is principally in products rather than crude oil. The following summarizes the principal interdistrict tanker-carried petroleum movements reported by the Bureau of Mines.

1974 *domestic coastwise tanker-carried petroleum*

Route:	*Average*
Gulf coast to east coast	*1.6*
Gulf coast to west coast	.2
Other west coast	.3
Total	2.0

I .Million barrels per day.

(It should be noted that the above does not include considerable inland, intra-district, barge, and small tanker movements which are large in number but very small in total tonnage.)

2. Projections of Petroleum Movement

Already extensive, the world movement of petroleum is projected to grow in the future (1980–85) at a rate considerably lower than the recent past. In part, the lower growth rate is due to a decline in the growth rate of oil consumption, which is expected to be 34 percent per year in the near future, as compared with 7–8 percent in recent years.' This decline in growth is influenced by—and in turn influences-many factors, including world economic conditions, conservation policies, monetary system policies, environmental pressures, and others.

Tanker traffic follows oil demand, moving petroleum from sources of supply to points of consumption. Because of the slowing in growth rate due to factors noted above, a significant downturn in the rate of increase of tanker demand is projected through 1985. In fact, recent demand forecast indicates the requirement. for tanker tonnage may remain almost level through 1985.[5] However, there is a high degree of uncertainty in all forecasts of this nature, and the tanker market is notorious for major fluctuation in supply and demand.

Thus, recent reports indicate that the supertanker building boom has peaked out, and that incentives for ships much larger than 500,000 dwt have abated. Recent cancellations of orders for VLCCS are a case in point.[G] (The re-opening of the Suez Canal is likely to further affect decisions on tanker sizes and trade routes.) [7] In general, it appears that demand for supertankers in the future will be level, not increasing. The trend toward use of these larger ships will probably continue but at a lower rate than the past few years.

Oil transportation by tanker in U.S. waters is also subject to major uncertainties. On the import side, the President has announced a

4 Mueller, W. U., Exxon Corporation, ***Seatrade Conference Presentation on World Tanker Outlook,*** London, March 1975.
5 ***Ibid.***
6 ***Marine Engineering/Log,*** December 1974.
7 The Maritime Administration **Office** of **Policy and Plans** has studied the implications of opening the Suez Canal on tanker trade. This and other work may be useful in more accurately determining future trends.

conservation plan incorporating a goal of reducing imports by 1 million barrels per day by the end of 1975. If such a reduction is possible, it appears that it cannot be achieved until after 1975 because of recent declines in U.S. production, delays in discoveries of new resources and delays in implementing price increases.

In addition, as noted above, Canada. plans to eliminate exports to the United States by 1981. The oil now shipped from Canada by pipeline will undoubted have to be replaced by tanker-carried oil from other sources. Given these factors, a reasonable near-term projection of imports by tanker would be that they will remain level. If new deepwater ports are developed, the future imports may be carried by a smaller number of much larger tankers than are used today. On the other hand, new deepwater ports may be more specifically tied to major new refineries or expansions in one region without substantially affecting another.

' .At the same time, domestic shipment of oil within the United States will undoubtedly grow substantially by 1980 principally because of the introduction of new production from Alaska, estimated to total 2 million barrels per day by 1980. This oil will be shipped from the Alaskan North Slope to Valdez by pipeline and then to West Coast ports by tanker. Since this trade will equal all of the present U.S. coastwise trade by tanker, it will mean a significant increase. in domestic tanker demand and use.. If other oil is cliscovered in Alaska (such as in offshore regions) even greater demancls for tanker trade will undoubtedly follow.

B. Historg of Tanker Growth

Tanker size increased dramatically beginning in the mid-1950's. Until then most of the world's tanker fleet was comprised of ships little larger than the 12,500 dwt tanker *Narragansett,* launched *in* 1903. Tankers of comparable size were even then, as supertankers today, among the largest ships afloat.

During World War II, the T–2 of 16,000 tons, built in large numbers to fill wartime demands for shipping fuels, became the standard for tanker measurements. By T–2 standards, a 25,000 dwt tanker of 1950 was considered large. However, in 1948, an analysis published in a Society of Naval Architects and Marine Engineers paper showed that a 50,000-ton tanker could reduce the ton-mile costs of shipping petroleum to 60 percent of the costs of a 12,000 -tonner. At this time, most of the worlclk petroleum was being transported in "handy-sized" tankers, defined (today) as ships in the 6,000–35,000 dwt range.

By the mid-1950's, a few of the larger and more ambitious owners had begun operating tankers in the 40,000-50,000 dwt range. In 1955, an 84,000 -tonner was ordered. and, impelled by the Suez crisis the following year, the first 100,000 ton ship was begun. Such ships demonstrated the economic advantages of increased **capacity, so that** the sizesof tankers subsequently ordered increased rapidly, until in the 1960's the most-frequently-ordered VLCC was just over 200,000 dwt. By 1968, a 326,000-ton ship had entered service, orders had been placed for ships in the 500,000-ton class, and patents sought for design and construction techniques for building one million ton tankers.

The 200,000-ton VLCC remained the most sought, however, and with the economic impetus to order large ships enhanced by the Middle East war of June 1967, the world's shipyards were pressed with orders for them. An unprecedented boom in tanker construction (especially supertankers) followed over the next several years, lasting until 1974 when the aftermath of the oil embargo began to be felt. During 1974, both tanker tonnage under construction and maximum sizes reached a peak.

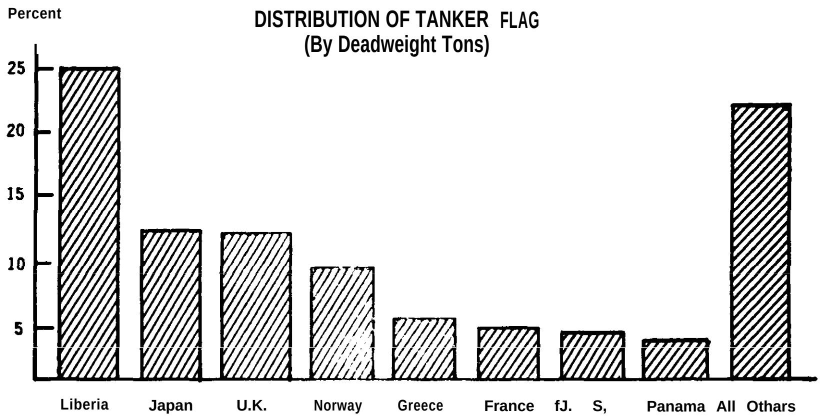
C. *status and Trends of Tankers*

Table II-5 summarizes the makeup of the world tanker fleet by flag and size range. Figure II–3 illustrates the large growth in total tonnage capacity of tankers and supertankers over the past 10 years. Also apparent is a corresponding growth in the world fleet of VLCCS (over 200,000 dwt), illustrated in Figure II–3 (including near-term projections).

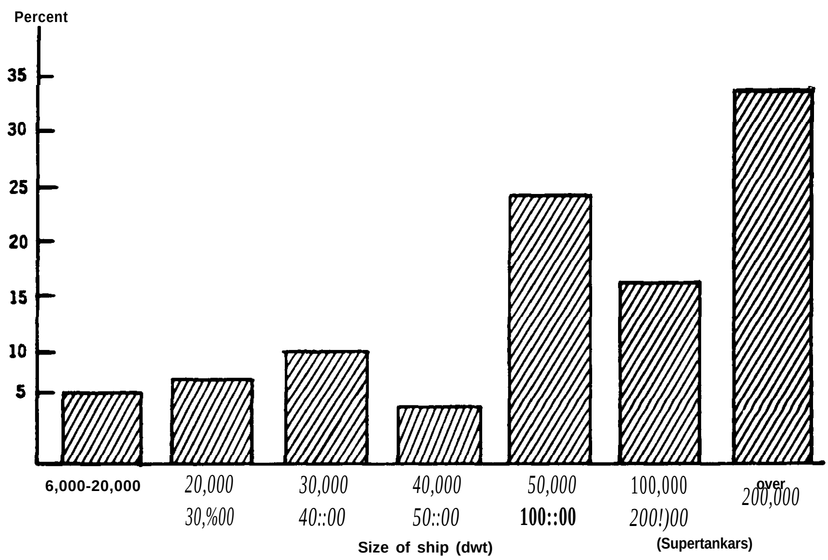
Table II-5
THE WORLD TANKER FLEET
1974
(Excluding Combination Carriers)

Tolal Number of tankers in the world fleet	6,785*
Total deadweight of world tanker fleet . . .	238 million tons
Total Number U.S. flag tankers (excluding U.S. Gov't reserve fleet)..	218
Total deadweight of U.S. flag tanker fleet	7.4 million tons

DISTRIBUTION OF TANKER FLAG
(By Deadweight Tons)



DISTRIBUTION OF TANKER SIZE
(By Deadweight Tons)

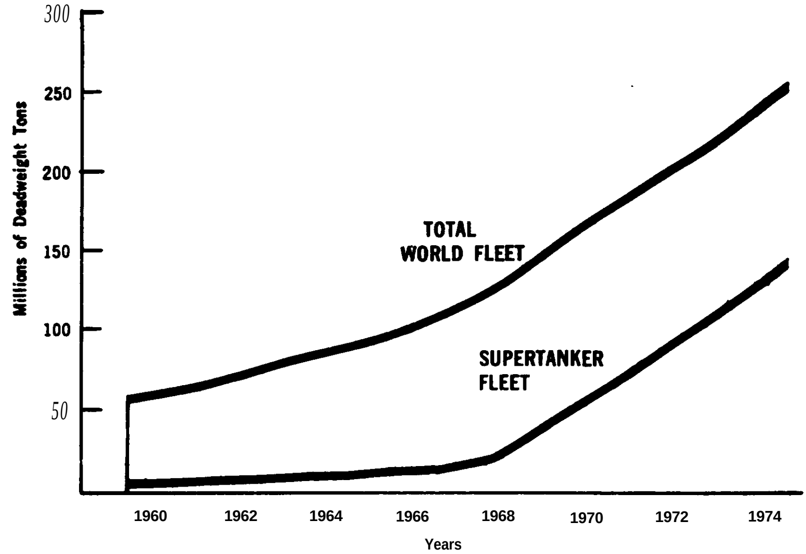


'Lloyds Register of Shipping—Statistical Tables-1974; data as of July 1, 1974.

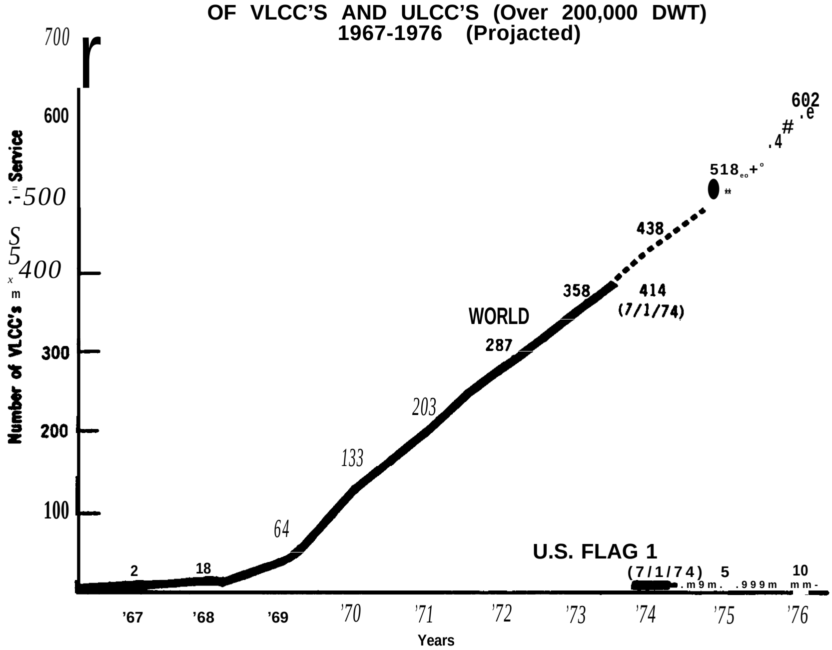
Figure II-3

GROWTH IN TONNAGE OF THE WORLD TANKER AND SUPERTANKER FLEETS

(Including Combination Carriers)



GROWTH IN WORLD AND U.S. FLAG FLEET OF VLCC'S AND ULCC'S (Over 200,000 DWT) 1967-1976 (Projacted)



Source: *18th* Annual Tanker Confaranca, API, 1973 and MARAD, Office of Policy and Plana, Dac. 1974.

From 1966 to 1970, supertanker fleet capacity increased, through the construction of 188 ships, from less than 2 million tons to over 50 million tons. During the next two years (1971-72), another 50 million tons were added to the supertanker fleet. As of July 1, 1974, that fleet was comprised of 623 ships (over 100,000 dwt each) totalling 127 million deadweight tons. Also, 699 additional supertankers were under construction or on order in the world which, if completed, could add an additional 170 million tons to the world fleet in the next five years.[8] It should be noted, however, that many tanker cancellations have taken place during late 1974 and early 1975, and that the present situation is changing rapidly. There is now a large worldwide over-supply of tanker tonnage, causing the lay-up of many ships.[9]

Relative to the world fleet, the U.S. tanker fleet is small (seventh largest), numbering 218 ships with a total capacity of 7.4 million deadweight tons, and comprising less than 4 percent of world tanker tonnage. Nonetheless, the United State is a significant maritime power since such nations as Liberia and Panama do not possess the power commensurate with their fleet size.

Most of this is used in domestic trade. At present many of the U.S. flag tankers are old and in need of replacement soon. Because they are less expensive to operate, foreign flag ships bring in 94 percent of the petroleum imported by the United States.[10] Table II–6 lists the various countries of register for those tankers carrying oil imports to this country.

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8 *The Petroleum Economist*, October 1974, and Appendix A. Also, on January 1, 1975, *Clarkson's Tanker Register* reported 895 tankers over 100,000 dwt and an additional 186 combination bulk/oil and ore vessels over 100,000 dwt.

9 *Business Week*, April 28, 1975.

10 U.S. flag tanker statistics are from the Martime Administration, Office of Policy and Plans, December 1974. Also see Appendix B.

Table II-6.-8unwuwy of tankers carrying U.S. imports/exports of crude and petrolewn products by country of registry

country of registry	Percent of total tons of cargo	Country ofregistry	Percent of total tons of cargo
Liberia	39.77	Medico	.24
Greece	10.79	Somalia	.24
Panama	9.82	Spain	.19
Norway	8.63	Kuwait	.19
United Kingdom	6.84	Brazil	.16
United States	6.34	Iran	.15
Unidentified vessels	2.55	Uruguay	.15
Italy	2.41	Yugoslavia	.13
Germany (West)	2.25	Chile	.12
Netherlands	1.73	India	.12
Sweden	1.16	Venezuela	.08
Denmark	1.03	Ethiopia	.08
Belgium	1.00	Thailand	.07
Finland	.89	British Colonies	.06
Japan	.70	Algeria	.06
fiance	.42	Ecuador	.03
Cyprus	.38	Poland	.03
Korea (South)	.37	Iceland	.02
Canada	.30	Turkey	.01
Union of Soviet Socialist Republics	.25	Burma	.01

Source: MARAD Office of Subsidy Administration, December 1974.

Comprised of eight ships at the present time, the U.S. flag supertanker fleet is also small relative to the total fleet. Six 120,000 dwt vessels were recently constructed for the Alaska-to-West Coast trade and two 225,000 dwt tankers recently completed for foreign trade. In addition, one 120,000 dwt and eight VLCCs (225,000-265,()()() dwt) are under construction; and six 165,000 dwt and three VLCCs (390,000 dwt) are on order for U.S. shipping companies. Figure II–5 depicts a recently-built foreign flag VLCC; Figure II-4 shows the launching of the U.S. flag VLCC, Massachusetts.[11]

[11] The *Massachusetts*, a 265,000 dwt tanker, built for Boston Tankers, Inc., was launched on January 10, 1975, at Bethlehem's Shipyard in Baltimore, Maryland. The two other U.S. flag VLCCs in service are the *Brooklyn*, a 225,000 dwt tanker delivered in December 1973 to Langfitt Shipping Company by Seatrain Shipyard, New York City and the *Williamsburg* of the same class delivered in 1974. The two additional VLCCs which were under construction at Seatrain were cancelled early this year and an EDA loan guarantee was subsequently made for the purpose of completing the construction.

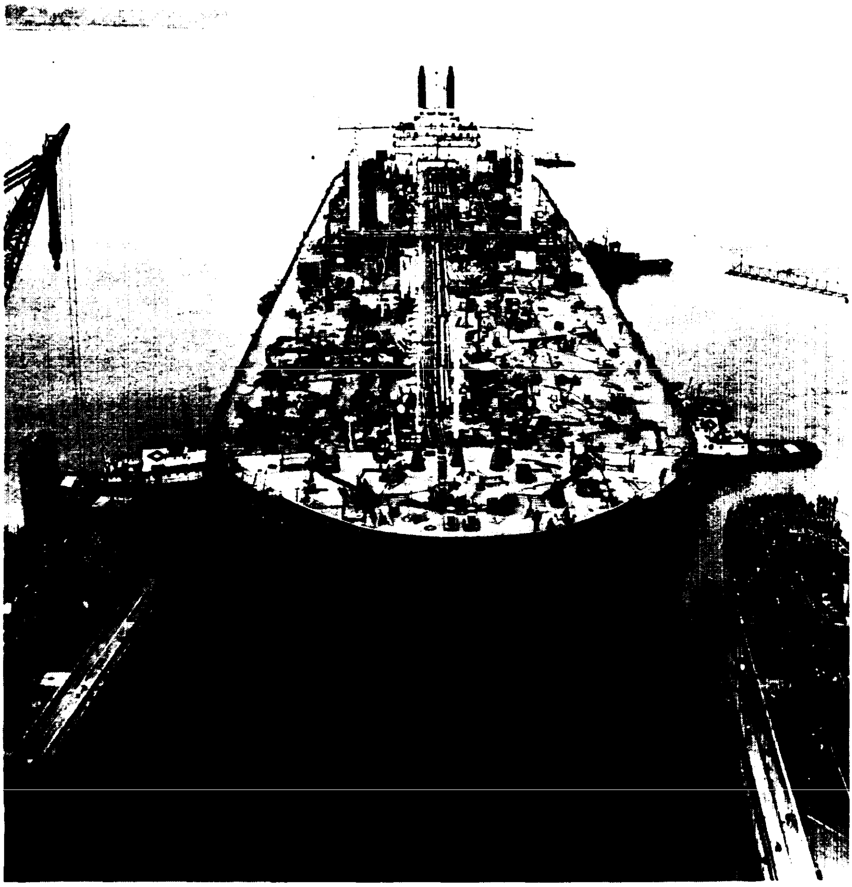

FIGURE 114.—The Largest U.S. Flag Tanker Massachusetts-265,000 DWT.—Launched January 1975.

—(Photo Credit—Bethlehem Steel Corp.)

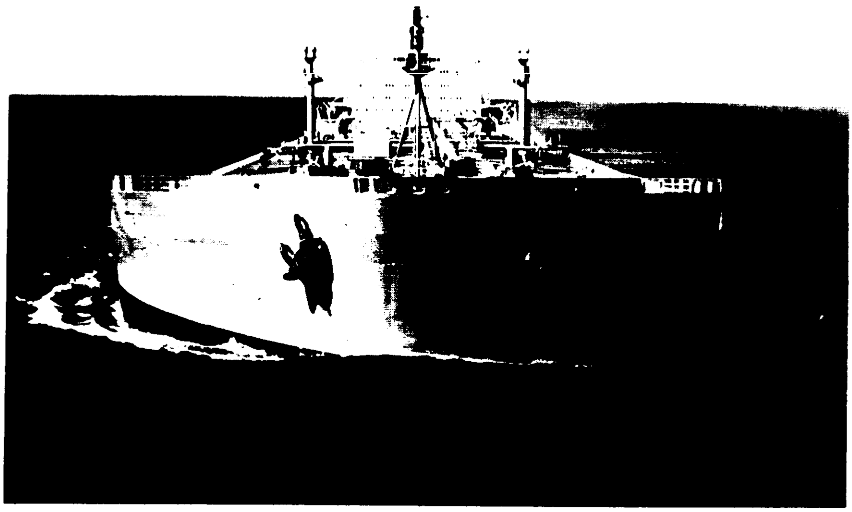

FIGURE II–5.—A Supertanker of 256,000 Tons Delivered in 1974.
—(Photo Credit—Sun Oil Co.)

Two factors providing impetus for growth in the U.S. supertanker fleet are the pending Alaska-to-U.S. West Coast trade, and the Maritime Administration's (MARAD) subsidy construction program. Nevertheless, while several VLCCS for use in foreign trade are now being built under subsidy in U.S. shipyards. In the absence of legislation requiring otherwise, it is expected that foreign flag tankers will continue to be the major carriers of the U.S. oil imports.

In addition to conventional crude oil and product tankers, the fleet of ships known as combination carriers is also growing—ships designed to carry oil or other bulk products, such as ore, salt, grain, etc. In the world fleet in 1975, there are over 175 bulk/oil and over 200 ore/oil ships, about 90 of each being over 100,000 deadweight tons.

D. Super fankers in U.S. Waters

The transportation of petroleum by mammoth ships expanded unusually rapidly, a result of extrapolating many technologies. In combination, these may present new hazards ancl unexpected impacts. Indeed, the history of supertanker operations over the past six to eight years has shown that safety hazards are present, that polluting accidents do occur, and that the operation of these ships could present a range of new problems. During this period, supertankers operating in many world trade routes outside of U.S. water have generated an experience from which can be derived projections of results to be expected from their potential use in U.S. waters.

The unusual experiences of supertankers derive primarily from their size. The existing world supertanker fleet includes ships that are the largest afloat. Their main deck dimensions are equivalent to the flight deck of the largest aircraft carriers, and their displacement tonnages exceed carriers by two to five times. Their most striking and limiting dimension is their deep draft (60 to 90 feet).

Typically, a supertanker contains 15 to 20 large individual tanks formed by bulkheads across and lengthwise to the ship. These tanks or compartments may each contain 10,00040,000 tons of cargo. The oil cargo tanks are an integral part of the ship, running from near the bow to the engine room in the stern. The bow usually contains ballast tanks, while the stern houses propulsion equipment and other machinery as well as crew's quarters and the navigating bridge in a pilot house above.

Tankers and supertankers are usually powered by steam turbines or large diesel engines driving single propellers. Commonly their operating speeds are 15–16 knots (nautical miles per hour). The ships are of all-welded steel construction, and have extra-heavy plating and framing members to form a composite structure that will resist the static and dynamic loads of the cargo in the tanks as well as the winds and waves of the external ocean.

While much larger than orclinary ships, supertankers are manned by a deck and engine-room crew of 25–35 men, equivalent to most cargo ships of much smaller sizes. Because automation of machinery and planned maintenance systems permit a small crew to cover a large expanse of ship, crew size and associated costs have remained virtually constant as ship sizes have increased and productivity has grown.

Supertankers are usually allocated to specific trade routes between major loading and unloading terminals. Because they spend much more time at sea than normal ships, crews stay aboard with little or no shore leave for several months at a time. The ship seldom spends more than a day or two in port unless undergoing major repairs.

I)rydocking facilities for supertankers are widely spread, the major repair facilities for VLCCS being located in Japan, Portugal, Singapore and ATorthern Europe. Several new facilities are under construction in the Arabian Gulf area.

The fact that very large tankers can operate at less cost per ton mile than smaller ships is evident from a simple analysis of operating costs. Capital costs per deadweight ton of ship decrease as the size increases, because machinery horsepower, the total amount of steel, and other required equipment increases at a very slow **rate compared with carrying capacity. At present, costs for a shipment of petroleum imported from the Arabian Gulf to the united States by tanker in the 50,000 dwt size category is $2 to $3 per barrel. The cost of shipping a barrel of** oil by means of a VLCC in the 250,000 dwt size category is $1.00 to $1.50 per barrel.1[2] From a net energy perspective, the system is energy-efficient for transporting oil. Having been demonstrated by experience, these form the economic rationale for the supertanker. While additional savings probably would result from still larger ships, the trend is less clear f or ships exceeding 500,000 dwt.

Only a few supertankers have begun trading in U.S. ports, and these during just the past year. Because their deep drafts prevent supertankers from entering any ports serving major refining centers on the East Coast and Gulf Coast, only the West Coast ports of Los Angeles, Puget Sount, and Long Beach, which have channels deep enough, have so far received small supertankers (of 100,000 or so dwt). Table 11–7 lists the capabilities of major U.S. tanker ports. Also, several transfers of entire VLCC cargoes to smaller vessels have been safely effected in the Gulf of Mexico and off the coast. of Southern California between Santa Catalina and San Clemente Islands.

TABLE *H-7.-Major U.S. tanker port capabilities*

Port or harbor area	Contr:;o:{ (feet)	Maximum draft vessel using areas (feet) 1970	1973	Ap~rQwJ..:I& tanker size provided for dwt
Portland, Maine---- -----------	45	51	47	80,000
Boston, Mass- ----------------	40	42	41	50, 000
New York, N. Y--------------	45	44	46	[2]55, 000
Delaware Bay to Philadelphia---	40	46	47	255, ()()
Baltimore, McL---- -----------	42	40	42	55, 000
Hampton Roads, Va- --- --- ----	45	47	47	50, 000
Jacksonville, Fla- --- ---------	40	35	35	30, 000
Houston, Tex- ----------------	40	40	40	55, 000
Galveston, Tex----- -----------	40	40	40	55, 000
Los Angeles, Calif - --- -_ -------	51	45	54	100, 000
Long Beach, Calif - ------------	55	51	54	150, 000
San Francisco Bay ---- --- --- ---	50	51	50	235, 000
Seattle area ----- --- ---------- -	60	39	39	150, 000

[2] The practice of lighterin from larger tankers at entrances to these harbors effectively doubles the maximum sizes accommodateds ıfce these larger tankers are partially unloaded before entering the port.

Note.—The largest tankers using U.S. ports are about 135,000 tons in Long Beach and 125,000 tons at Cherry Point near Seattle. The controlling depths listed for these ports are at the existing unloading terminals: plans are underway to increase these ship size capacity of each port.

Source: Corps of Engineers, "Waterborne Commerce of the United States-1973," and MARAD Division of Ports—1974. Also Port of Long Beach and Port of Seattle, January 1975.

The hazards and impacts associated with an expected acceleration of supertanker operations in U.S. waters pose a complex set of new questions: How effective would historical, standard practices be in dealing

~ M.i RAD Office of Policy and Plans, estimates.

with potential damage from tankers that are two to twenty times larger than most ships now delivering petroleum to the United States? What new protective, regulatory and control measures are needed to provide the best possible safeguards ? Are design and construction standards for supertankers such that the risk of hull and machinery failure will be acceptable over the life of the ship? What technical and logistical capabilities are available to deal with a catastrophic supertanker accident ? What economic, social and environmental impacts are to be anticipated if supertankers replace the existing large fleet of smaller tankers operating in the United States? How much control will the United States be able to exert over a supertanker fleet that operates mainly under flags of other countries?

The next section of this report will discuss possible oil pollution and safety hazards presented by all tankers in U.S. waters and, in particular, those special problems posed by the introduction of supertankers.

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~,ooo 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.

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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.

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.[g]

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

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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. "TORRlIY 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-

[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 accident and resulting pollution including estimates of inch rred costs.

[15] Michael, 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.

Chapter IV. Approaches for Reducing Pollution and Improving Safety

A. *Introduction*

This chapter deals with methodologies which address the total tanker transportation system in terms of system safety and environmental protection. This "systems approach" is considered highly desirable if meaningful improvements are to be made. Specifically, this chapter will discuss the aspects of the four interactive elements which describe the oil transportation system by tanker namely:

- the ship and its operational, design, and maintenance characteristics;
- the man who operates that ship;
- the systems (whether onboard or ashore) which furnish information and control for the man to operate that ship; and,
- the environment (in terms of wind, waves, harbor, channel configurations, traffic densities, etc.).

B. *Ship Improvement*

1. Nature of the Problem

As noted previously, the feature of tanker operations which accounts for the greatest volume of oil discharged into the sea by ships on a continuous, worldwide scale is ballasting and deballasting. Tanker accidents, on the other hand, while accounting for a lesser volume of oil discharges than do the operational discharges, have the distinct disadvantage of being large concentrated discharges often in the more ecological sensitive, near-shore zones. The following sections will describe certain ship design and construction features which would improve safety and reduce one or both of the previously discussed oil pollution sources by varying degrees. The possible improvements of each are also described.

i?. The Utilization of Segregated Ballast Spaces for Accident Protection

Although numerous alternatives have been suggested to improve the oil pollution protection of tankers, the one that has received greatest attention is the fitting of double bottoms to prevent or reduce oil spills in the event of grounding accidents.

A. DOUBLE BOT'I'OMS/DOUBLE HULLS

Double bottom construction had its advent in the early days of iron cargo ships in the latter part of the nineteenth centruy. It was necessary to provide a smooth deck on which to place the cargo within the hold, because of the cellular construction at the ship's bottom. Since then, double bottoms have been incorporated in passenger ships, naval craft (including Coast Guard vessels), combination carriers, container ships, dry bulk carriers, roll-on, roll-off vessels, etc. Moreover, every chemical tanker and liquefied flammable gas carrier are required both by the respective IMCO (International Maritime Consultative Organization) Codes and U.S. National Regulations, as published by the U.S. Coast Guard, to be provided with double hulls. (The intent here is to protect the hazardous cargoes from side and bottom damage due to collisions and grounding respectively.)

Although neither double hulls nor doube-bottom oil tankers have to date been required by regulations, a total of 34 ships so fitted are in operation, uncler construction, or under contract. These 34 tankers comprise a total of 3,483,000 deadweight tons (see Table IV-l). of these, 28 tankers, totalling 2,210,000 deadweight tons, are or will sail under the United States flag. As further shown by this same table, a great many of these tankers may enter the Alaska tn the West Coast trade.

TAIUA IV–1.—Double bottom *tankers in operation or under construction or under contract, January 1975*

Year built	Number	Deadweight *tons* (each)	Builder	Owner/operator	Flag	Remarks
1969-73	•6	***212,0@3***	***Sasebo,*** Japan	Mobil Shipping	United Kingdom and Liberia.	Foreign trade.
197476	bs	39,700	NASSCO, San Diego, Calff.	Aeron Marine	United States.	Do.
1975-76	4	89,700	do	Third Group	do	Do.
1977	2	***89,700***	do	Chestnut ShippiW	do	Do.
1976	4	89, 7CQ	do	ShipmorAssociation.	do	Alaska trade.
1977-7s	2	89,700	Todd, San Pedro, Calif.	do	do	***Do.***
1977	2	89,7CKI	do	Energy Tankers	do	Do.
1979	1	89,700	do	U.S. Linw	do	Do.
197s-79	3	89,700	do	Hawaiian International.	do	Foretgn trade.
1975-77	6	35,000	FMC, Portland, Oreg.	Chevron	do	Domestic.
1974	1	118,0tM	Sun Ship, Chester, Pa.	Not available	ado	Alaakatrade.
Total	034	3,483,000				
U.s. th3g	'28	2,210, m				

s All in service. 1 is actually *270,000* dwt.
b 1 in gervi~ec
o Mobil Oil Corp. has 7 additional tankers in the *30,000* to *40,000* range which have partial double bottoms, These tankers have double bottoms fitted beneath only the centerline cargo tanks and thusarenotincluded in the list of double bottom tankers.

Source: Maritime Administration, Office of Ship Construction, January 1975.

Table IV–2 lists all of U.S. flag tankers under construction or contract for construction as of October, 1974, according to statistics provided by the Maritime Administration. Of the total of 60 tankers under construction or under contract, within the United States 28 are of the double-hull or double-bottom design. In other words, nearly one half of the total number of ships under construction or under contract within the United States as of October, 1974, incorporate either a double hull or a double bottom. (While it is recognized that, due to the current worldwide tanker market "glut", any compilation of this sort is subject to fluctuations, it is especially noteworthy to recognize the order recently placed by two oil companies with NASSCO for 150,000 and 180,000 dwt double bottom tankers.)

TABLE IV-2.—U.S. *flag tankersqq under construction/contract, October* ***1974***

Compsny snd number	Desd-weight (w %	Estimated total cost (millions)	Percent subsidy	Owner	8cheduled delivery
Avondale Shipyards, New Orleans, La.: 6.	**165, 000**	**$400.0**	**None**	**Standard Oil of Ohio.**	**1978**
Bath Iron Works Bath, Maine: 4.	**25, 000**	**64.0**	**None**	**Marine Shipbearing Corp.**	**1975**
Bethlehem Steel Corp., Sparrows Point, Md.:					
3--.-----------	**265, 000**	**210.2**	**43**	Boston Tankers- --	1975-76
2--------------	**265, 000**	**162.9**	41	Gulf Oil---------	1976
FMC Corp., Portland, Oreg.:					
41-------------	**35, 000**	**64.4**	**None**	**Union Bank (Chevron).**	**1975**
21------------	**35,000**	**35.0**	**None**	**--- --do ----- ------**	**1977**
National Steel Co,, San Diego, Calif.:					
3 a-------------	89,700	**83.6**	**43**	Aeron Marine -----	1975
1--------------	38, 300	**18.2**	43	Margate Shipping-	1975
4 ~--------- ----	89,700	**112.8**	36	Third Group---- --	1975-76
4 ~------- ------	89, 700	**120.0**	None	Shipmore Associates.	1976
3-------------	**38,300**	**65.1**	35	Moore-Mc-Cormack.	1975-6
2 ~------------	**89, 700**	**65.8**	33	Chestnut Shipping.	1977

~ABLE IV–2.—U.S. *flag tankers under construction/contract October* 1974---Continued

Company and number	Dead-Weight tons (each)	Estimated total cost (millions)	Percent subsidy	Owner	Scheduled delivery
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.:					
2--------------	390,770	277.9	39	VLCCIanci II----	1978
l --------------	390, 770	136.6	39	Zapata -----------	1979
Seatrain Shipbuilding Corp., Brooklyn, N. Y.:					
I --------------	225, 000	57.3	43	Polk Tanker ------	1975
1--------------	225,000	70.6	41	Fillmore Tanker---	1976
1--------------	225, 000	94.2	39	Pierce Tanker ------	1977
Sun Shipbuilding & Dry Dock Co., Chester, Pa.: 1 l---	118, 300	49.0	None	Undisclosed -------	1975
Todd Shipyards Corp., *San* Pedro, Calif.:					
3--------------	25,000	48.0	None	Marine Ship Leasing.	1974
4--------------	35,000	79.4	43	Sea Service Tankers.	1975-76
2a- ------------	89,700	67.8	None	Energy Tankers Corp.	1977
2 z- ------------	89,700	67.8	None	Shipmore Associates.	1977-78
3 2---- ---------	89,700	116.4	34	Hawaiian International.	1978-79
1 2------ -------	89, 700	38.4	None	U.S. Lines --------	(a)

1 Tankers with both double bottoms and double sides, 7.
1 Tankers fitted with double bottoms, 21.
3 Not available.

NoTE.—TotfLl number under construction, 60; total deadweight tons under construction, 6,842,510 tons.

Source: Maritime Administration, Division of Ship Construction, December 1974/ January 1975.

Most of the discussion which has centered itself upon the double hull/double bottom issue might be placed in one of the following categories:

- cost;
- effectiveness, from both an operational and accidental point of view;
- safety, and
- salvage.

B. COST OF DOUBLE BOTTOMS AND HULLS

Estimates of the added costs for double hulls over the capital investment required for a conventional single-skin tanker have ranged over the last 5 years from approximately seven percent to 30 percent (or more, in some cases. The additional costs for double bottoms, on the other hand, have ranged from three percent to 22 percent, estimates indicate. (Most of these estimates were usually made on the basis of comparison with older tankers without segregated ballast capacity.)

However, in contrast to these estimates, U.S. shipyards say that, nowadays, double bottom and double hull tankers are being built at differential cost increases of approximately 3 and 5 percent respectively over the capital investment required for equivalent new single-skin tankers.1

Table IV–3 is a tabulation of the various estimates which were made between 19'71 and 19'73, the period immediately preceding the 1973 IMCO Convention. As can be seen from this table, the average of all estimates of the higher costs for double bottoms and double hulls shows differential increases of 12.3 and 17.4 percent respectively. In each case, when compared to actual construction/contractual costs, they are overestimated by a factor of three to four. (In fact, an active study is being pursued, by a Japanese shipbuilding firm for a number of countries, on the costs and feasibility of retrofitting double bottoms on existing tanke~ which transit the Malacca Straits.)

I As reported by the shipyards who are now constructing double bottom and double hull tankers.

TABLE IV–3.—Estimated cost increases (in percent) of double bottom and double hull tanker designs as compared to actual construction or contractual cost

	Double bottom des~.x increase (percent)	Double d~~~~ increse (percent)
ESTIMATES		
Tankers and the ecology, SNAME transactions, 1971.	9.6	---- --
U.S.A. segregated ballast study for IMCO, 1972-73:		
(a) 21,000 dwt designs___ -------------------	11. 9-12.7	16. 0-17.0
(b) 75,000 dwt designs- - _ ------- - ------- _____	12.2	17.2
(c) 120,000 dwt design- --- ------------------	------	22.9
(d) 250,000 dwt design- ------ ---------- ---- --	6.4-8.7	17.5
(e) 500,000 dwt design- - ---------------------	------	---- --
Ship design aspects of oil pollution abatement, 1971--	3.6	8. 0-13.1
Segregated ballast tankers, RINA, 1973------------	13. 5-17.8	12. 4-16.8
MARAD, economic viabili~y analysis from EDF, et alwvs. Peterson, etal., 1973:		
(a) 35,000 dwt tankers -------------- ---------	18.6	22.4
(b) 89,700 dwt tankers -------------- ---------	(1)	7.3
(c) 225,000 dwt tankers ---------------- ------	11.1	22.1
(d) 265,000 dwt tankers ----------------- ------	21.8	33.4
Average of all estimates -------------- ------	12.3	17.4
ACTUAL CONSTRUCTION/CONTRACTS		
212,000 dwtMobile Pegasus class built bylHI ------	4.0	------
NASSCO, 89,800dwtdesigns being builtby National Steel and Todd, San Pedro --------------------	2.5	-_----
FMC35,000dwt design --------------------------	------	4.0
Sun Shipbuilding 120,000 dwt design ------- --------	--- ---	5.0
NASSCO 150,000 dwTt design ---------------------	3.5	------
NASSCO 180,000 dw't design ---------------------	3.5	------

IProvided initially with double bottom.

C. EFFECTIVENESS OF POLLUTION PREVENTION

In regard to the effectiveness of any double hull or double bottom design there are a number of factors which n~ust be integrated; namely:

- Extent of penetration from historical data;
- The oil containment provided by the double bottom in the event of an inner bottom rupture; and
- The distribution of oil outflows as a function of the type of accident; i.e., colllsion, grounding, and rammings;
- The smooth wall/bottom feature in so far as it affects tank ballasting and cleaning, clingage and stripping.

Apart from the obvious advantages of providing segregated ballast spaces, double hull/double bottom construction below and along the cargo length can provide "defensive spaces" for the cargo in the event of a collision, grounding, ramming. (See table IV+L)

TABLE *IV-4-Effectiveness of double sides and double bottom aocording to various sources*

[In percfmt]

	I$umble	Double bottoms
United States segregated ballast study to IMCO, June 1972 and February 1973	1 15-55	60-65.0
United States segregated ballast study to IMCO, June 1972, and February 1973, alternate method of calculating double botton effectiveness		52
Preliminary analysis of tanker collisions and grounding by Bovet, January 1973	(2)	92
Effectiveness of doublt bottoms in preventing oil outflow from tanker bottom damage incidents by card, 1975		90
Booz-Allen study for Bethlehem Steel Corp. re Marad Eva in EDF versus Petersen, et al, 1973		37.5
Tankers and the ecology, 1971		73

1 For double side Widths of 1,4S m (4,79 ft) to 6,55 m (21 43 ft).

9 A complete range iaindicated as functions of striking sh~pmsw and velooity; to gfve an exam Ie however, for strikin velocitieaof9knota and lass, tohavea9Cpercent effective double side, its depth wd d ~aveto be on the ortdr of 7 m (23 ft).

Note:—The above data (except for item 4) was submitted to the 1973 IMCO Pollution Conference but that conference, after much deliberation, did not impose double ixttom requirements.

While the double side issue has not been subjected to the exhaustive studies that double bottoms have, a recent and thorough study on the effectiveness of double bottoms was conducted by LCDR J. C. Card, U. S.C.G., ("Effectiveness of Double 130ttoms in Preventing Oil Outflow from Tanker 130ttom Damage Inciclents", l!larine Technology, January, 1975.) This study analyzed 30 tanker grounding which occurred in U.S. waters during 1969 to 1973. In short, it concludes that a double bottom height of 2.0 meters would have been effective in 96 percent of the cases with an attendant 11,550 tons of oil pollution prevented; i.e., given a grounding, the probability of penetrating the inner bottom is on the order of 0.04.

In any case, it would appear from the various analyses conducted that double sides and double bottoms can distinctly provide protection, given a collision or grounding respectively. Moreover, in the more severe cases of collisions and ,groundings where the inner hull may be ruptured, the double hull or double bottoms will provide three valuable characteristics: survivability? containment and time. Survivability prevents a major incident from becoming a catastrophic event. (For instance, some time ago the 212,000 clwt, double bottom tanker, Mobil *Pegasus*, experienced a severe explosion in Number 1 center cargo tank during the course of tank cleaning/ballast operations [the ship was not inerted]. Her owners have stated that if it were not for the presence of the double bottom, the ship would have probably broken in two and sunk.) Containment of the cargo is also helped by the double hull or bottom. Finally, it will slow down the rate of oil discharge to the sea and thus buy additional time for response.

To learn more about the concepts of oil entrapment within and the effect on double hull oil outflow rates, a series of model tests were conducted on a tanker of approximately 225,000 dwt with and without a double bottom.[2] While many parameters were varied, such as wave height, ship speed, and tank pressure, in general the report concluded that, given inner bottom damage, the double bottom was very effective" in preventing pollution; above and beyond its effectiveness in preventing any inner bottom rupture. In general, the amount of oil outflow to the sea was significantly greater for the single bottom version as compared to the double version.

It also showed this same trend both in waves and with variance in tank pressure. This Disparity decreases somewhat with increased ship speed and with more water allowed in the double bottom prior to inner bottom rupture. Regardless of the quantitative values, the tests showed that much more oil was entrapped within the double bottom than previously believed (U.S. Reports to IhlCO on Segregated Ballast, Parts 1 and 2) and that oil outflow rates are distinctly lower for a double bottom hull than for its single hull counterpart.

The distribution of oil outflows by type of accident (i.e., collision. grounding, or ramming) has also been thoroughly studied. Based on the data available in 1969, and 1970, it had been stated that oil outflows clue to groundings exceeded those from collisions and rammings by a factor of three. With an additional three years of data, this same ratio

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[2] *Netherlands Ship Model Basin Report for Mobil Shipping & Transportation, Co.*, January 1972.

has decreased to something on the order to 7 to 6; or in other words, the outflows are approximately equal.

The additional three years of outflow data coupled with the cost data given h Table IV-3, which shows that the initial projected costs of complete double hulls were grossly overestimated, has supported a shift in the emphasis from double bottoms to double hulls. Thus, in the macroscopic view, it appears that double hulls deserve more consideration that previously given. It should be noted that a view opposing double bottoms is stated in a booklet "Double Bottoms—Yes or No" issued by the American Institute of. Merchant Shipping. The principal negative reasons are safety and salvage considerations which are discussed in the following sections.

In addition to providing tankage for the segregated ballast and defensive spaces from collisions, grounding, and rammings, there are some other eff~ts which are derived from the incorporation of a double hull or double bottom design; namely, the smooth tank bottom surface which does not have the usual cellular structure to either obstruct the flow of oil during discharge or provide additional surface area upon which the heavier oils will adhere; i.e., increases the efficiency of the (hscharge operation and reduces clin~age. Additionally, the double bottom will allow pump suctions to be placed below the tank bottom as opposed to the conventional suction bellmouths which are above the tank bottom. The effect here is that the main cargo pumps can draw suction for a longer period of time, thus minimizing discharge time and, secondly, when the stripping pumps are being usecl, they can draw suction for a longer periocl of time, thus allowing more cargo to be delivered,

Overall then, the double hull or double bottom design allows more cargo to be discharged (i.e., an increased payload per voyage), it increases the efficiency of the cargo discharge operation (i.e., reduce turnaround time), ancl it mitigates the sludge build-up problem due to both the ability to draw off the bottom more efficiently and the lesser amount of clingage. (The net effect of having less sludge build-up is that tank cleaning frequencies and the associated problems of the treatment and disposition of tank cleaning residues can be minimized.)

C. SAFETY OF DOUBLE BOTTOMS AND HULLS

Ever since double hulls and double bottoms have been proposed for oil tankers, there has been genuine concern expressed by people as to aspects of these designs which might be counter-productive in terms of safety. For the most part these concerns are: (1) the possibility of the accumulation of flammable vapors in the spaces between the outer hull and the cargo tanks; and (2) the concept of lost buoyancy or added weight which a double hull or double bottom tanker will experience when the outer shell is punctured.

13xplosion potential aboard oil tankers has existed from their very inception. Whenever one can introduce an ignition source to a vapor-air mixture within the flammable limits of a product in a confined space, an explosion will occur. Throughout the years, explosion protection has been achieved by precluding any ignition sources from hazardous areas aboard the tankers and in some instances (through an inerting system) by not ever allowing the tank medium to pass through the flammable range.

Insofar as the safety of enclosed spaces adjacent to cargo tanks is concerned, void spaces and pumprooms have always been present aboard oil tankers. Moreover, many classes of vessels, including cargo ships ancl combination carriers, have operated with bulk flammable liquids above a clouble bottom or adjacent to a transverse or longitudinal void space; neither have exhibited any explosion record in these spaces. (Also as mentioned earlier, regulatory agencies vequire double hulls on chemical carriers and liquefied flammable gas carriers.) Specifically, during 1973 and 1974, worldwide tankers had an explosion/fire casualty rate of 4.1, while ore/oil carriers and bulk/oil carriers had explosion/fire rates of 4.4 and 8.3 respectively. While at first glance these figures might suggest that the bulk/oil carriers have a high potential for explosions related to their double bottoms, in none of the 13 cases did the explosion occur in the double bottom. According to an article in Motor Ship, June, 19’74, the International Chamber of Shipping has indicated that they suspect the cause of the bulk/oil carrier explosions to be due to either static electricity discharge in a slack tank, or ignition by compression clue to sloshing. In any case, it is not the double bottom that is the causative factor for the cxplosic,ns. Moreover, the explosions involve a situation peculiar to the bulk/oil carriers.

Finally, with respect to the explosion potential issue, if there were an accumulation of flammable vapors in the double hull or double bottom, there are]nuch fewer ignition sources present to cause an explosion than in cargo tanks. Moreover, on every ballast voyage, the double hull or double bottom will be “gas-freed” by the infusion of the ballast water to these spaces.

D. SALVAGE CONSIDERATIONS OF DOUBLE BOTTOMS

The issue pertaining to the lost. buoyancy of a tanker with a double bottom stems from a basic principle of naval architecture. That is, when a conventional single skin tanker is “holed” in the bottom? oil escapes to the sea and the ship actually rises; on the other hand> a double bottom version when punctured in the bottom does not lose oil, but rather floods a portion of. the double bottom with seawater and thus sinks deeper into the water. The question raisecl is, can this lead to a more hazardous situation by having the tanker more firmly aground?

As previously indicated, many other ship types (combination carriers, chemical carriers, cargo ships, etc.) have double bottoms and have not indicated any a,dverse effects in a grounding due to the presence of the double bottom. In fact, sinking rates due to grounding are less for these types of ships. Secondly, from a salvage point of view> it is more advantageous to keep the ship as firmly aground as possible and then give her sufficient buoyancy an(l proper trim at the selected moment for refloating. In fact, this was precisely t]]e situation with the ilfetuZa grounding incident.. *Metu?a* was initially only aground in the forward portion of the ship and lost some 6,000 tons of oil. However, tides and currents swung *Metu7a* such that she became totally aground, including the flooding of the engineroom, and subsequently lost an additional 49,000 tons of cargo. The salvers were then faced with the prospect of eithe r discharging oil to the sea to generate the necessary buoyancy or 1 ightering it to another tanker, which was not an easy feat. A tanker with a. clouble bottom, on the other hand, may have been more firmly aground initially and thus precluded the tanker% further movement. 1t would also have provided more options to the salvers in terms of directly dewatering the double bottoms without oil discharge as well as providing additional compartmentation. As a matter of fact, the office of the Supervisor of Salvage of the U.S. Navy has indicated that the additional compartmentation of a double bottom design along with the more stabilized platform of a more firmly grounded vessel is a distinct advantage. To quote,"1 view the probability of a major sal~'age or pollution incident growing out of the grounding of a large single-bottom tanker an order of magnitude greater than for a double bottom tanker.'?

3. *Controllability Aspects*

one of the most discussed facets of tanker operations is controllability. For purposes of discussion herein, ship controllability is defined as the ability of the operator to control the ship according to the ship's inherent hydrodynamic characteristics and as modified by both the local environment in which the ship is operat ing and any periph~ral equipment (either on board or onshore) which furnish information :md/or control to the operator. Probably the most widely quoted statistic pertaining to supertanker controllability is its full-throttle-reverse stopping distance at 16 knots. For this maneuver, the supertanker requires about three nautical miles whereas a much smaller tanker (1'7,000 dwt) requires something less than one nautical mile.'

' Crane, C. L., *Maneuvering Safety of Large Tankers: Stopping, Turning and Speed Selection,* Transaction, **SNAME,** 1973. Full scale **trials** of three tankers of 191,000 **dwt** each demonstrated crash stopping **distances** of 14,400, 15,500 **and** 1%600 feet.

One would presume, however, that ships in general. and large oil tankers in particular, will be operating at speeds well below the 1(; knots when **in congested traffic areas or within the confines of a harbor. In fact, one would expect maneuvering speeds on the order of six knots,** wherein the stopping distances are reduced to three-quarters of a naut ical mile for a 250,000 dwt tanker and one-quarter of a nautical mile for a small tanker.

While speed regimes, or the limit thereof, narrow the disparity among tanker sizes, the tremendous difference in mass and the decrease in horsepower to displacement ratio of the larger tankers are such that at a given approach speed, the larger tanker will always require]]~ore distance and area in which to stop. ~~asica]ly, stopping performance is governed by ship size, speecl of approach, loading condition? astern thrust, time lag in reversing the propeller, added hydrodynamic resistance, added ~lo~ll]~'{lr"od~'~~amic retarding force, and use of tugboats.

As previously indicated, stopping distance increases with both ship size and approach speed; i.e., mass and velocity, the two parameters of kinetic energy. Thus, to minimize stopping distance for a gi}"en ship one must consider one or more of the following:

- Approach speed reductions;
- Ability to deliver more astern thrust;
- Ability to deliver astern thrust more rapidly; i.e., more quickly reverse the propeller;
- Added hydrodynamic resistance such as might be provided by parachutes and brake flaps;
- .Added nonhydrodynarnic retarding forces such as a rocket motor; and
- The use of tugboats.

Given that ship sizes, due to the economies of scale will probably not become smaller and that, after a point, approach speeds can become so low as to generate loss of steerageway, reducing ship size and minimizing approach speeds have limited application. However, in cases where wind and current effects are minimal, some studies indicate **that very low (2-3 knots) approach speeds can be maintained by a fully loaded tanker without losing steerageway. Based on improving a ship's stopping distance from slow and moderate speeds, the effectiveness** of practical l~min propulsion alternatives (that will deliver l~~ore astern power and cleliver it more rapidly is ranked as follows: double astern power, controllable-pitch propeller, slow-speed diesel, and ducted propeller. For in~proving stopping ability from h@l approach spee~~s. the ranking of effectiveness of practical main propulsion alternatives is: cent rollable-pitch propeller, double astern power, and ductecl propeller.

(The slow-speed diesel v-ould not be particularly useful here because reversing could not be attempted tintil ship speed and propeller speed had decelerated to safe levels.) In all, it may be said that it is of prime importance to minimize delays in response to engine orders, and make full use of astern power. (However, although this is emphasized, a large tanker's stopping response is rather insensitive to the time delay factor beyond that achievable with current main propulsion systems.)

Special hydrodynamic braking devices producing additional resistance do not at this time appear practical. These include water parachutes, wata brake flaps, bow flaps, and splayed twin mddem. At slow speeds, such devices would have to be enormous to be effective, and at high speeds they would present difficulties of construction, strength, arrangement, and handling. However, there may be some benefit to improving directional control while stopping and while going ahead at slow speeds.

Similarly, special devices, such as rockets producing nonhydrodynamic retarding force to aid in stopping, have generally little effect and are not practical.

In general it may be said that both added hydrodynamic resistance devices and added nonhydrodynamic retarding force devices appear to be unwieldly, impractical, or to have low cost effectiveness compared with other methods.[4]

Although dramatic improvements in stopping performance cannot be expected with increased power alone, this might be worthwhile if deemed needed and available at relatively small expense. Other alternatives which might be considered are combining a reversible slow-speed diesel with a controllable pitch propeller, or combining a ducted propeller with either steam turbine or diesel machinery. Tugboats are regularly used to provide stopping force at slow speeds within a harbor. Given the tugs fixed to the tanker in "power tie-up>' so that the forward speed of the tanker and tugs is always the same, the effect of the tugboats is essentially that of an added constant retarding force. Their effect will vary as a function of ship size, approach speed, ship horsepower, number and size of tugboats, and local conditions in terms of wind, current, channel configuration, etc.

As previously indicated, another aspect of tanker controllability is low speed maneuverability. That is, when a tanker% speed through the water reaches a certain minimal level (below 34 knots), and external forces such as wind and current become more dominant, there is insufficient directional control afforded by the rudder. This so-called loss of steerageway at low speeds leaves a tanker vulnerable to col-

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d Crane suggests that the most effective mechanisms for increased stopping ability are to increase astern power, provide controllable pitch propellers, power by slow speed diesel and/or tlt ducted propellers. He also demonstrates relatively small improvements gained by other added devices.

lisions with other ships and fixed structures as well as susceptible to grounding.

In order to afford a tanker more turning moment at the low speeds (which also normally coincides with shallower water in which it is more difficult to turn) such concepts as lateral thrusters, twin screw propulsion systems, twin rudders, and the employment of tugboats have been considered. In a case studied on a single screw, single rudder 60,000 dwt tanker at a rudder angle of 30 degrees, the turning moment at a ship's speecl of three knots is less than twenty percent of the turning moment for eight knots. VVith a 1,500 HP lateral thruster employed, however> the combined turning moment generated at three knots by the rudder and the thruster is two and one-half times greater. Similar improvements are available with installations on larger tankers, although these ship's greater inertia detracts from their maneuverability even more so at slow speeds. In addition, lateral thrusters presently are limited to about 3,000 horsepower and the ratio of lateral thrust available to lateral resistance decreases with increasing ship size.[5]

In berthing operations at these low speeds (below 4 knots) maneuvering aids are absolutely essential to provide lateral control to a tanker. Tugboats have been used traditionally to fill this need. However, the effectiveness of lateral thrusters is such that at zero speed a thruster will deliver lateral thrust approximately equal to that delivered by a tug of the same horsepower. The thruster's advantages are that lateral forces are easily controlled by the docking master or pilot, whereas tugboats may be out of position at the time they are needed. Tugboats are also handicapped by the necessity of relaying orders from the ship to them. Conventional thrusters, however, cannot deliver thrust to affect forward or astern motion of the ship which a tugboat can easily do. In most instances, lateral thrusters have been installed to supplement tugboat assistance rather than to entirely eliminate it. ~ lateral thruster requires a differential cost increase in capital investment of something on the order of two percent.

Twin screw propulsion of ships generally results in improved maneuverability. lt~ost merchant ships employ single screw propulsion clue to its higher hydrodynamic efficiency and lower cost. The prime disadvantage of twin screw systems is the necessarily more complex power plant used, which results in a greater initial capital investment of approximately eight percent. Slow speed berthing operations are perhaps the situations in which twin screw capability would be most used and in which the greatest maneuvering benefits would accrue.

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[6] A bow thruster can be quite effective at very slow speeds but ineffective at high speed (see Crnne).

Twin screws on a large tanker would have one main advantage for controllability: If a rudder was located behind each, one engine could be reversed to avoid forward acceleration as the other thrusts ahead to provide flow over its associated rudder. (Differential speeds and directions of rotation at higher ship speeds would not be a practical mode of operation. hforeover, unless twin rudders were simultaneously employed, no significant improvement in developing rudder forces would be realized since rudders derive much of their effectiveness from being placed in a propeller's race.)

With smaller diameter propellers, which are inherent to a twin screw design as opposed to the single screw variety, there will be a reduction in available astern thrust for a given horsepower. Improved control during a stop may nonetheless be possible, thus aiding in the avoiding of accidents in areas with limited maneuvering room. (As a side issue, twin screw propulsion systems will provide added reliability in terms of having redundant propellers, shafting, gearing, engines, etc.)

As previously indicated, rudders deri}"e much of their effectiveness by being placed directly behind a propeller. Thus, to maximize the rudder generated forces of a twin rudder installation, these should be employed in concert with twin screws. Twin rudders, whether utilized to their full capacity behind twin screws or used with only a single screw, will have their impact felt only at speeds above four knots. Just as with a single rudder, when ship speeds become so low as to not create sufficient rudder lift, the twin rudders become relatively inefl'ective.

In many low speed maneuvering conditions and in practically all berthing operations, tugboat assistance will be required to at least provide astern and forward motion. Additionally, depending on the ship>s ability to generate lateral thrust at low speed through the use of thrusters, twin screws, etc., tugboats will be necessary to assist in providing the necessary side forces.

Certainly controllability of supertankers is an area in which additional research into the subject may be very desirable for future ship and port designs.

4. Cargo Tank Atmo~phere ContvoZ (Iwrt gas system)

With flammable cargoes, such as crude oil and its refined products, the hydrocarbon vapor in the ullage space (the space between the liquid cargo surface and the tank top) is above the upper flammable limit and thus too rich for combustion to occur. However, at all other times of operation when the tank has not been gas-freed, a flammable mixture (11 to 21 percent of air by volume) usually exists somewhere with the tank. Thus, given the proper mixture of flammable vapor and air> any ignition source can cause an explosion. Generally, the flammable mixture will be within the tank during cargo handling operations and during tank cleaning operations; both are times when the ignition potential is highest through electrostatic discharge phenomena, by either the introduction of other elements to the tank atmosphere, such as tank washing apparatus, or by a direct ignition source coming into contact with the flammable mixture.

The object of an inerting system is to reduce the oxygen level well below the lower flammable limit by displacement of the oxygen with an inert gas. The inert gas may be derived from either an inert gas generator or, as is more popularly done, derived from boiler exhaust gases. In the second instance, the only special equipment required is that associated with cooling, washing, and delivering the inert gas to the tanks.

The composition of the flue gases using a water free measurement criterion is: carbon dioxide ($C0_2$) 12–14 percent; oxygen (0_2) 4 percent; sulfur dioxide (S02) o.%-().3 percent; and, nitrogen (N*) the remainder. The more efficient the combustion, through control of excew air> the higher will be the proportion of carbon dioxide in the g~e% and the lower the proportion of oxygen. After passing through the cooling and cleaning process, the gas composition is only slightly different; the sudfur dioxide, itself corrosive, is washed out, and the amount of water vapor is reduced. Nitrogen and carbon dioxide concentrations are practically unchanged.

Corrosion of steel and combustion or explosion of hydrocarbon vapors are only possible in the presence of sufficient oxygen. Ordinary air contains about 21 percent oxygen which is adequate to support both corrosion and combustion. An inert gas system displaces the original hydrocarbon-air mixture such that the oxygen level in the tank does not exceed five percent by volume. Thus combustion cannot occur due to the lack of sufficient oxygen quantities. Simultaneously, the inert gas system minimizes the corrosion rate of the most susceptible under-deck longitudimds by some 40 percent. Finally, untreated flue gases contain approximately 250 milligrams per cubic meter of solicl material (soot) which are normally discharged to the atmosphere. ~~sing a flue gas inerting system, the solid material discharged is reduced to less than four percent of the noninerted system or some eight milligrams per cubic meter.

To date, both IAICO and ICS have recommended against the use of high-capacity tank-cleaning machines without the usc of an inert gas system. 111.4 R.41), in consideration of the explosion hazard on the larger tankers, requires inert gas system installations on subsidized tankers of 100,000 dwt and greater. The L'.S. Coast Guard has indicated a similar preference in an Advanced Notice of Proposed Rulemaking.

It is important to note, however, that while IMCO, ICS, MARAD, and the Coast Guard have recognized the special explosion hazard which exists on the larger crude carriers during the course of tank cieaning operations, the explosion potential remains for all tankers, regardless of size, (and with many classes of petroleum products) without inert gas systems whenever the tank atmosphere is within the flammable range. It appears that only requiring inert gas systems on tankers above 100,000 dwt does not address the total problem. It should also be noted that inert gas systems could be retrofitted on most existing tankers for costs similar to those of fitting the same system on *a* new ship.

C. Mm"ntenance

Oil tankers sinking from structural failures and thereby losing their cargo of oil to the oceans contribute nearly *75,000* **long tons (25,000,000 gallons) of oil pollution each year. In fact, during the 1969–1972 reporting period, the ECXl [a] casualty statistics list 16 oil tankers with an** average age of 17 years which sank and contributed, in themselves, over 260,000 long tons of oil pollution.

All of these 16 oil tanker structural failures occurred at sea. Apart from ecological effects, their impact must not be disregarded for three reasons:

The large number of shipboard personnel being lost with the ship;

The large quantity of oil (25,000,000 gallons) being lost each year; and,

The loss of the ship, itself. .

Table IV-5 and Table IV-6 illustrate the number of structural failures which resulted in oil pollution and their associated oil outflows as a function of the age of the oil tanker. Additionally, these Tables show that tankers which are less than ten years of age (43 percent of the total fleet) account for less than *28* percent of the structural failures and *4* percent of the associated oil outflow.

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a Engineering Computer **Optecnomlcs,** Inc. **(ECO),** Arnold, Maryland, 21012.

TABLE *IV-5.-Distribution of t?te number of structural failures as a function of tanker age for the period of 1969-?'~ 1*

Tanker age (years)	Number of structural failures	Perce&t&f structural faflures	Perce&tg{ ta;k:~	Percent of structural failures/ percent of tanker fleet
0 to 4----- -------------	14	12	20	0.62
5 to 9-----------------	17	15	23	.64
10 to 14----------------	25	22	25	.88
15 to 19----------------	37	33	15	2.17
20 to 24----------------	15	13	5	2.57
25 to 29----------------	3	3	7	.42
Over 30------- _ --------	2	2	5	.35
Total- -----------	113	100	100	_.-.--------

I Based on oil tankers greater than 100 grt from the ECO accident statistics.

TABLE *IV-6.—Distribution of the oil outjlow from structural failures as a function of tanker age for the period of 1969-Z??* [1]

Tanker age (years)	Nurnb~j Str;$uc;:;	Asaoci-8tCd oil outflow in long tons	Percent toi[oil outflow	Percent of total tanker fleet	Percent of oil Outtlowl per~~; fleet
0 to 4------- --- ------	14	6,053	2.03	20	0.10
5 to 9----- -----------	17	4,770	2.00	23	.07
10 to 14--------------	25	30,222	10.11	25	40
15 to 19--------------	37	167,928	56.20	15	3: 72
20 to 24--------------	15	89,719	30.02	5	5.82
25 to 29--------------	3	90	0.03	7	.005
Over 30---- _ ---------	2	17	0.01	5	.002
Total- ---------	113	1298,799	100.00	100	----------

1 Baaed on oil tankers greater than 100 grt from the ECO accident statistics.
* 2 structural failures wfth a total outflow of 20,440 long tons are not included within this table since the age of the 2 tankers was indeterminate.

On the other hand, tankers which range between **10** and *20* years of age *(40* percent of the total fleet), account for nearly 55 percent of the structural failures and over *66* percent of the associated oil outflow.

This means that a l&year-old oil tanker has over three times the probability of having a structural failure as compared with a tanker of less than 10 years of age.

With respect to oil outflow, a 15-year-old tanker loses, on an average, nearly ten times the amount of oil per accident, when compared with an oil tanker of less than 10 years of age.

A significant portion of tanker polluting accidents has been traced to hull failures, which in most cases have resulted in total ship losses.[7] High stresses in rough water are common to all tankers and can result in fatigue cracks which propagate across the hull structure if these fatigue cracks are not detected during the early stages of their development.'

A "special" marine inspection procedure could discover these potential structural problems.[8] Specifically, when an oil tanker becomes **10** years old, the surveyors may want to consider combining the experience of their merchant marine inspectors with the expertise of their **trained naval architects and conduct a rigorous, detailed inspection of the subject 10 year old tanker. It is foreseen that the surveyors' "in-**spection team" (the marine inspectors and naval architects), would be equipped with appropriate nondestructive-testing instruments to enable them to properly determine the amount of corrosion within the critical amidships structural band. The maintenance and operation of machinery, including any electrical/electronic components, should also be thoroughly examined. Upon completion of this "special inspection", the inspectors would have a good handle on the structural adequacy of the subject tanker and could do the following:

- Continue to allow the tanker to operate in a manner similar to her first ten years of operation;
- s Limit operations to protected waters;
- Recommend the necessary corrective action to enable her to continue full oceans service; or,
- . Reduce the stress level within the hull structure by reducing the sagging bending moment through conversion of amidships cargo tanks to clean ballast tanks.

With respect to this last item, Mr. A. McKenzie, Director of the Tanker Advisory Center. suggested in a recent article that the present idle tanker capacity should be converted into an equivalent amount of

7 The SS ***Texaco-Oklahoma,*** which broke in half durg a **March** 1971 storm 120 miles east of Cape Hatteras, North Carolina with the loss of **31 lives and spilled** her **cargo** of 30,000 tons of black oil, 1s a typical example. See NTSB Marine Casualty Report, July, 1972.

8 Keith and **Porricelli**, "An Analysis of Oil Outflow due to Tanker Accidents," and McKenzie, "A Study **of** Tanker **Total** Losses 1964–1973," October, 1974.

9 The **USCG** and **classification** societies conduct periodic surveys **of** all ships licensed or "classed." Such surveys of hull steel are very **difficult** in large ships and tend to be more spot checks than careful inspections and tests. The proposal here is for very careful and more detailed inspections of both the hull and machinery of 011 tankers reaching 10 years of age.

segregated ballast capacity on existing tanke.rs.l" This action would not only reduce the present excess tanker capacity but may also curtail oil pollution by reducing the number of structural failures through a lower associated hull stress level, This practice would also reduce the operational oil pollution through the designated clean ballast tanks.

It has been estinmted that b-y converting an existing "dirty ballast') 70,000 dwt tanker to a "clean ballast'" oil tanker, as proposed by the International Conference for the Prevention of Pollution from Ships for *future oil* tankers of 70,000 dwt and greater, the cargo deadweight (payload) wotlld be reduced by approximately 30 percent and the associated shipyard modification cost would be approximately $100,000. .4dditionally, the maximum stress level within the hull structure could be reduced by as much as 20 percent, through the judicious choice of cargo tanks which would be redesignated as clean ballast tanks.

D. Personnel Training and Licensing

over *50* percent of the collision or grounding type of tanker casualties can be attributed to human error. Moreover, the tanker cas~lalty rate has not shown any decrease over the past years; in fact, both the number of collisions and the associated oil pollution from collisions have actually increased over the original 1969–19'70 casualty data, while the actual number of operating tankers throughout the world has remained nearly constant. The 6,000 oil tankers, over 100 gross tons, presently in operation throughout the world are involved in over 700 accidents with a resultant oil pollution in excess of 200,000 tons, *each year."* With this record the need for improved personnel training and licensing is self-evident.

By contrast, frequency of accidents within the aviation field as recorded by the National Transportation Safety Board (NTSB) show significant progress in improving overall flight safety. In fact, the fatality rate 12 has decreased from 5.2 to less than 0.1, or a 50 fold increase in the level of safety. IVhile some caution must be exercised in the transference of technology from the aviation industry to the marine industry, many of the principles are similar. Therefore> a considerable advance in the level of safety within the marine industry could be achieved by adapting some of the "tried and proven" techniques of their counterparts in the field of aviation.

The comments presented within this section on training and licensing can be app]ied to Marine Pilots and Docking Masters as well as

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[10] }f~~enzie, A. M., "Tanker Conversions Advocated", Journal of Commerce. March 25, 1975.
[11] USCG, "An Analysis of Oil Outflows Due to Tanker Accidents 1971–72."
[12] Fatality rate is defined as the number of passenger fatalities per 100 million passenger miles.

ships' officers. Many are excerpts, updated when necessary, from work originally advanced in May, 1972.[13]

1. Training

Airline.—At least so far, candidates have entered the commercial airline field as well-trained and qualified pilots. According to one airline representative, candidates average almost four years of college and some 1,500 hours of flying experience. The airlines build on this experience with extensive training and retraining during the course of a man% flight career. The basic attitude and philosophy of the airline seems to be that training is the key to safety and crewmen must be taught to fly, and handle emergency situations for that matter, according to prescribed procedures.

As far as the United States is concerned, regulations require that both commercial and airline-operated training schools and programs (including both ground and flight training) be approved by the 'FAA. Regulations also require that airline flight crews receive annual recurrent training, and that those programs be approved by the FAA. The purpose of such recurrent training is to:

- Review and practice emergency procedures;
- Review contemplated equipment or procedural modifications; and
- Review proper flight procedures.

The major U.S. airlines make extensive use of centralized training facilities complete with full-scale equipment mock-ups and other visual aids. They utilize simulators both with and without visual displays in all phases of flight training. on the basis of a one company sample their training personnel are very high caliber, competent, dedicated people themselves well trained in teaching techniques.

Marine.—In the marine area, officer training begins in the maritime academies which in the United States are authorized to grant college degrees. From there, training is generally on-the-job in nature, and relatively few shipowners have any formalized in-house training programs. Some marine operators have utilized ship model training and, more recently, real-time ship simulators to teach shiphandling. Others have shipboard safety inspection training of one sort or another. As mentioned earlier, the training of junior officers is in the hands of senior officers who may or may not be so inclined or qualified to provide this training. No refresher or recurrent training is required by regulation.

Comments.—In light of the importance placed upon training by the aviation industry in relation to the overall concept of flight safety, it

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[13] Ma&~, Nicastro, and Schumacher, "Aviation Marine, A Study of Contrast", 17th Annual Tanker Conference, May—1972.

would appear desirable for the marine industry to re-evaluate its own training practices. specific items include:

The curriculum of maritime training academies should be reviewed to ensure that up-to-date instruction is being given in such things as shiphandling and maneuvering> navigation and collision avoidance, cargo handling, etc. This is particularly important in light of the larger and/or more complex vessels that are now becoming common, and the availability of vessel simulators and more sophisticated electronc gear. Liquid cargo handling is hardly covered in todayk courses. Furthermore, the training and instruction to be given a cadet during his pre-licensing shipboard service should be formalized and made more specific. At the present time, it is essentially left to the Master of the vessel to which he is assigned.

Some form of formal training should be required before an officer can advance in grade. For example, this could take the form of stimulator, navigation, and/or collision avoidance training.

Some form of periodic, recurrent training should also be required to validate licenses. This again could take the form of real-time simulation training in maneuvering and in collision avoidance procedures. Perhaps! some actual ship board training, at sea, could be used as a follow-up to real-time simulation.

2. Lict?m"ng

Airline.—Pilot licensing requirements in the aviation industry are well controlled and administered by national governments. The regulations are designed to ensure that all aircraft are piloted by well-qualifiecl, medically fit personnel. In the case of commercial airlines, the regulations further ensure that the pilot is qualified on the particular aircraft he plans to fly, and that he maintains both medical fitness and flying proficiency. The key points are highlighted below:

In the U'nited States, the pilot of any and every t ype of aircraft must hold a current license issued by the Federal Aviation Administration (F.4.4) and validated for the type (single or multi-engine), CIWW (under or over 12,500 pounds gross weight) ? and category of operation (private, commercial, air transport, etc.). Furthermore, any pilot who wishes to operate his aircraft when visibility may be restricted must also hold an instrument rating on his license.

Specific requirements for the various kinds of licenses ~mry. However, in general, an applicant must pass a written examination, rornplete flight, training, and then undergo a flight test in an airplane of the appropriate type to demonstrate his skill and proficiency to an FAA flight examiner. Every licensed pilot must also hold a valid medical certificate.

An airline captain by regulation must hold an airline transport rating for the specific type of aircraft he plans to fly. Candidates for this rating must have accumulated a specified minimum amount of flight time, must pass a very rigid medical exam, and must pass a flight proficiency test on the particular aircraft involved. Parts of the latter ma-y now be performed in simulators. The latter two items must be repeated every six months to hold the rating.

The pilot licensing standards of the regulatory authorities of other national governments closely parallel those of the FAA. This is particularly so when the country has an international airline and is a member of the International Civil Aviation organization (ICAO), a branch of the United Nations. Many countries, lacking their own airline pilot training facilities, have their pilots trained by airlines or flight training schools in the United States or the United Kingdom. For this reason, plus the fact that perhaps 95 percent of the world's commercial airliners are manufactured in these two countries, it is not surprising that English is the international standard language of the industry.

Although not specifically covered by regulation, it is important for comparison with marine operations to understand the procedures whereby an individual advances through the flight crew ranks of the airlines to the position of Clapt ain. F] ight c re ~~" candidates must l]a~"e a **commercial pilot license and some minimunl amount of flying time. This ~'aries witl~ the airline, but is in the range of 400 to 500 hours. At least up until now, the majority of candidates have had military flying experience with flight time well above these minimums. Candidates are thoroughly screened ~'ia interviews, aptitude tests, psychological tests, and medical exams.** i~fteI' sllch testing the airhne will accept only those candidates they feel have the mental and physical ability and aptitude to achieve L'aptain% status. Those accepted go to three to four months' ground and flight school, finally qualifying as flight engineers for a certain type aircraft (i.e., 707, DC-8, 727. 74'7. etc.). The man will then advance to J?irst Officer, and finally captain on a seniority basis, with both gp.ound and flight training required be**tween advancement steps, as well as some minimum amount of flying time in grade. In addition, any officer must receive rather extensive** ~roun~ and fli@t training before he can fly as a crewman on a different type of aircraft. As described above, a man must obtain an airline transport rating before he can function as Captain.

llfcmhe.-Marine deck officers are also licensecl by national governments. The first license is obtained upon graduation from ~overnment-

sponsored n)erchant marine aca[lemies, and service as a cadet (nonlicensed officer). very few, if any, officers now come up through the seaman ranks or enter merchant marine service following a naval career.

Advancement is made up throu@~ the officer ranks on the basis of *some* minimum sea tin]e in grade, followed by taking a government administered written examination for the next grade. Since an ocean license qualifies the holder to serve on any vessel from a sailing ship to the Queen Elizabeth 11, without regard to either vessel size or type, the exan]ination in professional subjects such as seamanship, cargo hand]ing, ship construction and nomenclature, and related subjects, is more theoretical in nature than of practical value in today's en}'irol~ment. No demonst ration of proficiency is required. The training of junior officers is in the hands of senior officers.

In contrast to aviation, the operators of small craft (under 100 tons) need not have any license. Hence, operators of pleasure boats, as well as some of the smaller commercial boats, require no licenses.

Marine licenses issued in the United States must be renewed every five years. In order to qualify for license renewal, a man must have had either service as an officer during the preceding three years, not necessarily in the rank of the license, or in a job ashore related to the operation of ocean ships. A test for colorblindness is given along with an open book examination on the "Rules of the Road' '—the latter mainly to ensure that the applicant is aware of any changes that have taken place during the preceding five years. Licenses in other countries are issued for life.

The contrast with aviation in the area of licensing is striking. Marine licenses in themsell"es cIo not assure competency. Licenses of airline flight crewmen come much closer to doing so in light of the extensive formal training and proficiency testing required, coupled with the tough hiring practices of the airlines. Many individual marine operators do have their own more restrictive employment practices to ensure that their people are competent. However, since in many cases both officers and crew are considered casual labor by ship operators, it would appear desirable to stiffen international maritime licensing requirements to include:

- Performance testing of some sort under both normal and stress conditions prior to issuing a license;
- Periodic proficiency checks to maintain a license; and,
- Some restriction as to size and **type of ship the indivifiual.** is licensed to operate (i.e., small vs. supertankers. anf~ frpighter vs. tanker). This implies, of course. that both written and performance examinations would vary as require(l to demonstrate proficiency and competence in handling the size and class]'essel involved.

co?n.men~s.-l~hile the marine industry lags desperately behind its aviation counterpart with respect to a transportational safety level, upgrading of the U.S. Coast Guard licensin g practices is being considered to include requirements for more direct supertanker experience for persons requesting licenses h operate these 1arge vessels. These proposed requirements are now under study and will be published within the near future.

Many experts contend that licenses for any large tanker operation. whether it be oil or any other hazardous commodity, should consider both the ships' size and cargo. They also contend that these operations should include regular training courses, upgrading programs, proficiency tests and safety instruction with respect to both the ship and the cargo.

The National Academy of Sciences is conducting a study of human errors in ship accidents through a series of interviews with shipboard personnel, and MARAD is preparing a pollution control manual and a study course for instructing shipboard personnel in pollution control methods.

All of these efforts should be closely coordinated with the intent of broadening and improving licensing and training practices for all U.S. merchant mariners and for others who operate in our waters.

3. Captain/Pilot Operations

Another area in need of attention is the present ambiguous relationship which exists between ships' masters and ships? pilots with respect to the pilot having control of the ship but the master having the responsibility for the safety of the ship. This relationship was highlighted on January 31,1975, when the Edgar M. Queewy struck the oil tanker *Com*nt?w8* near Marcus Hook, Pennsylvania, with the loss of *25 lives, 2000* tons of **oil pollution, and a tanker. The Queeny's Captain took control from the Queeny's Pilot while the ship was maneuvering near the BP dock where the** *Corz"ntho8* **was** discharging her cargo. The Captain then ordered the engines full astern, the @weny then struck the *Com"ntho8,* an explosion ensued and the State of Delaware suffered its worst marine accident in history.

Whether this accident would have been prevented or whether this accident would have resulted in even worse consequences had the Captain not taken control from the Pilot will probably never be known but it is a clear indication that improvements are required.

In light of the newer, larger, more complex ships now becoming commonplace throughout the world, another innovation is the "piloting team" concept. The "piloting team") usually consists of three qualified pilots, a Chief Pilot and two assistant pilots. One assistant pilot is normally responsible to the Chief Pilot for any tugboats, while the other is stationed on the bridge to assure that the ('hief Pilot's commands art' properly executed. The ships' Master assists the Chief Pilot continuously during any maneuver and translates his commands, if necessary, to the ships' bridge personnel. This team concept has worked extrenwlj? well on the Very Large Crude carriers (VLCCS) operating at the Hess Refinery in St. Croix. A natural extension of this "piloting team" concept would give the Chief Pilot both the control and responsibility of the ship, thus freeing the Master and his license fronl any repercussions should the Chief Pilot err. Moreover, it would prevent the ship's Master from assuming control> during the execution of a maneu~-er which was originated by the Chief **Pilot,** with potentially disastrous results.

E. Information and Control Systems

1. *Gerwrat*

Given a ship and men to operate the ship, there exists an entire realm of subsystems which furnish information to the operator upon which he makes decisions and/or which furnish control to him in execution of his commands. In general, these subsystems fall into six broad categories; namely:

- navigational aid systems;
- communications systems;
- information systems;
- control systems;
- vessel traffic systems; and
- collision avoidance systems.

A?. *~avigationa$ Aid 8y8te?n#*

The **navigational aid system is composed of those subsystems which permit a tanker to establish its navigational position. They include, but are not limited to:**

- improl,ed aids to nal.igation (buoys, ranges, structure% et~~)
- dual radar systems;
- satellite navigation systems; and
- LORAN–C or OMEGA.

The overall effect of being able to more routinely and more accurately establish navigational position is obvious-it will mitigate those grounding which occur because of unknown or erroneous navigational position. While aids to navigation, such as lights, daymarks, etc., have been employed by mariners for thousands of years, their inception was to guide a mariner to a desired point or along a desired path or to warn him of a hazard. The question now arises as to the optimum design, planning, and operation of such subsystems from the total marine transportation safety viewpoint. In other words, are logical-technical methods being applied in the decisionrnaking process to answer such questions as:

Where should navigatio~~al aids be placed ?

Where should the channel be dredged?

What type and amount of information should be afforded the operator from such subsystems ?

In short, this is an area where for minimal costs, technologies and sciences exist which can increase system safety based on aid to navigation design, placement, type, etc.

Another subsystem in the navigational system is the installation and use of dual radars for position fixing. The two-radar concept stems not only from the redundancy/reliability concern but also from the fact that, by using both a 3 cm radar with its high resolution for shorter range work and a 10 cm radar with its longer range capabilty, an oper-ator can be aff'orded the best available radar navigation system. Moreover, as will be discussed later, the 3 cm radar provides the necessary accuracy in resolution for employment with an anti-collision device.

In terms of long range navigational systems in the United States, the two most feasible systems would be LORAN-C or OMEGA and satellite navigators. Satellite navigation systems have the limitations of availability of satellite communications and their accuracy being a function of ship speed input. Both LORAN-C and OMEGA have the tidvantages of being cheaper? more accurate, and continuous availability. Between LQRAN--C and OMEGA, there will ultimately be better LORAN-C coverage in the United States than OMEGA, I.ORAN-C is more accurate, and has such options as continual digital readout and direct x-y position recording.

.9. (?wnmunicativn iYy8tem8

With the passage and implementation of the Bridge-to-Bridge Radiotelephone Act of 1971, essentially all merchant vessels operating within the navigable waters of the United States are required to have bridge-to-bridge communications.

The intent is to promote safety by establishing a common ling among vessels through which information and intentions may be relayed. In principle, it is the cornerstone upon which any vessel traffic system is built.

It has been stated, however, that the ultimate effectiveness of this system will only be as good as the communications discipline, the utilization of the system, and some upper limitation on the number of channels which an operator must simultaneously monitor. In the case of the last matter, it appears that two or three channels are the maximum that can be effectively monitored bu an o~erator. In some areas this limit has already been reached; i.e., harbor frequency, bridge-to-bridge frequency, and company frequency.

4. Information Systems

As discussed with the controllability aspects of the ship, the operator's decisionmaking process is interactively related to the information he senses. Historically, "seaman's eye", "feel of the ship", and other such experience factors accounted for much of the information input to the operator. Today, however, with the rather rapid increase in tanker size and the resultant, nearly imperceptible dynamics of ship motion and response, the operator can no longer entirely depend upon sensations heretofore used. For example, at the larger end of the tanker scale, it has been said that by the time a ship's turn can be sensed by a human, it is then very difficult to respond to that reaction. Thus in some instances. rate-of-turn indicators have been provided to measure this motion and provide the information to the operator well before he could sense it.

Also with the larger tankers, because of their tremendous mass (both actual and virtual), touching a dock even at very low speeds can exert tremendous forces both on the dock and the ship's structure. Thus, it is critical to be able to accurately measure very small differentials in ships' speed, differentials so small that they are imperceptible t% the operator. As a result, a number of devices have been developed to very accurately measure ship speeds at very low velocities as it approaches a dock.

Another aspect of largeness in tankers is that when a pilot or docking master is maneuvering the ship from a bridge wing, he is now removed up to one hundred feet from the center of the navigating bridge. This means that he cannot directly observe the helm position, engine orders, engine responses, etc., unless an appropriate means Of relaying these vital data are afforded, such as repeaters. (At the smaller end of the tanker scale, these may not be as vital since the physical dimensions would not remove the operator from the bridge center as dramatically.)

The intent of the foregoing three specific examples is not to necessarily underwrite the items discussed, but rather to cite an overall issue, namely the need to more fully understand in general what information an operator should be provided with. Furthermore, it is also necessary to comprehend how ship size and local environments may affect the general case.

Finally, it is important to note that, desipte the cited examples, information systems need not be restricted to onboarcl the ship. Information is also provided to the operator from external sources in the form of navigation data from aids, ship movement/intention data through communication systems, and other data through shore based radars.

5. *Control Systems*

Similar to information systems, ship control systems vary with ship size and local environments. However, in the context used herein, control systems are always aboard the ship since they are defined to be systems which directly cause control surfaces to respond and also including control surface dynamics. (This is opposed to traffic control where indirectly, from the controller through the pilot, the rudder is moved. Traffic control systems will be discussed later.

Basically, control systems fall into two broad categories: engine/propeller control and rudder control. Between the two, all directional and magnitude operator inputs to control surfaces (propellers, rudders, thrusters, etc.) are made.

The concepts of variations on propellers (twin-screw, controllable-pitch, ducted, etc.) and rudders (twin, flayed, and other devices to generate lateral thrust) were previously discussed as were the concepts of generating additional forces (more astern horsepower). This section will thus only speak to the systems which direct those control surfaces.

There again, as with information systems, the examples will neither be all inclusive nor specifically underwritten. Rather they will serve to illustrate a point.

It has been previously stated in the text that a prime consideration in stopping distance is the time which it takes to develop astern thrust. Once an operator has made the decision for astern thrust, his command must then be transmitted to the enginw and propeller shafting. Until very recently, this transmittal was done through a servo-mechanism known as the “engine order telegraph” whereby the engineroom matched “pointers” with the bridge's and then engineering personnel closed and opened throttles to the turbines accordingly. Nowadays, the bridge can be provided with direct control of both engine speed and direction, thus eliminating any error in transmittal as well as being able to do it more quickly.

Another control system is the one that exists between docking master and assisting tugboats. Conventionally, commands and executions are relayed through whistle signals and radio. However, with the larger tankers where the tugs cannot always be seen directly or where, as previously mentioned, channel monitoring may become overloaded and thus ineffective, or where, because ship speed is so critical, the time delay in tug response becomes paramount, all suggest at the very least the need to explore alternate methods for improving this control link. Now, it may be that the existing system is the most effective and practical arrangement. On the other hand, it may not be. In any case, its necessity exists and its criticality increases with tanker size, thus suggesting the need for further analysis.

The two examples presented are meant to illustrate the potential impact of control systems on overall ship controllability and ultimate system safety.

6'. Ve88eZ Traj%c h'y8tenw (VTL5')

VTS can run the spectrum from a basic communication link to traffic separation to surveillance and advisory services to vessel traffic control. As can be seen, VTS can and do include communication systems, information systems, and indirect control systems; thus they are treated as a separate system within this portion of the text.

A VTS is an integrated system encompassing the technologies, equipment, and people employed to coordinate ship movements in or approaching a port or waterway. Regardless of the VTS level, its objective is to reduce the probability of ship collisions and grounding.

Historical casualty data and future projections for waterborne commerce have indicated a need for improved marine traffic safety in U.S. ports and waterways. VTS can make significant contributions to this effort.

Ports and waterways do not come in standard sizes or shapes. Each has its own physical characteristics, special hazards and degree of congestion. Some extend for only a few miles. Others cover several hundred miles. VTS must be tailored to the specific area serviced.

In general terms, there are three degrees of traffic management or control envisioned for the coordination of vessel traffic; namely:

- physical arrangements, such as a traffic separation scheme without manned traffic centers;
- disseminating advice in the form of navigational, weather, and vessel movement information; and
- positive control of vessel movements. (In this sense, the \'essel traffic center will direct ship movements as necessary for overall ship coordination.)

The Coast Guard in 1973 completed a detailed analysis of ports and waterways in the United States. Its ultimate result was a rank ordering of VTS needs for major U.S. ports. Systems for San Francisco and Puget Sound are now operational, the Houston system is under development, and New Orleans, Valdez (the southern terminus of the Trans-Alaska Pipeline), and New York are scheduled next. (The GAO in a report on VTS to the Congress dated January 21, 1975, concluded that the Department of Transportation should redirect its current program such that VTS implementation be more extensive initially and that the move from basic systems to more sophisticated systems be graduated; i.e., have much coverage with lesser levels of VTS.)

7. *Collision Avoidance System (CAS)*

Personnel error has been frequently cited as the dominant probable cause of collisions. The National Transportation Safety Board in "Special Study of Collisions Within the Navigable Waters of the United States-Consideration of Alternative prevention Measures", l?ebruary, 19'72, recommended that all vessels be equipped with a CAS. ~ number of on-board data processor/plotting, collision avoidance aids are currently available.

These systems all utilize a digital computer to automatically process radar data and display encounter situations in a form enabling the ship to be maneuvered to avoid potential grounding and collisions. There is some variation among the systems in regard to number of contacts tracked and automatic capabilities, but all provide at least one alarm for dangerous situations. The potential of CAS for reducing casualties through relief of deck officers' workload and improvement in decisionmaking process is generally considered excellent. (A ~ARAD study indicated that 40-50 percent of a deck officer's total workload is involved in collision avoidance.) The CAS has the added advantage that the onboard computer itself can be used for other functions, including the calculation of optimal cargo stowage and ballasting to reduce hull stresses.

MARAD currently requires a CAs on all U.S. subsidized ships; it is estimated that the average installed cost of each unit is approximately $90,000~ including ship-speed log. The U.S. Coast Guard has also proposed regulations requiring a CAs on new tankers.

F. Local Port Conditions

As has been referred to from time to time above, the variation in port configuration, traffic density, local current and wind conditions, bottom clearances, etc., will have a direct influence on marine transportation systems safety. In fact, the Ports and Waterways safety Act itself requires that the need and substance of any measures prescribed be in concert with not only the scope and degree of the hazard presented, but moreover, traffic patterns, port and waterway physical and environmental conditions, the ecological impact, and the economic effects. In essence, any measures which might be prescribed must be underwritten by their need, their effect or impact upon implementat ion, and their practicality in terms of cost and effect.

Due to the many factors of the local environment which affect system safety, it is clear that to attain a given level of safety will require different solutions at different sites at correspondingly different economic costs to the consumer. These different solutions will be derived as a result of the particular set of interactive elements which are in fact present from one site to the next. ,For example, consider the cases of an offshore port versus a conventional inshore port; or of a port with little traffic versus the port of New York; or finally, the case of a port with narrow channels, high traffic density, and high currents versus a port with no channel restrictions, little traffic, and minimal currents.

While equal levels of safety may be attained throughout the spectrum of ports and potential sites, it is a fact that to attain equal levels of safety will not only require different solutions but also different economic costs-costs which may be so prohibitive as to eliminate a site from consideration.

G. Oil Spill Cleanup Approaches

The previous sections have described alternative approaches to prevent oil spills originating from tankers. Even with optimum prevention systems employed, however, some spills inevitably will occur, and it is necessary to consider how such spills may be cleaned up before significant damage is done. The occurrence of such spills will constitute emergency situations which will require quick response and effective deployment of clean-up equipment. The following will describe some aspects of oil clean-up capability.

The U.S. Coast Guard has developed a quick response capability for emergency spill situations, particularly those arising from tanker accidents, to prevent further propagation of spilled oil in addition to cleaning up oil already spilled. This "U.S. National Strike Force" has available an Air Deployed Automatic Pumping and Transfer System (ADAPTS) which can be used to ofTload oil from a damaged tanker before it can spill from the tanker. This equipment, which was developed by the Coast Guard after a study of the Torrey Canyon disaster, was used in the salvage of the iKetuZu, which proved the value of such an approach. The U.S. Coast Guard strike force contingent and equipment sent to the Metuhz played an important part in restricting the oil pollution following this major casualty.

The Coast Guard also has under development a range of equipment for containment and clean-up of oil spilled on the seas. Such developments are valuable and necessary to meet the possible needs associated with tanker accidents.

Proposals for improvements in this clean-up capability are numerous and varied. These improvements can be categorized as follows:

1. Tanker Pump-out and Containment Equipment (ADAPTS with portable containers).
2. Oil 13arriers for Rough l~ater (to "fence" in a spill on the surface).
3. Oil Absorbent Material (to "sop" up a spill).
4. Oil Clean-up Equipment for Rough Water (to skim oil off the water surface).

5. Dispersant.s which do no additional damage to the environment.

This report will not describe or analyze these systems. Such analyses are the subject of considerable attention in research programs of several federal agencies including the U.S. Coast Guard and the Environmental protection Agency. The oil industry has also developed capabilities for cleaning up oil spills. ~ major need at present is for effective methods and equipment to contain and recover oil spills in relatively rough offshore seas. These on-going programs could readily be directed toward possible new problems presented by the introduction of more or larger tankers into ~'.S. ports or coastal waters.1[4]

The grounding of the VLC(l ,WetuZa in the Strait of Mngellan, in .&ugust, 1974, with the loss of over 500,000 tons of crude fuel oil in the surrounding waters, is an example of unnecessary delays leading to successively greater damage and more spillage over a long period of time-six weeks from the date of the accident. The total pollution damage from this spill is yet to be assessed and very little cleanup has been accomplished. However, the events and steps taken during this salvage operation constitute a guide for preparing contingency plans for similar problems that may occur in the future.

It may be desirable to require tanker operators to file emergency contingency plans prior to operation of supertankers in U.S. waters. (Contingency plans for accidents would describe source of salvage tugs and equipment? method of and source of pumpout equipment, available cirydock and repair facilities, method of cleanup in case of spills, source of containers for pumped-out oil, salvage techniques, and any other factors that could help minimize the impact of an accident. The U.S. Coast Guard engages in contingency planning efforts now and may also consider the unique planning problems of deepwater ports with regulations now under development.

Summzmy

The following list is intended to briefly point out items which have been discussed and proposed throughout this chapter as feasible approaches for reducing tanker pollution and improving safety. They include major aspects of the total tanker transportation system:

Ship Improvements:

- Double bottoms and double hulls.
- Segregated ballast tanks in double bottoms or double sides.
- Higher astern power levels and better control systems.
- Auxiliary thrusters and improved use of tugs.
- Twin screws and rudders for certain applications.

M 'Ioil Spills and Spills of Hazardous Substances, " U.S. Environmental Protection Agency, March 1975.

- Further research in slow speed maneuverability.
- Inert gas systems.
- Improved maintenance and survey practices.

Personnel Improvements:

- Improved training programs including review and recurrent training.
- Use of ship simulators for training and testing.
- Training for advances in grade.
- Periodic performance testing for licenses.
- Licenses tied to ship size and type.
- Special training for pollution control and safety.
- Clarify pilot/captain relationship and authority.

Improvements in External Controls:

- Improved navigational aid systems.
- Improved communications and information for captain? pilot, crew. tugboats.
- I'essel traffic systems for specific ports.
- ('ollision avoidance systems.

Chapter V. International and Domestic Regulatory Authority

A. Introduction

This section is a discussion of legal and jurisdictional aspects of tanker regulation and control. The discussion is limited to a treatment of law relating to non-military vessels since a different set of legal rules applies to military vessels and these need not be treated here.

This section seeks to provide a brief but complete synopsis of the general legal rules applicable to jurisdiction over vessels, and, in particular, tankers. Both international and national law is discussed. An understanding of these basic rules and statutes is a prerequisite to understanding the public policy issues raised in this report.

B. International Law and Jurisdiction

International Law is a body of rules which nations consider t hey are bound to observe in their mutual relations. The sources of international law are:

1. customary practice of nations;

2. Treaties and other international agreements;

& General principles of law recognized by civilized nations; and

4. ,Judicial decisions and scholarly legal works as supplemental to other sources.

‘rho domimmt legal concept concerning jurisdiction over vessel-related matters is the notion of freedom of the seas which recogniz~~ minimum national control of the oceans. .4 corollary of that concept is the rule of nearly exclusi~’e flag-nation control over vessels. According to this generally recognized principle, a vessel is subject to the jurisdiction of the nation whose flag it flies for almost all matters, including pollution control and safety. How-ever, a coastal-nation can exert control over other nations’ vessels for certain purposes while such vessels are in the coastal-nation% waters or ports. The breakdown of authority between flag-nation and coastal-nation is in~portant to understand] for this allocation of authority determines who sets the rules and what are the respective rights and duties. There are at least three fundamental questions, relating to jurisdiction o~’er pollution from ships, which ought to be kept in mind:

1. \Vhat are the duties of a flag-nation to prevent pollution from its vessels ?

il. lt~hat are the rights of coastal- (or port-) nation to protect itself f ronl I’essel-source pollution?

3. **What are the** interests of the world community at large in these matters ?

Definition of these rights, duties and interests. because of historic practice. is a function of geography-—-e.,., where on the ocean the vessel is located?

In general, all nations have a duty to prevent pollution of the sea from whatever source. Instructive on what nations consider to be general principles of international law are periodic statements and resolutions issued from international conferences. In 1972, nations attending the Stockholm Conference on the Human Environment made the following statement of principle:

> States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine 1 life, to damage amenities or to interfere with other legitimate uses of the sea.

Another basic, general principle of international law threading through all ocean legal rules is the concept of reasonableness. Nations are bound to **use the ocean in a reasonable fashion and must act so as not to adversely affect the ocean interests of other nations.**

These are the overriding standards of conduct which give general, but vague, guidance, to the conduct of nations in the sea. Further elaboration of rights and duties is contained in various treaties on the subject of law of the sea.

1. The High&m

The Convention on the High Seas (15 UST/1606; TIAs 5639) reflects the basic principles of vessel jurisdiction and expressly provides in article 2:

> The high seas being open to all nations, no state may validly purport to subject any part of them to its ,sovereignty. Freedom of the high seas is exercised under the conditions laid down by these articles and by other rules of international law. It comprises. ***inter alia,*** both for coastal and non-coastal states :
>
> (1) feedom of navigation;
>
> *   *   *   *   *   *   *
>
> 'These freedoms, find others which are recognized' by the general principles of international law, shall be exercised by all states with reasonable regard to the interests of the other states in their exercise of the freedom of the high seas.

The high seas are defined in the Convention as constituting all parts of the ocean beyond the generally recognized limits of the territorial sea (now set at three miles from shore, but likely to be extended to 12 miles shortly).

Article 5 of the Convention defines the jurisdictional authority and related duties, of the flag-nation over its vessels:

1. **Each state** shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the state whose flag they are entitled to fly. There must exist a genuine link between the state and the ship; in particular, the state must effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag.

The duties of the flag-nation in connection with vessel safety and pollution prevention are defined in articles 10 and 24 of the treaty:

ARTICLE 10

1. Every state shall talie such measures for ships under its flag as are necessary to ensure snfety at sea with regard inter a.lia to:

(a) The use of signals, the maintenance of communications and the Prevention of collisions;

(b) The manning of ships and lahour conditions for crews taking into account the applicable international labour instruments;

(c) The construction, equipment and seaworthiness of ships.

2. In taking such measures each state is required to conform to generally accepted international standards and to take any steps which may he necessary to ensure their observance.

ARTICLE 24

Every state shall draw UP regulations to prevent pollution of the seas by the discharge of oil from ships * * *, taking into account existing treaty provisions on the subject.

In sum, when a vessel is on the high seas, it is primarily the duty of its flag-nation to see that the vessel does not pollute the ocean. Safety features are inextricably tied to the pollution problem: a structurally unsound tanker can break up and sink, injuring the environment. Since vessels generate oily waste water which needs to be either discharged overboard or retained for pumping ashore, discharge standards during the voyage are also important. In fact, intentional discharges at sea are the greatest oil pollution problem in terms of volume. Consequently, the treaty requires both safe construction and discharge standards from the flag-nation.

Until recently, each maritime nation set its own standards for its vessels, or set no standards, largely without the benefit of generally agreed upon international standards. It was not until the establishment of the Intergovernmental Maritime Consultative Organization (IMCO) that international discharge and construction standards were codified by treaty to any real extent. (Treaty law development has been slow largely because only in the last few years has oil pollution been identified as a serious world problem.) IMCO was set up in 1959 under the auspices of the United Nations to deal with traditional maritime problems. l~hen pollution became a concern, IMCO began to focus on liability, construction standards, and discharge limits.

Treaties on the subject of vessel-source pollution continue the flag-nation principle for enforcement of treaty provisions, where they exist, while the vessel is on the high seas. Unfortunately, the effectiveness of this principle (and> in fact, the principle itself) in controlling pollution from ships is being called into question, and alternate regimes are being considered in the U'.N. Law of the Sea Conference. In addition, standard setting for both discharge and construction has increasingly become a multilateral undertaking through IMCO.

.2. TJte Territon"aZ Seat and ~ontiguous Zone

Once a vessel enters the territorial sea or contiguous zone of a coastal nation, it becomes subject to increased control by that nation. Of course, the duties of the flag-nation (and the vessel itself) under the general principles mentioned above continue. But, because of the obvious interest of the coastal nation to protect its waters, shorelines, and natural resources, jurisdictional competence to regulate vessels for certain purposes is afforded the coastal nation by the law of the sea.

One particular concern in ocean law has been resolving the conflict between the basic freedom of navigation and the coastal state's sovereign rights in the territorial sea, that area of the ocean which is included within a nation% boundaries. An accommodation between these divergent interests has been accomplished, somewhat imperfectly, by what is known as the "right of innocent passage". Article 14 of the 1958 Convention on the Territorial Sea and the Contiguous Zone (15 UST/1606; TI~S 5639) outlines this general right:

> **1.** Subject to the provisions of these articles, ships of all States, whether coastal or not, shall enjoy the right of innocent passage through the territorial sea.
>
> * * * * * * *
>
> *4.* Passage is innocent so long as it is not prejudicial to the peace, good order or security of the coastal State. Such passage shall take place in conformity with these articles and other rules of international law.

Article 1'7 specifies the general duty of vessels exercising the right of innocent passage:

> Foreign ships exercising the right of innocent passage shall comply with the laws and regulations enacted by the coastal State in conformity with these articles and other rules of international law and, in particular, with such laws and regulations relating to transport and navigation.

The right of imocent passage has been criticized by some as allowing too much subjective latitude to the coastal nation in determining what passage is innocent and what is not. Yet the concept seems to have worked reasonably well in its application, despite doubts about the theory. On the other hand, criticism of the concept of the right of innocent passage centers on the definition of and perception of what is innocent.

The contiguous zone is an area of the high seas contiguous to the territorial sea. In this zone, the coastal nation may exercise authority necessary to (a) prevent infringement of its customs, fiscal, immigration and sanitary regulations within its territory or territorial sea, or (b) punish infringement of such regulations committed within its territory or territorial sea. The term "sanitary" is considered broad enough to encompass pollution control. The contiguous zone can extend no farther than 12 miles from the baseline by which the territorial sea is measured.

Accordingly, pollution prevention is one of the coastal-nation interests which must be observed by vessels in imocent passage. Failure of a vessel to observe regulations promulgated by the coastal nation, such .w discharge restrictions, traffic lanes or pilotage, among others, could be viewed as a threat to the coastal nation and as amounting to non-innocent passage. A ship which does not comply with antipollution provisions can be denied access to a coastal nation's territorial sea or ports; if the vessel violates such provisions while in the territorial sea or contiguous zone, the master or owner is subject to prosecution by the coastal nation. Moreover, the vessel would bc liable for any pollution damage it caused.

3. The 1973 IMCO *Conference on Matiw PoZZ@on from i5%ip8*

The Conventions just discussed serve to describe the general international law on the question of pollution from ships. None of the "~onvention articles, however, set down specific international community standards for pollution prevention. An accommodation of maritime and coastal nation interests on particular standards obtains no guidance from these unspecific precepts.

To serve as the institutional mechanism for establishing worldwide vessel standards, the Intergovernmental Maritime Consultative Organization (IMCO) was founded in 1959 under the auspices of the United hT~tionso since its inCeptiOn, IMCO htts been primarily a maritin~e 'a-tion agency dealing with technical maritime problems. The costs of IMCO administration are divided among the maritime nations according to the tonnage of vessels flying each nation's flag. ~Non-nlaritime nations have a standing in~'itation to attend IMCO meetings, but few have done so and their ~'otin~ power has not been substantial.

The **followin$_g$ international** conventions developed bv or under the jurisdiction of IMCO relate to vessel safety and p~lluti& prevention:

1. Convention for Safety of Life at Sea, 1960. (General life saving requirements for vessels.)
2. International Convention on bad Lines, 1966. (Establishes load limits.)
3. International Regulation for Preventing Collisions at Sea, 19'71. (~"oluntary rules of the road.)
4. International Convention for the Prevention of Pollution of the Sea By Oil, 1954. (operation discharge standards and prohibited discharge zones: amended 1962, 1969 and 1971; amendments not yet in force.)
5. International L'onvention Relating to Intervention on the High Seas in Cases of Oil Pollution, 1971. (Right of coastal-nation to protect itself from a disabled vessel carrying oil.)
6. International Convention on Civil Liability for oil Pollution Damage, 1969. (Sets strict liability with limits for shipowners in cases of oil pollution-expected to be in force by mid 1975.)
7. Convention on the Establishment of an International Fund for Compensation for oil Pollution Damage, 1971. (Creates an international funcl to cover oil pollution damages beyond the liability of the shipowner up to about $36 million—not yet in force.)
8. International Convention for Prevention of Pollution From Ships. 19'73. (hTew clischarge and construction standard treaty for all polluting substances designed to substitute for the 1954 Convention-not yet in force.)

International efforts to strictly control vessel-soume pollution were act ually initiated at, the behest of the United States. A conference on the subject convened in 1926 *in* Washington, D. C., but a U.S. proposal for a total prohibition of oil discharges from ships was defeated two to one. It was not until 1954 that a convention was finally concluded—but v'it.hout a discharge ban. Intentional discharges were merely limited znfl en for~'ement, was to b-e carried out by the flag-nation, using penalties it determined appropriate. Nations other than the flag-nation could inspect the vessel% oil record book (mandated by the Convention) only when it called at their ports and, if discrepancies were discovered, they would have to request the flag-nation to take enforcement action.

The discharge standards and prohibited zones were made more stringent in 1962. The 1969 amendments (not yet in force) did away with zones altogether and limited the rate of discharge of oil even further. But the discharge standards aclopted would still permit a 300.000 deadweight ton tanker to discharge a maximum of 20 tons during the course of any one ballast. voyage at a rate not to exceed 60 liters per mile.

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The 1971 amendments to the 1954 convention are more significant. For the first time construction standards were developed to prevent or minimize oil outflow in the even of an accident. These requirements restrict cargo tank size as a means of limiting maximum oil outflow resulting from a tanker collision or grounding. Unfortunately, these amendments have not entered into force.

Although the recently agreed-upon IMCO Convention for Prevention of Pollution from Ships will, when ratified, substitute for the 1954 Convention, the 1954 Convention is still existing law for signatory nations on the subjects it covers. However, the histury of its enforcement is extremely poor, and it is generally viewed as being largely ineffectual in stemming the growing incidence of vessel-source oil pollution in the ocean.[1]

In 1969, the IMCO assembly decided to convene in 1973 an International Conference on Marine Pollution for improving international constraints on the contamination of the sea by ships. Two years later, the Assembly further decided by Resolution A. 237 (VII) that "the Conference should have as its main objectives the achievements by 1975 if possible, but certainly by the end of the decade, of the complete elimination of the willful and intentional pollution of the sea by oil and noxious substance other than oil, and the minimization of accidental spills."

The IMCO Convention on Marine Pollution from Ships developed in London in November, 1973, is the most comprehensive treaty yet on the question. Included are measures to control more pollutants than ever before and greater stress is put on prevention rather than cleanup and other post-accident measures. Briefly, the new treaty includes the following salient features:

1. regulates ship discharges of oil, various liquid substances, harmful package goods;
2. contro]s for the fimt time tankers carrying relined products;
3. requires segregated ballast for all tankers over 70,000 dwt contracted for after December 31, 1975 (but does not require double bottoms) ;
4. prohibits all oil discharges within 50 miles of land; (as did the 1969 amendments) ;
5. mandates all tankers to operate with the load-on-top system if capable;
6. reduces maximum permismble discharge for new tankers from 1/15,000 to 1/30,000 of cargo capacity (NOTE: no tc.td discharge prohibition) ;

[1] The U.S. Coast Chard's EIS on the IMCO 1973 Ptllution Convcut!on .Iescr!bed U.S. experience with flag state enforcement of the 1954 Convention. Of seven cased discharged during 1969-72 and referred to the flag state, only two were observed to rece!ve my action.

7. **regulates the carriage of 353 noxious liquid substances with requirements ranging from reception facilities to dilution prior to discharge;**

8. controls harmful package goods in terms of packaging, labeling, stowage and quantity limitations [z]

9. prohibits discharge of sewage within four miles of land unless the ship has an approved treatment plant in operation, and from 4 to 12 miles unless the sewage is macerated and disinfected; and

10. prohibits dispoa+x-il of all plastic garbage and sets specific minimum distance from land for disposing of other kinds of garbage.[2]

In the area of enforcement, the internatoinal legal status quo was modified to some degree. The flag-nation must punish all violations by the ship. But, a coastal nation has the right (as well as the duty) to punish a violation by a foreign-flag vessel occurring in its waters or to refer the violation to the flag-nation for prosecution. A provision giving nations the right to prosecute vessels in their ports for discharge violations wherever they occurred was defeated. Nations must also deny per]l~ission to leave their ports to ships which do not substantially comply with the treaty's construction requirements until such ships can sail without presenting an unreasonable threat to the marine environment. Nations which ratify the treaty must apply its terms to all vesds, including those flying flags of nations which do not sign the treaty? in order to prevent vessels of non-signatory nations from gaining competitive advantage. To settle any disputes, compulsory arbitration is a treaty requirement.

On the question of standarcl-setting authority, a provision was defeated which would have made the treaty provisions exclusive on the subjects it addressed. Consequently, there are no treaty restrictions on the right of coastal nations to set more stringent requirements within their jurisdictional waters.

As yet, the treaty has not been submitted to the Senate for ratification and complete international approval is not expected until later in this decade. This convention must be ratified by at least 15 nations which, between them, represent at least 50 percent of the tita.1 tonnage in the world fleet. (In that previous conventions required ratification by 32 nations, this represents a significant easing of the ratification process.) So far, only Australia hw ratified the 1973 Pollution Convention. It is expected that this convention will come before the U.S. Congres for ratification in 1975.

The 1973 Convention by no means covers the entire area of pollution prevention from ships. In fact, the official end-of-Conference

[2] These features are stated as optional annexes to the Convention, Le., a state could adopt the Convention with or without any of these features.

press **release notes that it "may not cover completely the problem of accidental pollution." IMCO is proceeding with additional work on matters not covered in the Convention: Crew training, improvements of traffic separation schemes, development of effective methods of cleaning up, and other** safety and pollution prevention measures.

4. *The Law of the Sea*

Since 1973 tho third Law of the Sea Conference has become the forum for re-evaluating the fundamental questions of ocean jurisdiction, including pollution control jurisdiction. The 1973 IMCO Conference purposely shied away from jurisdictional issues wherever it could; the Stockholm Conference on the Human Environment did the same.

Three approaches to jurisdiction over vessels are being discussed in the Conference:

1. exclusive or near exclusive jurisdiction in the flag-nation;
2. jurisdiction by coastal nations over all vessels in their waters, whether calling at their ports or not;
3. jurisdiction by-nations over all vessels calling at their ports.

The "flag-nation)' approach contemplates international agreed-upon standards, but only flag-nations (and possibly port-nations) could set higher standards. The "coastal-nation" proposal would be coupled with an extended "pollution control zone" and would allow special standards to be set by a coastal nation whenever adequate international standards have not been established. The "port-nation" proposal would enable a nation to set standards higher than those internationally agreed upon for all vessels calling at its ports and to enforce violations occurring anywhere on the high seas. There are other variations, but these serve to illustrate the alternatives being discussed. A result combining these concepts is expected out of the Conference.

The U.S. position on vessel pollution on Law of the Sea reflects that of a maritime nation. The U.S. delegation has continually stated its belief that the best approach to vessel-source pollution problems is through exclusively international standards with supplemental standards by flag- and port-nations allowed on a limited basis. Key to this position is the assumption that conflicting and unduly restrictive standards will be imposed under any other regime, thereby greatly hindering the free flow of navigation. The U.S. position is foursquare against coastal-nation jurisdiction to set standards for regulating vessel-source pollution in broad zones off their coasts.

Enforcement, in the U.S. view, is best done by a combination of flag-nation/port-nation authority. But the United States would support coastal-nation enforcement jurisdiction beyond the territorial sea in

"carefully defined circumstances involving emergency situations or habitual violations of international standards by vessels flying a particular flag."

C. Federal Law and Jurisdiction

1. ~onstitutionul Authwz"ty

Federalism has three **important elements which are relevant here:**

1. the Federal government possesses certain "enumerated" powers;

2. the remaining "residual" go~"ernment powers reside with the individual States; and

3. the Federal government is supreme within areas of its assigned power over any conflicting assertion of State power.

The practical question of which level of government has legislative authority over vessel-source pollution is answered according to these three elements.

The IT.S. Congress derives its basic legislative authority over vessels from the so-called "commerce clause" of the Federal constitution (Article I, section 8, clause 3) :

> The Congress shall have power * * * to regulate Commerce with foreign nations, and among the several States * * ●

The courts long ago concluded that commerce includes navigation; therefore, the power to regulate vessels and navigation is a natural adjunct of the power to regulate commerce. In addition, the constitutional language extending the judicial authority of the United States to "all cases of admiralty &~d maritime jurisdiction" has, through historical practice, become the basis of broad legislative authority over vessels and maritime affairs.

From this legislative power over navigation and commerce has come the power to pret'ent pollution and environmental degradation. As an example, Congress can require that a permit for a project in navigable waters be denied solely on the basis of environmental protection, even though the project would not impair navigation. Federal authority exten(ls to all waters. salt or fresh, with or without tides, natural or art ificial which are navigable in fact by instruments of interstate or foreign commerce. These waters, but not those of the contiguous zone, are referred to as the navigable waters of the United States.

It is on the basis of constitutional authority over commerce and maritime matters that the Federal government has enacted pollution prevention statutes. Vessel-source pollution has traditionally been considered to be nearly exclusively in the Federal domain. The policy arguments on why this is, or should be, so are not unlike the arguments given f-or nearly exclusive international? as opposed to national standards for preventing contamination from ships: IJniformity, harmony, avoidance of patch-work legislation, preventio]~ of undue interference, conflicting and inconsistent standards, and so on. But like all rules, the exclusive Federal authoritj' rule is not without its substantial exceptions.

The commerce clause ser}"es not only to give the Federal go~'ernment certain powers but also to restrain state power. For sure, the commerce clause standing alone cannot settle the question of what power is left to the states to regulate Commerce. Over time, the courts have filled the gaps and ha~'e concocted the following rules:

1. ~?ongress" **power over interstate commerce (and maritime matters) is exclusi~-e; e.g. l~o st:~te ~~ction is a]]o~~,e~~ as to tl~ose aspects which require uniform regulation whether congress has acted or not.**

2. Outside these exclusive areas, states enjoy concurrent power with the Federal government subject to override by Congressional action,

3. On a case-by-case basis, if a Federal statute preempts or take over an entire field of activity under the commerce c]nuse, no state law in that same field can stand.

4. On a case-by-case basis! if Congress has not acted in an area or its action leaves room for supplemental state legislation, a state may exercise its authority over matters of commerce if it is designed to effectuate a legitimate local public interest without unduly burdening commerce.

The Supreme C'ourt most recently applied these rules to the question of state vs. Federal pollution control in i4skeIo v. *American Water-~L~ay8 operato?>~]nce, and* found constitutional a Florida statute imposing strirt liability on vessel owners for oil pollution damage to the state or private parties. Because the Florida ilct did not interfere with maritime matters requiring unifornl Federal regulation and was not otherwise inconsistent with Federal legislation, it was ruled a proper exercise of the public power of the State.

2. Federal Statutes and Programs

It is against the above backdrop of constitutional principles that Federal statutes can now be analyzed. For the most part, it is Federal law which governs vessel safety and pollution prevention.

The most important recent law governing the construction ancl operation of vessels carrying polluting substances, including oil in bulk, in U.S. waters is the l)orts and J\'aterways Safety Act of 19'72. This Act has two parts: Title I which provides the United States Coast Guard with broad authority for controlling vessels in the nation% ports, coastal waters, and waterways. for operating vessel traffic control systems. and for otherwise improving the safety of the marine transportation system as a way of preventing pollution; and Title II which directs the ('east Guard to develop new regulatory standards for vessels carrying polluting substances.

('ongress adopted the Ports and Waterways Safety Act to complement and eventually implement the later developed IMCO Convention on Marine Pollution from Ships. However. the ('east Guard is to independently develop tanker regulations on the basis of best available pollution control technology, without regard to the relative adequacy of standards developed in the IMCO forum. It was Congress' intent that even if the IMCO Conference in 1973 did not adopt U.S. proposals for tanker construction, the Coast Guard is required to implement its own proposals. through the Ports and Waterways Safety Act, not later than January 1, 1976.

On June 28, 1974, the Coast Guard gave notice of proposed rulemaking for the design and operation of U. S. vessels certified to carry oil in the domestic trade. The domestic trade (trade between U.S. ports) by law is restricted to vessels built in the United States, manned by U.S. crews, and owned by U.S. citizens. It is expected that these new rules will be promulgated in their final form shorty. The Coast Guard has indicated that substantially the same regulations will apply to U.S. vessels engaged in the foreign trade as well as to foreign vessels in U.S. walers.

Within the contest of Title 1, the most important developments have been in the area of vessel traffic control systems. Through these systems, greater control over vessels in crowded harbors and waterways can be exerted. Traditionally the master of each vessel is given nearly complete control over his vessel's movements within the confines of the martime rules of the road. With a vessel traggic control system, the master or pilot will be given additional assistance in congested areas, and, if necessary, his control will be restricted if the conditions or circumstances merit it.

The *primary Federal* statute governing U.S. vessel oil discharges on the high seas is the Oil Pollution Control Act of 1961. This Act implements the 1954 IMCO Convention, and amendments thereto, which (1) Prohibits oil discharges from ships within 50 miles from land; (2) sets standards for tank arrangements and limitation of tank size in tankers: (3) establishes discharge limits as a function of volume, speed of the ship, and the cargo carrying capacity of the vessel; and (4) establishes penalties and enforcement requirements.

In addition, the Federal Water Pollution Control Act Amendments of 1972 regulates the discharge of pollutants from vessels in the territorial sea and contiguous zone. The Act also prohibits the discharge of oil into the navigable waters and contiguous zone of the United States. Penalties are spelled out for violators whatever the flag of the vessel. The law further provides for a National Contingency Plan for dealing with an oil spill event and authorizes the Federal government to inordinate and direct all public and private efforts for the removal or elimination of the oil. The owner or operator of a vessel can be held liable for cleanup costs to the extent of $100 per gross ton or $1-1,000,000, whichever is less.

These are the primary sources of Federal law on the issue of pollution control of vessels.

D. State Law and Jurisdiction

Several states have enacted statutes relating to the control of pollut ion in their coastal waters to protect themselves from the economic and social costs which inevitably go along with an oil spill. If a state is seeking to protect a legitimate local interest and Federal legislation has not occupied the field, a state can address the problem of ~'essel-source pollution. As the Supreme Court put it in tile Askew case :

> [A] state, in the exercise of its police power, may establish rules applicable on land and water within its limits, even though these rules incidentally affect maritime affairs, provided that the state action "does not contravene any acts of Congress, nor work any prejudice to the characteristics features of maritime law, nor interfere with its proper harmony and uniformity in its international and interstate relationship,"'

In the same vein, the Supreme Court adopted an inspection code of the State of Washington regarding the safety and seaworthiness of vessels (Kelly v. Washington, 302 U.S. 1. (1937')), and a Detroit Smoke Abatement Code as applied to vessels (Huron *Cement Co. v. Detroit, 362 U.S. 440* (1960)). Furthermore, the states have always had the power to legislate pilotage requirements in their waters.

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APPENDIX A

STATISTICS ON THE WO- TANKER FLEET

THE WORLD TANKER FLEET IA 1!) 74

Table A–1 summarizes the number and tonnage by flag of registry of all tankers in the world fleet. This data? extracted from Lloyd's Statistical Tables, is the most current and comprehensive available. It includes all ships as of ,July 1, 1974 which are larger than a small base size of 100 gross tons.

Table .4-2, from the same source? summarizes the size, and age distribution of this same number of ships.

Table A-3 uses the same data base and summarizes the world supertanker fleet both in service and under construction in 1974. Table A4 lists the number of supertankers registered in the major maritime countries of the world and Table A–5 summarizes the trade routes of the world fleet.

TABLE *A-l.—Summary of the world tanker$eet (excluding combination carriers)*

[All ships over 100 gross tons]

Flag of registry	Total number	Milllons of total deadweight tons
Argentina	63	.8
Belgium	20	.5
Bermuda	25	1.5
Brazil	52	1.5
Cyprus	51	9
Denmark	70	4;2
Finland	52	1.2
France	125	10.2
Germany	133	3 9
Great Britain	581	27.9
Greece	389	13.6
India	23	9
ltaly	332	6:4
Japan	1,537	29.6
Korea (south)	47	.8
Kuwait	6	.8
Liberia	877	66.1
Netherlands	109	4.5
Norway	297	23.1
Panama	248	8.4
Portugal	30	1.0
Russia (U.S.S.R)	477	5.4
Singapore	68	1.3
Spain	108	4.0
Sweden	117	4. t
Taiwan	13	.6
Turkey	51	.6
United States	' 314	~8.6
Ml other	580	6.0
World total	6,785	238.4

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*7.4 flcttve.

Source:"Lloyd's Register ofShipping, StatisticalTables, 1974/' include.s exiating fleetsasofJuly 1,1974.

TABLe; A-2.—World *tanker fleet summary (excluding "combos")*

[All ships over 100 gross tons]

	Total number	Total deadweight tons (millions)
Range of deadweight tons (size):		
Under 100,000	6, 162	111
100,000 to 200,000	209	27
200,000 to 400,000	412	99
Over 400,000	2	1
Total	6,785	238
Age (years):		
oto 4	1,333	95
5t09	1,412	60
loto 14	1,499	36
15to 19	1,265	30
2oto 24	596	11
25 t029	192	3
Over do-	488	3
Total	6,785	238

Source: "Lloyd's Register ofShipping, Statistical T8ble9,1974."

~Ammii-3.—Wortis upertanker$eet ***mojJu~y Jj1974(emluding %Yrd)od)***

Size range (deadweight tons)	Existing		On order	
	Numbe/e~~	Total deadweight tonsin fleet (millions)	Nu&& construction	Approximate total deadweight tons under construction (millions)
loo,ooo to 200,000	209	27	239	32
2oo,ooo to 400,000	412	99	390	108
Over 400,000-	2	1	70	30
Total	623	127	699	170

Source; "The Petroleum Econornist~' October 1974.

T'1'AIILE A-4. -Major flag *distribution o, supertankers, 1972 (excluding 'icombo8'!)*

Flag	Number of supertankers 100,MW200,000dwt	21X),GO&t00,000dwt	Total
Liberia. - -------------------- -------	67	80	147
Japan-- -------------------- -------------	61	47	108
Britian -_ -------------- _ -----------	27	64	91
Norway ------------------- ---------	34	34	68
France- ---------l ------------- -----	14	15	29
Sweden -------------------- ---------	11	7	18
Greece ----------------- ----..--------	7	9	16
1taly ------------------------- ------	10	5	15
Denmark --------------------------	2	8	10
Germany ------------------------- -	6	4	10

Source: Clarkson, H. C., "The Tanker Register:' 1973.

l'iiBLE li—J5.-T%6!%?routes of world tanker$eet

EMPLOYMENT OF TANKERS 1973—ESTIMATED PROPORTIONS OF WORLD'S ACTIVE OCEAN-GOING FLEET ON MAIN VOYAGES

IInpercenti

voyages to-	Voy8gesfrom— United States	Caribbean	M k &	North Africa	Others	Total
Utitid States -----------	3	3.0	4.0	1.0	2.5	13.5
Cwada----------------	----	.5	1.5	----	.5	2.5
Other Western Hemisphere -----------	----	----	4.0	.5	2.0	6, 5
WesternEurope, North and West Africa -------	----	1.0	46.5	3.0	3.0	53.5
Eastand South Africa, South Asia ------------	----	----	1.5	----	.5	2,0
Japan ------------------	----	----	14, 0	----	3.0	17.0
Other Eastern Hemisphere -----------	----	----	4.0	----	----	4.0
U.S.S.RV Eastern Europe andChina------------	----	----	1.0	----	----	1.0
Total ------------	3	4.5	76.5	4.5	11.5	100.0

Reproducedfrom:"BP St.atistical Reviewofthe WorldOilIndustry, 1973."

APPENDIX B

STATISTICS ON THE CT.S. TANKER FLEI;T

46-406 0 - 75 - 8

Table B-1 summarizes the makeup of the IJ.S.-flag tanker fleet of October 1, 19'74. This includes only those ships listed as active oceangoin, and thus excludes the Great I.akes fleet, the government reserve fleet and laid-up ships.

TABLE B-1.—U.S. *oceangoing tanker $eet in service, 19?'4*

Size range (derbdweight tons)	Numher of ships	Total (XIli~iOIIS of deadweight tons)
10,000 to 50,000	179	4.2
50,000 to 100,000	32	2.2
100,000 to 200,000	6	.8
200,000 to 400,000	1	.2
Total	218	7.4

Table B–21iststhe U.S. flag tanker operators and the number, sizes and agesoftankersthey operate fromdatacollected asofDecember31~ 197'3. Theprincipal changes in 1974arenoted.

Table B-3 lists those tankers which are considered economically suitable for the Alaskan Oil Trade including some now under construction. This data was prepared in September 1974. This list includes all U.S. flag supertankers except the two VLCC'S delivered in 1973 and 1974 and the others still under construction. Table B4 lists all major U.S. flag tankers under construction today including all supertankers and the above mentioned VLCC*s.

TABLZ 11-2. -U.S. ji?ag *tanker $eet* **as** *of Dec.* ***31, 1973***

Owner	Number of ships	Sizes (thousand deadw;;g$~	~e:~
Admanthos Shipping Agency	1	46	1959
Amerada Hess Corp	0	26-55	1961-64
American Foreign S.S. Corp	1	40	1959
American Trading Transportation Co	5	19-67	1943-71
Amoco Shipping Co	4	18-31	1943-71
Atlantic Richfield	9	30-120	1951-73
Chevron Shipping Co	13	14-70	1943-73
Cities Service Tankers Corp	7	30-39	1956-70

'TABLE B-2--U.S. flag tanker *fleet* as *of Dec. 31*, 1973—Continued

Owner	Number of ships	sizes (thousand deadweight (tons)	Years built
Colonial Tankers Corp	1	80	1961
Ecological Shipping	1	80	1973
Exxon Corp	19	31-81	1949-70
Empire-Ship Agents.	1	29	1963
Getty Oil Co	4	28-30	1945-68
Gulf Oil Co	15	20-39	1952-61
Hendy International Co	13	16-70	1945-71
Hudson Waterways Carp	7	23-162	1949-69
KeystoneShipping Co	23	19-68	1944–73
Maritime Overseas Carp	10	38-120	1960-73
Mathiasens Tanker Ind	5	35-92	1962-71
T. M. McQuilling Co	3	29-35	1950-53
Mobil Oil Carp	10	29-126	1954-72
National Transport Carp	1	80	1959
Nautilus Petroleum Carriers Carp	1	20	1958
Ogden Marine	7	23-41	1949-69
Penn Shipping Co	1	19	1945
Phillips Petroleum Co	3	18-48	1954-60
Prudential-Grace Lines	1	33	1959
Sabine Towing&Transportation Co	5	16-34	1943-72
Sun Transport, Inc	7	35-90	1953-69
Texaco, Inc	18	22-39	1953-68
Trinidad Carp	5	29–30	1962-68
Union Oil Co	2	15-25	1945-61
United Maritime Carp	6	31-38	1958-69
Vantage S.S. Corp	2	16-33	1942-68
Victory Carriers	5	13–53	1945-63
Western Tankers Carp	3	34	1953

Summary: 224 Tankers; 36 U.S.-flagtanker operators; 8 operators with 10 or more ships; 4 tankers ove 100,000 dwt; 3 120,000 dwt; l 162,000 dwt.

Note.–At least 10 new tankers were dellvered to the fleet during 1974 including the 225,000 dwt tankers Brooklyn and Willamsburg: 15-20 of the fleet were retired or laid up during1974.

Source: Marine Engineering Log-June1974and December 1974.

Table B-3.-U.S.-Flag privately owned tankers considered suited for the Alaskan oil trade

Vessel name	Year built	Deadweight tons
Exxon San Francisco	1969	75,600
Exxon Philadelphia	1970	75,600
Exxon Baton Rouge	1970	75,600
Golden Gate	1970	61,000
Overseas Alaska	1970	62,000
Arco Prudhoe Bay	1971	69,800
Sansinena II	1971	69,800
Overseas Arctic	1971	61,400

TABLE *B-3.—U.8.-Flag privately owned tankers considered suited for the Alaskan oil* trade-Continued

Vessel name	Year built	Deadweight tons
Arco Sag River	1972	69, 800
Chevron California	1972	70,200
Chevron Hawaii	1973	69,800
Manhattan	1962	115,000
America Sun	1969	80,700
Joseph D. Potty	1970	80,000
Sohio Intrepid	1971	80,000
Sohio Resolute	1971	80, 000
Chevron Missi=ippi	1972	70, 500
Arco Anchorage	1973	120, 000
Overseas Juneau	1973	120,000
Arco Fairbanks	1974	120,000
Arco Juneau	1974	120, 000
Mobil Arctic	1972	125, 000
Sun Shipbuilding	1975	118,300
Shipmor Associates (6)	1976,1977	89,700
Energy Tankers Co. (2)	1977,1978	89,700
U.S. Lines	1979	89, 700
Total (32 vessels)		2,877,100

Assumptions: All tankers have been built without construction differential subsidy with all deliveries except the *Manhattan* since 1969. The vessels range in size from 61,000 to 125,000 dwt, which are considered to be reasonable sizes for tankers in this trade.

NOTE: Estimated requirements for this trade are 3,500,000 dwt. In addition to the above, a contract to build six 165,000 dwt tankers was concluded January 1975 with Avondale Shipyards by Standard Oil of Ohio for delivery in 1978.

Source: MARAD, Office of Policy and Plans, September 1974.

Attachment 1

TANKSHIP ACCIDENTS AND RESULTING OIL OUTFLOWS, 1969-1973

Lt Comdr James C Curd
Paul V Ponce
L i Comdr Warren D Snider
Umted Smtes Coast Guard
Offie of Merchan/ Marine .Wfety
Washington. D C

ABSTRACT

Information has been collected on 3,715 *woddwlde tankship acckdent mvolvemenn during the period 1969.1973 from Lkoyd> Mly (Xsrmlty Repwti and other sauces Scope of the effort, aasumpoons and definttmns used* m *data collection, and uncertatn. ttes obout datu are descrtbtd For 3,183 in&ements of tonkshps over 3,t30f3 duxftvaght tons. frequencies of occurrence of brcok. downs.* coflk$ions, *exploswms, jires, groundmgs, tummtngs, and strucmml failures are presented Fadure consequences mcludmg deaths.* mmries. vessel *damage, and accu!enml otk oulffows are tabu. hted ami refationshrp of vessel nze, age, and focalwn of tnvolve. ment are exammed In fcwmatton collected, once analyzed, should be useful m fvafualrng meamves for reducing occidentsand resulting od outffows and evaluating risks associated with od tmnsport and pro. ductwn decutons*

INTRODUCTION

In formal#on IS an essential prercquiwte for understanding and mtefhgent decwwn makmg In formatmn on tanksh]p acodents M essential to tientify hazards and evaluate rwks associated wtth marure transportation of 011 and to make mtelbgent decmons contirnmg faws and reguf.atmns affecting vessel demgn, construction, operatton, and traffic-control systems Recausc of decmon compkx!ty, sy$temat}c approach IS essenttal If we are to make the right cholw The need for a systemal!c approach to marme tran$portatlon safety M recogmzed m the Ports and Waterways Safety Act of 1972, wh}ch gives the Secretary of the Lkpatment of Transportation and the U.S. Coast Guard broad regulatory authority over tank vessel des~n and operation as well as authority to estabbdt vessel trafficmntml systems The act provides that a number of factors must be conmdered in developing regukatlons, among them are the scope and deg~ of hazard, vessel traff]c cbaractenstlcs, port and waterway con ftgurat]on, environmental factors, economic Impact, extent to whwh propored ruks WIO contribute to rafety or protectum of the marme enwronment, and theu cost and technmal feaabthty [11 Information about tank$hlp acadents M essent#al to understanding the mfluen.x of each of these factors on safety and envuonmental protection

There have been a number of studtes of tanker accidents over the last few years The effort reported here or]gmated m 1971 when Porrtcelft, Ketth, and Storch recogmzrd that although tanker cawalty mformatmn was available from varmu% wurces, there was no mmpcmte collection of mformatfion on mternatlonal tanker casualtm$ which included pollutton data [2] Pomceib ct al reported and analyzed 1,416 tanker cawalt!e~ w!th the assomted 269 polluting tncidents occurrinfi dumw 1969-1970. Porricefb and Keith later added utformatlon on mf-outflow amounts for the 269 f.toffutmg mmtenls *[3].* Referenw 4, comp!kd for the Coast Guard by the naval arch!lectural firm of J.J. Henry Company, Inc., extended the data base to include 1971 and 1972. The informal}on presented here includes both these efforts and adds 1973 for a total of fwe years.

Referencz 5, wbmltted to the International Mantlme Consultatwe Organmrt]on (IMCO) by France and discussed m 131. pre=nted mfmmatmn on mctients mvofwng tankers over 7,000 deadwelgbt tons. t%mes [6] reported on 13,379 tanker accmtents worldwnde during the penmt 1959-1968 as part of an effort to prcdtct probabk future frequency of accufents ftkely to result m polfutton of the Ututed Kingdom coastltne Qudfe [7] prexnts ntformalwn on actual and constructwe total losses colkcted by the Lwcrpool Underwr!tem As$ocmtlon and diwusses the growth m recent years of constructwe total losses and the worwtmg tanker loss ratios, both actual and comtructwe Rectntly, the Tanker Adwsory Center, a reporting servme for the tanker industry located m New York, has rekased reports of tanker losses [81. Most of the= efforts have not included esttmates of ml outflows resulting from acctdcn!s

Data collection

The basic source for the tanker acculent in formatwn reported here M *Lloyd's Weekly Casualty Repcws.* pubhshed by the Corporatmn of Lloyd's al Lloyd's, London, England. Information from Ll~yd's has been supplemented and crow-checked with Coast Guard acodent and plluuon reports, pubfished news accounts, *Lloyd's RWSIU of Sh]ppmg CasmdtY Returns,* pubfi$bed by Lloyd's Relw. ter of Shlppmg, and mformatmn from oil compames m some minstances

Some terms need to be defined for the dwmsslon to foUow. An acc!dent ts an unexpected and undestred event It may revolve one or more vessels. An mvolvcmenf IS the participation of a vessel m an acctdent One vessel m one accident results m one involvement A colfmon between lwo tank=.hips is one accident but two mvolvenwnts Involvement *rype* refers to categories or group% of evolvements, such as breakdowns, colbstons, groundmgs, fme$, explosions, etc The term *total toss* IS ured here to refer to the smkmg or breakup of a vewel, tt IS an event rather than a condltmn The term *occtdenkd od outffow,* refers to ml cargo or bunkers lost to the sea as a result of a tankshlp involvement

'flu? marme !ransport.ttmn system used for moving ml mcludcs the followq ekment~ tankvhtps, tank barges ind tugs, lermmals (onshore and offshore) with theu Pwrs, plpebnc$, buoys, tank,, and other compiment$, the tramportdtton pitthw~y, and the envtronmenl (weather, wind, currents, etc) We are concerned w!tb the tankshlp portmn of the system, the vessel !twlf PIU, the factors ksfkmnckng its pmform-ce. These factors may ba categorized cc human, equipment, urgu, path, or enviromnarst [91. The tarskskup performance goal is tfm mfe cnd efllcbnt tmnaportction of oil cargo from the locdmg terminal to the dmharge terminal. Accidents are undesired events wluch k-pus from achkwing that gual.

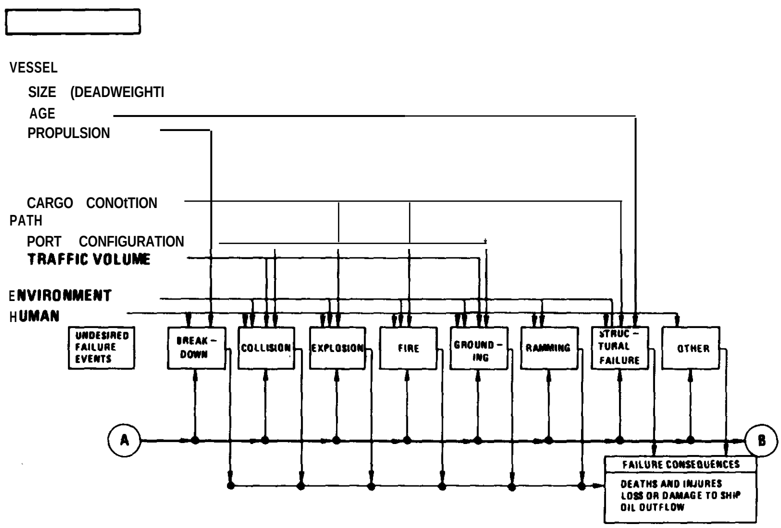
FKUX 1 shows the relationship bet-n the system factors, undesired failure events, ● nd failure cmmqracnces. A succe=ful voyage from point A, the loadmg terminal, to point B, the discharge termi. MI, can be represented by a strcight L@ connecting the two puints. A voyase can change f:om a mcm$s to a failure due to occurrenm of a fadum event Failure events rmult from interaction of the tcnksfup system and various system factors. Eacb of the failure events can result in *failure consequences*. Some of the most common are listed. We cm tnterewed in armral thugs. One is the *pvhbiliry* of an undedmd failure event oczurrmg, Another M the ceucrlly of the conecqumces associated with such an event. And when it comes time for decisions on action to rcdua the probability and mcvemty of fsiiurc events, we ncad to cmssidm cosf and effecfivcneas of the aftemative actions wailabb to us.

TfM acope of this study includes ship-movement acsidents to tcnkships carrying oil. Tank barges are not kncluded, Combinadon carriers, such as om/okl card bufk/oil vassals, am kncludcd if the ● cckdent occurred whik the vessel was in tanker service. Not included am hackdents of hostifa action. akdpyard acidents, mdsinery derangements not requirkng tow to port, mad fucdirag mad discharge mishaps such as broke.n how aasd overfllk?d tanks. Fhes, explosions, daskings, wsd upaizhgs nccmfng whife a ship u at a pkr am inckudad even tfauugh the ahkp was not "moving." Oi/ includes petrokum in any form; tankships carrybtg wine, grafts, molasses, dudge, fish oU, vegetabk oil, or the like am not kncJuded. Casualties to od/chamical cawkm am incfudad even if cugo was not petJokum Tlwee uc caded m they may be studied sepcmtely, B$ am the minvolvements of kiquefii gas tcnkships,

I%a data record of tmkatnp involvements *covers* the five-year pemod 1969-1973. For aach mvolvmnem the fcdlowmg information is recorded:

Vesd name
International cdl sagn
Country of registry
Grosc tonnage
Deadweight tommge
Year wasel bult
Type of involvement
Month and year of mvolvemcnt
Ship's loading rendition
Occurren= and amount of ml outllow
Methnd u$ed to detennuw amount of outflow
Severity of damage to the ve%scl
Portion of vcsd mvcdved
Number of persons kilkd OK mjurcd
Ce~aphiccl ama of involvement
Reketaon of area to lcnd and harbors
Source of reformation

Since the reasilts are mflumrmd by the aammptions mcdc in data cdkcction, some of the mom important ones cre worm notkng. In detarmkning mvolvemant type, if more then one uncle srmd event nccurmd (shrp gnes aground after a breakdown) the whok chain of events was considered m im'ofvement of the type that fkmt ocammd. lhddown inckudes canes where the Wsml lost p?opufakon power or anchored when bsc of propulsion power seamed imminent, cnd later was towed to port for repairs. Cases where a vewel proccded to port under IIS own pnwer after making mpaira were not included. *Collicions are* lsmited to cases of a lankship striking of being struck by another ves~l. Ramming mcludcs tankship hitting a pier, breakwater, tuck wall, dolphin, or other umikar fixed object. Reports of "stnkmg a subnwrged object" were



F$gure 1 Tanksh!p sysrem faolure dmgram

considered rammings unless it was apparent from the report that the object struck was some part of the bottom Groundings include strandings where the ship remained aground for some time, as well as "touching bottom" and striking a submerged object where it appeared from the report that the ship contacted the bottom Strucrural *failures* include tankships breaking up and reports of "heavy weather damage" ranging from shell plating failure down to dam. aged piping, catwalks, bulwarks, and the like on deck due to boarding seas. Failure of structural components due to deterioration with age, inadequate design, or unusual loadings are all included The category *other* includes those movements not fitting into one of the previous categories. Capsizing of a tankship or sinking *at the* pier due to flooding of machinery space are two examples of involvement in this category

The seventy of damage to a tankshlp was recorded as one of the following

1 *Sunk,* including cases where a vessel broke m two and part of it sank, or where the vessel was raised later,
2 Heavily *damaged,* where huff structure was weakened so ship was in danger of breaking up, a major fire occurred involving most of ship, or other damage was sustained with estimated repair costs exceeding $250,000. Note that this category would include a number of ships regarded as total losses or constructive total losses for insurance purposes, even though the vessel did not actually sink,
3 *Light damage* include% cases where ship was not in danger of sinking and estimated repair costs were less than $250,000;
4 No *damage* include% all cases where no damage or only superfical damage occurred

Location of tankship at the time the accident occurred is given m terms of a two-digit code for the area of the world's ocean and a code for pier, harbor including rivers and canal-,), entranceway m harbor. coastal area (within 50 miles of land), or at sea (over 50 miles from land)

Probably the most difficult part of the data collection, the one subject to the most uncertainty, and yet one essential to the whole effort is the problem of determining oil-outflow occurrence and amount In some cases, outflow amounts appear in the incident reports, generally without any indication of how they are deter. mined. These have generally been accepted at face value as the best information available. Where outflow amounts were not reported, but information on vessel damage was available, an attempt was made to estimate outflow amounts Where a loaded vessel sank, the involvement was credited with outflow equal to the vessel's deadweight. Where a tankship on a ballast voyage sank, an outflow amount equal to the ship'! bunker capacity was used In other cases, amounts were based on damage location and extent, loading condition, tanks reported open to sea, and other information available One serious problem is that of estimating what portion of a tankship's cargo burns if a fire follows a collision or grounding. This appears to be a highly variable factor and each case was estimated on basis of best information available Where the report indicated there was visible sign of oil outflow but there was no great volume of outflow, a minimum quantity of one ton was attributed to the involvement. In the remaining involvements where it could be inferred from the information available that oil outflow did occur. but neither outflow data nor damage details were available, the follow. ing procedure was used: It was assumed that none of these involvements resulted in an outflow greater than 500 long tons. An oil outflow amount equal to the mean value of the outflows less than 500 long Ions for similar involvement type (e.g., groundings, collisions, etc.) was attributed to each of these involvements This is the same procedure used and discussed at some length in [3 and 4].

Before moving on to the data analysis, let us look at some of the uncertainties involved in the data collection process. It is possible that the list of tankship involvements is not complete, either due to incidents not reported m the data sources used or because they were missed during the collection process. Experience during collection and cross-checking of data supports the belief that the list IS relatively complete, particularly for the more serious accidents. It is also possible that tome of the information recorded IS not accurate due to misreading reports or miscoding data. This could include incidents being included which do not meet our definition of tanker involvement, or wrong data, year built, loading condition, etc., being recorded Again, cross-checking and rereading reports. particularly for more serious accidents, gives confidence that relatively few errors of this type remain.

There is also uncertainty regarding outflow amounts, considering the quality and amount of information upon which these figures are based. *In* fact, even the reported values are probably no more than estimates. The problem of estimating what portion of a tankship's cargo burns after collision or grounding is particularly troublesome considering the *influence that a* few large outflows nave on overall amounts All of the outflow amounts must be considered estimates and used with caution The figures on deaths and injuries reported m the information sources have been accepted at face value, and no specific effort has been made to verify or cross-check them since the overall lost of life and injury occurrence are not large.

Data analysis

During the course of tankship operations, some undesired failure events or tankship involvements which interrupt the trip from A to B may occur Some (we hope all) of these involvements are reported and are now accurately represented in our data file. Figure 2, representing our data records, shows how reported tankship involvements can be subdivided into those with oil outflow and those without oil outflow And some portion of those involvements where damage is serious enough to result m outflow also result in sinking of the tankship. (Because of the outflow assumptions we have made, any sinking is considered to result in outflow, although it is not uncommon for oil to remain in intact tanks rather than escape immediately to the sea when a vessel sinks.)

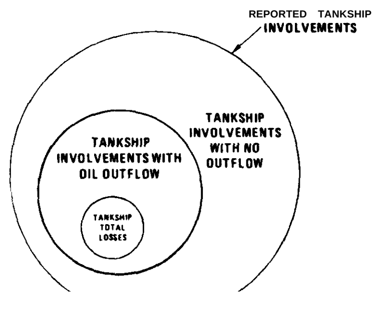


Figure 2 Relationship of #evolvements outflow and total losses to reported *tankship involvements*

The complete data record contains information on 3,715 tankship involvements during the period 1969.1973 These involvements range m seriousness from from bumps and scrapes to major casualties. The analysts reported here includes vessels larger than 3,000 deadweight tons, which is roughly equivalent to a size of 2,000 gross tons. Tankships smaller than this are generally used for specialized service, such as product distribution among terminals within a harbor or on short coastwise routes. They are not used on long-haul voyages and the differences between them and larger ships warrant separate consideration. The choice of a dividing line between these two classes of vessels IS of some concern An analysis by Exxon [10] of the previously published 1969.1970 data used 6,000 deadweight tons as a dividing line. Further study and discussion of fleet composition and vessel utilization would help to clarify this point. For tankships over 3.000 deadweight tons, over the five-year period there were *3,183* involvements. Of these, there were 452 involvements where accidental oil outflows totaling an estimated 950,000 long tons occurred. During the period 1971-1973 there were 381 reported deaths and 178 injuries.

Referring back to figure 1, we will look first at the frequency of occurrence of the various undesired failure events and the resulting failure consequences. Then we will look for relationships between some of the system factors and the failure events.

The frequency of occurrence during the five-year period of the various undesired failure events or involvement types is shown in table 1, and the percentage figures are shown graphically in figure 3.

Table 2 shows the distributions of deaths and injuries among incident types for the period 1971.1973. Collisions and explosions account for the bulk of deaths and injuries; and. in fact, most of the deaths and injuries caused by collisions are the result of fire or explosion following the collision. The total of 381 deaths over three years is not a very large number-approximately 1,500 persons are killed in the U.S. every year in recreational boating accidents, therefore, the loss of life associated with tankship accidents is not great. Table 3 presents information on loss or damage to tankships resulting from involvements. These must be thought of in terms of repair or replacement costs, lost revenue, sailing delays, and increased insurance premiums. The true cost of these depends a great deal on tanker, shipyard, and insurance market conditions.

Table 1. Tankship involvements, 1969-1973, tankships over 3000 deadweight tons

TYPE OF INVOLVEMENT	NUMBER
Breakdown	355
Collision	744
Explosion	104
Fire	197
Grounding	790
Ramming	473
Structural Failure	515
Other	5
TOTALS	3,183

information on oil outflows appears in table 4 and is shown graphically in figure 4.

Size distribution of oil outflows fot various involvement types is shown in figures S and 6. Most outflows resulting from breakdowns and rammings and fires are relatively small (90% less than 850 long tons), Outflows resulting from collisions, grounding, explosions, and structural failures tend to be larger as indicated in Figure 6.

Table 5 shows that most of the total oil outflow (81%) is a result of tankship sinkings, even though less than 2% of all tankship involvements result in the vessel sinking, The 15 vessels lost due to structural failure accounted for 34% of the total oil outflow from tankship accidents. Because of their contribution to oil outflows, a more detailed study was made of tankship total losses. There were 47 tankships of over 10,000 deadweight tons that were total losses during the 1969-1973 period. They were responsible for 81% of the total oil outflows of 951,000 long tons. Table 6 shows that most of these revolved a sequence of failure events, Table 7 gives additional detail on the events leading to loss of structural integrity and sinking of the tankship.

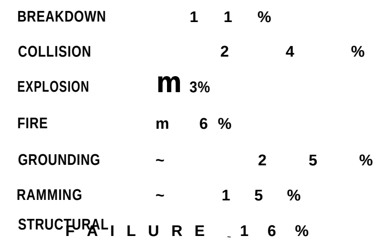


Figure 3. Distribution of tankship involvements, 1969-1973, tankships over 3000 deadweight tom

Table 2. Deaths and injuries resulting from tankship accidents, 1971-1973, vessels over 3000 deadweight tons

Accident Type	No.	Deaths	Injuries
Breakdown	4	5	53
Collision	26	259	130
Explosion	33	46	47
Fire	14	34	10
Grounding	0	0	0
Ramming	0	0	0
Structural Failure	6	37	32
Other	0	0	0
TOTALS	83	381	178

NOTE: Deaths and injuries include those occurring on other vessel or ashore as a result of the accident.

This kind of reformation on the occurrence of various failure events and then consequences should help us answer questions such as, Gwen a failure of a given type, what m the probability of various losses or failure consequences occurring? Referring again to figure 1, we will now look for relationships between some of the system factors and the failure events m an attempt to better understand accident experience. Since our interest here m m preventing accidental oil outflows, we will look at the 452 cases (14 2% of all involvements) where outflow occurred

Vessel size is an important and impressive variable whenever tankships are talked about Figure 7 gives the distribution of tankship size and also the distribution of deadweight tonnage or cargo-carrying capacity as of July 197 I (the midpoint of the five-year period) for reference purposes. Figure 8 gives the distribution of involvements where outflow occurred and the outflow amounts

Table 3. Damage or loss of tankships, 1969-1973, tankships over 3000 deadweight tons

TYPE OF Involvement	TOTAL LOSS	HEAVY DAMAGE	LIGHT DAMAGE	NO DAMAGE	DAMAGE UNKNOWN
Breakdown	2	lb	197	131	9
collision	7	64	570	78	25
Explosion	11	30	52	10	1
Fire	1	26	149	14	7
Grounding	12	63	487	206	22
Ramming	0	23	412	35	3
structural Failure	15	39	445	2	14
Other	3	1	1	0	0
TOTAL	51	262	2313	476	81

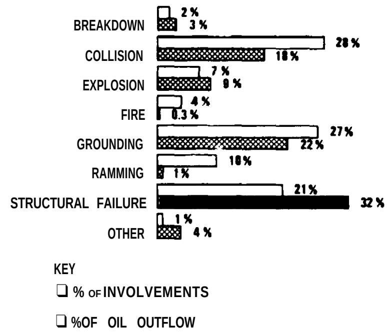


Figure 4 Distribution of involvments resulting in oil outflows and amount of oil outflow, 1969-1973, tankships over 3000 deadweight tom

Table 4. Tankship involvements resulting in all outflow, 1%9-1973, tankships over 30000 deadweight tons

Involvment TYPE	NUMBER RESULTING IN OUTFLOW	Amount 0f OIL OUTFLOW (Long Tons)
Breakdown	11	29,940
COllision	126	185,08.9
Explosion	31	94,803
Fire	1 -	2,935
Grounding	123	230,306
Ramming	46	13,645
structural Failure	94	339,101
Other	4	54,911
TOTALS	452	951,317

Table S. Tankship total losses and their influence on oil outflow, 1%9-1973, tankships over 3000 deadweight tons

Involement Type	No.	oil, outflow (Long Tons)	OF Total Outflow From All Involvements
●.nkdo.n	2	29,350	3
Collision	7	140,779	15
Explosion	11	68,700	9
Fire	1	1,233	0.1
Grounding	12	134,449	14
Ramming	0	0	0
Structural rail.,.	15	322,519	34
Other	3	54,790	
TOTALS	51	771,917	81

NOTE TOTAL OIL OUTFLOW FROM ALL 111=-S EQUALS 951, 317 LONG TONS (FROM TABLE 4)

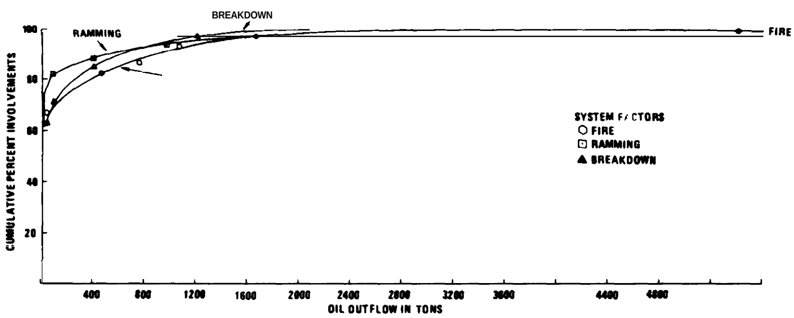


Figure 5. Size distribution of oil outflows for breakdowns, fires, and rammings.

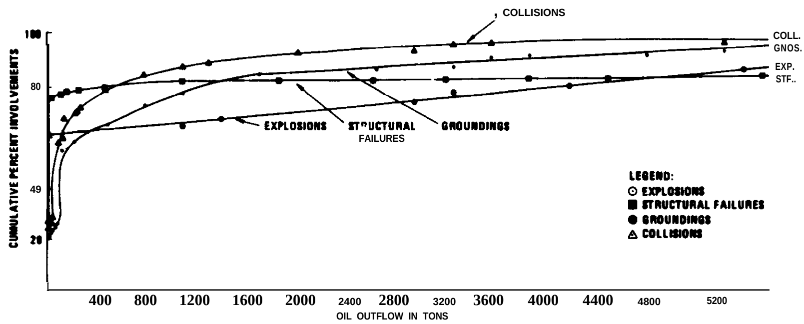


Figure 6. Size distribution of oil outflows for collisions, ● xplc.ciom, groundings, and structural failures,

Table 6. Accident for-47 tankship losses, 1969-1973, tankships over 10,000 deadweight tons

Accident Sequence	Number	Oil Outflow (Long Tons)
Breakdown-Structural Failure-Sink	1	1°, 330
Breakdown-Grounding-Sink	1	13,000
Collision-Sink	2	4,138
Collision-Explosion/Fire-Sink	4	136,163
Explosion/Fire-Sink	12	90,030
Grounding-Explosion/Fire-Sink	1	2,500
Grounding-Sink	9	134,726
Flooding-Sink	2	54,669
Structural mil.,.-aro".di"~-sinb	1	40,000
Structural Failure-Sink	14	282,519
Totals	47	774,.%.,

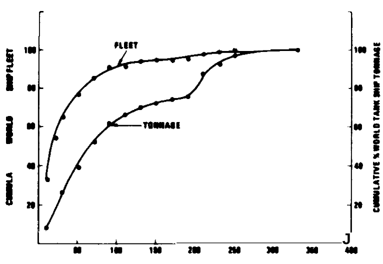


Figure 7 Size distribution of world tankship vessels and tonnage, vessels over 2000 gross tom, 197t

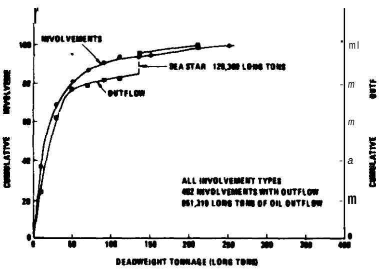
Table 7. Description of loss of structural integrity for 47 tankship losses 1969-1973, tankships Over 10,000 deadweight tons

Description	Number	Oil Outflow (Long Tons)
A. Loss of structural integrity of hull caused F., i- ily by -t. rnal forces or where local ",..,1.1 conditions deteriora ted. No explosion . r fire was associated with the ... ident. These may be broken down into:		
1. Structural failure of main hull girder from excess bending or shear loading	12	743,619
2. Local structural failure of hullenvelope		
. .Failure of hull penetrat ion	2	36,750
b. Local hull plating failure	2	39,169
. . Unknown local structure failure	1	34,000
3. Hull damage C.". *4 by C.111,1OII or grounding		
a. Collision	2	4,138
b. Grounding	11	187,726
	30	343,402
B. k... of str UC, ural I., egrit " from damage ..... d primarily by explosion or 11,. or where explos ion or fire contributed to loss of struct ural int egrity. These may be broken down into ,		
1. Explos ion or fire initiat ed in own ship cargo tanks	12	90,030
2. Explos I." or fire set off by vessel coll ision or grounding		
a. Collis i..	4	136,163
b. Grounding	1	2,500
		228,693

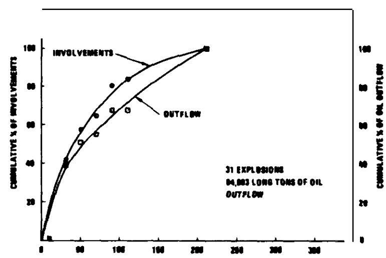
Figures 9 through 15 show the distribution of involvements and resulting outflows for different involvement types.

Vessel age is another factor we might suspect bears come relationship to the occurrence of future events, ● nd structural failures in particular During the five-yew period, 515 structural failures occurred Of those, 94 resulted in an estimated 339,181 long tons of 011 outflow. Fifteen total losses due to structural failure accounted for 322,5 19 long tons of outflow (95% of total outflow due 10 structural failures and 34% of all outflows). Figure 16 shows the distribution of these structural failures with vessel age, and figure 17 shows their distribution by size. Structural failures can result from

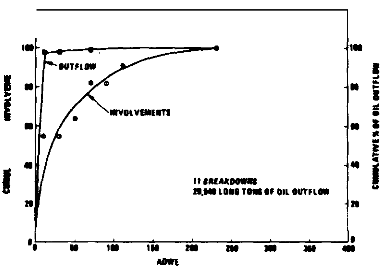
103



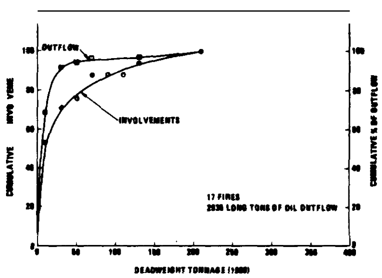
Rffurc 8. Dwtnbutwn of 452 mvol— ts wtth outflow end out. flow amounts



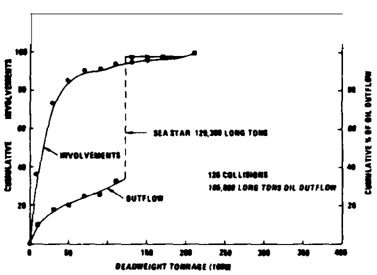
FMwm 11. Otstr{butmn of 31 .mkwms wtth outflow ● nd rowltma Ouiflom.



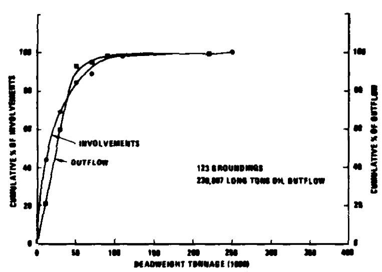
F!fpre 9, Dmrbtmon of 11 breakdowm w!th outflow and ramdtmg outflows.



Fqurc 12. Dtstr!butlon of 17 ftra with outflow ● d rmulting outflows.



Ft~re 10 Dmr,butmn of 126 colllsmns with outflow md remdtmg Cutflowl



Flwr@ 13 O,strlbutma of 123 ground,ngs with outflow and r.. sultmg outflc+w

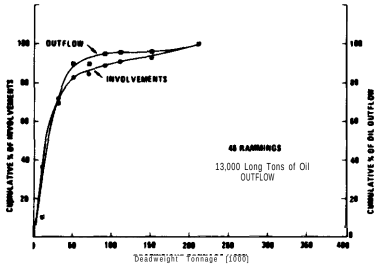


Figure 14 Distribution of 46 rammings with outflow and resultlng Outflows.

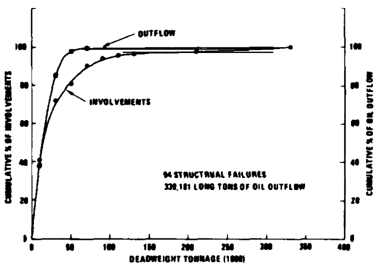


Figure 15. Distribution of 94 structural failures with outflow and resulting outflows.

poor structural **design, loads exceeding the design loads due to unusual environmental conditions or improper loading, or deterioration due to corrosion or erosion. Corrosion and erosion depend cm time as well as inspection and maintenance, protective coatings, cargo, and** *environmental conditions.* **Time may also be required for design defects to make themselves apparent. The sharp increase in structural failures between 15 and 20 years indicates** ships in this age **group are** more subject to loss from this cause. Quaille [7] reports m increase **of tanker loss ratio (ratio of tonnage lost to tonnage in the group) for tinkers in the 15-19 year and 20-24 year age groups but does not indicate how the vessel losses occurred. At the** very beat though, age can only be a gross **indicator** of probability **of failure. We must look further into these** structural failures to **identify factors more directly linked with them.**

Table 8 gives a breakdown by location of the 443 tankship involvements with oil outflow where location could be determined, The bulk of collisions with outflow occurred in the coastal, entranceway, and harbor areas, as one would expect Half of the explosions occur at sea. Over half of the fires with outflow occur at the pier. The majority of grounding occur in coastal or entrance areas, with a smaller contribution coming from harbors. **Rammings in the harbor or at a pier are the bulk of ramming involvements. And a majority of structural failures occur at sea. This confirms that pathway plays** m **important role in collisions** and groundings, along with the ship and human factors.

There are a number of other ways the data records could be examined ιo test for relationships between **system factors and**

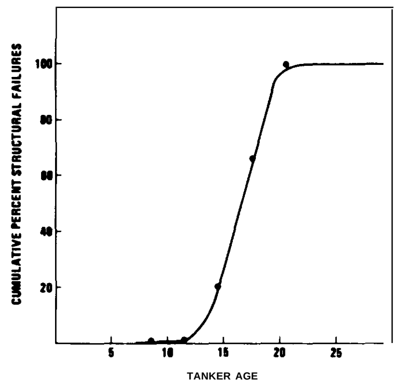


Figure 16 Distribution of 15 tankship total losses due to structural failure by vessel age

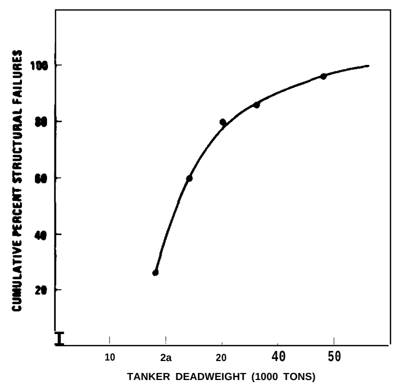


Figure 17 Distribution of 15 tankship total losses due to structural failure by vessel size.

occurrence of failure events. Additional work on several of these is underway.

Application of results

Analysts of the information collected has really just begun Properly digested, the accident information should be useful in evaluating various alternative measures for reducing accidents and resulting oil outflows, as well *as* **other losses They may also be of use m evaluating risks associated with future 011 transport** and production **activity decisions.**

Table 8. Location of 452 tankship involvements with outflow, tankships over 3000 deadweight tons

INVOLVEMENT TYPE	Pier	*Harbor*	Entrance	*Coastal*	
Breakdown	0	1	1	5	3
collision	5	41	25	45	9
Explosion	5	4	0	6	15
Fire	10	2	0	1	4
Grounding	1	27	40	53	0
Ramming	18	15	5	4	2
structural Failure	6	9	4	7	64
Other	1	0	0	2	1
TOTALS	48	99	75	123	98

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Attachment 2

INTER GOVERNMENTAL MARITIME
CONSULTATIVE ORGANIZATION

C XXXII/14/l
9 May 1974
Original: ENGLISH

COUNCIL - 32nd Session
Agenda item 14

IMCO

RELATIIONS WITH THE UNITED NATIONS
THE SPECIALIZED AGENCIES

The Third United Natlons Conference on the Law of the Sea

Note by the Secretariat

1. In document C XXX/20 the thirtieth session of the Council was given a report on the work of the United Nations Committee on the Peaceful Uses of the Sea-bed and Ocean Floor beyond the Limits of National Jurisdiction (the Sea-bed Committee) end, In particular, the role played by the Secretariat in collaborating with the Committee and its Sub-Committee in relation to those subjects on the Committee's Term of Reference which were of interest to tCo. The Council took note of this Report.

2. Following the consideration of the Final Report of the See-bed Corm.ittee the United Nations Gneral Assembly adopted, in November 1973, resolution 3067 (XXVIII) by which it decided to hold an organizational session of the Third United Nations Conference on the Law of the Sea in New York in December 1973 and to hold the first working session of the Conference in Caracas, Venezuela, from 20 June to 29 August 1974.

3. The IMCO Secretariat was represented at the organizational session *of the Conference held in New York from* 3 to 14 December 1973.

4. The Secretariat will be represented at the main session of the Conference to be held in Caracas from June to August 1974. The Secretary-General intends to be present during the early stages of the session, and he expectsi to make a statement to the Conference in which he will affirm IMCO's readiness to co-operate with the Conference in relation to those aspects of its work which are relevant

to the work end purposes of IMCO. Other members of the Secretariat till participate in the work of the Conference, to the extent necessary and possible within the financial and manpower resources available.

5. *In* accordance with varioue resolutions of the General Assembly of the United Nations and the wish expressed in the Marine Environment Protection Committee (MEPC) during Its first session, the Secretariat has submitted to the Conference a comprehensive document on IMCO and its work in relation to shipping and other maritime activities.

6. This document describes IMCO'S work in the field of maritime safety end efficiency of navigation, in the prevention of marine pollution from chips, vessels and other craft operating in the marine environment, in legal matters end the facilitation of maritime transport and the provision of technical assistance to developing countries. It also provides background information on the objectives, functions, membership and structure of the principal organs and bodies of IMCO; and describes recent constitutional developments regarding the composition and size of the principal organs and the re-organization of the institutional arrangements for IMCO's environmental work, including, in particular, the establishment of the Marine Environment Protection Committee (MEPC).

7. A copy of the docunent submitted by the Secretariat to the Law of the Sea Conference is attached hereto.

8. As till be observed, the Secretariat's document Is confined to a'description of the areas in which IMCO has completed or begun substantive work. The Secretariat did not consider it necessary or useful to make any claim on behalf of IMCO. In particular no references are made either to the prevention and control of marine pollution arising from the exploration and exploitation of sea-bed resources or to ocean dumping.

9. The Council is invited to take note of the action taken by the secretariat in relation to the Third kited Nations Conference on the Law of the Sea, to cement as it deem appropriate and to give to the secretariat any further directives it considers necessary.

THE ACTIVITIES OF THE INTER-GOVERNMENTAL MARITIME CONSULLTATIVE ORGANIZATION IN RELATION TO SHIPPING AND RELATED MARITIME MATTERS

Document submitted by the Secretariat of IMCO

CONTENTS

	Paragraphs	Page
I. INTRODUCTION	1-2	3
II. ORIGINS, PURPOSES AND STRUCTURE	3-19	4
Membership	6-7	4
Main Organs and Bodies	0-16	5
Recent Developments	17-19	6
III. SCOPE OF ACTIVITIES	20-121	7
A. MARITIME SAFETY AND EFFICIENCY OF NAVIGATION	24+3	8
(i) Conventions and Similar Instruments	25-41	8
Safety of Life at Sea	25-29	8
Load Lines	30-34	9
Prevention of Collisions at Sea	35-37	10
Special Trade Passenger Ships	38-40	10
Containers	41	11
(ii) Recommendations, Codes of Practice and Guidelines	42-58	11
Routeing of Ships	44-49	11
Navigation Equipment and Crew Training	50-52	13
Buoyage Systems and Navigational Warnings	53-55	14
Safety of Off-Shore Drilling Rigs	56-57	14
Carriage of Dangerous Goods	58-60	15
Other work relating to maritime safety	61-63	16
B. PREVENTION AND CONTROL OF POLLUTION	64-101	17
(i) Conventions and other Instruments	69-99	18
Prevention of pollution of the Sea by Oil, 1954/62	69-72	18

	Paragraphs	Page
Prevention of Pollution by ships, 1973	73-88	19
Intervention on the High seas, 1969	89-90	23
Protocol on Intervention on the High Seas, 1973	91-92	24
Civil Liability for Oil Pollution Damage, 1969	93-94	24
Compensation for Oil Pollution Damage, 1971	95-99	25
(ii) Recommendations and Other Guidelines	100-101	27
Manual on Marine Pollution	100	27
Other matters	101	27
C. Other WORK	102-126	28
Tonnage Measurement	103-104	28
Facilitation of Maritime Traffic	105-106	28
Legal work	107-113	29
Technical Assistance to Developing Countries	114-125	31
Relations with other Organizations	126	33
IV. CO-ORDINATION OF IMCO'S WORK WITH RELATED WORK IN THE UNITED NATIONS SYSTEM	127-146	35
The United Nations	129-130	35
The Regional Economic Commissions	131	35
UNCTAD and UNCITRAL	132	36
United Nations Development Programme	133	36
The Specialized Agencies and the IAEA	134-135	36
The United Nations Environment Programme	136-137	37
The Sea-bed Committee and the Conference on the Law of the Sea	138-146	37
V. CONCLUSION	147	40
ANNEXES:		
Annex I - Membership of IMCO		41
Annex II - Convention and other Instruments adopted under the auspices of IMCO		44
Annex III - Certain Resolution adopted by the 1973 Conference on Marine Pollution		47

46-406 0 - 75 - 9

I. INTRODUCTION

1. In accordance with various resolutions of the General Assembly inviting the specialized agencies to assist the work of the Third United Nations Conference on the Law of the Sea, the Secretariat of the Inter-Governmental Maritime Consultative Organization (IMCO) is submitting the present document which summarizes the work of the Organization in relation to shipping and related maritime activities, in particular those connected with:

(a) the promotion of maritime safety and efficiency of navigation;

(b) the prevention and control of marine pollution from ships, vessels and other craft, and

(c) the provision of technical assistance to developing countries in these fields.

2. The IMCO Secretariat hopes that the information provided on the work of IMCO, which is a specialized agency of the United Nations whose activities are entirely in the maritime field, will be of interest and use to the United Nations Conference on the Law of the Sea.

II. ORIGINS , PURPOSES AND STRUCTURE

3* The Inter-Govemnental Maritime Consultative Organization (IMCO) was established in pursuance of the Convention on the Inter-Governmental Maritime Consultative Organization adopted by the United Nations Maritime Conference held in Geneva in 1948. The Organization came into being January1959, following the entry into force in March 1958 of the Convention. IMCO was brought into special relationship with the UN by means of an Agreement in accordance with Article 57 of the Charter of the United Nations. .,. :

4. The Organization's objectives, as provided for in Article 1 of its Convention, are, inter alia, to provide machinery for co-operation anew governments in the field of governnental regulations and practices relating to technical matters of all kinds affecting shipping engaged in international trade, to encourage the general adoption of the highest practical standards in netters concerning maritime safety and efficiency of navigation.

5. The Organization also provides for the consideration of any matters concerning shipping that maybe referred to it by any organ or specialized agency of the UN. It provides a forum and machinery for the exchange of information anew governments on all matters under consideration by the organization.

Membership

6. IMCO is open to membership by all States Members of the United Nations and by other States In accordance with admission procedures contained in the Convention establish it. The Secretary-General of the United Nations is the depositary of this Convention. The Convention stipulates in Article 11 thereof that "No State or territory become or remain a Member of the Organization contrary to a resolution of the General Assemly of the United Nations"

7. There are at present 8 full Members of the Organization and one Associate Member. Of this number, 18 are States from Africa, 22 are States from Asia, 14 em States from Latin America, 8 are States from Eastern Europe and 23 are States from Western Europe and others. A list of the membership of IMCO is given in Annex I to this document.

Main Organs and Bodies

8. The organization has three principal organs, the Assembly, the Council and the Maritime Safety Committee.

9. The Assembly is the supreme governing body of the organization. It determines the policy of the Organization, decides upon the work programme and votes the budget to which Members of the Organization contribute according to a scale of assessment based in part on the United Nations scale of assessments and in part on the total tonnage of ships registered in each Member State. The Assembly approves all financial regulations and elects the Member States to serve on the Council and the Maritime Safety Committee. It also has the responsibility of approving the appointment of the Secretary-General of the Organization. The Assembly is composed of all Member States of the Organization and normally meets once every two years.

10. The Council consists of eight.oen14enberStatee elected for a term of two years at a tine, by the Assembly. Subject to the authority of the Assembly, it supervises the execution of the work programme of the Organization and performs the functions of the governing body between sessions of the Assembly.

11. The Maritime Safety Committee consists of sixteen Member States elected for a four-year tern by the Assembly. It is responsible for the technical work of the Organization, concerning in particular maritime safety and efficiency of navigation. It performs its functions mainly with the assistance of Sub-Committees and other subsidiary bodice which are generally open to participation by all States Members of the Orgnization.

12. In addition to these principal organs, there are a number of important subsidiary organs. These are described in the following paragraphs.

13. The Marine Environment Protection Committee is a permanent subsidiary organ of the Assembly whose membership is open to all Member States of IMCO as well as States which are parties to the conventtions in respect of which the Committee performs functions. It is responsible for administering and co-ordinating the activities of IMCO relating to the prevention and control of marine pollution from ships, vessels and other equipment operating In the marine environment.

14. The Legal Committee is a permanent subsidiary organ of the Council and is charred with the consideration of legal matters of concern to the Organization. The Legal Committee is open to participation by all Member States of IMCO.

15. The Committee on Technical Co-operation is a subsidiary body of the Council end performs advisory functions in respect of IMCO's programme of technical assistance to developing countries. Membership of the Committee is open to all Member States of IMCO.

16. The Facilitation Committee is a subsidiary body of the Council established to advise the Council on matters relating to the facilitation of maritime traffic. It also provides advice to the Secretary-General of the Organization in relation to his functions under the International Convention for the Facilitation of Maritime Traffic, 1965. Membership of this Committee is open to all Members of IMCO as well os to States parties to the 1965 Convention.

Recent developments

17. The 8th regular session of the IMCO Assembly which was held in November 1973 gave consideration to the size and composition of the Council and Maritime Safety Committee, particularly view of the recent Increase in the membership of IMCO and the increasing importance of IMCO's technical work to these new Members, many of when are developing countries. A special Ad Hoc Working Group, open to all Members of the Organization, was established to study the problem and make recommendations thereon for consideration by the Assembly at an extraordinary session.

16. The Ad Hoc Working Group net in February 1974 and made recommendations on proposed amendments to the IMCO Convention. Briefly, these proposed amendments are intended: (a) to Increase the membership c& the Council from its present total of eighteen to twenty-four: and (b) to make membership of the Maritime Safety Committee open to all States Members of IMCO, with the right of participation to any State not a Member of IMCO if it is a party to a Convention In respect of which the Committee perfoms functions.

19. These proposed amendments have now been submitted to the Member Governments of IMCO prior to their consideration by the extraordinary session of the Assembly to be held in October 1974.

III. THE SCOPE OF IMCO'S ACTIVITIES

20. Through the nachinery ouklined above, IMCO provides to its Member States a forum for the exchange of information and experiences on all maritime matters falllng within the scope of the objectives and functions enumerated in the IMC0 Convention, The Organization performs its functiona lnter laia by:.

(a) providing for the adoption of conventions or other instrumentation those matters which are suitable for solution through formal international of agreements;

(b) adopting recommendations, codes, standard Practices and guidelines where appropriate; and

(c) initiating studies on particular problems and making the results of such studies available to interested States.

21. Annex II to this document contains a full list of the conventions and similar instruments which have either been adopted under the auspices of IMCO or entrusted to IMCO for administration end further development.

22. The extensive range ofactivitiea undertaken by IMCO nay, for convenience, be grouped under three broad category headings. These are:

(a) Activities relating to the promotion of maritime safety and efficiency Of navigation;

(b) work relating to the prevention and control of marine pollution from ships and other craft and related questions; end

(o) other work relating to shipping and related maritime activities, including in particular. technical assistance to developing countries.

23. The various aspects of the organization's work are, of course, lnte=related. Thus, for example, the work in relation to maritime safety and efficiency is, in a very important sense, Part of the "environmental" programme of IMCO since, by ensuringthehigh standards of safety, it serves to eliminate or at least reduce to a minimum incidents such as collision, stranding, etc., which are likely to result in the discharge into the sea of harmful cargoes. Such accidental discharges are of course a major source of marine pollution from ships and other craft. Similarly the efforts to prevent pollution of the seas from ships demand, and have promoted, the development of equipment, procedures and facilities which increase efficiency of navigation.

A. ACTIVITIES OF IMCO RELATING TO MARITIME SAFETY AND EFFICIENCY OF NAVIGATION

24. The promotion of maritime safety and efficiency of navigation through inter-governmental co-operation is, of course, one of the principal objectivee of IMCO. To this end the Organization has prepared for the adoption of a number of important conventions and similar instruments and has, through its appropriate organs, adopted a large body of Recommendations, Codes of Practice and other guideline which have been submitted to States for adoption and implementation, as appropriate. The main areas In which this activity has been pursued, and the results so far achieved, are summarized below.

(1) Conventions andsimilar instruments

International Convention for the Safety of Life at See, 1960

25. Follow@ the loss of the passenger ship 'Titanic" in 1912, an international conference on safety of life at sea was convened end resulted in the adoption of the International Convention for the Safety of Life at Sea, which, however, did not come into force because of the outbreak of World War I. A fresh stark was node at anew Conference in 1929 which produced the first effective . Convention for the Safety of Life at Sea. The Convention was subsequently reviewed and revised by an international conference in 1948. In 1960 IMCO convened a Conference which adopted a revised Convention to replace that of 1948.

26. The 1960 Safety convention deals with various aspects of maritime safety and contains provisions in respect of:

- construction of ships, including subdivision, stability, machinery and electrical installations, and fire protection;
- life-sating appliances;
- radiocommunication, including radiotelegraphy and radiotelephony;
- safety of navigation;
- carriage of grain;
- carriage of dangerous goods;
- nuclear ships;
- survey and certificates.

27. The Convention applies to all merchant ships engaged on international voyages, including passenger ships (ships carrying more then twelve passengers) of all sizes and cargo ships of 500 tone gross tonnage and upwards, but excluding fishing vessels, pleasure yachts, barges and ships solely navigating the Great Lakes and the River St. Lawrence.

28. Amendments to the 1960 Convention were adoptedby the IMCO Assembly in 1966, 1967, 1968, 1969, 1971 and 1973.

29. Preparations are now completed for the holding in October 1974 0f an International Conference to revise the 1960 Convention. The Assembly of IMCO has decided that the following should be incorporated in the revised Convention:

(a) provisions for rapid entry into force of the Convention;

(b) improved and accelerated amendment procedure;

(c) amendments to the 1960 Convention which have already been adopted;

(d) new Regulations which have been recommended for inclusion in the Convention.

<u>International Convention on Load Lines, 1966</u>

30. Overloading is often the cause of casualties to ships, particularly cargo ships. In 1930 an International conference produced a convention on local lines. This Convention lasted for 36 years until it was replaced by a new Convention drawn up by an international conference convened by IMCO in 1966.

31. The 1966 Load Line Convention prescribes the minimum freeboard (or the maximum) to which the ship is permitted to be loaded. The Convention applies to all merchant ships engaged on internationao voyage except ships of less than 24 meters in length, fishing vessels, pleasure yachts and ships solely navigating the Groat Lakes, the River St, Lawrence, the Caspian Sea and the Plate, Parana and Uruguay Rivers.

32. The load line mark shown on the ship's sides consists of several lines for different zones and seasonal areas, additional lines for the carriage of timber are marked. The zones and seasonal areas are defined in the Convention.

33. In both Safety and Load Conventions, the control of ships at foreign ports is exercised In a similar namer as in the 1973 Pollution Convention (see paragraph 87).

34. Amendments were adopted to this Convention by the IMCO Assembly in 1971.

International Regulations for Preventing Collisions at Sea, 1960 and 1972

35. The International Regulations for Preventing Collisions at Sea, 1960 sets out basic rules which regulate the behaviour of vessels at sea in respect of other vessels in order to prevent collisions, and deals with such matters as:

lights and shapes

sound signals and conduct In restricted visibility

steering and sailing rules

sound signals for vessels In sight of one another

36. The Regulation developed in 1960 took account of the technological knowledge at that tine. In view of significant changes In the size and speed of vessels, the introduction of new types of craft in the marine environment and the experience gained from the application of the existing Regulations, a need arose to consider comprehensive revision of the Regulations,

37. A Conference convened by IMCO in October 1972 concluded anew Convention on the International Regulations for Preventing Collisions at Sea to replace the 1960 Regulations at present in force. The revised Regulations take account of current technical developments and constitute a significant improvement on the existing rules. They prescribe in a comprehensive way the manoeuvering procedures and actions to be token by ships under various circumstances for the purpose of avoiding collisions, with reference to the need for avoiding hampering the safe passage of vessels restricted in their ability to manoeuvre due to their draught.

Amendments Concerning Special Trade Passenger Ships

38. In October 1971 IMCO convened a conference to consider a number of questions regarding the safety of ships carrying large numbers of unberthed passengers In special trades, such as the pilgrim trade which is of particular interest to certain developing countries, Unill then the carriage of passengers by this mode of transport was regulated by the Simla Rules of 1931 which had steadily become out of date. The 1971 Conference adopted the Special Trade Passenger Ships Agreement, This Agreement entered Into force in January 1974.

39. Pursuant to a resolution of the 1971 Conference,~OproPedror@ , conference to formulate technical Rules covering the safety aspects of the disposition of passengers on special trade passenger ships. The Co-operation of other organizations, particularly the WHO, was sought and utilized in this work.

40. As a result of this work, IMCO convened in July 1973, a Conference which adopted a Protocol on Space Requirenents for Special Trade Passenger Ships, 1973. Annexed to this Protocol, which is complementary to the 1971 Special Trade Passenger Ships Agreement, are the technical rules covering the safety aspects of the disposition of passengers in special trade passenger chips,

Safe Carriage of Containers

41. IMCO hoe spent a number of years working on the technical and safety aspects of containerization. In 1972, IMCO co-sponsored with the United Nations the UN/IMCO Conference on International Container Traffic, One of the Instruments adopted by this Conference is the International Convention on Safe Containers (CSC). This Convention seeks to maintain a hi@ level of safety of hunan life in the transport and handling of containers, while facilitating their international inter-modal transport.

(Ii) Recomendations, Codes of Practice and Guidelines

42. In addition to these conventions and instruments, the work of IMCO in many cases results in the development of recommendations to governments, codes of practice and guideline which are supplementary to the convention and instruments.

43. This device has been used extensively in regard to a large number of subjects. They include the following:

Routeing of ships

44. The practice of following predetermined routes originated in 1898 end woe adopted, for reasons of safety, by shipping companies operating Passenger ships across the North Atlanttic. It wee subsequently Incorporated into the International Convention for the Safety of Life at Sea.

45. Since then a steady increase In number, size and speed of ships has emphasized the necessity of separating maritime traffic, particularly in areas where congestion or convergence of maritime traffic exist in main shipping lanes and narrow channels. It was in this connexion realized that consequence of accidents may become more serious if chips carry oil or hazardous cargoes.

46. In 1961 the Institutes of Navigation of the United Kingdom, France and the Federal Republic of Germany undertook a study of measures for separating traffic in the Strait of Dover. Their studies and subsequently other studies In certain other areas where statistics indicated an increased rick of collision, resulted in concrete proposals submitted to IMCO. After examination by expert working bodies the proposed traffic separation schemes were adopted by the IMCO Assembly.

47. Up to the Present nearly 100 schemes have been adopted byIMCO and recommended to governments for observance. These schemes are located all over the world, almost exclusively in areas of congested or converging traffic. As experience is being obtained and in line with the expansion of maritime traffic, these schemes exe mended and new schemes added. All schemes adopted by IMCO are being collated In a publication which is being updated as and when required. Anew 1974 edition is expected to be published shortly. The publication includes:

- terns, definitions and symbols
- methods of routeing
- general principles of ship's routeing
- description of schemes in operation

The publication also specifies the areas, particularly those of special significance to wildlife, which should be avoided by ships constituting an unacceptable environnental hazard.

48. When a proposed scheme is examined, consideration is given as to whether the existing aids to navigation (buoys, lightvessels, etc,) and/or those proposed by the State concerned are adequate for the purpose of the scheme and to enable mariners to determine their position with the accuracy required for safe navigation in the area. The State concerned will remain responsible for the exact location, type and characteristics of aids provided around its coed and the dissemination of Information through the usual channels.

49. At present these schemes pretreated as recommendatiOne. However, following resolutions adopted by the Asenbly of IMCO, a number of major maritime States have introduced or are in the process of introducing, national legislation making it mandatory for ships under their flag to follow the general direct.lon of the traffic whenever they navigate within the areas under traffic separation schemes adopted by IMCO. The 1972 Convention on the International Regulations for Preventing Collisions at Sea stipulates in Rule 10 principles to be followed by chips using traffic separation schemes. Thus, the observance of such schemes by ships will be regulated on a mandatory basis when the 1972 Collision Regulations come into force.

Provision of navigational equipment and crew training

50. The International Convention for the Safety of Life at Sea, 1960 has recently been amended to make mandatory the carriage of modern electronic navigational equipment which was mostly carried on a voluntary basis. IMCO supplemented this by developing performance standards for each item.

51. The training requirements and qualifications for certification of masters and officers are at present under consideration. The intention is to specify n.in.lmm qualification for training and certification for' all grades of officers and crew on board merchant ships with priority for those immediately responsible for the safe navigation and handling of tho chip. The ultimate aim is to conclude a Convention through a Conference which is planned for 19770 The Assembly has adopted two recommendations, one on the basic principle and guidelines on the handling of the ship to be observed during watchkeeping and the other on the training and qualifications of officers and crew of ships carrying hazardous or noxious chemicals in bulk. Particular attention is given

to the qualificationa off the personnel serving on ships carrying hazardous and noxious cargoes and the need for special provisions concerning watchkeeping at sea and in ports, cargo handling and related operations of such ships.

52. A joint IMCO/ILO Comittee on Trainings constantly reviewing training requirements for masters, officers and seamen, for the guidance of governnents.

Unification of buoyance systems and navigational warnings

53. A study has been initiated with a view to unifying the buoyage systene which are at present in existence all over the world. As a first step, on a matter which deserved some priority, agreement has been reached regarding the making of wrecks which present an immediate danger to navigation.

54. The Improvement and standardization of the existing system for transmission of radio warnings to shipping is another part of a wider plan for improving safety.

55. The study on the buoyage system and the radio navigational warnings is the subject ofa concerted effort by IMCO, the International Hydrographic Organization, the International Association of Lighthouse Authorities, the International Chamber of Shipping and other organizations concerned with maritime matters.

Safety requirements for off-shore drilling rigs

56. Recent increase titheoff-chore activities for the exploration and exploitation of sea-bed mineral resources gave rise to a need for developing international standards for the construction and equipment of off-shore drilling rigs and platforms engaged in such activities in order to ensure their safe operation and avoidance of danger to ships navigation the vicinity. Studies being out in IMCO in this field have so far resulted in the formulation of recommendations on:

(a) the establishment of fairways through off-chore exploration areas;

(b) the dissenination of information, charting and manning of drilling rigs and production platform;

(a) radiocommunication requirements for drilling rigs and production platforms;

(d) life-saving appliances of off-shore mobile units; and

(e) fire safety of off-shore units.

5'?. It is intended to prepare a composite document covering all aspects of safety of such equipment based on recommendations which have been or are being developed by the various technical bodies concerned.

Carriage of Dangerous goods

58, The carriage of dangerous goods is regulated, in general, by the provisions of the International Convention for the Safety of Life at Sea, 1960 which accepted the classification of dangerous goods agreed by the relevant UN Committee of Experts. To supplement the provisionof the 1960 Convention IMCO has developed an International Maritime Dangerous Goods Code which classifies each dangerous substance according to the nature of the danger and specifies provisions for packaging and stowage as well as other information for the guidance of the meter. The substances which have been included in the Code 00 far ore those which may affect the safety of the ship and those on board.

59. IMCO recently initiated detailed studies of the environmental impact of the transportation by sea of noxious substances in packaged fern, containers and portable tanks and agreed that the International Maritime Dangerous Goods Code should be modified by including therein detailed instruction for the carriage of noxious cargoes dealing with packaging, identification and marking, stowage, quantity limitation, leakages and jettisoning, incident reporting procedure, salvage and intact recovery.

60. There has been a renarkable increase in recent years In the carriage of dangerous chemicals in bulk. In order to ensure safe carriage of such substances, IMCO has developed a Code for the Construction, Equipment and Operation of ships carrying Dangerous Chemicals in Bulk. The Code provides suitable design criteria, construction standards and other measures for transporting dangerous chemical substances in bulk so as to minimize the risk to the ship, its crew and the neighbourhood with respect to fire, health, water pollution, air pollution and reactivity hazard.

Other work relating to maritime safety

61. In association with FAO and the ILO, IMCO has developed a Code of Safety for Fishermen and Fishing Vessels, which consists of Part A - Safety and Health Practice for Skippers and Crew and Part B - Construction and Equipment of Fishing Vessels. Work is in progress on the preparation for an international conference in 1976 to adopt a convention on safety of fishing vessels.

62. Preparation for an organizational plan for an International maritime satellite system are now well In progress. An international conference is scheduled in 1975 for the establishment of an international maritime satellite system.

63. IMCO has developed recommendations, Codes end guidelines on a large number of subjects, including subdivision, stability, electrical installations, ships under automated control, fire protection, life-saving appliances, radiocommunications, safety of navigation, carriage of bulk cargoes, novel types of craft, merchant ships search and rescue, etc. The following are examples:

- Recommendation on intact stability of passenger and cargo ships below 100 metres in length;
- Fire safety requirements for the construction and equipment of new oil tankers;

- Recommnendation for testing life-jackets;
- Performance standards for shipborne navigational equipment;
- Merchant ship search and rescue manual (MERSAR);
- International Code of signals;
- Code of safe practice for bulk cargoes.

B. WORK RELATING TO PREVENTION AND CONTROL OF MARINE POLLUTION FROM SHIPS AND OTHER CRAFT, AND RELATED ISSUES

64. From its very inception, IMCO has been concerned with' the prevention and control of marine pollution from ships. In 1954, before IMCO had been formally established, the International Conference for the Prevention of Pollution of the Sea by Oil, which was held in London, designated IMCO as the international organization to be responsible for the depositary and other functions associated with the Convention adopted by it. The depositary functions in respect of the 1954 Convention for the Prevention of Pollution of the Son by Oil which had been provisionally assigned to the Government of the United Kingdom, were assured by IMCO immediately on its establishment in January 1959.

65. Since then, IMCO has continued work in relation to the prevention and control of marine pollution, not only by oil but also by other vessel-borne hazardous substances.

66. At present, the control and prevention of marine pollution is one of the nest important aspects of IMCO's work in the technical and legal fields.

67. IMCO'S work in this field was, at its inception, confined to the prevention and control of pollution of the sea by oil arising from the routine operation of ships. The programme was later developed to deal also with:

(1) Prevention of oil pollution arising from accidents and casualties at sea,

(2) Prevention of pollution from all shipborne substances,

(3) The problem of compensation for pollution damage, including questions of liability, and

(4) Prevention of pollution arising from the operation of vessels and craft other than conventional ships. This facet in IMCO's work is still in its formative stages.

68. The main areas of work undertaken by IMCO in the field of marine pollution prevention and control are summarized below:

(i) Conventions and Instrumets relating to Marine Pollution

International Convention for the Prevention of Pollution of the Sea by oil, 1954 as amended in 1962

69. The first major step towards the international control of marine pollution was taken in 1954 when a conference held in London adopted the International Convention for the Prevention of Pollution of the Sea by Oil. The *Convention was* provisionally deposited with the United *Kingdom* Government until *IMCO* was established in 1959 when the depositary functions were taken over by the Organization. The principal object of the 1954 Convention was the protection of the seas from oil pollution. The Convention prescribed certain "prohibited zones" extending to at least 50 miles from the nearest land, within which the discharge of oil or oily mixtures was prohibited.

. 70. In 1962 IMCO convened a Conference which adopted amedments to *the* 1954 Convention, particularly by exteding its application to include ships of lesser gross tonnage and by extending zones in which the discharge of oil was prohibited. A revised Article on Ammendments was adopted under which the IMCO Assembly is empowered, on the recommendation of the Maritime Safety Committee, to adopt amendments to the Convention and submit then to Contracting Governments for their acceptance. The 1954 Convention, as mended in 196?, has been In force since May 1967.

71. In 1969, the IMCO Assembly adopted further extensive amendments to the Convention which, apart from certain practical exemptions, prohibit oil discharge through normal operation of a ship, such as tank cleaning, deballasting, etc., except under the following conditions:

(i) the total quantity of oil which a tanker may discharge in any ballast voyage should not exceed l/15000 of the total cargo carrying capacity of the vessel;

(ii) the rate at which oil nay be discharged should not exceed 60 litres per mile travelled by the ship, and

(iii) any oil whatsoever from the cargo spaces of a tanker should not be discharged within 50 miles from the nearest land.

46-406 0 - 75 . 10

72. In 1971, the IMCO Assembly adopted two further amendments. The first of these was aimed at minimizing the amount of oil which could escape as a result of maritime accidents, particularly those involving very large tankers, and the second was for the protection of the Great Barrier Reef.

International Convention for the Prevention of Pollution from Ships, 1973.

73. By Resolution A.176(VI) the IMCO Asssembly in 1969 decided to convene in 1973 on international conference for the purpose of preparing a suitable international agreement for placing restraint on the contamination of the sea, land and air by ships, vessels and other equipment operating in the marine environment. In 1971, the seventh regular session of the Assembly decided, by Resolution A.237(V11) that the main objective of the 1973 Conference would be the achievement, by 1975 if possible but certainly by the end of the decade (i.e. 1980). of the complete elimination of intentional marine pollution by oil and other noxious substances and the minimization of accidental spills.

74. A considerable part of IMCO's time and resources between 1969 and 1973 woe devoted to the preparatory work for this Conference, which was convened in October 19730 . . .

75. The conferenoe adopted a new International Convention for the Prevention of Pollution from Ships, 1973 to replace the 1954/62 Oil Pollution Convention.

76. The new Convention covors all aspects of pollution from ships, exoopts disposal of waste into the sea by dumping. It applies to ships of all types including hydrofoil boats, air-cushion vehicles, submersibles, floating craft, and fixed or floating platforms operating in the marine environment. The Convention does not, however, apply to pollution directly arising out of the coloration and exploitation of sea-bed mineral resources.

77. The Convention consists of Articles, two Protocols dealing respectively with Reports on incidents involving harmful substances and Arbitration, and five Annexes which contain regulations for the prevention of:

(a) pollution of oil;

(b) pollution by noxious liquid substances carried in bulk;

(o) pollution by harmful substances other than those carried in bulk;

(d) pollution by sewage from ships; end

(e) pollution by garbage from ships.

78. The main provisions of the 1973 Convention, supplemented as appropriate by the related decisions of the Conference, are summarized In the following paragraphs.

(a) Prevention of pollution by oil (Annex I)

79. The Convention maintains the oil discharge criteria prescribed in the 1969 amendments to the 1954 Oil Pollution Convention, without substantial changes, except that the maximum quantity of oil which is permitted to be discharged in a ballast voyage of new oil tankers has been reduced from 1/15,000 to l/x,000 of the mount of cargo carried. These criteria apply equally both to persistent (black) and non-persistent (white) oils. Anew end important feature of the 1973 Convention is the concept of "special areas". Specified areas considered to be particularly vulnerable to pollution by oil have been designated as 'special areas' in which oil discharges have been completely prohibited, with minor and well-defined exceptions. The main special areas in the Convention are The Mediterranean Sea Area, the Black Sea Area. the Baltic Sea Area, the Red Sea Area and the 'Gulfs' Area.

80. All oil-carrying ships will be required to be capable of operating with the method of retention on board In association with "load-on-top" system or discharge to reception facilities. To effect this, all new end existing oil tankers and other ships will, with certain exceptions, be required to be fitted with appropriate equipment, which will include an oil discharge monitoring and control system, oily water separating equipment or filtering system, slop tanks, sludge tanks, piping and pumping arrangements.

81* With regard to the constructional aspects of oil tankers, two important provisions have been incorporated in the 1973 Convention. Firstly, new oil tankers, i.e. those for which the building contract is placed after 31 December 1975, of 70,000 tons deadweight and above, will be required to be fitted with segregated ballast tanks sufficient in capacity to provide adequate operating draught without a need to carry ballast water In cargo oil tanks. This requirement does not, however, cell for the fitting of double bottom tanks. *Secondly, new* oil tankers will be required to meet subdivision and damage stability requirements so that they con survive after collision or stranding damage at any loading conditions.

(b) Control of Pollution by noxious liquid substances
(Annex II)

82. The Convention sets out detailed requirements for the discharge criteria and measures for control of pollution by noxious liquid substances carried In bulk. For this purpose, noxious liquid substances are divided into four categories depending upon their hazard to marine resources, human health, amenities and other legitimate uses of the sea. Sons 250 substances have been evaluated and included in tie list appended to the convention. The discharge of residues containing such substances is allowed only either to receptions facilities or into the sea provided that certain conditions which vary with the category of substances are complied with. In any case no discharge of residues containing noxious substances is permitted within 12 miles from the nearest lend. The Baltic Sea Area and Black Sea Area are designated as special areas In which discharge of noxious liquid substances is prohibited,

(c) Prevention of pollution by harmful substances carried in packaged form or in freight containers or portable tanks or road and rail tank wagons (Annex III)

83. The Convention contains general requirements relating to the prevention of pollution by harmful substances carried by sea in packaged form or In light containers, portable tanks or road and rail tank wagons. Detailed requirements on packaging, marking and labelling documentation, stowage. quantity limitations and other aspects aimed at preventing or minimizing pollution of the marine environment by such substances will be developed in the future within the framework of the International Maritime Dangerous Goods Code or in other appropriate form.

(d) Prevention of pollution by sewage and garbage
(Annexes IV and V)

84. Ships will not be permitted to discharge sewage within 4 miles from the nearest load unless they have in operation an approved treatment plant; between 4 and 12 miles from land. sewage must be comminuted and disinfected before disc&m&e.

85. As regards garbage, specific minimum distances from land have been set for the disposal of all the principal kinds of garbage, The disposal of all plastics is prohibited.

(e) Violation (Article4)

56. Any violation of the Convention, such as the unlawful discharge of harmful substances or non-compliance with the Convention requirements in respect of the construction and equipment of a ship, wherever such violation occurs, will be punishable under the law of the flag State. Any violation of the Convention within the jurisdiction of any Party to the Convention shall be punishable either under the law of that Party or under the law of the flag State. In this respect, the term "jurisdiction" In the Convention should be construed in the light of International law in force at the time of application or interpretation of the present Convention.

(f) Inspection of Ships (Article 5)

87. With the exception of very mall Shops, ships(engaged on intentional voyages are required to carry on board valid International Certificates required by the Convention. Such certificate may be accepted at foreign Ports as a prima facie evidence that the ship complies with the requirements of the Convention. If, however, there are clear grounds for believing that the condition of the ship or its equipment does not correspond substantially with the particulars of the certificate, or if the ship does not carry a valid certificate, the authority carrying out the inspection may detain the ship until they satisfy themselves that the ship can proceed to sea without presenting unreasonable threat of ham to the marine environment.

(g) ~~conference Resolutions~~

80. The Conference adopted 126 Resolutions, many of which called upon IMCO to pursue further studies directed towards effective implementation and improvement of the 1973 Convention. An action plan to implement these resolutions was adopted by the Marine Environment Protection Committee at its first session.

International Convention Relating to Intervention on *High Seas* in caseS of Oil Pollution Casualties. 1969

89. The "Torroy Canyon" disaster of1967 revealed certain shortcomings in the public international law regime regarding activities on the high seas which pose the threat of pollution to the interests of States. In particular questions wore raised as to the extent to which a coastal State could take measures to protect its coastline where a casualty on the hi@ seas threatened that State with oil pollution, especially If the measures involvodare likely to affect the interests of foreign shipowners, cargo-owners and even flag States. The general consensus was that there was need for a new regime which, while recognizing the mood for sane State intervention on the high seas in oases of grave emergency, clearly restricted the right of intervention and stipulated the conditions under which, and the procedures through which, such intervention could be exercised.

90. At the request of the IMCO Council, the Legal Committee prepared draft Articles on these questions and these were considered by a *Conference convened* in Brussels in 1969. The Conference adopted the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969. This Convention affirms the right of a coastal State to take such measures on the high seas as may be necessary to prevent, mitigate or eliminate danger to its coastline or related interests from pollutionby oil or the threat thereof, following upon a maritime casualty. The coastal State is, however, empowered to take only ouch action is is necessary and proportionate in the light of the pollution *or threat* thereof, and after due consultations with appropriate interests, including, in particular, the flag State or States of the ship or ships involved, the owners of the chips or cargoes in question and, where Circumstances permit, independent exports appointed for this purpose.

A coastal State which takes measures beyond those permitted under the Convention is liable to pay compensation for any damage caused by such measures. The Convention contains provisions for the settlement of disputes through negotiation, conciliation or arbitration,

Protocol Relating to Intervention on the High Seas in Cases of Marine Pollution by Substance other than Oil

91. The 1969 Intervention Convention applied to casualties involving pollution by oil. In view of the increasing quantity of chemical substances carried by ships some of which would, if released, cause serious hazard to the marine environment, the 1969 Conference recognized the need to extend the Convention to cover substances other than oil. Following considerable work on this subject within the Legal Committee, draft articles for an Instrument to extend the application of the 1969 Convention to substances other than oil wore prepared and submitted to the 1973 Conference on Marine Pollution.

92. The Conference adopted the Protocol Relating to Intervention on the High Seas in Cases of Marine Pollution by Substances other than Oil which extends the regime of the 1969 Intervention Convention to those substances other then oil which are either annexed to the protocol or which have characteristics substantially similar to those substances.

International Convention on Civil Liability for Oil Pollution Damage, 1969

93. The other major legal issue brought to light by the "Torrey Canyon" Incident related to the basic and extent of the ship or cargo owners! liability for damage suffered by States or other persons as a result of a marine casualty involving oil pollution. This mainly "private law" problem was also taken up by the IMCO legal Committee. Based on the draft articles prepared by that committee, the 1969 Brussels Conference adopted the International Convention on Civil Liability for Oil Pollution Damage.

94* under the Convention, liability for oil pollution danage is placed on the owner of the ship transporting the oil. The shipowner's liability is strict, but he is relieved of liability if he is able to prove that the escape of oil was due to one of a few well-defined exceptional causes. The liability of the shipowner is limited in respect of each incident. This limitation is based on the tonnage of the ship, but there is an upper limitation figure, irrespective of the tonnage of the ship involved. The Convention contains provisions determining the courts which hove jurisdiction in cases where pollution damage occurs in more than one State, and provisions relating to the recognition and enforcement of the judgments of competent courts in the other contracting States. Shipowners of contracting States are required to carry insurance or other acccptable guarantee to cover their liability under the Convention.

International Convention on the Establishment of an International Fund for Communication for Oil Pollution Damage 1971

95. Although the 1969 Liability Convention provided a useful mechanism for ensuring the payment of compensation for oil pollution damage, it did not deal satisfactorily with all the legal, financial and other questions raised during the 1969 Conference. Some States objected to the regime established, since it was based on the strict liability of the shipowner for damage which he could not foresee and, therefore, represented a dramatic departure from traditional maritime law which based liability on fault. On the other hand, some States were dissatisfied with the system of liability limitation adopted. They felt that the limitation figures adopted were likely to be inadequate in cases of oil pollution damage involving some of the large oil-carrying ships in the process of construction and development. They therefore wanted an unlimited level of compensation or a very high limitation figure, if any such figure was to be accepted.

96. In the ligh of these reservations, the 1969 Conference considered a compromise proposal to establish an international fund, to be subscribed by the cargo interests, which would be available for the dual purpose of, on the one hand, relieving the shipowner of the burden imposed on him by the requirements of the new convention and, on the other hand, providing additional compensation to the victim of pollution damage in cases where compensation under the 1969 Convention was either inadequate or unobtainable, The Conference recommended that IMCO should take in hand the study and preparation for such a scheme. The Legal Committee accordingly prepared draft articles for a convention to establish an international compensation fund for oil pollution damage.

97. In 1971, a conference convened by IMCO adopted the International Convention on the Establishment of on International Fund for Compensation for oil pollution Damage. This Convention is supplementary to the 1969 International Convention on Civil Liability for Oil Pollution Damage.

98. Under the 1971 Fund Convention, an International Oil Pollution Compensation Fund is established. firstly to ensure adequate compensation for victims of pollution damage who are unable to obtain any or adequate compensation under the 1969 liability Convention end, secondly, to provide some relief to shipowners in respect of part of additional financial burden imposed on them by the 1969 Civil Liability Convention. However, a shipowner is only able to benefit from the 1971 Convention if his ship complies with certain international conventions establishing safety and anti-pollution standards. A State which has suffered oil pollution damage and which has not been fully compensated for it under the 1969 Convention will receive compensation from the Fund, up to a level more than twice the limitation figure established in the 1969 Civil Liability Convention.

99. The Fund is maintained by initial and annual contributions from persons in Contracting States who receive "contributing oil" in substantial amounts in ports or terminal installations in those States. Assessments and other necessary adinistration are carried out by a Fund Organization composed of all Contracting States. The Fund Organization consists of an Assembly, an Executive Committee (in certain cases) and a secretariat headed by a Director.

(ii) **Recommendation and other Guidelines relating to the Prevention of Marine Pollution from Ships**

Manual on Marine Pollution

100. IMCO has been preparing a practical manual on marine pollution which will eventually consist of the following four sections:

I. Methods of preventing oil pollution from ships

II. Contingency Planning ... ...

III. Salvage of oil from stricken vessels . . !

IV. Practical information on means of dealing with oil spillages.

So far the work on Section IV in relation to oil spillages has been completed and issued as a separate volume. It is intended to assist Governments, particularly those of developing countries which may be called on to deal with such spillages, and contains information on such matters as:

(i) The properties of the various types of oils encountered and their behaviour when spilt at Boa;

(ii) methods of containment, removal and treatment (mechanical and chemical) of oil spills in the sea;

(iii) methods of removal and treatment of oil on various types of beaches and coastlines.

Other matters

101. Recmmendations have also been node to governnents on the following Subjects:

(a) Reports on accidents involving significant spillages of oil including the appointment of a national officer or agency to receive such reports and to transmit relevant details to all other governments concerned;

(b) international performance specifications for oily-water separating equipment and oil content meters;

(o) disposal of oily bilge and ballast water from ships in ports (excluding effluent from cargo/ballast tanks in tankers) including piping arrangements and specifications for a standard shore connection; and

(d) provision of facilities in ports for the reception of oily residues from ships.

C. C. OTHER WORK RELATING TO SHIPPING AND RELATED MARITIME ACTIVITIES

102. IMCO's activities include work in relation to other aspects of shipping and maritime activities which cannot be easily subsumed under any one of the two categories described above. The most important of these other areas of IMCO's activities are the following:

Tonnage Measurement of ships

103. IMCO convened in 1969 an International Conference on Tonnage Measurement of Ships which resulted in the adoption of the International Convention on Tonnage Measurement of Ships, 1969. The Convention provides for gross and net tonnage of ships. The gross tonnage is determined from a formula as a function of the total moulded volume of all enclosed spaces, while the net tonnage is derived from a formula as a function of the total moulded volume of cargo spaces, ratio of moulded depth and number of passengers.

104. The significance of the *new* Convention is not only that it provides a unified system of tonnage measurement which has not existed hitherto, but also that, by comparison with the existing tonnage measurement regulations, it simplifies ton meat extent the calculation of tonnage. The new Connation will, when it comes into force, greatly benefit maritime administrative, port authorities, shipowners, shipbuilders and others who use tonnage.

Facilitation of International Maritime Traffic

105. The Convention on Facilitation of International Maritime Traffic was adopted by a Conference convened by IMCO in 1965 and was aimed at reducing and simplifying governmental formalities, documentary requirements and procedures connected with the arrival, stay and departure of ships; it came into force on 5 March 1967. Thirty-four Governments are so far Parties to the Convention. The Conference made explicit reference to a number of problems which required the immediate

attention of the Organization, such as the establishment of Standard ferns of documents, facilities for cruise ships and their passengers, formalities concerning transit passengers and quarantine procedures for the carriage of animals and plants by sea.

106. These problem have been considered, first by on Ad Hoc Working Group 'appointed by the IMCO Council and, later, by the Facilitation Committee. As a result of these discussions recommendations have been produced on the following subjects:

(1) Standardization of shipping documents.

(2) Facilitation of container transport.

(3). Facilitation of ships on cruises.

(4) Facilitation measures for ships engaged in scientific services.

(5) Facilitation measures in respect of passengers in transit, and

(6) Facilitation of international travel and tourism.

IMCO's Work in the Legal Field

107. In addition to the legal work which is directly related to the prevention and control of marine pollution, the Legal Committee of the Organization has undertaken work on several aspects of shipping and maritime law. Principal subjects on which work has been begim or concluded are:

(I) Maritime transport of nuclear material .

108. In 1971 the Organization convened, in association with the International Atomic Energu Agency, a Conference which adopted a convention to regulate liability in respect of damage arising from the maritime carriage of nuclear substances. The purpose of this convention is to resolve difficulties and conflicts which arise from the simultaneous application, to nuclear damage, of certain maritime conventions dealing with shipowners' liability as well as other conventions which Placed liability arising fro nuclear incidents on the operators of the nuclear installations from which or to which the material in question was being transported

(ii) Conditions of Carriage of Passengers and their Luggage on Board Ships

109. The Legal Committee has just completed its work in preparing draft articles for a convention to regulate the liability of Shipowners in respect of death or injury to passengers and damage or loss of their luggage. The draft convention will be considered for adoption by a diplomatic conference which wills be convened in November 1974.

Other matters on which the Legal Committee is currently engaged include:

(a) Wreck Removal and Related Issues

110. The object of this study is to provide for an international convention which till regulate the rights and obligations of States and shipowners in respect of the removal of wrecks which pose a hazard to navigation. There has been a proposal to include in the scope of the convention wrecks which pose a hazard to the environment. It is envisaged that a convention on the subject will be ready for consideration and adoption some time in 1976.

(b) The Revision of the Convention Relating to the Limitation of Liability of (Owners of Sea-Going Ships, 1957

111. The Legal Committee is beginning consideration of this subject with a view to the adoption of a revised convention in 1976.

(o) Legal Status Of ODAS

112. Oceanographic activity on the seas has increased considerably and this calls for a detailed legal regime which would, in particular, define and regulate the legal status of the devices, large and small, employed in and under the seas for scientific research. These devices, conveniently referred to as Ocean Data Acquisition System (ODAS) have boon the subject of joint and collaborative study by IMCO and UNESCO and its Intergovernmental Oceanographic Commission (IOC). The purpose is to produce a treaty which will d.eel, inter alia, with the identification and positioning of these devices and the question of liability for damage caused by or as a result of the siting or operation of these devices.

113. The Legal Committee is also giving active consideration to the extoneione of the 1969 Convention on Civil Liability for Oil Pollution Damage (see paragraphs 88-89 above) to cover pollution arising from substances other than oil.

IMCO's work in the Field of Technical Assistance to the Developing Countries

114. The International Development Staetegy has as one of its main objectives the development by the developing countries of their own national shipping lines as a neons, *inter alia*, of improving their balance of payments position in world trade. One of the principal problemsq faced by developing countries, in the development as well as the operation of national shipping lines, is the non-availability or inadequate supply of the technical expertise required for the administration, manning and servicing of shipping concerns. By virtue of its activities in respect of technical and specialized fields of shipping and related matters, IMCO is particularly equipped to provide assistance in this field. A programme of technical assistance to developing countries is in operation and expert assistance has been provided to the developing countries in diverse fields such as:

(1) Safety of navigation and maritime training

(2) Administration of ship safety .

(3) Design of ships and technical aspects of ship construction

(4) Carriage of goods by sea

(5) Prevention and control of pollution of the sea by lps '

(6) Transport' of Containers

(7) Special ships and off-shore craft

(8) Facilitation of maritime traffic

(9) Ports operations

(lo) Law and regulations applicable to ships and shipping

(n) Maritime Law

115. IMCO is an executing agency of the UNDP and by virtue of this has been assigned responsibility for a number of large-scale projects in Algeria, Brazil, Bulgaria and Egypt.

116. In Algeria(Algiers)IMCO is executing a project for the training of maritime personnel. The aim of the project in to assist the Government of Algeria in the training of nationals for its growing merchant fleet, and the adoption of legislation implementing the various international conventions ratified by that country.

117. In Brazil (Rio de Janeiro) IMCO is executing a project for the expansion and modernization Of the programme Of training merchant marine personnel and port operations. The aims of this project are to provide training facilities "and courses to train teaching staff for courses to be offered by the Centre end to train officers, engineers end technicians to meet the expanding Brazilian Merchant Marine.

118. In Bulgaria (Varna) IMCO is the executing agency for a project for broaden@ the scope of the shipbuilding design and research Institute.

119. In the Arab Republic of Egypt (Alexandria) IMCO is executing a regional project for the development of a regional maritime training Institute. The following countries are, to date, contributing to or expected to contribute to the project: Arab Republic of Egypt, Democratic Republic of Yemen, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, Sudan, Syria end the United Arab Emirates. The purpose of this project is to develop a comprehensive programme of training to suit the regional requirements and to strengthen and develop the maritime transportation section in each of the participating countries. b

120. IMCO is also responsible for a large number of small-scale projects and fellowships. It provides individual experts to a number of developing countries in the field of maritime training, maritime legislation, harbour piloting, prevention of marine pollution, maritime safety, chip construction and repairs and naval architecture. Fellowship and training programs for the nationals of developing countries, which are considered nest vital as a follow-up of UNBP-assisted project activities, continue to grow at a steadily increasing pace annually.

121. IMCO has kept very much in the forefront the need for consultation and eo-ordination with other agencies which may be engaged in fields related to those in which IMCO is interested. As a result of these consultations, working arrangements have been entered into with some of these other agencies. In particular collaboration with the ILO and UNCTAD has been strengthened.

122. For example the ILO has provided the services of experts in port operations and catering as port of the project in Brazil, while UNCTAD has been requested to provide exports on the commercial and economic aspects of shipping for the regional project in Alexandria.

123. With regard to technical assistance for the training of sea-going personnel, which involves the activities of both IMCO and the ILO, the Secretary-General of IMCO and the Director-General of the ILO have established a common undertaking to co-operate as closely as possible to promote a better use of the resources mailable to their organizations.

124. Recognizing that the activities and Interests of the two organizations in the field of shipping and other maritime matters are complementary to each other, IMCO and UNCTAD have developed close working contacts in order to ensure, where appropriate, a co-ordinated programme of technical assistance In maritime transport for the benefit of developing countries requesting assistance. As part of this close contact, the two organizations have issued a joint document outlining the main areas of their respective competence and describing the services which IMCO and UNCTAD can offer, jointly or separately, in providing resistance under the auspices of the UNDP.

125. The IBRD has sub-contracted to IMCO, the execution of a project for the rehabilitation of the existing Indonesian Inter-island Fleet, involving over 200 ships. This project, when completed, Will bring as many of the Inter-island ships as can be economically repaired up to internationally accepted standards of safety, thereby making the maximum use of the existing resources.

Relations with Other Organizations

126. In performing its many and varied activities IMCO relies on the Information and advice from a large number of International organizations, inter-governmental as well as non-governmental, which have interests in various aspects of shipping and maritime transport. Inter-governmental organizations are brought into association with IMCO by means of special agreements or arrangements of co-operation, and non-governmental organizations are granted “consultative status" where necessary. Under those arrangements the organizations concerned are enabled to participate in discussions in IMCO bodice and to submit documents, data and views to these bodies for their consideration. By this arrangement a large body of technical, professional and inter-disciplinary expertise is made available to the IMCO bodies; and this helps to ensure that the regulations, recommendations and guidelines prepared by those bodice take due account of practical realities as well as the views and special interests of the concerns which will be involved

in implementing them. Anong the organizations with which IMCO has established orking relationships are:

1. The Organization of African Unity
2. The International Association of Lighthouse Authorities
3. The International Hydrographic Organization

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IV. CO-ORDINATION OF IMCO'S WORK WITH RELATED WORK WITHIN THE UNITED NATIONS SYSTEM OF ORGANIZATIONS

127. IMCO has always recognized that the work it does in respect of technical end legal matters relating to shipping and related maritime operations is a part of the total effort of the United Nations system in promoting the objectives in the economic, social and educational field set forth in Article 55 of the United Nations Charter. For this reason it has, from its very inception, accepted the central and co-ordinating role of the United Nations and has agreed to co-operate in making the co-ordination of the policy and activities of the UN and its specialized agencies fully effective.

128. In pursuance of this agreement IMCO has established appropriate working arrangements, formal as well as informal, with the United Nations, its subsidiary bodies and commissions and all the specialized agencies and related organizations whose work affects, or is affected in any way by, the work and concerns of IMCO. A brief resume of IMCO's relations and co-operation with organizations in the UN system is provided in the following paragraphs.

The United Nations

129. By virtue of its Relationship Agreement with the United Nations IMCO maintains, primarilyh@ the Secretariat, a continuous liaison with the United Nations In respect of all its activities. A full report on the work of IMCO is presented to the Economic and Social Council every year for consideration and comments by the Members. Details of IMCO's proposed work programmes, biennial, medium and long-term, are always submitted to the United Nations Secretariat for submission to the appropriate bodies for information and comment. IMCO, through its Secretariat, participate fully in the" various bodies established to promote maximum co-ordination within the United Nations system, including in particular the Committee on Programme and Co-ordination, the Administrative Committee on Co-ordination and the Joint Inspection Unit.

130. IMCO also co-operates and maintains liaison with the other organs and specialized bodies of the United Nations.

The Regional Economic Commissions

131. IMCO has established lines of communications with the Regional Economic Commissions, especially in respect of matters affecting maritime transport.

These relations, which have not been very strong in the pad, are in the process of being re-organized and improved. Particular emphasis is now being placed on IMCO's liaison with the regional economic commissions operating in developing countries.

UNCTAD and UNCITRAL

132. IMCO has closely followed the work of these two bodies and has actively participated In their work, especially regarding international legislation on shipping. There is a particularly close relationship between the Secretariats of IMCO and UNCTAD who consult and co-operate with each other in netters of common interest to both organizations. In the matter of technical assistance to developing countries in shipping matters, the two organizations work together, where appropriate.

The United Nations Development Programme

133. IMCO is an executing agency of the United Nations Development Programm and is responsible for an expanding programme of technical assistance in the field of shipping. In performing its fictions in this field, IMCO makes full use of the facilities provided by the UNDP, particularly through its Resident Representatives, and also relies on advice, information and other assistanoe from the regional economic commissions.

The Specialized Agencies and the IAEA

134. IMCO has entered into working arrangements with a large number of the specialized agencies and the IAEA. In some cases, these arrangements are embodied in formal agreements, whilst in others they are baaed on informal understanding@ entered into between the Secretariats, with the approval of the appropriate governing bodies. On the basis of these arrangements, continuous liaison is maintained with the various agencies. Where the circumstances so require, standing or ad hoc arrangements have been initiated to deal with problems identified to be of common concern to IMCO on the one hand and to one or more of the agencies on the other. Examples of these, in addition to three already referred to in this document are:

1. The Joint IMCO/ILO Committee on Training of Masters and Crow.
2. Joint IMCO/FAO/ILO Group of Consultants on Safety of Fishing Vessels.

135. Perhaps the nest important of the co-operative arrangements established between IMCO end the other agencies is the Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) which is jointly sponsored by the UN, the FAO, UNESCO, VMO, WHO, the IAEA and IMCO. This Group considers various scientific matters upon which the sponsoring agencies require export advice in connexion with the pollution of the marine environment. IMCO has relied on this Group in its work on the identification of noxious and hazardous cargoes which nay be considered as potential pollutants.

The United Notions Conference on the" Human Environment and the UN Environment Programme

136. IMCO participated actively in the preparations for the United Nations Conference on the Human Environment held in 1972. In accordance with decisions of the IMCO Assembly and Council, the Secretariat co-operated with the Secretariat of the United Nations in connexion with the various stages of the preparatory work. In particular the cervices of a Member of the IMCO Secretariat were made available to the United Nations secretariat in connexion with the preparatory work relating to marine pollution. . In addition, IMCO provided a venue and facilities for the helm of the first session of the Inter-Governmental Working Group on Marine Pollution as part of the preparations for the Conference and the Secretariat participated fully in the work of the Conference itself. In a resolution passed at its seventh regular session in October 1971, the Assembly requested the Council, the Maritime Safety Committee and the Secretary-General of IMCO to "implement any decisions of the (Human Environment) Conference entrusting responsibilities to IMCO..."

137. Since the establishment, by General Assembly resolution 2997 (XXVII) of the United Nations Environment Programme, the IMCO Secretariat has established co-operative relations with the Secretariat of the Programme and has followed and participated in "the work of the Governing Council of the Programme.

The Committee on the Peaceful Uses of the Sea-Bed and Ocean Floor Beyond the Limits of National Jurisdiction and the Third United Nations Conference on the Law of the Sea

138. Pursuant to decisions of the IMCO governing bodies, the IMCO Secretariat participated fully in the work of the Sea-bed Committee, particularly in relation to the parts of its mandate dealing with the preservation of the

marine environment, including, inter alia, the prevention of pollution, and scientific research. Either on its own initiative or at the request of the Committee, its Sub-committees or individual deletions, the IMCO Secretariat submitted documents containing information on aspects of IMCO's work which were related to the work of the Committee. In many cases those documents were supplemented by statements made by the representatives of the IMCO secretariat at various sessions of the Sea-bed Committee, its Sub-Committees and the subsidiary bodies of the Sub-committees.

139. The following is a list of the main documentsandstatenents which were submitted by the IMCO Secretariat at various sessions of the Sea-bed Committee and its Sub-Committees.

1. Statement made to Sub-Committee III on 17 March 1972.
2. Document on the preparations for the 1973 Marine Pollution Conference sented to Sub-Committee III at its July/August session in 1972 QAC.138/SC.111/L.15).
3. Document on Traffic Separation Schemes presented to Sub-Committee III at its July/August session in 1972 (MISC.72(8)).
4. Statement introducing the document on Traffic Separation Schemes, made to the 22nd session of Sub-Committee III on 26 July 1972 (A/AC.138/ SC/ III L/21).
5. Statement Introducing document A/t.c.138/sC.111/L.15, made to the 23rd session of Sub-Committee III on 28 July 1972.
6. Document on developments in the preparations for the 1973 IMCO Marine Pollution Conference presented to Sub-Committee III at its March/April session in 1973. (A/AC.138/2C.111/L.30).
7. Statement Introducing document A/Ac.138/sc.111/L.30, made to the 37th cession of Sub-committee III on 29 March 1973.

In addition to these documents and statements, the representatives of the IMCO Secretariat participated in many of the meetings of the Working Group established by sub-Committee III of the Sea-bed Committee.

140. As was to be expected, nest of the references to the work of IMCO during the discussions of the Sea-bed Committee were directed particularly to the preparations which were going on in IMCO for holding a Conference on Marine Pollution in 1973. In the documents and statements made to the sea-bed Committee the IMCO Secretariat informed the Committee of the preparations

for this Conference and passed on to the appropriate 11420 bodies the views expressed in the Sea-bed Committee In respect of subjects which wore relevent to the work of the IMCO Conference.

141. When the Conference convened in October 1973, it took note, inter alia, of a Communication from the Chairman of the sea-bed Committee on the relationship between the Conference's work and that of the law of the Sea Conference. On the basis of its discussions on these matters, the Marine Pollution Conference included, in the Convention on the Prevention of Marine Pollution from Ships, 1973, a provision to the effect that:

> "Nothing in the present Convention shall prejudice the codification and development of the law of the sea by the United Nations Conference . . on the Law of the Sea convened pursuant tO Resolution 2750(xxv) of the General Assembly of the United Nations nor the present or future claims and legal views of any State concerning the law of the sea and the nature and extent of coastal and flag State jurisdiction". (Article 9, paragraph 2.)

142. Again, in its Article 3 (which deals with the scope of application of the Convention) the Convention provides that "nothing in the (provisions of that Article) shall be construed us derogating from or extending the sovereign rights of Parties under international law over the sea-bed and subsoil thereof adjacent to their coasts for the purposes of exploration and exploitation of their notional resources".

143. In addition to these provisionss of the Convention Itself, the Conference found it necessary to explain further, in resolutions, the way it conceived the relationship between its work and the work of the Conference on the Law of the Sea.

144. In its Resolution 23 the Conference, after noting that the Convention it had adopted dealt mainly with technical questions such an the operation, equipment and design of ships, expressed the view that:

(a) the appropriate forum to deal with the question of the nature and extent of States' rights over the sea is the Conference on the Law of the sea;

(b) the decision of the (IMCO) Conference reflects a clear intention to leave that question to the Conference on the Law of the See, end

(o) the rights exercised by a State within its jurisdiction in accordance with the (1973) Convention do not preclude the existence of other rights of that State under international law,

145. In another resolution (Resolution 25) the Conference, after noting the Law of the Sea Conference had been convened by the United Nations, declared that in its view international low concerning marine pollution ferns part of the Law of the Sea and requested the Secretary-Conoral of IMCO to forward the 1973 Convention for the Prevention of Pollution from Ships to the Conference on the Law of the Sea so that that Convention could be "taken into account in the broader context of the Conference (on the Law of the Sea)".

146. In yet another resolution (Resolution 24) the 1973 Conference recognized the need for effective co-ordination of activities carried out by different international organizations concerned with the prevention and control of marine pollution and recommended that IMCO, where necessary, should consult with and seek assistance from other international organization and expert bodies concerned within the UN system in order to achieve the objectives of the (1973) Convention. The texts of the Resolution of the Conference referred to above are reproduced in Annex III to this document.

V. CONCLUSIONS

147. The IMCO secretariat has submitted this rather extensive document at this stage because it felt that a fairly comprehensive description of the work which IMCO has done, or plans to do in the future, in the maritime field would be of interest to the delegations attending the Third United Nations Conference on the Law of the Sea.

ANNEX1

STATUS OF THE CONVENTION ON THE INTER-GOVERNMENTAL MARITIME CONSUMPTIVE ORGANIZATION AS AT 31 MARCH 1974

States	Date of receipt of the instrument of acceptance
ALGERIA	31 October 1963
ARGENTINA	18 June 1953
AUSTRALIA	13 February 1952
BARBADOS	7 January 1970
BELGIUM	9 August 1951.
BRAZIL	4 March 1963
BULGARIA	5 April 1960
BURMA	6 July 1951
CANADA	15 October 1948
CHILE	17 February 1972
CHINA	1 March 1973
CUBA	6 May 1966
CYPRUS	21 November 1973
CZECHOSLOVAKIA	1 October 1963
DENMARK	3 June 1959
DOMINICAN REPUBLIC	25 August 1953
ECUADOR	12 July 1956
EGYPT	17 March 1958
EQUATORIAL GUINEA	6 September 1972
FINLAND	21 April 1959
FRANCE	9 April 1952
GERMAN DEMOCRATIC REPUBLIC	25 September 1973
GERMANY, FEDERAL REPUBLIC OF	7 January 1959
GHANA	6 July 1959
GREECE	31 December 1958
HAITI	23 June 1953
HONDURAS	23 August 1954
HONG KONG*	7 June 1967

* Associate Member

States	Date of receipt of the instrument of acceptance
HUNGARY	10 June 1960
ICELAND	8 November 1960
INDIA	6 January 1959
INDONESIA	18 January 1961
IRAN	2 January 1958
IRAQ	28 August 1973
IRELAND	26 February 1951
ISRAEL	24 April 1952
ITALY	28 January 1957
IVORY COAST	4 November 1960
JAPAN	17 March 1958
JORDAN	9 November 1973
KENYA	22 August 1973
KHMER REPUBLIC	3 January 1961
Kuwait	5 July 1960
LEBANON	3 May 1966
LIBERIA	6 January 1959
LIBYAN ARAB REPUBLIC	16 February 1970
MADAGASCAR	8 March 1961
MALAYSIA	16 June 1971
MALDIVES	31 May 1967
MALTA	22 June 1966
MAURITANIA	8 May 1961
MEXICO	21 September 1954
MOROCCO	30 July 1962
NETHERLANDS	31 March 1949
NEW ZEALAND	9 November 1960
NIGERIA	15 March 1962
NORWAY	29 December 1958
OMAN	30 January 1974
PAKISTAN	21 November 1958

States	Date of receipt of the instrument of acceptance
PANAMA	31 December 1958
PERU	15 April 1968
PHILLIPPINES	9 November 1964
POLAND	16 March 1960
REPUBLIC OF KOREA	10 April 1962
ROMANIA	28 April 1965
SAUDI ARABIA	25 February 1969
SENEGAL	7 November 1960
SIERRA LEONE	14 March 1973
SINGAPORE	17 January 1966
SPAIN	23 January 1962
SRI LANKA	6 April 1972
SWEDEN	27 April 1959
SWITZERLAND	20 July 1955
SYRIAN ARAB REPUBLIC	28 January 1963
THAILAND	20 September 1973
TRINIDAD AND TOBAGO	27 April 1965
TUNISIA	23 May 1963
TURKEY	25 March 1956
UNION OF SOVIET SOCIALIST REPUBLICS	24 December 1958
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND	14 February 1949
UNITED REPUBLIC OF CAMEROON	1 May 1961
UNITED REPUBLIC OF TANZANIA	8 January 1974
UNITED STATES OF AMERICA	17 August 1950
URUGUAY	10 May 1968
YUGOSLAVIA	12 February 1960
ZAIRE	16 August 1973

ANNEX II

LIST OF CONVENTIONS AND OTHER INSTRUMENTS FOR WHICH IMCO IS THE DEPOSITARY

(1) The International Convention for the Safety of life at Sea, 1948 (SOLAS 1948)
Entry into force; 19 November 1952

(2) The International Convention for the Safety of Life at Sea, 1960 (SOLAS 1960)
Entry into force: 26 May 1965

(a) 1966 amendments:	not yet in force
(b) 1967 Amendments:	n
(c) 1968 Amendments:	n
(d) 1969 Amendments:	n
(e) 1971 Amendments:	N
(f) 1973 (General) Amendments:	0
(g) 1973 (Grain) Amendment:	n

(3) The International Relations for Preventing Collisions at Sea, 1960 (COLREG 1960)
Applied since 1 September 1965

(4) The Convention on the International Regulations for Preventing Collision at Sea, 1972 (COLREG 1972)
Not yet in force

(5) The International Convention for the prevention of Pollution of the Sea by Oil, 1954, as amended (OILPOL (amended) 1954)

(a) 1969 Amendments:	not yet in force
(b) 1971 (Great Barrier Reef)Amendments:	n
(0) 1971 (Tanks.) Amendments:	n

(6) The International Convention for the Prevention of Pollution from ships, 1973 (OILPOL l973)
Rot yet in force

(7) The Convention on Facilitation of International Maritime Traffic, 1965 (FAL 1965)

Entry into force: 5 March 1967

(a) 1973 Amendment: not yet in force

(b) Amendments to the Annex:

(i) Cruises and Cruise passengers
Entry into force: 12 August 1971

(ii) passengers in Transit and Scientific Services
Not yet in force

(iii) Cargo Handling Equipment
Not yet in force

(iv) Shore Leave
Not yet in force

(v) Upgrading of Recommended Practices
Not yet in force

(8) The International Convention on Load Lines, 1966 (LL 1966)

Entry into force: 21 July 1968

(a) 1971 Amendnents: not yet in force

(9) The International Convention on Tonnage Measurement of Ships, 1969 (TONNAGE 1969)

Not yet in force

(10) The International Convention Relating to Intervention *on the* High Seas in Cases of Oil Pollution Casualties, 1969 (INTERVENTON 1969)

Not yet in force

(11) The Protocol Relating to Intervention on the High Seas In Cases of Marine Pollution by Substances other than Oil, 1973 (INTERVENTION PROT 1973)

Not yet in force

(12) The International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC 1969)
Not yet in force

(13) The Specia; Trade Passenger Ships Agreement, 1971
(STP 1971)
Entry into force: 2 January 1974

(4) The Protocol on Space Requirements for Special Trade Passenger ships, 1973 (SPACE STP 1973)
Not yet in force

(15) The International Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material, 1971
(NUCLEAR 1971)
Not yet in force

(16) The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971
(FUND 1971)
Not yet in force

(17) The International Convention for Safe Containers, 1972
(CSC 1972)
Not Yet in form

ANNEX III

CERTAIN RESOLUTIONS ADOPTED BY THE 1973 CONFERENCE ON MARITIME POLLUTION

RESOLUTION 5

THE COMPLETE ELIMINATION OF OIL POLLUTION FROM SHIPS

THE CONFERENCE

HAVING CONCLUDED the International Convention for the Prevention of Pollution from Ships, 1975,

BEING AWARE of Recommendation 86 (e) adopted by the United Nations Conference on the Human Environment, 1972, recommending Governments, within the framework of the 1973 Inter-Govermental Maritime Consultative Organization Conference on Marine Pollution, inter alia, to strive towards complete elimination of deliberate pollution by oil from ships, with the goal of achieving this by the middle of the present decade,

NOTING that the Governing Council of the United Nations Environment Programme at its first session has requested the Executive Director to urge the Inter-Governmental Maritime Consultative Organization to set a time-limit for the complete prohibition of intentional oil discharge in the seas,

CONSIDERING that the Convention and Particularly the regulations contained therein on the discharge of oil into the sea will be an important means of curbing pollution by oil from ships,

RECOGNIZING, ho~'ever, that the Convention alone may not be sufficient for a satisfactory protection of the sea from pollution by oil from ships,

RECOMMENDS that Governments and other interested bodies concerned undertake concerted efforts, including the elaboration of additional regulations within the framework of the Organization arid the provision of the necessary reception facilities, further to reduce the discharge of oil from ships into the sea with a view to the complete elimination of intent inentional pollution as soon as possible, but not later than the end of the present decade,

INVITES the organization to take all possible measures to assist Governments in this task.

RESOLUTION 5.

INTENTIONAL POLLUTIONS OF THE SEA AND ACCIDENTAL SPILLAGES

THE CONFERENCE,

NOTING that it was assigned the following two objectives by Resolution A, 237 (VII), adopted by the Assembly of the Inter-Governmental Maritime Consultative Organization,

(1) the complete elimination of willful and intentional pollution of the sea by oil and noxious substances other than oil; and

(2) the minimization of accidental spills;

these objectives to be achieved by 1975, if possible, but certainly by the end of the decade,

RECOGNIZING that it has primarily been as a result of extensive preparatory work within the Organization that the Conference has been able to prepare and open for signature the International Convention for the Prevention of Pollution from Ships, 1973,

BEING AWARE that the said Convention comprehensively covers the problem of intentional pollution by oil, noxious liquid substances in bulk, harmful substances in packaged forms or in freight containers or portable tanks or road and rail tank wagons, sewage and garbage, whereas it deals with the problem of accidental pollution only to a limited extent, bearing in mind that many aspects of this problem are and will continue to be dealt with within the framework of other technical Conventions relating to maritime safety,

BEING ALSO AWARE of the close relationship between ship safety and the prevention of pollution from ships,

RECOGNIZING ALSO that considerable progress has been made by the Organization in furtherance of the second objective, by developing proposed international rules and standards directed towards, or contributing to, the prevention, mitigation and minimization of accidental pollution, including the prevention of accidents to ships, minimization of spillages after accident and mitigation of damage after spillages, RECOGNIZING FURTHER that a considerable amount of work in this field leading to the formulation of, and amendments to, conventions for which the Organization is depositary, and other instruments relating to ship safety and prevention of pollution, has yet to be accomplished,

RECOMMENDS that the organization pursue and encourage studies relating to pollution abatement in the marine environment such as:

(a) collection of scientific data on the identification of harmful substances transported by ships and their effect on the marine environment;

(b) collection of ship casualty statistics, particularly on casualties resulting in the pollution of the marine environment;

(c) analysis of such casualty data including the interrelationship of average tanker size and age with incidents and magnitude of pollution casualties,

RECOMMENDS FURTHER that the Organization continue its work With high priority on the development of measures for the minimization of accidental spillages, particularly those relating to:

(a) prevention of accidents to ships including:

(i) safe navigational procedures and traffic separation schemes for the prevention of collisions, strandings and grounding, this to include the ultimate development of international performance standards for navigational aids;

(ii) watchkeeping practices in port and at sea and the training and certification of seamen;

(iii) provision of modern navigational and communications equipment;

(iv) the operational procedures during the transfer, loading and unloading of oil and noxious substances;

(v) manoeuverability and controllability of large ships;

(vi) construction and equipment of ships carrying oil or noxious substances; and

(vii) safe carriage of dangerous goods in packaged forms or in freight containers or portable tanks or road and rail tank wagons,

(b) minimization of the risk of escape of oil and other noxious substances in the event of maritime accidents, including facilitation of transfer of cargo in the event of accidents,

(c) minimization of pollution damage to the marine environment including:

(i) study and development of new techniques and methods for cleaning, recycling and disposing of hazardous substances carried by ships; and

(ii) technical study and development of devices and chemicals used in removing oil and other harmful substances discharged into the sea,

with a view to having appropriate action taken by way of the adoption and implementation at an early date of amendments to existing conventions relating to safety at sea and prevention of pollution or of new conventions, as appropriate.

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RESOLUTION 22

' PROM3TIO!4 OF TECHNICAL CO-OPERATION

THE CONFERENCE,

RECOGNIZING that the complete elimination of pollution in the marine environment by ships requires broad international co-operation and technical and scientific resources,

RECOGNIZING FURTHER that Parties to the International Convention for the Prevention of Pollution from Ships, 1973, will be asked to undertake full responsibility and make arrangements for detecting, monitoring and preventing or mitigating pollution by ships,

BELIEVING that the promotion of technical co-operation on an inter-governmental level wills hasten the implementation of the Convention by States not already possessing the necessary or adequate technical and scientific expertise,

URGES Governments to promote, in consultation with the Inter-Governmental Maritime Consultative Organization and other international bodies, and with assistance and co-ordination by the Executive Director of the United Nations Environment Programme, support for those States which request technical assistance for:

.(a) the **training** of scientific and technical personnel;

(b) the supply of necessary equipment and facilities for monitoring;

(c) the facilitation of other measures and arrangements to prevent or mitigate pollution of the marine environment **by** ships; and

(d) **the** encouragement of research,

URGES FURTHER Governments to initiate action in connexion with **the above** without awaiting the entry into force of the Convention.

RESOLUTION 23

NATURE AND EXTENT OF STATES' RIGHTS OVER THE SEA

THE CONFERENCE,

BEARING IN MIND that a United Nations Conference on the Law of the Sea is to be convened pursuant to Resolution 2750 C (XXV) of the General Assembly of the United Nations,

TAKING INTO ACCOUNT the specialized character of the present Conference,

CONSIDERING that the International Convention for the Prevention of Pollution from Ships, 1973, establishes technical requirements relating to the operation, design and equipment of ships with regard to the prevention of marine pollution, and that, wherever necessary, these international standards should be progressively amended and further improved within the framework of that Convention,

MINDFUL of paragraph (2) of Article 9 of the Convention,

NOTING that the Convention deals mainly with technical questions such as operation, equipment and design of-ships,

BEING CONVINCED that the appropriate forum to deal with the question of the nature and extent of States' rights over the sea is the above-mentioned Conference on the Law of the Sea,

DECLARES that the decision of the present Conference reflects a clear intention to leave that question to the above-mentioned Conference on the Law of the Sea,

DECLARES FURTHER that the rights exercised by a State within its jurisdiction in accordance with the Convention do not preclude the existence of other rights of that State under international law.

RESOLUTION 24

CO-ORDINATION OF ACTIVITIES
ON THE PREVENTION AND CONTROL
OF MARINE POLLUTION

THE CONFERENCE,

NOTING that the International Convention for the Prevention of Pollution from Ships, 1973, has conferred upon the Inter-Governmental Maritime Consultative Organization and its Secretary-General, important functions to be performed under the Convention,

RECOGNIZING the need for effective co-ordination of activities carried out by different international organizations concerned with the prevention and control of marine pollution,

RECOMMENDS that the Organization, where necessary, consult with and seek assistance from other international organizations and expert bodies concerned within the United Nations system in order to achieve the objectives of the present Convention.

RESOLUTION 25

TRANSMISSION OF THE INTERNATIONAL CONVENTION FOR
THE PREVENTION OF POLLUTION FROM SHIPS, 1973
TO THE UNITED NATIONS CONFERENCE ON THE LAW OF THE SEA

THE CONFERENCE,

BEARING IN MIND that a United Nations Conference on the Law of the Sea will be convened pursuant to Resolution 2750 C (XXV) of the General Assembly of the United Nations,

NOTING that, in accordance with the foregoing Resolution, international law concerning marine pollution forms a part of the Law of the Sea,

REQUESTS the Secretary-General of the Inter-Governmental Maritime Consultative Organization to forward the International Convention for the Prevention of Pollution from Ships, 1973, to the United Nations Conference on the Law of the Sea, so that this Convention can be taken into account in the broader context of that Conference.

Attachment 3

Public Law 92-340
92nd Congress, H. R. 8140
July 10, 1972

An Act

To promote the safety of ports, harbors, waterfront areas, and navigable waters of the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That **this Act may be ciited as the "Ports and Waterways Safety Act of 1972".** **Ports and Waterways Safety Act of 1972.**

TITLE I—PORTS AND WATERWAYS SAFETY AND ENVIRONMENTAL QUALITY

SEC. 101. In order to prevent damage to, or the destruction or loss of any vessel, bridge, or other structure on or in the navigable waters of the **United States, or any land structure or** shore area immediately adjacent to those Waters; and to protect the navigable waters and the resources therein from environmental harm resulting from vessel or structure damage. destruction. or loss. the Secretarv of the department, in **which the (Coast** Guard is operating may— 86 STAT. 424

(1) establish, operate, and maintain vessel traffic **services and systems for ports, harbors, and other waters subject. to congested vessel traffic;** **86 STAT. 425**

(2) require vessels which operate in an area of a vessel traffic service or system to utilize or comply with that service or system, including the carrying or installation of electronic or other devices necessary for the use of the service or system;

(3) control vessel traffic in areas which he determines to be especially hazardous, or under conditions of reduced visibility, adverse weather, vessel congestion, or other hazardous circumstances by--

(1) specifying times of entry, movement, or departure to, from. within, or through ports, harbors, or other waters;

(ii) establishing vessel traffic routing schemes;

(iii) establishing vessel size and speed limitations and vessel operating conditions; and

(iv) restricting vessel operation, in a hazardous area or under hazardous conditions, to vessels which have particular operating characteristics and capabilities which he considers necessary for safe operation under the circumstances;

(4) direct the anchoring, mooring, or movement of a vessel when necessary to prevent damage to or by that vessel or her cargo, stores, supplies, or fuel;

(5) require pilots on self-propelled vessels engaged in the foreign trades in areas and under circumstances where a pilot is not otherwise required by State law to be on board until the State having jurisdiction of an area involved establishes a requirement for a pilot **in that area or under the circumstances involved;**

(6) establish procedures, measures, and standards for the handling, loading, discharge, storage, stowage, and movement. including the emergency removal, control and disposition, of explosives or other dangerous articles or substances (including the substances described in section 4417a(2) (A), (B), and (C) of the Revised Statutes of the United States (46 U.S.C. 391a(2) (A), (B), and (C)) on structures subject to this title; **Post p.** 427.

(7) prescribe minimum safety equipment requirements for structures subject to this title to assure adequate protection from fire, explosion, natural disasters, and other serious accidents or casualties;

(8) establish water or waterfront safety zones or other measures for limited, controlled, or conditional access and activity when necessary " for tile protection of any vessel, structure, waters, or shore area ; and

(9) establish procedures for examination to assure compliance with the minimum safety equipment requirements for structures.

"United States."

SEC. 102. (a) For the purpose of this Act, the term "United States" includes the fifty States, tile District of Columbia, Puerto Rico, the territories and possessions of the United States, and the Trust Territory of the Pacific Islands.

86 STAT. 425
86 STAT. 426

(b) Nothing contained in this title supplants or modifies any treaty or Federal statute or authority granted thereunder, nor does it prevent a State or political subdivision thereof from prescribing for structures only higher safety equipment requirements or safety standards than those which may be prescribed pursuant to this title.

(c) In the exercise of his authority under this title, the Secretary shall consult with other Federal agencies, as appropriate, in order to give due consideration to their statutory and other responsibilities, and to assure consistency of regulations applicable to vessels, structures, and areas covered by this title. The Secretary may also consider, utilize, and incorporate regulations or similar directory materials issued by port or other State and local authorities.

Panama Canal; Saint Lawrence Seaway.

(d) This title shall not be applicable to the Panama Canal. The authority granted to the Secretary under section 101 of this title shall not be delegated with respect to the Saint Lawrence Seaway to any agency other than the Saint Lawrence Seaway Development Corporation. Any other authority granted tile Secretary under this title shall be delegated to the Saint Lawrence Seaway Development Corporation to the extent that the Secretary determines such delegation is necessary for the proper operation of the Seaway.

(e) In carrying out his duties and responsibilities tinder this title to promote the safe and efficient conduct of maritime commerce the Secretary shall consider fully the wide variety of interests which may be affected by the exercise of his authority hereunder. In determining the need for, and the substance of, any rule or regulation or the exercise of other authority hereunder the Secretary shall, among other things, consider—

(1) the scope and degree of the hazards;

(2) vessel traffic characteristics including minimum interference with the flow of commercial traffic, traffic volume, the sizes and types of vessels, the usual nature of local cargoes, and similar factors;

(3) port and waterway configurations and the differences in geographic, climatic, and other conditions and Circumstances;

(4) environmental factors;

(5) economic impact and effects;

(6) existing vessel traffic control systems, services, and schemes; and

(7) local practices and customs, including voluntary arrangements and agreements within the maritime community.

Investigatory powers.

SEC. 103. The Secretary may investigate any incident, accident, or act involving the loss or destruction of, or damage to, any structure subject to this title, or which affects or may affect the safety or environmental quality of the ports. harbors, or navigable waters of the United States. In any investigation under this title, the Secretary may issue a subpena to require the attendance of any witness and the production of documents and other evidence. In case of refusal to obey a subpena issued to any person, the Secretary may request the Attorney General to invoke the aid of the appropriate district court of the United States to compel compliance. Witnesses may be paid fees for travel and attendance at rates not exceeding those allowed in a district court of the United States.

SEC. 104. The Secretary may issue reasonable rules, regulations, and standards necessary to implement this title. In the exercise of his rulemaking authority the Secretary is subject to the provisions of chapters 5 and 7 of title 5, United States Code. In preparing proposed rules, regulations, and standards, the Secretary shall provide an adequate opportunity for consultation and comment to State and local governments, representatives of the marine industry, port and harbor authorities, environmental groups, and other interested parties. Rulemaking authority. 80 Stat. 380, 392; 81 Stat. 195. 5 USC 500, 701.

SEC. 105. The Secretary shall, within one year after the effective date of this Act, report to the Congress his recommendations for legislation which may be necessary to achieve coordination and/or eliminate duplication between the functions authorized by this Act and the functions of any other agencies. Report to Congress.

SEC. 106. Whoever violates a regulation issued under this title shall be liable to a civil penalty of not more than $10,000. The Secretary may assess and collect any civil penalty incurred under this title and, in his discretion, remit, mitigate, or compromise any penalty. Upon failure to collect or compromise a penalty, the Secretary may request the Attorney General to commence an action for collection in any district court of the United States. A vessel used or employed in a violation of a regulation under this title shall be liable in rem and may be proceeded against in any district court of the United States having jurisdiction. Penalty.

SEC. 107. Whoever willfully violates a regulation issued under this title shall be fined not less than $5.000 or more than $50,000 or imprisoned for not more than five years, or both.

TITLE II—VESSELS CARRYING CERTAIN CARGOES IN BULK

SEC. 201. Section 4417a of the Revised Statutes of the United States (46 U.S.C. 391a) is hereby amended to read as follows:

"SEC. 4417a. (1) STATEMENT OF POLICY.—The Congress hereby finds and declares-

"That the carriage by vessels of certain cargoes in bulk creates substantial hazards to life, property, the navigable waters of the United States (including the quality thereof) and the resources contained therein and of the adjoining land, including but not limited to fish, shellfish, and wild life, marine and coastal ecosystems and recreational and scenic values. which waters and resources are hereafter in this section referred to as the 'marine environment'.

"That existing standards for the design, construction, alteration, repair, maintenance and operation of such vessels. must be improved for the adequate protection of the marine environment.

"That it is necessary that there be established for all such vessels documented under the laws of the United States or entering the navigable waters of the United States comprehensive minimum standards of design, construction, alteration, repair, maintenance, and operation to prevent or mitigate the hazards to life, property, and the marine environment.

"(2) VESSELS INCLUDED.—All vessels, regardless of tonnage size. or manner of propulsion, and whether self-propelled or not, and whether carrying freight or passengers for hire or not, which are documented under the laws of the United States or enter the navigable waters of the United States, except public vessels other than those engaged in commercial service, that shall have on board liquid cargo in bulk which is-

"(A) inflammable or combustible, or

"(B) oil, of any kind or in any form, including but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil, or

"(C) designated as a hazardous polluting substance under section 12(a) of the Federal Water Pollution Control Act (33 U.S.C. 1162);

84 Stat. 98.

shall be considered steam vessels for the purposes of title 52 of the Revised Statutes of the United States and shall be subject to the provisions thereof: Provided, That this section shall not apply to vessels having on board the substances set forth in (A), (B), or (C) above only for use as fuel or stores or to vessels carrying such cargo only in drums, barrels, or other packages: *And provided further*, That nothing contained herein shall be deemed to amend or modify the provisions of section 4 of Public Law 90-397 with respect to certain vessels of not more than five hundred gross tons: *And provided further*, That this section shall not apply to vessels of not more than five hundred gross tons documented in the service of oil exploitation which are not tank vessels and which would be subject to this section only because of the transfer of fuel from the vessels' own fuel supply tanks to offshore drilling or production facilities.

46 USC 361 *et seq.*

82 Stat. 341.
46 USC 391a.

"(3) RULES AND REGULATIONS.-In order to secure effective provision (A) for vessel safety, and (B) for protection of the marine environment, the Secretary of the department in which the Coast Guard is operating (hereafter referred to in this section as the 'Secretary') shall establish for the vessels to which this section applies such additional rules and regulations as may be necessary with respect to the design and construction, alteration, repair, and maintenance of such vessels, including, but not limited to, the superstructures, hulls, places for stowing and carrying such cargo fittings, equipment, appliances, propulsive machinery, auxiliary machinery, and boilers thereof; and with respect to all materials used in such construction, alteration, or repair; and with respect to the handling and stowage of such cargo the manner of such handling or stowage, and the machinery and appliances used in such handling and stowage; and with respect to equipment and appliances for life saving, fire protection, and the prevention and mitigation of damage to the marine environment; and with respect to the operation of such vessels; and with respect to the requirements of the manning of such vessels and the duties and qualifications of the officers and crew thereof; and with respect to the inspection of all the foregoing. In establishing such rules and regulations the Secretary may, after hearing as provided in subsection (4), adopt rules of the American Bureau of Shipping or similar American classification society for classed vessels insofar as such rules pertain to the efficiency of hulls and the reliability of machinery of vessels to which this section applies. In establishing such rules and regulations, the Secretary shall give due consideration to the kinds and grades of such cargo permitted to be on board such vessel. In establishing such rules and regulations the Secretary shall, after consultation with the Secretary of Commerce and the Administrator of the Environmental Protection Agency, identify those established for protection of the marine environment and those established for vessel safety.

"(4) ADOPTION OF RULES AND REGULATIONS.-Before any rules or regulations, or any alteration, amendment, or repeal thereof, are approved by the Secretary under the provisions of this section, except in an emergency, the Secretary shall (A) consult with other appropriate Federal departments and agencies, and particularly with the Administrator of the Environmental Protection Agency and the Secretary of Commerce, with regard to all rules and regulations for the protection of the marine environment, (B) publish proposed rules and regulations, and (C) permit interested persons an opportunity for hearing. In prescribing rules or regulations, the Secretary shall consider, among other things, (i) the need for such rules or regulations, (ii) the extent to which such rules or regulations will contribute to safety or protection of the marine environment, and (iii) the practicability of compliance therewith, including cost and technical feasibility.

Regulations, publication, hearing opportunity.

"(5) RULES AND REGULATIONS FOR SAFETY; INSPECTION; PERMITS: FOREIGN VESSELS.—No vessel subject to the provisions of this section shall, after the effective date of the rules and regulations for vessel safety established hereunder, have on board such cargo, until a certificate of inspection has been issued to such vessel in accordance with the provisions of title 52 of the Revised Statutes of the United States and until a permit has been endorsed on such certificate of inspection by the Secretary, indicating that such vessel is in compliance with the provisions of this section and the rules and regulations for vessel safety established hereunder, and showing the kinds and grades of such cargo that such vessel may have on board or transport. Such permit shall not be endorsed by the Secretary on such certificate of inspection until such vessel has been inspected by the Secretary and found to be in compliance with the provisions of this section and the rules and regulations for vessel safety established hereunder. For the purpose of such inspection, approved plans and certificates of class of the American Bureau of Shipping or other recognized classification society for classed vessels may be accepted as evidence of the structural efficiency of the hull and the reliability of the machinery of such classed vessels except as far as existing law places definite responsibility on the Coast Guard. A certificate issued under the provisions of this section shall be valid for a period of time not to exceed the duration of the certificate of inspection on which such permit is endorsed, and shall be subject to revocation by the Secretary whenever he shall find that the vessel concerned does not comply with the conditions upon which such permit was issued: *Provided*, That rules and regulations for vessel safety established hereunder and the provisions of this subsection shall not apply to vessels of a foreign nation having on board a valid certificate of inspection recognized under law or treaty by the United States: *And provided further*, That no permit shall be issued under the provisions of this section authorizing the presence on board any vessel of any of the materials expressly prohibited from being thereon by subsection (3) of section 4472 of this title.

46 USC 391a et seq.

46 USC 170.

"(6) RULES AND REGULATIONS FOR PROTECTION OF THE MARINE ENVIRONMENT; INSPECTION; CERTIFICATION.—No vessel subject to the provisions of this section shall, after the effective date of rules and regulations for protection of the marine environment, have on board such cargo, until a certificate of compliance, or an endorsement on the certificate of inspection for domestic vessels, has been issued by the Secretary indicating that such vessel is in compliance with such rules and regulations. Such certificate of compliance or endorsement shall not be issued by the Secretary until such vessel has been inspected by the Secretary and found to be in compliance with the rules and regulations for protection of the marine environment established hereunder. A certificate of compliance or an endorsement issued under this subsection shall be valid for a period specified therein by the Secretary and shall be subject to revocation whenever the Secretary finds that the vessel concerned does not comply with the conditions upon which such certificate or endorsement was issued.

"(7) RULES AND REGULATIONS FOR PROTECTION OF THE MARINE ENVIRONMENT RELATING TO VESSEL DESIGN AND CONSTRUCTION, ALTERATION, AND REPAIR; INTERNATIONAL AGREEMENT.—(A) The Secretary shall begin publication as soon as practicable of proposed rules and regulations setting forth minimum standards of design, construction, alteration, and repair of the vessels to which this section applies for the purpose of protecting the marine environment. Such rules and regulations shall, to the extent possible, include but not be limited to standards to improve vessel maneuvering and stopping ability and otherwise reduce the possibility of collision, grounding, or other accident, to reduce cargo loss following collision, grounding, or other accident, and to reduce damage to the marine environment by normal vessel operations such as ballasting and deballasting, cargo handling, and other activities.

Publication.

"(B) The Secretary shall cause proposed rules and regulations published by him pursuant to subsection (7) (A) to be transmitted to appropriate international forums for consideration as international standards.

"(C) Rules and regulations published pursuant to subsection (7) (A) shall be effective not earlier than January 1, 1974, unless the Secretary shall earlier establish rules and regulations consonant with international treaty, convention, or agreement, which generally address the regulation of similar topics for the protection of the marine environment. In the absence of the promulgation of such rules and regulations consonant with international treaty, convention, or agreement, the Secretary shall establish an effective date not later than January 1, 1976, for rules and regulations previously published pursuant to this subsection (7) which he then deems appropriate.

"(D) Any rule or regulation for protection of the marine environment promulgated pursuant to this subsection (7) shall be equally applicable to foreign vessels and United States-flag vessels operating in the foreign trade. If a treaty, convention, or agreement provides for reciprocity of recognition of certificates or other documents to be issued to vessels by countries party thereto, which evidence compliance with rules and regulations issued pursuant to such treaty, convention, or agreement, the Secretary, in his discretion, may accept such certificates or documents as evidence of compliance with such rules and regulations in lieu of the certificate of compliance otherwise required by subsection (6) of this section.

"(8) SHIPPING DOCUMENTS.—Vessels subject to the provisions of this section shall have on board such shipping documents as may be prescribed by the Secretary indicating the kinds, grades, and approximate quantities of such cargo on board such vessel, the shippers and consignees thereof, and the location of the shipping and destination points.

"(9) OFFICERS; TANKERMEN; CERTIFICATION.—(A) In all cases where the certificate of inspection does not require at least two licensed officers, the Secretary shall enter in the permit issued to any vessel under the provisions of this section the number of the crew required to be certified as tankermen.

"(B) The Secretary shall issue to applicants certificates as tankermen, stating the kinds of cargo the holder of such certificate is, in the judgment of the Secretary, qualified to handle aboard vessels with safety, upon satisfactory proof and examination, in form and manner prescribed by the Secretary, that the applicant is in good physical condition, that such applicant is trained in and capable efficiently to perform the necessary operations aboard vessels hat"ing such cargo on board, and that the applicant fulfills the qualifications of tankerman as prescribed by the Secretary under the provisions of this section. Such certificates shall be subject to suspension or revocation on the same rounds and in the same manner and with like procedure as is provided in the case of suspension or revocation of licenses of officers under the provisions of section 4450 of this title. 46 USC 239.

"(lo) EFFECTIVE DATE OF RULES AND REGULATIONS.-Except as otherwise provided herein, the rules and regulations to be established pursuant to this section shall become effective ninety days after their promulgation unless the Secretary shall for good cause fix a different time. If the Secretary shall fix an effective date later than ninety days after such promulgation, his determination to fix such a later date shall be accompanied by an explanation of such determination which he shall publish and transmit to the Congress.

"(11) PENALTIES.—(A) The owner, master, or person in charge of' any vessel subject to the provisions of this section; or any or all of them, who shall violate the provisions of this section, or the rules and regulations established hereunder, shall be liable to a civil penalty of not more than $10,000.

"(B) The owner, master, or person in charge of any vessel subject to the provisions of this section, or any or all of them. who shall knowingly and willfully violate the provisions of this section or the rules and regulations established hereunder, shall be subject to a fine of not less than $5,000 or more than $50,000, or imprisonment for not more than five years, or both.

"(C) Any vessel subject to the provisions of this section, which shall be in violation of this section or the rules and regulations established hereunder, shall be liable in rem and may be proceeded against in the United States district court for any district in which the vessel may be found.

"(12) INJUNCTIVE PROCEEDINGS.-The United States district courts shrill have "jurisdiction for cause shown to restrain violations of this section or the rules and regulations promulgated hereunder.

"(13) DENIAL OF ENTRY.—The Secretary may, subject to recognized principles of international law, deny entry into the navigable waters of the United States to any vessel not in compliance with the provisions of this section or the regulations promulgated thereunder."

SEC. 202. Regulations previously issued under statutory provisions repealed, modified, or amended by this title shall continue in effect as though promulgated under the authority of section 4417a of the Revised Statistics of the United States (46 U.s.c. 391a), as amended by I his title, until expressly abrogated, modified, or amended by the Secretary of the Department in which the Coast Guard is operating under the regulator-y authority of such section 4417a as so amended. Any proceeding under such section 4417a for a violation which occurred before the effective date of this title may be initiated or continued to conclusion as though such section 4417a had not been amended hereby. Savings provision.

Report to Congress.

SEC. 203. The Secretary of the Department in which the Coast Guard is operating shall, for a period of ten years following the enactment of this title, make a report to the Congress at the beginning of each regular session, regarding his activities under this title. Such report shall include but not be limited to (A) a description of the rules and regulations prescribed by the Secretary (i) to improve vessel maneuvering and stopping ability and otherwise reduce tile risks of collisions, groundings, and other accidents, (ii) to reduce cargo loss in the event of collisions, grounding, and other accidents. and (iii) to reduce damage to the marine environment from the normal operation of the vessels to which this title applies, (13) the progress made with respect to the adoption of international standards for. the design, construction, alteration, and repair of vessels to which this title applies for protection of the marine environment, and (C) to the extent that the secretary finds standards with respect to the design, construction, alteration, and repair of vessels for the purposes set forth in (A) (i), (ii), or (iii) above not. possible, an explanation of the reasons therefor.

Approved July 10, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORTS: No. 92-563 (Comm. on Merchant Marine and Fisheries) and No. 92-1178 (Comm, of Conference).
SENATE REPORT No. 92-724 (Comm. on Commerce).
CONGRESSIONAL RECORD:
Vol. 117 (1971) Oct. 18, considered end passed House.
Vol. 118 (1972): Mar. 30, considered and passed Senate, amended.
June 26, Senate agreed to conference report.
June 28, House agreed to conference report.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS:
vol. 8, No. 29 (1972): July 10) presidential statement.

Attachment 4

VLCC METULA GROUNDING AND REFLOATING REPORT

EXECUTIVE SUMMARY

At **10:20 P.M. on 9 August 1974,** the VLCC METULA, **transiting westbound through the Strait of Magellan and laden with 194,000 tons of light Arabian crude oil, ran aground on Satellite Bank, at** the west end of the First Narrows. Grounding at almost her full speed of 14.5 knots, METULA came to a stop in about 260 feet, opening up five of her forward-most compartments, including two cargo tanks, to the sea, initially losing about 6,000 tons of oil, which amount increased with time due to the action of tides and current.

At first METULA held fast on her grounding heading of 235° True, but on the afternoon of 11 August, her stern swung to starboard and the after portion of the hull grounded, holing the engine room, which was flooded in about an hour. **METULA** was then stranded starboard side to a steep rocky ledge on a heading of about 185° True, and she held this position thereafter despite cross currents of up to eight knots.

Shell Tankers B.V., Rotterdam, operators of METULA, made salvage arrangements on a daily rate basis with Smit International Ocean Towage and Salvage, Rotterdam. The salvage tug ZWARTE ZEE departed Montevideo for the scene. A salvage team headed by Smit's senior salvage inspector, CAPT COLTHOFF, designated Salvage Master, was dispatched by air to Punta Arenas, along with some fourteen tons of equipment. CAPT JONGENEEL, Shell Tankers' Marine Superintendent, went along to manage the ship operator's interest in the salvage effort, as did ANDREW MARSHALL, London Salvage surveyor for the hull underwriters.

Meanwhile, Shell arranged for two tankers to proceed to the scene -- the Argentine tanker HARVELLA of 19,000 DWT, for initial lightening, and the Norwegian tanker BERGELAND of 96,000 DWT, for the HARVELLA to discharge into.

The ZWARTE ZEE arrived in Punta Arenas on 15 August and picked up the men and equipment that had been flown in. After a delay due to weather, she secured alongside METULA on 17 August. At that time damage was assessed, calculations were started, and plans for refloating began to be formulated. Meanwhile, two more salvage tugs -- the SMIT SALVOR and the NORTH SEA -- were dispatched to the scene from the Panama area.

The Coast Guard first became aware of the incident on 13 August through a message from the United States Delegation to the Law of the Sea Conference in Caracas. Two days later it was derided that a Coast Guard observer should go to Chile to learn as much as possible about the incident, in view of prospective supertanker traffic into and near the United States.

The Coast Guard observer, CDR James A. ATKINSON, arrived in Punta Arenas on 19 August, was briefed by the Chilean on-scene commander, RADM ALLEN, conferred with Shell and insurance representatives, and the next day visited METULA, There he was apprised of METULA'scondition, the severe complexities of the situation, and the salvage plans. He described to CAPT COLTHOFF the U.S. National Strike Force and ADAPTS pumping systems and told him that Chile might obtain Coast Guard assistance through a government to government request. The following day CAPT COLTHOFF sent a request to the Chilean government, which apparently contributed to Chile's decision to request U.S. assistance on a cost reimbursable basis.

Progressive damage occurred on the subsequent spring tides with four more cargo tanks opening to the sea on 19 August, a ballast tank and bunker tank on 4 September. On 24 September another cargo tank began to leak.

The tankers arrived on scene, but, were delayed awaiting the Yokohama fenders, which, due to the difficulty in finding an aircraft that could transport them, did not arrive until 26 August.

The U.S. Strike Force contingent and three ADAPTS systems arrived on 27 August. One of the systems and six men went out to METULA in time for the first offloading into HARVELLA on 28 August. After the salver's plans changed, the other two systems were ordered out and all were thereafter fully integrated into the pumping off of cargo, the injection of compensating ballast, and the deballasting during refloating.

After four offloading by HARVELLA, totalling about 50,000 tons, BERGELAND) departed the scene to deliver this cargo to Quintero Bay, Chile, (its original destination) with orders to return for the remainder of METULA's cargo.

Refloating was planned for 21 September, but was delayed by weather until the 24th. On that date an effort was made, with a combination of deballasting intact tanks and "blowing down" open tanks with air. This attempt was not successful. So on the next tide more ballast was pumped out and more air was applied, this time with success. METULA came afloat at 0235 on 25 September and was moved to anchor a few miles west of her stranded position. Here adjustments were made in list and trim, and cargo was transferred to reduce the chance of pollution. Severe winds occurred from 27 to 30 September with velocities from 90 to 100 knots. After this moderated, on 1 October, BERGELAND) went alongside METULA and offloading continued, broken by periods of high winds. Offloading was completed on 10 October. The total amount of cargo saved was about 140,500 tons; about 2,000 tons remained in the ship, mostly in clingage, and about 51,500 tons of crude oil and some Bunker C was lost into the waters of the Strait.

Pollution surveillance by air was carried on almost every day. The appearance of the polluted water and beaches from the air varied from day to day, the marked differences apparently stemming from the effects of wind and tide. The heaviest water pollution observed was on 20 August after the largest cargo release, when slicks covered about 1,000 square miles. At most other times the oil was penned against the beaches by the wind, reducing drastically the water surface coverage. A beach survey by Dr. Roy HANN of Texas A & M University, who had visited the scene on behalf of the U.S. Coast Guard, revealed massive beach deposits of oil-water emulsion, some of which was well above the highest water level, apparently carried there by the gale force winds from the breaker tops during highest tides. His rough measurements showed that most of the oil that had not either evaporated or dissolved had apparently gone ashore. At first this was confined to a strip of beach on Tierra del Fuego, on the southern shores of eastern Bahia Felipe, and the First Narrows, but it later spread farther to east and west; some ended up on the north shore eastward of Cabo Posesion, and patches were sighted west of the Second Narrows. There was an appreciable bird kill, but many migrating penguins passed the polluted area and reached their nesting islands in the Strait without damage.

The ADAPTS equipment, which was developed by the Coast Guard after a study of the TORREY CANYON disaster, gave excellent performance, fully vindicating the efforts expended in its development. The NSF contingent operating that equipment, self-supporting under primitive living and severe climatic conditions, carried out their duties with perserverence, dedication and skill confirming the best traditions of the Service and in keeping with the Strike Force concept. In so doing they played a most important part in restricting the oil pollution to a minimum, before, during and after the refloating operation.

Attachment 5

Report No. CG-D-54-75
Task No. 4111.15.1

VLCC "METULA" OIL SPILL

Roy W. Harm, Jr.

December 1974

FINAL REPORT

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22151

Prepared for

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
Office of Research and Development
Washington, D.C. 20590

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15. Supplementary Notes

16. Abstract

On 9 August 1974, the METULA, a 206,000 deadweight VLCC (Very Large Crude Carrier) enroute from Ras Tenura, Saudi Arabia to Quintera Bay, Chile with a load of 195,673 tons of Arabia light crude, ran aground on the Satellite Patch Shoal in the Straits of Magellan, Chile. The author was detailed by the U. S. Coast Guard to proceed to the spill site to serve in the capacity of Science Advisor to the U. S. National Strike Force sent to assist the Chilean government abate the spill. This report summarizes:

a. History of the Spill
b. Deposition of Oil on the Shore
c. Impact of the Oil on the Shore
d. Comments regarding Feasibility of Containment, Cleanup or Stabilization.

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The author Is particularly indebted to his wife, Ann, for her support in undertaking the trip and her excellent endeavors with regard to the arrival of their daughter, Karen Bea, while he was in Chile.

INDEX

I. INTRODUCTION

- History of the Spill
- Details of the Trip
- Format for the Report

II. DEPOSITION OF OIL ON THE SHORE

111. IMPACT OF THE OIL ON THE SHORE

IV. COMMENTS REGARDING FEASIBILITY OF CONTAINMENT, CLEANUP OR STABILIZATION

V. LESSONS LEARNED FROM THE SPILL

APPENDICES

APPENDIX 1.

Chronological Report of the Trip

APPENDIX 2.

Written Report to Admiral Eduardo Allen, Chilean Navy

APPENDIX 3.

Persons Involved at Punta Arenas with METULA Spill

APPENDIX 4.

Instituto de la Patagonia Brochure

APPENDIX 5.

Information on Los Pinguinos National Park

LIST OF FIGURES

Figure 1 Straits of Magellan

Figure 2 Site of Grounding and Impacted Beaches

Figure 3 The METULA

Figure 4 The METULA and Oil Slicks and METULA Tank Layout

Figure 5 Field Program Stationing and Zones Covered

Figure 6 Estimate of Oil on Shore

Figure 7 Typical Uncontaminated Beach in The Straits of Magellan

Figure 8 Oil on Shore of Estuary

Figure 9 Cormorants

Figure 10 Number of Dead Birds Found

Figure 11 Penguin

TABLE

Table 1. Birds Observed to be Affected by Oil on the South Shore of the Straits of Magellan Between Punta Anegada and the Center of Bahia Felipe

SECTION I. INTRODUCTION

This report was prepared by the author following a trip to southern Chile at the request of the United States Coast Guard to serve in the capacity of Science Advisor to the National Strike Force sent to assist the Chilean government with regard to the grounding of the VLCC (Very Large Crude Carrier) METULA.

This report primarily contains information obtained during the trip with some supplemental information provided that has been learned after returning to the United States.

History of the Spill

The following description of the incident and spill was obtained by the author from a variety of verbal and published sources. It should not be considered as a formal and complete accounting of the entire incident, but is presented here as the author's best knowledge of the incident, to provide background information necessary to the reader.

The METULA is a VLCC of 206,000 dead weight tons, 1,067 feet long, which is owned by the Curacao Scheepvaart Maatschappij, a company of the Royal Dutch Shell group and managed by Shell Tankers BV Rotterdam.

On August 9, 1974 the METULA was enroute from Ras Tenura Saudia Arabia to Quintera Bay Chile with a load of 195,673 tons of Arabia light crude. At 10:18 p.m. on August 9, 1974 the METULA ran aground on the Satellite Patch Shoal immediately west of the First Narrows in the Straits of Magellan at approximately latitude 52 34 00 south and longitude 69 40 48 west.

The location of the site of the grounding of the tanker METULA is shown on the general map of the Straits of Magellan (Figure 1) and in the detailed map of the Bay of Felipe and the First Narrows area in Figure 2.

Figure 3 is a photograph of the METULA taken on August 28, 1974.

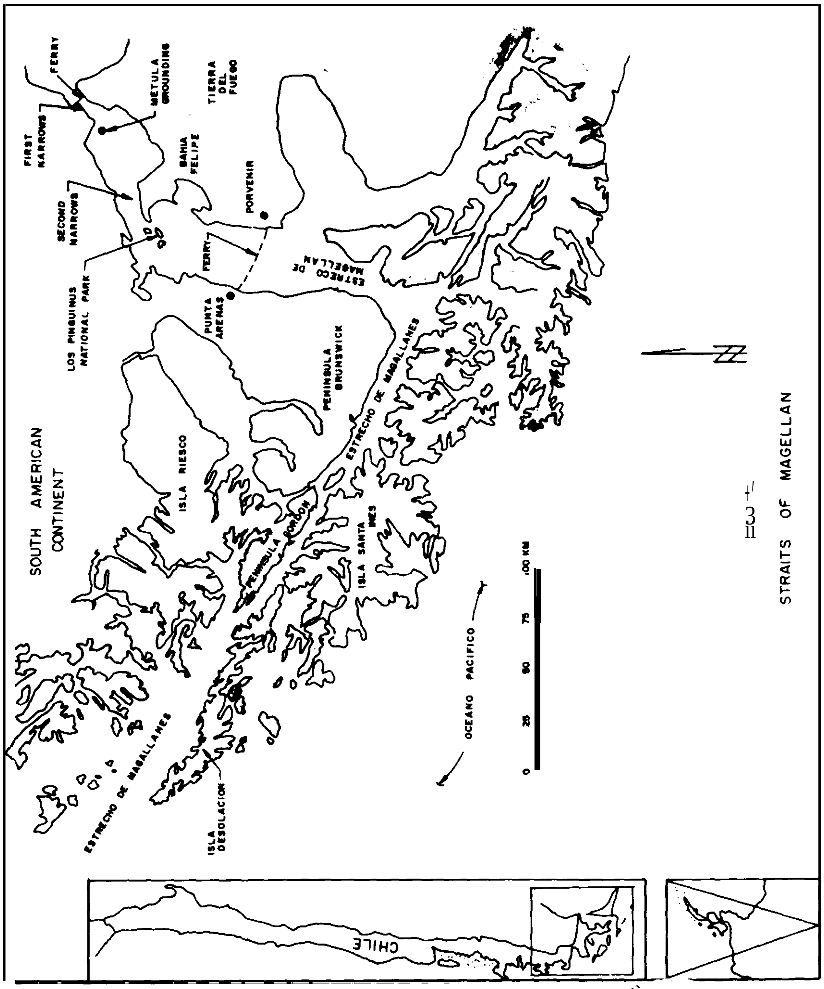
Figure 4 is a photograph taken on the same day which shows the grounded METULA and streaks of oil spreading away from the METULA.

Figure 4 also shows a rough diagram of the tank layout of the METULA.

The METULA was reported to have stopped within the length of the ship with the water depth at the forward ballast tank being 43 feet whereas the depth of the ship before grounding was estimated to be 58 feet 6 inches. Estimates placed initial oil loss around 6,000 tons. Initial damage was reported to the forward most cargo tanks.

During the evening of the night of August 11, the tanker was reported to have swiveled stern to starboard and the engine room double bottom was pierced causing the vessel to lose all power and electricity.

3



STRAITS OF MAGELLAN

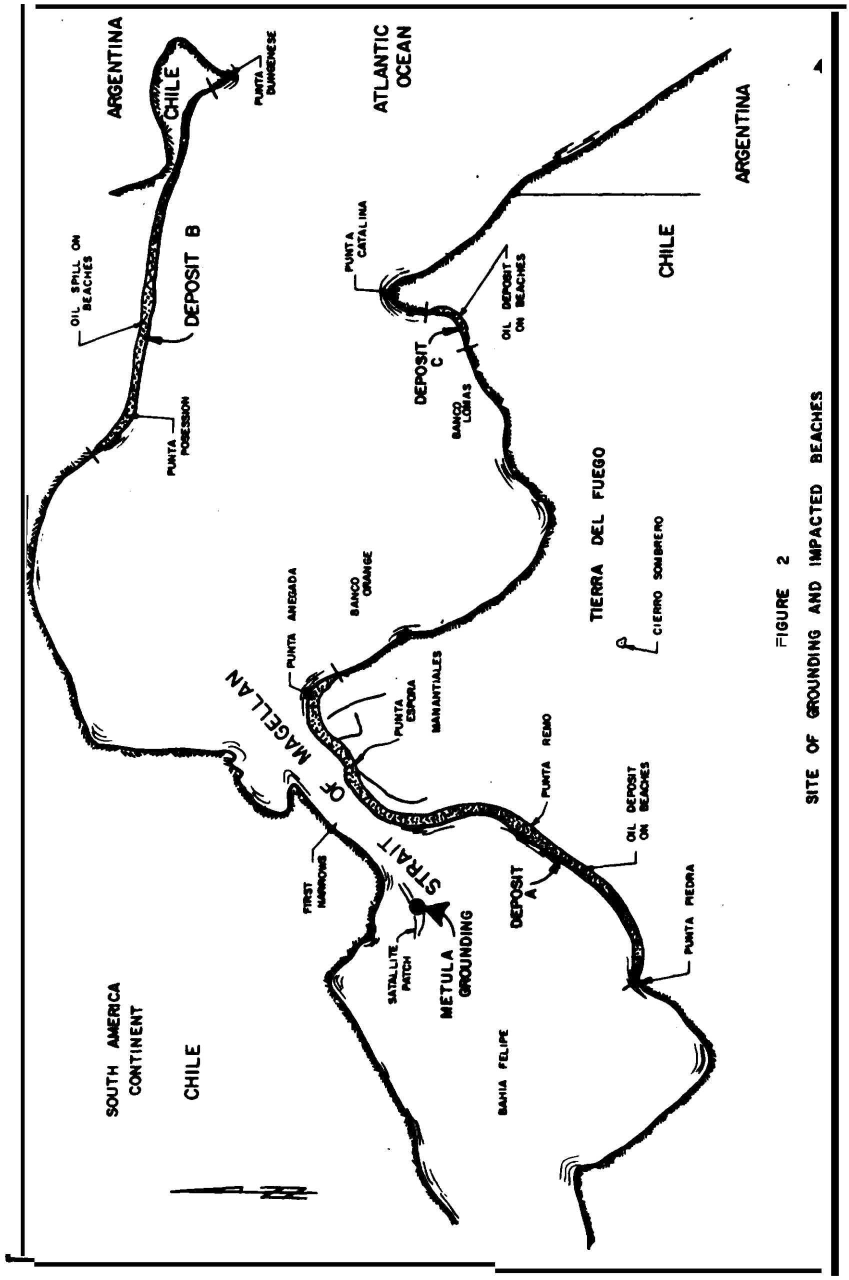


FIGURE 2
SITE OF GROUNDING AND IMPACTED BEACHES

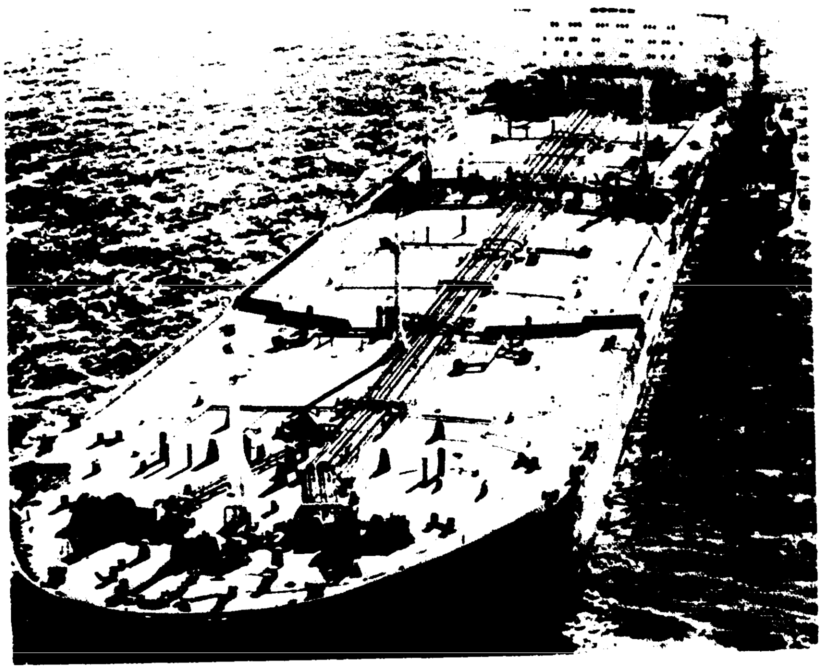
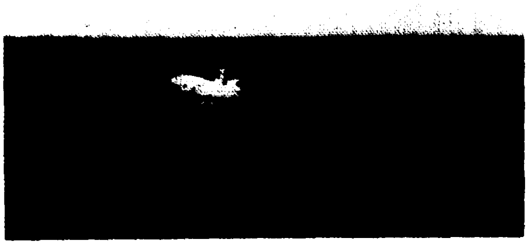
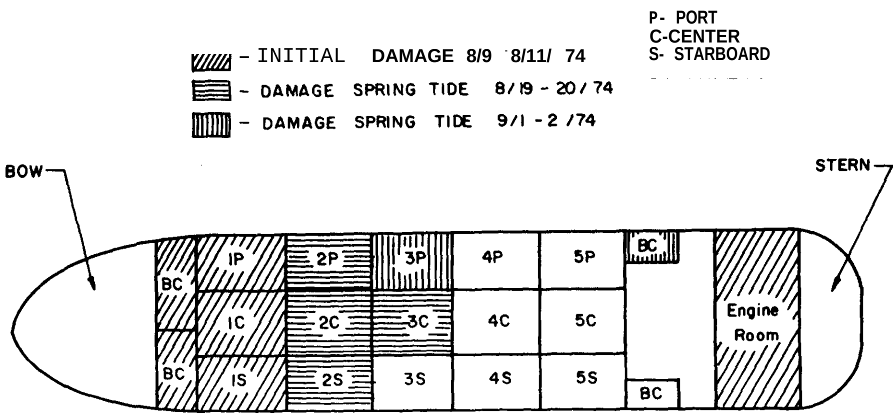


FIGURE 3

H/v METULA

6





METULA TANK LAYOUT

FIGURE 4

METULA & OIL SLICK

By August 15, it had been estimated that 20,000 tons had been lost. On or about August 19 , additional damage occurred and the second row of cargo tanks, two port, two center, two starboard and three center were reported as being open to the sea, either through the bottom or through piping connections, and additional losses were reported. As of August 22, it had been estimated that 40,000 tons of oil had been lost. On August 29, the small tanker HARVELLA of 19,000 dead weight tons was brought alongside and the initial pumping of oil from the METULA was carried out as part of the attempt to minimize pollution and to remove sufficient oil to float the ship. An initial load of about 15,000 tons was removed and unloading suspended until the next period of low tide range.

During September approximately 50,000 tons of oil were ultimately transferred to the HARVELLA and subsequently to the tanker BERGLAND, a tanker of approximately 96,000 dead weight tons, for transport to central Chile. The METULA was subsequently refloated at 2:20 a.m. on September 25, 1974 and moved approximately ten miles west to a safer anchorage for the rest of the oil to be pumped off.

Details of Trip

The author was contacted on the afternoon of August 23 and asked to proceed to Chile under the title of Science Advisor to the U.S. Coast Guard National Strike Force being assembled to aid in the prevention of pollution by offloading remaining oil from the tanker METULA. The duties of the Science Advisor were specified as: (a) observing the offloading, salvage and cleanup operations, if any of the M/V METULA's grounding and resulting oil spill, (b) observing the behavior and effects of the oil spill, (c) observing the nature of the oil spill and the vast current environment, (d) taking photographs as appropriate, and (e) preparing and submitting a detailed report summarizing the observations and conclusions in the METULA oil spill.

The author departed Houston, Texas on August 24, 1974 and arrived in Punta Arenas on Monday morning, August 26, 1974. It was soon learned that the high winds and currents in the vicinity of the METULA plus the remoteness of the location had led to decisions to not attempt any containment at sea or to use any chemical agents as of that time. Furthermore, the extremely crowded conditions aboard the METULA and the difficulty of obtaining transport to the METULA and back made it impractical for the author to actually go on board the METULA.

As the result of the above factors it was decided to emphasize the evaluation, behavior and effects of the oil spill. During the first day in Punta Arenas, the author became acquainted with Dr. Jon Wonhom who had been dispatched from the English Warren Springs Laboratory as a consultant to IMCO, to serve as an international contribution to the METULA problem and Mr. Claudio Venegas, a biologist with the local Instituto de la Patagonia. Following meetings with the staff of the Instituto de la Patagonia and the flyover of the impacted area, it was determined that a field program on the northern shore of Tierra del Fuego would be extremely valuable. As of that time, no detailed scientific survey of the status of the oil on the beach or its impact on marine life and waterfowl had been attempted.

On the 29th of August a team composed of the author, Dr. Jon Wonhom, Mr. Claudio Venegas and Jean and Bill Texera, a Peace Corp couple assigned to the Instituto de la Patagonia, departed from Punta Arenas via an Instituto de la Patagonia Landrover to carry out the field study. Over the next six days, approximately three and one half days were spent either walking the impacted beach or observing the effect of the wind and weather on the oil on the beach.

A detailed accounting of the field survey is presented in the following sections and in the chronological accounting of the trip in Appendix 2.

Following the field survey, which included observation of the spring tide cycle on the oil on the beach, an additional aerial survey was made aboard a Chilean Naval Aircraft and reports covering the observations of the aerial flights and field survey were made to the on-scene Coast Guard Coordinator, Admiral Eduardo Allen of the Chilean Navy, United States Ambassador Popper in Santiago and Captain Poisson of the Chilean Navy in Santiago.

After returning to the United States, the author participated in a formal press conference at Coast Guard Headquarters in Washington and made presentations of the incident to Shell Oil Company staff in Houston, Texas and to a seminar on the Texas A&M University campus. The author also provided information to a large number of interested scientists and newspaper reporters, including representatives of the Wall Street Journal, the Associated Press, the New Orleans Time Picayune, the Seattle Times and the Smithsonian Institute, as well as providing information, upon request, to the Office of Senator Gaylord Nelson.

Report Format

The following sections of the report will describe the physical deposition of the oil on the coastline of the Island of Tierra del Fuego and the southshore of the South American Continent; will describe the nature and characteristics of the oil on the shore and the impact of the oil on marine organisms and waterfowl; will cover some details regarding the feasibility of containment, cleanup and stabilization; and will attempt to summarize the importance of what was observed in Chile in regard to the METULA in terms of significance to United States problem.

SECTION II. DEPOSITION OF OIL ON THE SHORE

The oil which left the METULA was rapidly spread by the currents and by normal gravity spreading after release. It was reported by Commander Atkinson (USCG) that on August 20 some 1,000 square miles was observed to be covered with oil slick and on the two flights made by the author, slicks surfacing from the ship were evident in both Bay Felipe and the Bay east of the Narrows. The surface slicks, however, were much more evident on the flight on September 5 than they were on the initial flight over on August 28.

The part of the Straits of Magellan is noted for its exceptional high winds, predominantly from the west, and these winds tended to rapidly drive the oil ashore. The winds during August were such that essentially all of the oil that did not volatilize or absorb into the water column was driven onto the north shore of the Island of Tierra del Fuego. This deposition is shown on Figures 2 and Figure 5. This initial deposition covered between 40 and 50 miles of coast line.

During the field operation some 25 miles of this beach was walked by two person teams of the field party and estimates were made of the amount of oil on the beach. The beach deposits were generally described as being between 50 and 200 feet wide with a depth of from one to four inches. Figure 5 shows the specific zones walked by the different teams during the two days of intensive field study and shows the station numbering system used to describe the estimate of oil on following figures. The distances shown are

12

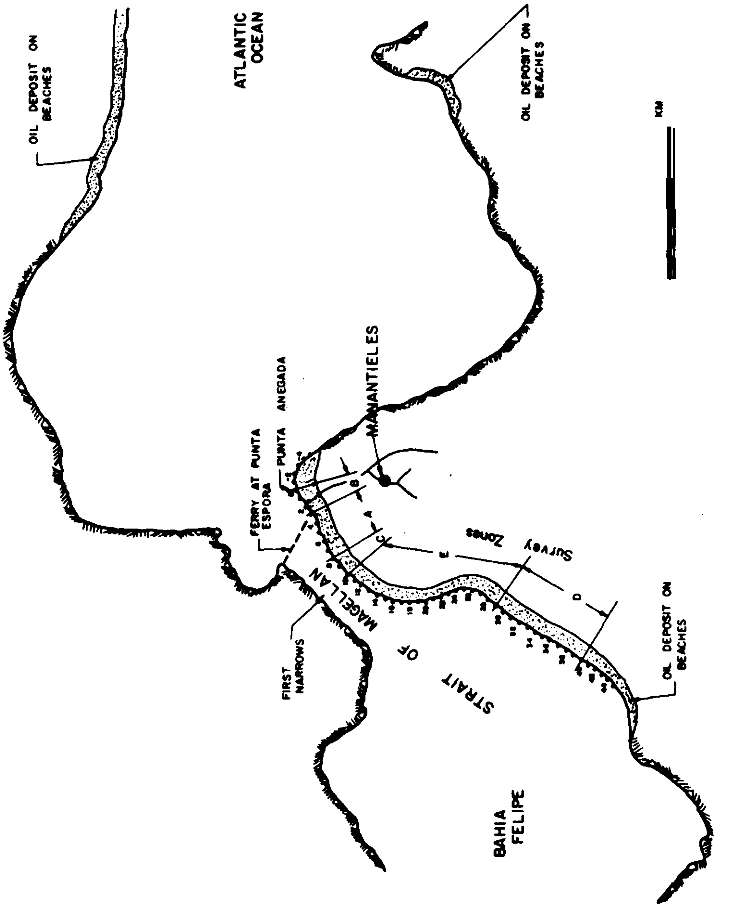


FIGURE 5

FIELD PROGRAM STATIONING AND ZONES COVERED scaled distances from Point Anegada at the eastern end of the First Narrows. Stationing westerly of that point are indicated as PIUS values and easterly as negative values. The total accumulation of oil as cross sectional square feet, i.e. the width of the deposit perpendicular to the shore times the depth of the oil, is shown in Figure 6.

The oil deposit appeared as two distinct layers or bands. One was a dark brown mousse, which could be described as a dark chocolate pudding, which had been deposited above the previous spring high tide mark by the strong winds. This material was later evaluated to have a 5% moisture content and was mixed with sand particles, seaweed, marine worms and other materials picked up In its transport to the beach and which had been blown into the oil while on the beach. In a few cases, this darker deposit had been completely covered by the blowing sand which would dry out on the shore during the periods of low tides and high winds and they blow onto the oil deposits. This phenomenon was demonstrated in. some of the color slides taken during the trip.

The second band consisted of a light brown mousse, very similar to milk chocolate pudding in color and texture and seemingly to behave like taffy when mixed with water in that it stayed in long, stringy bands. Both the light brown and dark brown deposits behaved quite differently from fresh oil in that it tended to stay together. It could be easily shoveled, with the depth of the oil on the shovel of about three inches deep, and when shoveled, the material

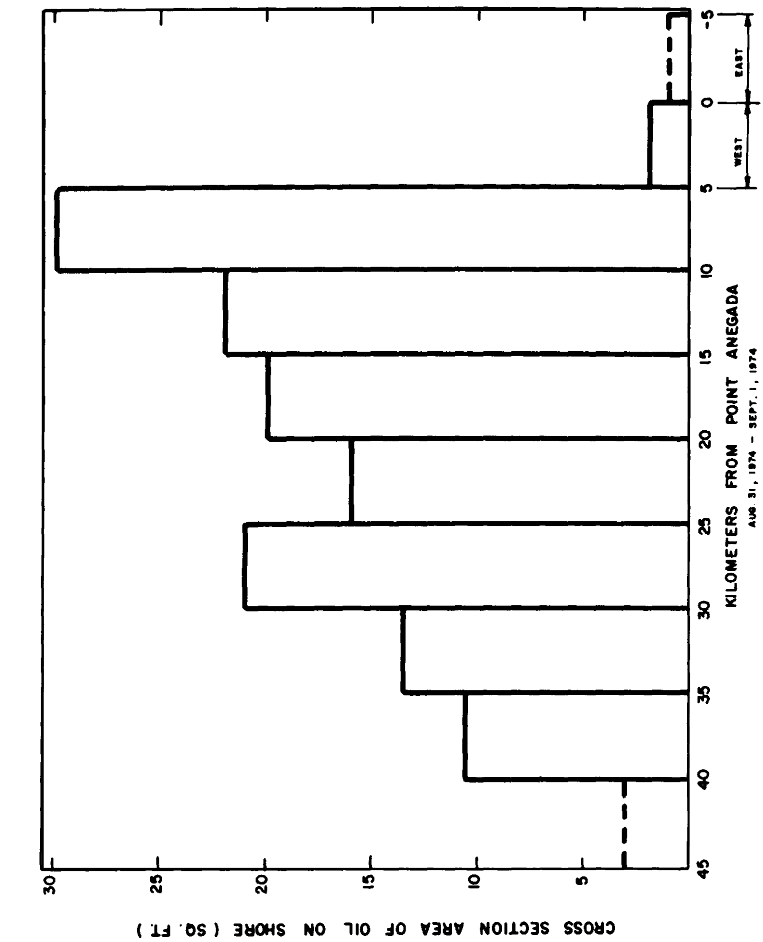


FIGURE 6

ESTIMATE OF OIL ON SHORE

had sufficient water content that it would slide loose and the shovel would stay water wet.

As the tide would go out, the wind would tend to keep the oil pinned against the shore and the water would flow from beneath it, leaving most of the oil suspended at the latest high tide line. During the following hours, the oil so deposited would run back down the beach In stringers. This phenomenon of staying a narrow band of oil during high tide periods and a wider band of oil during low tide periods, led to some of the earlier beliefs that the oil was “going away”, when in reality, most of the oil was remaining on the beach.

Figure 7 shows a typical uncontaminated beach in this stretch of the Straits of Magellan.

The beach zone typically consisted of a relatively shallow upper level near the spring tide high water mark, a steeper embankment between spring high water mark and near the spring low water mark and then a broad shallow flat that was exposed only on the lowest, spring low tides. These shallow areas that were exposed during low tide were covered with rocks ranging in diameter from three to eight inches. Many of these would be coated with oil on the top very similar to milk chocolate icing on a cupcake. Oil would also be found floating in the water that had been trapped by the rocks when the tide went out. As will be discussed later, many marine organisms including mussels, limpets and starfish were found in these rocky intertidal areas.

FIGURE 7

TYPICAL UNCONTAMINATED BEACH
IN THE
STRAITS OF MAGELLAN

Assuming the oil/water ratios of five percent in the dark mousse and twenty-five percent in the milk chocolate mousse, it was estimated that approximately 50 pounds of oil was contained per cubic foot of the chocolate mousse (the chocolate mousse had a specific gravity of very close to one).

There were two minor estuaries which entered in the Narrows area of the Straits and it was observed that oil was carried a substantial distance, i.e. one mile or more, up each of these estuaries. The most easterly of the two estuaries appeared to be the most greatly affected.

During Monday, September 1, a very strong southwesterly wind blew almost in direct line with the centerline of the Narrows. This caused some of the chocolate mousse material on the beaches to be blown into the large bay to the east of the Narrows and on the flight made on September 4, it was observed that this material had been deposited on an approximately twenty-five mile stretch of the southern shore of the continent. This location is labeled Deposit B on Figure 2.

During the trip across the channel on September 2 and during the flight on September 4, large patches of darker oil appearing to be spreading faster than the chocolate mousse were observed on the water on the Narrows and to the east of the Narrows. It was later learned that an additional Bunker C tank had been ruptured prior to this period. When the wind shifted from the southwest to the northwest on September 3, the darker, fresher oil was swept to the south shore of the Bay east of the Narrows and pooled just south of the Point Catalina. (Deposit c)

It was not possible to visit either of these two locations to observe the extent of the oil on the beach, although the extent of oil located east and west of Punta Posession appeared to be much smaller in magnitude than that located on Tierra del Fuego, whereas that pooled behind Point Catalina appeared to be a very wide “puddle”.

Figure 8 shows two black and white photographs taken in the estuary which enters at Punta Espora, showing the deposits of oil on the shore. Colored photographs which show the oil deposits more vividly at a number of places along the coast are available in the author’s files, and through the U.S. Coast Guard.

Samples of both the light and dark brown oil/water emulsions were collected for tram-shipment to the U.S. Coast Guard Research Center in Groton, Connecticut.

FIGURE 8

Oil On Shore of Estuary

SECTION 111. IMPACT OF OIL ON THE SHORE

In the previous section, the magnitude of the oil deposition on the shore and the physical nature of the shoreline was described. The discussion of the impact of the oil on the shore is broken into three sections: (1) esthetics, (2) effects on marine organisms, effect on marine waterfowl, and (3) other impacts.

Esthetics:

The coastline of the Straits of Magellan in the vicinity of the Straits is very beautiful in that it consists of clean coarse sand beaches with occasional boulder strewn areas with occasional seaweed and liter strewn at the spring high tide mark. (See Figure 6) The rocky areas exposed during extreme low tides has a rich life of mussels, limpets, seaweed and other marine organisms. The waters were a beautiful greenish-blue. Above the spring tide high water mark, *were* brush grasses which at this time of the year were dormant.

Over much of the north shore of the Island of Tierra del Fuego, there are cliffs which arise from the beach line behind the spring high tide water mark a few feet behind the spring tide high water mark. These arise anywhere from a few feet to fifty feet in height. On the tops of the cliff are low straggly bushy cedar which grows to a height of about 18 inches in windy areas and to a height of about 3 feet in sheltered areas. The cedar gives way to grasslands within a few hundred feet. The grasslands behind the beaches support sheep and cattle and the endangered guanaco, a llama like animal. Inland from the beach line and in protected areas are found shell middens which were left by the Indians which originally inhabited the Island of Tierra del Fuego, and who are the mussels and limpets from the tide flats. In one of these middens, a whalebone vertebrae was observed and in a number of others, and discarded spearhead were found."

Normal access to the Island of Tierra del Fuego is possible only by air or by ferry landings at Punta Espora near the middle of the Narrows and at the town of Porvenir some sixty miles to the west. Some tourism does occur, however, and the automobile club of Chile maintains a restaurant near the ferry at Punta Espora only a few yards from the oiled beaches.

The general citizenry of Chile did not appear *to* consider the north shore of Tierra del Fuego as a particular valuable environmental resource; possibly because of its remoteness; and possibly because of the other areas of extreme environmental beauty elsewhere in the province of Magellenes which is the southernmost state of Chile. The area does, however, possess a considerable amount of rugged beauty and charm and the presence of the guanaco and other species are of environmental significance.

TABLE 1

BIRDS OBSERVED TO BE AFFECTED BY OIL
ON THE SOUTH SHORE OF THE STRAITS OF MAGELLAN
BETWEEN PUNTA ANEGADA AND THE CENTER OF BAHIA FELIPE
August 30 - September 1, 1974

Scientific Name	Common Name (English)	(Spanish)
*Phalacrocorax atriceps	Blue-eyed Cormorant	Cormoran Imperial
*Phalacrocorax albiveuter	King Cormorant	Cormoran Imperial de las Malvinas
*Phalacrocorax magallanicus	Rock Cormorant	Cormoran de las Rocas
*Impossible often to identify species where covered with oil.		
Speniscus magellanicus	Magellanic Penguin	Pinguino del Sur
Eudyptes crestatus	Rockhopper Penguin	Pinguino de Penaebo Amarillo
Larus dominicanus	Kelp Gull	Gaviota Dominican
Larus Maculipennis	Brown-hooded Gull	Gaviota Caguil
Fulmarus glacisloides	Southern or Silver-Grey Fulmar	Petrel Plateado
Oceanites oceanicus	Wilgon’s Storm Petrel	Golondrira del Mar Comieu
Polyborus plancus	Crested Caracara	Carancho
Diemedea melauophris	Black-browed Albatross	Albatross de Ceja Negra
Lophonetta specularioides	Crested Duck	Pato Juarjuae
Pelecauoides magellanicus	Magellaim Diving Petrel	Pato Yunco
Rollandia remand	White-tufted Grebe	Pimpollo
Also observed affected, but not killed by oil:		
Undetermined species of plover,		
Probably Zonibyx modestus	Winter Plover	Chorlo Negro
Numenius Phaeopus	Whimbrel	Zarapito de Pico Curvado

The beauty, of course, has been degraded by the oil on the beach and no estimate of the recovery time to obtain to its original state is possible at this time.

Impact on Marine Waterfowl:

One of the major impacts of the spill is its affect on marine waterfowl. The species most affected by the oil are cormorants and penguins. Other birds found to be affected were gulls, albatross, petrels and ducks.

Figure 9 shows the three species of cormorants which were affected. The topmost cormorant is the rock cormorant, the second is the blue-eyed cormorant and the bottom one is the King cormorant. Approximately 150 dead cormorants were found during the initial survey.

Figure 10 shows a graph of the numbers of the dead birds found in each of the five mile segments of the field study. Subsequent correspondence from Chile indicates a marine patrol sent to the area by the Commander of the Third Naval Zone had found approximately twice as many dead birds as found on the initial survey.

Table 1 is a list of the scientific name, common name in English and common name in Spanish of the marine waterfowl in the area and of which one or more dead birds were found.

Particular concern was expressed for the penguin population which migrates from the Atlantic Ocean to three islands in the Straits of Magellan during September or early October for nesting and raising of their young. These three islands, Isla Magdalena,

FIGURE 9

Cormorants

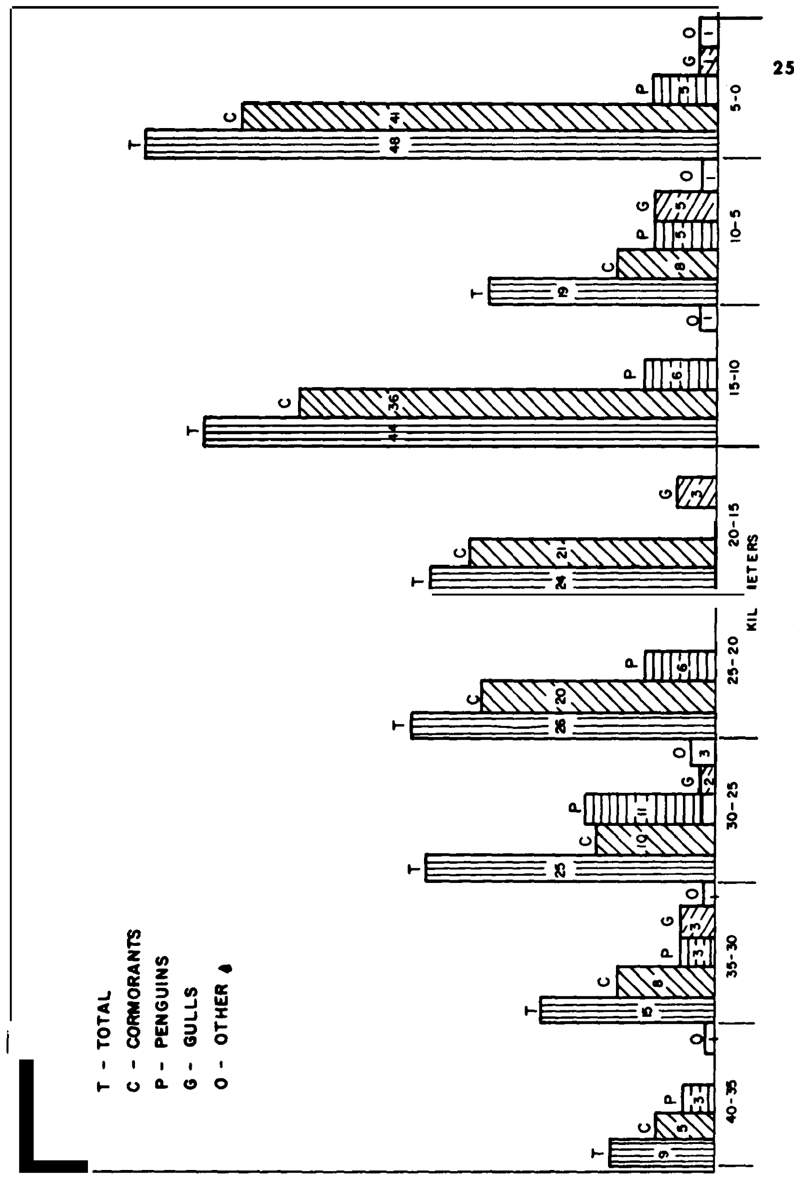


FIGURE 10

NUMBER OF DEAD BIRDS FOUND

Isla Marta and Isla Contramaestra form Los Pinguinos National Park in Chile. Two types of penguins are common to that area. The magellanic penguin sometimes referred to as the jackass penguin and the rock-hopper penguin.

Figure 11 shows a typical penguin from the local area. This penguin was less oiled than most of those found, but still is believed to have had his insulation waterproofing sufficiently destroyed so that he would not survive.

Impact on Marine Organisms:

The primary impact of marine organisms is expected to be in the broad littoral zone exposed by the twenty-foot spring tides. The beach zone exposed varied from a few hundred feet in the Narrows area to broad tidal areas of several miles to the east of the Narrows. As mentioned earlier, the rocky areas in the lower beach zone contain limpets, mussels, starfish and other aquatic organisms. The value of these organisms as a food in primitive times was demonstrated by the shell middens. Behind a number of the local habitations were found piles of the shells which remained after the shellfish were used as food. on two occasions, it was noted that octopus of about three inch diameter and with tentacles stretching to between 12 and 18 inches had crawled out of the oily water up onto the beach and in one case, an octopus was found on the top of a twenty-foot cliff where it had been carried by a bird.

FIGURE 11

Penguin

During the period of time that the onshore survey was being made, a group made a marine survey utilizing a vessel of the Chilean Fisheries Organization. This group did not find any deep water evidence of environmental impact in the form of dead fish, etc.

When samples of the light and dark chocolate mousse were brought back to the laboratory for analysis and the material diluted with salt and screened, a large number of worms and other organisms that had become entrapped in the oil were discovered. No attempt was made to identify the organisms.

The author was not able to estimate what impact was made on Phytoplankton and Zooplankton nor was it possible to estimate the secondary impact caused by the degradation in the Littoral Zone.

Recolonization will be difficult because of the climatic extremes, but may be aided by the high currents in the vicinity.

Economic Damage:

Minor economic damage has occurred in the vicinity of the ferry at Point Espora in that labor consisting of three or four men is required to clean off the ferry landing each day to permit the docking of the ferry from the north shore. It is understood that this work is being carried out by a local contractor with payment from the tank owners insurance company.

SECTION IV. COMMENTS REGARDING FEASIBILITY OF CONTAINMENT, CLEANUP OR STABILIZATION

At the time the author departed Punta Arenas on September 6, 1974, there had been no attempt to contain the oil leaving the tanker METULA, no attempt to apply dispersants or other chemicals to the oil in the water, and no attempt to remove or stabilize the oil on the beaches. There was at that time no stated intention to pursue cleanup operations, but there was a growing concern on the part of the local Chilean government over the continually increasing magnitude of the problem of additional oil released, the persistence of the oil on the water on the beaches and an increased awareness and concern over environmental matters particularly dealing with the upcoming penguin migration.

The purpose of this section of the report is neither to criticize nor defend the decisions reached with regard to containment, treatment or removal, but to explain some of the pertinent points which undoubtedly entered into the decision process of the people who were charged with making the appropriate decision.

1. Tides, Currents and Winds. This location on the Straits of Magellan is characterized by spring tides which range upward from 20 feet and neap tides of about three feet. The currents in the area of the Satellite Patch where the METULA went aground are on the order of 8 knots during spring tides. The winds in the area are consistently strong and westerly and probably averaged between 40 and 50 knots during the period of time that

the author was in the field. The presence of the high tidal ranges and currents is very similar to that found in The Forelands area of Cook Inlet, Alaska. The strong winds are unique to the Straits of Magellan. The presence of the strong winds and currents caused the oil which left the ship to move rather quickly at velocities that would have bypassed all containment equipment currently available. The high currents combined with gravity spreading the oil would have made it quite difficult to apply chemicals effectively to the oil because of the rapid movement and dispersion of the oils.

2. Shear Mass of the Problem. The loss of approximately 60,000 tons of oil creates a problem of gigantic proportions. If this volume of oil were contained, trans-shipped, cleaned up off the beaches and ultimately disposed of, large inventories of men and material would be necessary. In this remote part of the world, very little was available.

3. Myth that the Oil Would go to Sea. During the early days of the spill, the hope existed that most of the oil spilled in the Straits would be washed out into the Atlantic Ocean by winds and currents. This myth was supported to some extent by the aerial observations which noted that slicks that occurred from the massive spills seemed to “disappear”, and by the fact that the magnitude of the oil deposit on the shore appeared to change from day to day when observed from the air. The knowledge of estuarine behavior and the phenomenon of oil spilled on water and

its behavior under current and wind conditions was not available in the area to permit better predictions to be made. In retrospect, the net movements of the currents is minimal and, perhaps, actually inland, as opposed to easterly to the Atlantic. Indeed, the westerly components of the wind would move the oil slicks to the east, but this would merely impact on the beaches of Tierra del Fuego and on the south edge of the continent as actually occurred. Undoubtedly, some modest quantities of oil did escape to the Atlantic, but it is believed that the greatest fraction by far resides on the shores of Tierra del Fuego and the Punta Posession area of the continent.

4. Minimization of Environmental Resources. The south shore of the Bay of San Felipe and the Narrows , which is the north shore of the Island of Tierra del Fuego did not appear to be considered a particularly valuable environmental resource by those dealing with the oil spill. This may well be because the local Chilean State (Magallanes) has many beautiful environmental areas and this shoreline may to them seem dull when compared to their other environmental resources.

5. Apparent Attitude of the Initial Advisors from the Tanker Owners and TOVALOP. The outside groups which arrived most quickly on the scene were the representatives of the tanker owners, the salvage operators and the representatives of the International TOVALOP Insurance Fund. From my viewpoint, some members of this group seemed to work quite strongly to "spread oil over the troubled waters of environmental concern" with both local government

authorities and with the scientists at the local Instituto de la Patagonia. Members of this group tended to voice quite loudly that there was “no pollution” because they did not consider damage to environmental resource to be of any value. It did not appear this group had gone to the impacted beach zone except for brief trips on the part of one or two individuals to the ferry crossing at Punta Espora. Members of the group tended to discount greatly the damage to marine waterfowl and when initial suggestions were made with regard to the possibility of a bird reclamation program, a story was circulated which reported that penguin eggs from the local penguin nesting grounds were sold in the restaurants in Punta Arenas and as long as this continued, they could not see the value of any worry about the penguins and other birdlife. When the story was later checked, it was found that this indeed had happened in times past, but since 1966 the nesting islands had been a national park in Chile and that such practices had been discontinued years ago. During a meeting between some members of the group and scientists at the local Instituto de la Patagonia, there appeared to be an attempt to play down the fears the scientists had with regard to environmental damage.

6. Lack of Logistical Support. The location of the spill on the Straits of Magellan is without doubt a very remote and desolate area. Almost everything that would have been necessary for control of the oil spill was lacking or totally non-available. For example, booms and barriers that could have been used for

containment if the currents permitted, were not available. Chemical dispersants and other chemicals which could have been used to disperse the oil if conditions permitted, were not available except for a few planeload flown in weeks after the spill. Chemical applicators in the form of tugs, agitating equipment, etc. to apply chemicals were not available. Bulldozers, front-end loaders, dump trucks and other mechanized equipment to remove the oil from the beach were not available except for a small number used by ENAP. Indeed, the Island of Tierra del Fuego, which is south of the Straits which most of the oil impacted is very sparsely populated and the majority of the population is either involved with the local oil production through the Chilean National Petroleum Company (ENAP) or with cattle and sheep ranching. Even if adequate resources were located in Santiago and the Valpariso area, the country of Chile is extremely long and this would require between a 1500 and 2000 mile transportation by sea or air to bring these materials to the Island of Tierra del Fuego. The only connection that Tierra del Fuego has with the mainland is by two ferries, both of which are old World War II landing craft , which are already completely utilized by the existing commerce and business.

7. <u>The Fear That Cleanup Would Cause More Damage Than the oil.</u> Inasmuch as the grounding of the METULA took place at 10:00 at night, it is evident that oil was on the beaches even before dawn the next morning. Thus, initial damage was done almost

immediately. There was concern that if major cleanup operations were scheduled on the beaches that perhaps more damage could be caused by the cleanup than would occur from the oil that was already on the beaches. This would include damage by mechanized equipment on the beaches, and the removal of marine organisms underneath the surface beach sand. It would particularly be true if detergents were used to attempt to wash the oil off the beaches back into the water, thus suspending substantially more oil in the water column than had occurred.

There was also concern that the removal of this tremendous quantity of oil to the inland areas could *not* help but cause additional environmental damage to the inland areas. This factor is not considered of great importance, however, because there are already some spoiling of land areas due to the production of oil by the ENAP Company.

8. <u>Philosophy That Damage is Done</u>. It was hoped that the oil already on the beach would go away in successive spring tides and be washed to the Atlantic. Since beach damage had already occurred, little harm was envisioned in allowing time to see if this would occur.

9. <u>The Priority of Preventing Further Pollution by Concentrating on the Ship and Cargo</u>. The greatest priority established by all concerned appeared to be that of preventing further pollution by the removal of oil from the strickened ship and by the salvage

and removal of the ship itself. This philosophy can really not be faulted because there still remained in the ship over three-fourths of its cargo which had the potential for release to the environment and very appropriately emphasis should have been placed on removing the source of the pollution, so that further pollution would cease to occur.

10. Lack of Time for Response. As mentioned in other sections above, the grounding took place within roughly one mile of the north shore of Bahia de Felipe and approximately three miles of the south shore. Thus, there was no reaction time available to local people before the oil reached shore. Indeed, much oil had already undoubtedly reached shore before the initial observation of the ship and local area were available early the next morning.

11. Lack of Technology and Trained People. There is quite evidently a grave lack of technology and trained people to both completely evaluate the nature of the problem and all possible alternatives and to carry out containment, treatment or cleanup operations. One recommendation which was made to the local administration was that consideration for cleanup be made in at least the local area near the ferry at Punta Espora in order to permit local personnel, very probably those of the ENAP Organization, to gain hands-on experience in the containment and removal of oil near the shore and on the shore. The local people appeared to have absolutely no knowledge of the technologies to carry out these operations.

12. Recommendations Regarding Containment and Treatment. As the spill progressed, several knowledgeable people arrived on the scene and a general agreement of these people was that booms, dispersants and surface tension agents would be ineffective in this situation. The booms were considered ineffective because of the currents and winds. The dispersants were considered ineffective because of the difficulty of application and mixing and surface tension agents were considered unusable because the oil was already on the shore and because daily application of the agents would have been required even if equipment *were* available. A single dispersant dispensing rig was made available through the British Warren Springs Laboratory and was tested using a fishing boat in the harbor at Punta Arenas. Beach cleanup was technically feasible and technology for cleanup available.

13. Difficulty of Access to the Beach Zone. The field survey on foot really emphasized how very poor is the access to the beach zone on Tierra del Puego. It would be possible to get equipment *to* the beach only about every five miles. In other areas, there are cliffs ranging from a few feet tall to over 50 feet tall immediately behind the beaches.

14. Scarcity and Lack of Scientific Information. Throughout the study, it was evident there was a grave lack of scientific information with regard to the marine biological community. The marine biological program at the local Instituto de la Patagonia

and through the local fisheries agency had very limited information with regard to the species, habitats, etc. in the affected area. For example, it was almost three weeks after the spill occurred that information with regard to the pending penguin migration became available and concern was begun to be shown for the migration.

15. Other Factors. The author undoubtedly does not have access to the complete list of factors that were used in the decision process. Some of these may have revolved around the fact that the Chilean government owned the cargo and the effect of high cleanup costs on future insurance rates on cargoes shipped through the Straits. There undoubtedly were other factors of importance.

In summary, there were a wide range of factors to be taken into account in making decisions with regard to what to do with the oil after it had escaped into the environment. Frankly, it appears that in view of the economic stress of the country, the mass of the problem, the tremendous difficulty that would have been necessary to arrange logistical and manpower resources and the cost of these undertakings, coupled with the extreme climatical difficulties of the area, a decision to assess the situation, but defer cleanup was reached in the early stages of the spill.

It appeared from being on the scene that there were only two groups that could have effectively dealt with the spill. One, the Chilean National Oil Company, ENAP, which did have men and materials, although somewhat limited on the Island of Tierra del Fuego. Although there appeared to be local interest on the Island for their involvement in the spill cleanup activities, this enthusiasm did not appear to be shared by their higher officers in Punta Arenas, who were reported as stating that their entire staff was completely occupied with their everyday business.

The second group which could have been mobilized was the Chilean Military. For whatever the reasons, the Chilean government elected to withhold military forces from cleanup efforts at this stage of the evolving incident.

SECTION V. LESSONS LEARNED FROM THE METULA SPILL

One of the major purposes to be served in sending the author to Chile to observe the fate and affect of oil from M/V METULA was to determine what lessons of importance could be learned from this incident which would be of value in considering supertanker and superport considerations in the United States. A number of these lessons are summarized below.

1. Spills Can Happen. Very Large Crude Carriers (VLCC's) and the superports to handle them are not designed with the intent of having oil spills, just like highways are not designed with the intent of having traffic accidents. However, it is realized in both of these cases that accidents will happen in time and the potential of an accident must be considered in determining the risk faced in handling this type of ship and in dealing with superports in general.

The spill volume from the METULA was at 51,500 tons of crude oil plus an undetermined amount of Bunker C. It was roughly four times the 15,000 tons that has been considered as the maximum credible accident for a collision involving supertankers in the Gulf Of MexiCO. This large oil loss does indicate that such larger spills can occur, even though it is likely that comparable damage would not have resulted in a comparable spill in the Gulf of Mexico because of the Gulf of Mexico's one foot tide as opposed to the 20 foot tidal range in the Straits of Magellan.

Similarly, it should be remembered that this size of spill is not restricted to supertankers, inasmuch as many tankers which are not in the supertanker or VLCC class carry 51,500 tons of oil which could conceivably be released In present waterways and in existing ports.

2. Ships are Vulnerable. It seems obvious to the untrained that ships which have single skins , single propulsion units, single screws and single rudders are designed primarily for the economy of the transportation of oil, and not for the safety and containment of the cargo. On that premise, accidents can be expected almost anytime and anyplace, either over the waterways these ships travel or at the port terminals where they receive or unload their cargo.

3. The Magnitude of the Problem is Huge. The release of 51,500 tons of crude oil plus an undetermined amount of Bunker C (i.e. approximately 16,500,000 gallons or 400,000 barrels) is a tr~ndous volume of oil and the subsequent coating of roughly 75 miles of coastline with an oil emulsion from 50 to 200 feet wide and one to four inches deep is a major problem. Many people still just don't realize how truly large a volume 50,000-60,000 tons of oil is.

4. Most Spill Control Methods Aimed at Small Spills. Many of the control techniques from start to finish involving booms, skimmers, dispersants, surface active agents, cleaning and hauling techniques, etc. are really aimed at spills that are much smaller than the METULA spill. For example, it would take a pretty good

size tanker just to haul enough detergent to Chile to have combined with the 60,000 tons of oil. Even under ideal mixing, it would have taken some 6,000 tons. Under poor mixing conditions, it could have been as large a volume as that of the oil spill. Other agents such as absorbents, etc., are just not designed for use with spills of this size.

5. Keeping Superports Offshore Helps Provide Reaction Time. The closeness of the METULA accident to shore emphasizes that when large supertankers come close to shore that the environmental resource can be damaged even before the people have a chance to go out and recognize that it is going to happen. Having superports sufficient distance offshore so that the one to two days travel time is provided before the oil could hit the beach, does provide time for the marshaling of equipment, and for the use of containment devices, detergents, etc.

6. Huge Amounts of Men and Materials are Required. It is considered that an average dump truck could haul about five tons of oil-water emulsion mixture, then it would require 12,000 dump truck loads to move the METULA oil from the beaches to the disposal areas. It is recognized that considerable sand, seaweed and other trash would have been picked up with the oil then the number would even be higher. Thus, you could not attempt to cleanup a spill the size of the METULA with one or two front-end loaders, a handful of dump trucks or a handful of vacuum trucks. It truly takes large amounts of equipment, access to the beaches, etc.

7. Need for Fast Mobilization and Trained People. Almost every training manual or document dealing with oil spills emphasizes the need for speed in dealing with the problem. The speed requires that a wide range of very competent people ranging from experts in salvage to cleanup to scientists be available to assess the damage and direct cleanup techniques. For a long period of time, from August 9 until the local and external personnel resources were assembled, much of the environmental damage had already occurred and that the number of options available was severely limited.

8. Thoughts on the Use of Detergents Should be Re-examined for Middlesize Offshore Spills. The toxic nature of detergents at the time of the Torrey Canyon Spill had generally led to the use of detergents as being frowned on for use in the United States. After seeing the impact of the oil on the shores in Chile, it is believed that the use of detergents for middlesized spills from offshore would generally be preferable to allowing the oil to come to the beaches, since present day detergents are much less toxic than those originally used. A substantial re-examination of the present philosophies should be instigated.

9. Port Location. Ports, particularly superports, should be located where cleanup is possible or else the risk of a spill without substantial cleanup must be accepted. In other words, one of the parameters which should determine the selection of sites for superports is the value of the environmental resource

which could be impacted and the expected effectiveness of cleanup operations on the exposed environmental resources.

10. Contingency Planning. Contingency planning with regard to oil spills should take into account spills of this size. If port facilities are built for supertankers in the United States, it is recommended that contingency plans which are required with regard to oil spills specifically show how a spill of the size of the METULA be physically handled.

11. Dollars in the Bank Doesn't Solve the Problem. It was quite evident in Chile that the availability of the TOVALOP funds did not solve the problems for (Chile. If the funds cannot be transferred into men and material to cleanup the spill, they are not of much value.

12. Everything is Harder to do and Takes Longer in Remote Areas. Almost every activity in Chile appeared *to* take longer than it would in the United States. This included travel, customs, communications, etc. Planning for operations in remote areas will take almost a completely different type of thinking than that which would take place in the populated areas of the United States.

13. Local Scientific Capability Needs to be Utilized. To adequately evaluate the potential environmental harm in a remote area, it is necessary to find out about the local environment. Only local scientists can usually provide this information. Studies described in this report by the author could not have been carried

out without the personnel of the local Instituto de la Patagonia in Punta Arenas, Chile. The involvement of the Instituto de la Patagonia staff in providing information for the decision process in the latter stages of the METULA incident made for much more knowledgeable decisions.

14. Aerial Surveys are Very Valuable. Aerial surveys of the spill of the METULA proved to be extremely valuable to determine an over-review of the extent of the area affected, but they turned out to be grossly inadequate to give a detailed assessment to the problem. Only the field survey on the impacted beaches was able to determine: (a) the extent the sand wee being blown over and into the oil, (b) the number of dead end oiled birds, (c) the depth of oil, (d) the deposits of oil above the tide lines, and (e) the full magnitude of the problem.

APPENDIX I. CHRONOLOGICAL REPORT OF TRIP

Saturday, August 24

Departed College Station at 4:00 p.m. for Houston to catch the 7:45 flight to Miami and, then, the 12:30 flight to Santiago, Chile.

Sunday, August 25

Arrived in Santiago and was met by Captain Switzer. Was advised to wait at the hotel for travel information. Later, was advised to leave at 9:00 a.m. Monday by commercial jet since the C130 was delayed for 24 hours.

Monday, August 26

Arrived Punta Arenas at noon. Was met by Commander Atkinson, who was not yet advised of my status or mission. Though the Chilean Government in Santiago had been advised of my role, my way had not been cleared with local naval commander Admiral Allen. Admiral Allen was concerned with large numbers of people arriving with various purposes and missions. Other Monday arrivals included Commodore Roland Engdahl, commander of the Swedish Coast Guard and Dr. Jon Wonhom of the British Warren Springs Laboratory representing IMCO.

In the evening, I had a chance meeting with Irving Barron, American Equipment Vendor, Peter Fassbender with the Chilean National Petroleum Company (ENAP) and Dr. Wonhom, which led to contact and later meeting with Claudio Venegas, local biologist with the Instituto de la Patagonia, a local research organization. A meeting with the Instituto Director was set for the next morning.

Later met Mr. Wardley Smith of TOVALOP Insurance Group and Commodore Enghahl. I was advised of the space available on the Tuesday morning navy flight.

Tuesday, August 27

Missed the flyover when the guards at the airport would not pass Mr. Venegas, Dr. Wonhom or myself. Met with the Instituto Director Mateo Martinque and Dr. Edmundo Pisano regarding the possible role of the Instituto in assessing the impact of the oil spill.

Since an aerial survey was desirable to locate the extent of the oil on the shore and to evaluate the area for field program planning, arrangements were pursued through the Instituto to charter a small plane. Arrangements were finally made with the local Air Force Aero Club to charter a Piper Cherokee and appropriate police clearance for the flight was obtained. A joint sea-land field program was tentatively planned for Thursday.

Toured the facilities of the Instituto and reviewed stuffed collections of birds likely to be in the spill area.

Wednesday, August 28

Made an aerial survey with Dr. Wonhom and Mr. Venegas that covered the south shore of Bay Felipe, both shore of the First Narrows and the area eastward for about five miles.

Oil was observed on approximately 40 miles of beach. Photographs primarily color were taken of the beach zone and the ship.

Following the flight, the decision was made to separate the land portion and the sea portions of the field survey. Dr. Wonhom and myself were to join with William and Jean Texera and Claudio Venegas. Our departure was set for early Thursday morning.

Met with Commander Atkinson. He deemed it was appropriate to meet Admiral Allen the next morning, and a meeting was scheduled by Commander Atkinson.

Met strike team members who were departing for the METULA.

Thursday, August 29

Met with Admiral Allen and advised him of the details of the proposed field study and advised him I would coordinate any information, ideas or recommendations through Commander Atkinson. He was very cordial and appeared interested in receiving information and constructive comments.

Departed on field trip in the Instituto Landrover via Ferry (LCM) to Porvenir and by land to the ENAP Cerro Sombrero Petroleum Camp, where we were hosted by ENAP in a company apartment.

Friday, August 30

Following an extremely cold night and a 2 inch snowfall, we were plagued with car trouble and spent most of the day with the car in Manantiales. We were ingloriously towed back to Cerro Sombrero.

Made brief radio contact with the METULA and learned of first success of offloading to the HARVELLA. Radio contact was lost due to frequency change on the METULA.

Saturday, August 31

Were delivered to the Ferry Crossing at Punta Espora by ENAP. Jean Texera and I covered the beach zone about one mile west from the ferry landing and about one mile up the small estuary that enters at that point. Dr. Wonhom and Mr. Venegas covered about three miles east of the landing including the small estuary to the east. They were at or near Point Anegada.

Oil deposits were measured and pictures were taken of oil, oiled-live birds and dead birds. The temperature was 40°F and wind was approximately 50 knots. We were picked up by Bill Texera, patroled a one and one-half mile section west of Punta Espora and returned to Cerro Sombrero.

Sunday, September

Noting the strong westerly wind of 50 knots and 40°F weather, we planned the survey to have the wind at our backs. Dr. Wonhom and Mr. Venegas were dropped west of Punta Remo at a point 28 kilometers from Manantiales. They proceeded eastward for approximately 13 kilometers where the landrover was left for them. Jean Texera and I proceeded eastward from the latter location to the zone west of Punta Espora covered the previous day. Bill Texera remained with the vehicle to facilitate pickup. We covered approximately 18 kilometers of beachline by dusk when we were met by the rest of the team and proceeded to Cerro Sombrero.

The beach was heavily coated over the 18 kilometer stretch and was reported heavily coated to the west by Dr. Wonhom and Mr. Venegas.

When downwind from the ship near Punta Bahia a strong petroleum odor was present.

Width and depths of oil deposits were measured or estimated and photographed. The presence of dead and oiled birds was regarded.

Some unusual impacts such as a dead fox, dead octopus and oil high on cliff tops were noted.

After completing the survey, we returned to Cerro Sombrero.

Monday, September 2

Reviewed the results of the surveys with Mario Mirando and Roberto Rayment, the ENAP Director and Assistance Director at Cerro Sombrero. We discussed cleanup methods, dispersants and oil burning.

We proceeded to Punta Espora in hope of taking the ferry. Weather prevented our crossing. We then spent the day collecting oil samples, sumnarizing data and observing local area. The extremely strong winds from approximately 240-250° at 50 knots and high spring tide was moving some oil out into Bahia Posession. Oil was pooling in the area behind Punta Espora.

To comply with the curfew, we returned to Manantiales for the evening.

Tuesday, September 3

Left Manantiales and proceeded to Punta Espora. The wind slackened to 10-15 knots from approximately 320-3300, moving some oil back westward and pooling oil on the south shore of the Narrows. We boarded the ferry (small LCMI) about noon. During the passage, we noted some patches of oil/water emulsion near shore and some darker fresher slicks near mid-channel. On the north side of the channel, we found more dead cormorants and an oiled penguin.

Wednesday, September 4

Briefed Commander Atkinson and Admiral Allen on results of our field survey. I arranged to accompany the naval flight on Thursday to observe any change on the beaches.

Proceeded to the Instituto de la Patagonia to package oil samples for shipment to the United States. These samples were later delivered to the Chilean Navy personnel for transport to Santiago and trans-shipment to the United States.

Thursday, September 5

The aerial survey with the Chilean Navy indicated oil still was on the beaches previously covered, but that deposits of oil/water emulsion were found from 5 miles west of Punta Posession to within two miles of Punta Dungenese. A large pool of darker oil that appeared to be a fresh slick was located west of Punta Catalina. This was later explained when the rupture of a Bunker C compartment was reported.

Spent the remainder of the day preparing the report requested by Admiral Allen.

Friday, September 6

Commander Atkinson and I met with Admiral Allen and presented a handwritten report summarizing the information learned on the field trip and during the over-flights. We departed early evening for Santiago.

Saturday, September 7

Met with U.S. Ambassador Popper, Captain Switzer and Commander Atkinson to report on trip activities. I then met with Captain Poisson of the Chilean Navy for the same purpose

Departed Santiago in the early evening for return to the U.S.A.

APPENDIX 2.

Letter Report **to Admiral Eduardo Allen, Chilean Navy prior to departing Punta Arenas, Chile.**

The letter was submitted in handwritten form on Friday, September 6, 1974.

53

TEXAS A&M UNIVERSITY
CIVIL ENGINEERING DEPARTMENT
COLLEGE STATION TEXAS 77043

ENVIRONMENTAL ENGINEERING AND ENVIRONMENTAL SCIENCE DIVISION

September 16, 1974

MEMORANDUM

To: Admiral Allen

THROUGH: Commander Atkinson

FROM: Roy W. Harm, Jr.

SUBJECT: ENVIRONMENTAL ASPECTS OF THE "METULA" OIL DISCHARGES

The extent of oil discharged from the Tanker METULA was observed by air on August 28, 1974 and September 5, 1974 and by field survey with Instotuto de la Patagonia staff and Dr. Wonhom (IMCO Representative of English Warren Springs Laboratory) on August 31, 1974 through September 9, 1974.

The field survey covered 25 miles (40 kilometer) from Punta Anegada to west of Punta Remo. Oil averaged 50 to 75 feet (18 to 25 meters) wide and 2 inches deep and consisted of a dark brown layer at and above the spring tide high water mark and a lighter brown layer at present high water mark. Some oil is covered by blown sand and rocky areas exposed by low tides (from 200 feet to 1/4 mile) have light brown oil on top of rocks.

The flight on September 5, 1974 indicates the area from Punta Piedra past Cabo Orange is heavily loaded as well as the zone between approximately Cabo Posession and Punta Dungenese (light brown oil emulsion) and westward from Punta Catalina (new black oil) approximately 75 miles (120 kilometers) affected. Some lighter loadings are apparent on south shore and in waters of Bahia Lomas and eastward from Punta Catalina.

A broad intertidal zone is affected by oil with immediate impact on mussels, limpets and other intertidal life and perhaps longer range foodchain effects on commercial species.

Over 200 dead birds were observed during the field study with cormorants (approximately 150) and penguins (approximately 40) predominating. Oil in water and on shore remains a hazard to waterfowl. Expected penguin migration (tens of thousands) is In danger.

It is my opinion that more oil is ashore than originally believed and that it will remain longer than expected.

Study of the impact and the recovery is recommended with the Instituto de la Patagonia playing a leading role. Have suggested study should center on 1) amounts of oil on shore, 2) study of penguin migration fate, including survey of resident population, and 3) study of inter-tidal organism fate and recovery. I will be pleased to support to degree feasible.

Clean up of the spill is possible, but difficult and expensive due to location, weather, terrain, tide conditions and logistics. For example, only two ferries connect the Mainland to Tierra del Fuego and they are tide and weather limited and already busy. If clean up attempted, initial action is recommended on shores of narrows and westward.

Samples of oil on the beach have been collected for shipment via the U.S. Embassy to United States Coast Guard Research and Development Program Center, Groton, Connecticut.

Crude oil samples have been requested of Commander Park. If these are not forthcoming by September 7, 1974 suggest Admiral Allen order their collection and subsequent shipment to the U.S. Coast Guard.

It is believed knowledge gained from observing the "METULA" spill will be of considerable value to the United States Government. Assistance in helping accomplish my mission deeply appreciated. I thank you and your staff for the kind hospitality.

Roy W. Harm, Jr.

Roy W. Harm, Jr.

APPENDIX 3. PERSONS CONCERNED WITH METULA SPILL, PUNTA ARENAS, CHILE

Governmental Agencies

Chile Navy	Contra Almirande Eduardo Allen Commodore 3rd Naval Zone
Instituto de la Patagonia	Mateo Martinique, Director'
	Edmundo Pisano, Head of National Resources Department
	William Texera, Zoology Department
	Jean Jory Texera, Ornithologist
	Claudio Venegas, Ornithologist
	Italo Campodonico, Marine Biologist
	Leonardo Guzman, Marine Biologist
ENAP (Chilean National oil co.)	Eduardo Gonzales, Director-Administrator
	Peter Fassbender, Drilling Engineer
	Mario Mirando, Director, Cerro Sombrero
	Roberto Rayment, Assistant Administrator, Cerro Sombrero
IFPO (Instituto de Fomento Pesquero)	Alfredo Sanhueza
USCG	Commander James Atkinson
	LT. CMDR. Bill Park, Gulf Strike Team
	LT. CMDR. Weichert, Pacific Strike Team
Swedish Coast Guard	Commodore Roland Enghahl
IMCO	Dr. Jon Wonhom, English Warren Springs Laboratory

<u>Pollution Aspects of Spill</u>

Shell International Marine	Mr. John Butt Captain Rod Brown, Laisson Office
TOVALOP (Tanker Owner Voluntary Assoc.)	Mr. Wardley Smith, Oil Pollution
P & I Clubs (underwriters)	Rex Palmer
Local Shell Agent Products	R. Gibbons
Ultramar (Local Maritime Firm)	P. Fussel

<u>Salvage</u>

Schmidt & Company	Mr. Colthoff, Salvage Master
Shell Tanker BV Rotterdam	Captain D. Jongerneel
Shell International Marine, London	Captain N. Jolviet
Metula Captain	Captain F. Minkels

APPENDIX 4. BROCHURE OF THE INSTITUTO DE LA PATAGONIA

INSTITUTE OF PATAGONIA

The Institute of Patagonia is a center for studies and investigations which was founded the 2nd of March of 1969, with the object of contributing to scientific knowledge and to the cultural, social end economic development of Chilean Patagonia end adjacent regions.

It is divided Into two large areas of work, one, of basic investigation and the other of applied investigation and experimentation.

In the first area falls the Department of History and Geography with sections in History, Geography and Archeology end Anthropology, faculties which have the purpose of studying human events in the past and, in this case, acquiring a better knowledge of the physical aspects of the region. Besides, there is the Department of Natural Resources with its sections of Botany, Zoology and Hydrobiology, whose objectives are to pursue the scientific knowledge encompassed In the ecosystems in the extreme American south and by the varied biota that inhabit them.

In the area of applied investigation and experimentation are located the Center of Experimentation and Development of Craftsmanship, with its studios in Ceramics, Wood Carving and Weaving, and its faculty of investigation that searches out the creation of a typical craftsmanship of the region with indigenous roots

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with regard to motivation and design, and using materials from Magallanes itself. Also located in this area is the Center of Experimentation in Horticulture and Floriculture, which has for objectives the testing and adaptation of varieties of vegetables and flowers cultivated under glass and in the open air, with designs of encouraging a regional horticulture, bettering its technology and increasing, consequently, its productivity and production.

The Institute owes its being to and works for the community where it is located and tries to publicize the results of its various scientific works by means of conferences, periodical courses and seminars, permanent displays, expositions, and publications.

Finally, it depends on the Magallanes (Magellan) Foundation which is a private, non-profit organization that concentrates its funds on public works. The offices, studios, laboratories and other installations of the Institute are located on a campus of an area of 12 hectares, which is located near Avenue President Bulnes, 4 kilometers from the City of Punta Arenas.

MAGALLANES

The Province of Magallanes has an area of 132,033.5 square kilometers, which makes it the largest of the Chilean provinces. On it also depends administratively the Chilean Antarctic Territory, which covers an area of 1,250,000 square kilometers.

Such a *vast* area -- which is referred to as the American part -- occupies the southern portion of Patagonia, the central-western section of Tierra del Fuego and the Patagonian and Fuegan archipelagos. The Andes Mountain range which crosses from the north down toward the southeast divides it into two very dissimilar regions. One, the western slope, is the singular world of the archipelago characterized by the abrupt orography and the domain of mists and glaciers, region of a pristine, natural life where humans are found lacking. The other, on the other hand, the eastern slope, is an area whose smooth slope descends gently toward the Atlantic, characterized by the immensity of the Patagonian Steppe, a region where human life is located, where in fact all the provincial economic activity is developed.

The most outstanding natural and economic resources of Magallanes are sheep -- of which the region possesses 50% of the natural total -- being important in addition to the bovine population in the pre-cordilleran terrains; petroleum and natural gas, of which the Province is the only producer in the country; as well as the resources of the forests, minerals -- in particular the coals and calcium carbonate --, fishing and tourists, So many resources allow the existence of an industrial Infrastructure destined to be exploited and transformed.

Magallanes has a population slightly more than 100,000 inhabitants -- this is a little more than 1% of the total population In Chile; this population, however, is a product of national emigration particularly from Chiloe, and of European immigration, mainly from Yugoslavia and Spain, occurring between 1880 and 1920. The capital and principal urban and economic center of southern Patagonia is Punta Arenas (population 70,000) founded the 18th of December of 1848. Other centers of life are Puerto Natales, in Ultima Esperanza (Last Hope), Puerto Eden, on the Patagonian channels, Bernardo O'Higgins, on the eastern pampas, Porvenir and Cerro Sombrero, on the island of Tierra del Fuego, and Puerto (Port) Williams, on the Islas Australes (Southern Islands), the most southernly point on the globe that is inhabited by humans.

The Fuego-Patagonian region -- and consequently Chile throughout the south -- were discovered by Ferdinand Magellan the list of November of 1520 and incorporated under the jurisdiction of the Chilean Government in 1555. The effective occupation occurred in 1843, an era in which there was the start of national colonization in the Patagonian and southern lands.

Translated from ***Spanish.***

APPENDIX 5. INFORMATION ON LOS PINGUINOS NATIONAL PARK

National Park

"LOS PINGUINOS"

(The Penguins)

97 hectares Strait of Magellan

It is also of small size, 97 hectares. It **includes the small islands of Marta and Magdalena, located in the Strait of Magellan, to the south of Segunda Angostura (Second Narrow). As in previous times, its principal purpose is the protection of the rich marine avifauna which nest in this territory, for which it is also classified as a Sanctuary for Forest Life.**

These islands, also located in the territory of the Patagonian Steppe, are formed by a gross moraine sediment of quaternary origin, modified more or **less intensely by fluvial processes and which lies over a dioritic substrate. These characteristics make its coasts abrupt and steep due to the effects of marine erosion.**

As with the National Park "Laguna de los Cisnes" ("Lagoon of the Swans"), its natural vegetation is very strongly altered by the effects of the nesting birds. This situation has become extreme on the island of Marta, which, due to the lack of vege-tation, presents an aspect that is totally desert-like.

Translated from ***Spanish.***

Attachment 6

MARINE CASUALTY REPORT

COLLISION INVOLVING THE SS ARIZONA STANDARD AND SS OREGON STANDARD AT THE ENTRANCE TO SAN FRANCISCO BAY ON JANUARY 18, 1971

U.S. COAST GUARD
MARINE BOARD of INVESTIGATION REPORT
and COMMANDANT'S ACTION

ACTION BY
NATIONAL TRANSPORTATION SAFETY BOARD

DEPARTMENT OF TRANSPORTATION
WASHINGTON D.C. 20591

RELEASED 11 AUG 1971

**SS ARIZONA STANDARD AND SS OREGON STANDARD
COLLISION ON 18 JANUARY 1971**

TABLE OF CONTENTS

	Page
ACTION BY NATIONAL TRANSPORTATION SAFETY BOARD	
Synopsis	1
Summary of Facts	2
Analysis	8
Summary	17
Probable Cause	18
Recommendations	19
Attachment A	21
Attachment B-1	23
Attachment B-2	24
Attachment B-3	25
ACTION BY THE COMMANDANT - U. S. COAST GUARD	
Synopsis of Findings of Marine Board of Investigation	27
Remarks	29
Action Concerning the Recommendations	29
MARINE BOARD OF INVESTIGATION	
Findings of Fact	31
Conclusions	41
Recommendations	43

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C. 20591

COLLISION INVOLVING THE SS ARIZONA STANDARD AND SS OREGON STANDARD AT THE ENTRANCE TO SAN FRANCISCO BAY ON JANUARY 18, 1971

ACTION BY NATIONAL TRANSPORTATION SAFETY BOARD

This casualty was investigated by a U. S. Coast Guard Marine Board of Investigation convened at San Francisco, California, on January 25, 1971. A Member of the National Transportation Safety Board attended the proceedings as an observer. We have reviewed the investigative record and considered those facts which are pertinent to the Board's statutory responsibility to make a determination of cause or probable cause and to make recommendations to prevent recurrence of such a casualty.

SYNOPSIS

The tankships ARIZONA STANDARD and OREGON STANDARD, both owned by Standard Oil Company of California and operated by Chevron Shipping Company, collided at about 0140 P.s.t.– on January 18, 1971, several hundred yards west of the Golden Gate Bridge in San Francisco Bay, California. No persons were killed or injured as a result of the collision. Both vessels were extensively damaged. Approximately 800,000 gallons of bunker fuel escaped from the ruptured cargo tanks in the OREGON STANDARD. The oil spill caused extensive pollution of the Bay and the adjacent coastline.

The collision occurred in a dense fog. The fully laden ARIZONA STANDARD was inbound en route from Estero Bay, California, to Long Wharf, the Standard Oil dock in Richmond, California. The OREGON STANDARD carried a full load of bunker fuel, was outbound en route from Long Wharf to Bammerton, British Columbia.

The National Transportation Safety Board determines that the cause of this collision was the failure or inadequacy of four different systems or subsystems, any one of which could have prevented the collision had it functioned adequately.

~/ All times used herein are Pacific standard time based on a 24-hour clock.

The regulatory system prescribed by the Inland Rules of the Road failed in that neither vessel complied with the rules by keeping to its starboard side of the channel. This non-compliance was contributed to by immoderate speed for prevailing conditions on the part of both vessels, failure of both vessels to use the radar capabilities available to maintain an accurate plot, and the absence of a positive indication of the center of the main ship channel through the Golden Gate.

The radar system by which the vessels could have avoided each other failed because the ARIZONA STANDARD did not obtain and evaluate correctly information from radar pertaining to the movements of the OREGON STANDARD, and the OREGON STANDARD did not check periodically at least one of the radarscopes, set on a sufficiently long range scale, to ensure the prompt detection of the ARIZONA STANDARD.

The whistle signal system of avoiding collision failed because neither vessel heard the other vessel's fog signals. A contributing factor was the high noise level caused by the diaphone and fog horns located on the Golden Gate Bridge.

The Harbor Advisory Radar system was inadequate to prevent the collision. The inadequacy arose from the decision of the OREGON STANDARD not to guard channel 18A, which precluded its participation in the system, and the prohibition of Harbor Advisory Radar operators from providing interpretative information or direction to vessels. The underlying and most significant inadequacy of the Harbor Advisory Radar was the lack of authority of the Coast Guard to regulate this traffic, which prevented a publicly financed facility from protecting the public against loss.

SUMMARY OF FACTS

The ARIZONA STANDARD departed Estero Bay, California, at 1230 on January 17, 1971. The weather was fine and her northbound voyage was uneventful until approximately 2221. As the vessel approached San Francisco, visibility was greatly reduced by a dense fog which blanketed the entire Bay area. The tide was flooding and the set and drift of the current was NE at approximately 1.5 to 2 knots. The master ordered the engines to be placed on maneuvering speed status and the fog signals to be sounded.

At 0049, the ARIZONA STANDARD heard, on VHF channel 18A, the OREGON STANDARD report to Harbor Advisory Radar (HAR) that the OREGON STANDARD was departing Long Wharf, Richmond, bound for sea. At 0058, the ARIZONA

STANDARD advised HAR that she was entering the Main Ship Channel bound for Point Orient. (See Attachment A, a chart depicting the area.)

Upon arrival at the Main Ship Channel at approximately 0100, the ARIZONA STANDARD reduced speed to approximately 13.5 knots. (All speeds referred to in this report take into account the effect of the current and are stated in terms of speed over the ground.) The master was conning the vessel, the chief mate was manning the radar, the second mate was handling the engine order telegraph, and the lookout was posted on the wing of the bridge. Visibility was very limited. The white lights of the buoys on the port side of the channel were visible, but the red light of the buoys on the starboard side could not be seen. The channel is approximately 2,000 feet wide. While the vessel was transiting the channel, the lookout was sent forward to the bow.

The base course steered as the vessel proceeded through the Main Ship Channel and while approaching Mile Rocks was 069 T. At 0120, HAR advised the ARIZONA STANDARD that the OREGON STANDARD was passing north of Alcatraz Island bound for sea. At 0125, the ARIZONA STANDARD changed course to 065° T. Her average speed between the Main Ship Channel Buoy No. 2 and a Position abeam and one-half mile off Mile Rocks Light, was approximately 13.5 knots. The master sighted the loom of Mile Rocks Light at approximately 1 mile.

At about 0127, the chief mate of the ARIZONA STANDARD observed a contact, the OREGON STANDARD, on the radarscope at a range of 6 miles. The contact was about one-half mile south of Point Blunt. The mate plotted three positions of the contact on the face of the radarscope. No times were recorded or noted. The positions were about 250 to 300 yards apart. No further plots were made. The only information the mate obtained from these plots was that the relative motion line was approximately parallel to the OREGON STANDARD's course, and that the closest point of approach (CPA), would be 1 mile. The mate continued to observe the movement of the contact on radar for approximately 6 minutes before it disappeared from the scope. At the time of disappearance, the OREGON STANDARD was east of Pt. Cavallo and approximately 1 mile northeast of the center of the Golden Gate Bridge. The mate testified that he did not see the OREGON STANDARD on the radarscope again prior to the collision. At 0130, HAR advised the ARIZONA STANDARD that the OREGON STANDARD's position was 1 mile east of the Golden Gate Bridge. HAR did not provide the ARIZONA STANDARD any further advisory reports concerning the position of the OREGON STANDARD. The ARIZONA STANDARD made several attempts to contact the OREGON STANDARD on channels 18A, 10, and 16. None of the attempts was successful.

When Mile Rocks Light was abeam at a range of one-half mile at approximately 0130, the ARIZONA STANDARD changed course to 056° T. At 0132, she reduced speed to approximately 11.5 knots. The helmsman reported that he was having difficulty steering and had to use 15 to 20° of both left and right rudder in order to keep the vessel headed close to the course. This speed was maintained until just before the two vessels collided at about 0140. The ARIZONA STANDARD's average speed during this 10-minute period was about 11.4 knots. Adherence to the course of 056° T. would place the vessel in the middle of the channel as she passed under the Golden Gate Bridge. A natural range which could be observed on the radarscope was used to determine whether the vessel was making good the desired course of 056° T. The range consisted of the Harding Rock Buoy as the front range marker and the offshore rocks just south of Point Blunt as the rear range marker. At 0134, the ARIZONA STANDARD again tried to contact the OREGON STANDARD without success.

At approximately 0136, the master, upon hearing the mid-channel signal, which is located on the center span of the bridge, slightly to port, ordered the helmsman to come right to 058° T. At 0138, HAR advised the ARIZONA STANDARD that HAR has been unable to contact the OREGON STANDARD on channel 18A. The ARIZONA STANDARD advised HAR that the ARIZONA STANDARD was about to pass under the Golden Gate Bridge. Prior to the helmsman's steadying on the new course, at about 0139, the master observed the red navigation light of the OREGON STANDARD one to two points on the starboard bow at approximately 200 yards. The master ordered hard left rudder and stop all engines. The collision occurred at approximately 0140 hours (as noted on the ARIZONA STANDARD). The bow of the ARIZONA STANDARD penetrated the port side of the OREGON STANDARD in way of the Nos. 2, 3, and 4 port tanks just forward of the deckhouse, at about a 45° angle.

The OREGON STANDARD departed Long Wharf, Richmond, California, at 0024 on January 18, 1971, bound for Bammerton, British Columbia. At 0049, she reported her departure to HAR on channel 18A. She then shifted her receiver to channel 10. As a result, despite numerous attempts by both HAR and the ARIZONA STANDARD, neither was able to establish contact with the OREGON STANDARD on channel 18A until after the collision.

She cleared Southampton Shoal Channel at 0053 steering 168° T. at a speed of approximately 8.5 knots. The master was conning the vessel, using the Raytheon radar, the second mate was assisting the master and observing the Decca radarscope, the lookout was posted in the bow, engines were on maneuvering speed status, and fog signals were being sounded. The fog was thick and reduced visibility to 200 to 300 yards. Speed was increased to approximately 11.5 knots at 0054. When abeam Southampton Shoal Light, the course was changed to 170° T. At 0108, speed was reduced to approximately 9.5 knots. At 0111, with Pent Blunt abeam to starboard at 0.6 mile, the vessel came right slowly, rounded the Point and steadied up on course 260° T. Speed was increased to approximately 11 knots at 0116.

At 0125, when abeam of Harding Rock Buoy at 0.2 mile, the vessel came left to a course of 231° T. About 6 to 7 minutes later when 0.3 mile off Pt. Cavallo, the master realized the vessel had been set to the north of the desired trackline, and ordered the helmsman to come left to 220 T. At 0134, he reduced speed to approximately 9 knots. Approximately 1 minute later, 0135, with Lime Point abeam as determined by the sound of the Lime Point fog horn, the master ordered hard right rudder and told the helmsman to steer 265° T. The vessel passed under the Golden Gate Bridge at approximately 0138. The mid-channel diaphone on the center span of the bridge was heard overhead as the vessel passed under the bridge. Speed was reduced to approximately 4 knots at 0138.2.

The OREGON STANDARD was approximately 0.1 mile east of the Golden Gate Bridge when the master observed a contact, the ARIZONA STANDARD, on the Raytheon radarscope (range scale l 1/2 miles) at about 0.8 mile bearing 25° on the port bow. At approximately 0140, the two white and one green navigation lights of the ARIZONA STANDARD were observed at about 250 yards approximately 25° on the port bow. Full astern was ordered and the general alarm was sounded. The vessels collided at approximately 0141 (as noted on the OREGON STANDARD).

Subsequent to the collision, the two vessels remained locked together and drifted on the flood tide under the bridge into the inner bay. Using one of the OREGON STANDARD's anchors, the vessels anchored off Point Knox, Angel Island. During the next 7 hours, numerous barges, tugs, oil booms, and various types of oil removal equipment arrived in the area and proceeded to off-load cargo and contain and clean up the spilled oil. Approximately 800,000 gallons of oil spilled from the OREGON STANDARD. No cargo was lost from the ARIZONA STANDARD. After sufficient off-loading had been accomplished to allow the vessels to free themselves, they proceeded to Long Wharf at Richmond.

The subsequent tides carried the oil several miles to sea. As the oil spread up and down the coastline, beaches became fouled as far south as Half Moon Bay (approximately 25 miles south of the Golden Gate Bridge) and as far north as Kellam Beach (approximately 20 miles north of the bridge). Hundreds of birds perished, despite extensive efforts to collect and clean them. It is estimated that only about 3.5 percent of the birds which were coated with oil survived. The damage, if any, to shellfish and other sea life has not been determined and may not be known for several years, if ever.

Standard Oil of California, many Federal, State, and local government agencies, and hundreds of volunteers coordinated their efforts to contain and clean up the oil spill in an effort to minimize the environmental damages. It is estimated that Standard Oil of California spent over $4,000,000 in efforts to reduce and rectify damages caused by the spill.

The U. S. Coast Guard operates a Harbor Advisory Radar (HAR) system in the San Francisco Bay area as an experiment to evaluate the desirability of such systems. Participation is on a voluntary basis. The system's radio net consists of vHF radios using the 156.9 MHz frequency which is designated channel 18A, Navigation Channel. The HAR operator provides traffic information to participating vessels in the various areas included in the system, in terms of the position and general direction of movement of vessels observed on the radarscope. He does not provide interpretative information such as CPA, course, speed, etc. Participating vessels report their identification, movement information, position, and destination each time they enter or depart the system. The U. S. Coast Guard has no statutory authority to require vessels to participate.

Both vessels were standard T-2 type tankships. They were 10,553 gross tons, 504 feet in length, 68.2 feet in breadth, 39.2 feet in depth, with steam turbo-electric propulsion of 6,000 hp.

Each vessel was equipped with two radar sets. One set was a Decca Type RM 426 and the other was a Raytheon Mariners Pathfinder. The Decca radar has eight range scales from one-half mile to 48 miles. The Raytheon radar has four range scales from 1 1/2 miles to 50 miles. Both of the radar sets were in operation on each vessel at the time of this casualty.

The vessels were also equipped with similar vHF radio equipment. The equipment has a 10-channel capability which included channels 10 (156.50 MHz), 16 (156.80 MHz), and 18A (156.90 MHz). Channel 10 is the working frequency for conducting company business, channel 16 is the calling and distress channel, and channel 18A is the navigation channel and the one used in the HAR system. Both vessels were continuously monitoring channel 16. The ARIZONA STANDARD also was guarding channel 18A continuously except when she tried to contact the OREGON STANDARD on channel 10. The OREGON STANDARD guarded channel 10 in lieu of 18A. It is the Standard Oil Company's policy that all its tankships participate in the HAR system.

The masters of both vessels testified that all their navigational, electronic, propulsion, and steering equipment was operating normally.

The master of the ARIZONA STANDARD holds a master's license endorsed for any gross tons, any ocean, radar observer and first-class pilot on San Francisco Bay. He has held a master's license for 12 years, the pilot's endorsement for 10 years, and has been master of the ARIZONA STANDARD for 2 years. The master of the OREGON STANDARD holds a master's license with the same endorsements plus first-class pilot for many additional pilotage waters on the west coast. He has sailed in the capacity of master for 22 years and has 40 years of experience at sea.

46-406 0- 75 - 18

The chief mate of the ARIZONA STANDARD holds a master's license endorsed for any gross tons, any ocean, radar observer and first-class pilot on San Francisco Bay. He has been sailing in a licensed capacity since 1945. He has been the chief mate of the ARIZONA STANDARD for 6 years. The second mate of the OREGON STANDARD holds a second mate's license endorsed for any gross tons, any ocean, radar observer, and authorization to serve in the temporary capacity of chief mate, any gross tons, any ocean. He has been sailing for about 45 years, the past 17 years with Standard Oil Company.

ANALYSIS

Position of Collision

There is little conflict in the evidence with respect to the movements of each vessel as each approached the ultimate point of collision. The testimony of the masters does conflict with respect to the position of the vessels at the time of collision. The master of the ARIZONA STANDARD testified that his best estimate of the position at which the collision occurred was 175 to 600 yards southwest of the center span of the Golden Gate Bridge. His estimate was not based upon ranges or bearings taken at the time of collision. The southwesterly direction was based upon the direction of the sound of the diaphone on the center span of the bridge. The master of the OREGON STANDARD testified his best estimate of the position of the collision was approximately 450 yards due west of the center span. His estimate apparently is based upon his belief that the OREGON STANDARD, on a course of 270° T., passed directly under the center of the bridge.

The HAR system photographs the radarscope every 3 minutes. (See Attachments B-1, -2, and -3.) The photograph taken at 0141:58 shows the two radar pips representing the ARIZONA STANDARD and OREGON STANDARD merged in a position 300 yards due west of the center of the bridge. The 0139:02 photograph indicates the OREGON STANDARD had just passed under the bridge and was approximately 150 yards southwest by west (236° T.) of the center of the bridge. This same photograph revealed the ARIZONA STANDARD was in a position approximately 900 yards west southwest (247° T.) of the center of the bridge.

The 0139:02 photograph indicates that the OREGON STANDARD was actually a little south of the center of the channel. The master testified that he had commenced his turn to starboard to swing under the bridge when he determined, by listening to the fog horn, that Lime Point was abeam. The 0136:08 photograph indicates that Lime point was actually abaft the beam before the vessel changed course to 270° T. The master testified that he had slipped further south than he had intended. Although the more accurate method of using a radar range and bearing off Lime point was available, the master determined his position abeam Lime point by listening to the fog horn. Also, due to the northerly set encountered off Point Cavallo, the vessel approached the bridge on a course of 220° T. in lieu of the normal course of 231° T. As a result, a sharper turn to starboard was required to pass under the bridge. The advance of the vessel during the turn may have contributed to the fact that the vessel proceeded further south than would normally be anticipated.

The ARIZONA STANDARD's position, as depicted by the 0139:02 photograph, is approximately 150 yards north of its intended trackline. In view of the northeasterly set of the approximately 2-knot flood current and the fact that, according to the chief mate, the radar range was always kept open with the pip of the rocks off Point Blunt never appearing to the right of the heading flash, a northerly deviation from the desired trackline would be expected.

Despite slight differences in the observed times of the collision and the times of the radarscope photographs, plus any errors which may exist in interpreting the photographs, it is concluded that the collision occurred approximately in mid-channel, 300 to 450 yards to the seaward side of the Golden Gate Bridge. Each vessel failed to keep to its starboard side of the channel. The masters' desire to keep well clear of the bridge abutments, the absence of a direct or readily available indication of the center of the channel in the vicinity of the bridge, and the failure to plot accurately their positions contributed to the fact that each vessel did not favor its starboard side of the channel.

Speed in Fog

The speed of the ARIZONA STANDARD is well documented. Between the time the vessel was abeam buoy No. 2 in the Main Ship Channel (0104) and abeam Mile Rocks Light (0130), she traveled a distance of approximately 5.85 nautical miles in 26 minutes at an average speed of about 13.5 knots. From 0130 until 0140, the time of collision, the vessel traveled approximately 1.9 nautical miles at an average speed of about 11.4 knotsVessels in a fog are required to proceed at a "moderate speed." The generally accepted definition of "moderate speed" is a speed at which a vessel is capable of stopping within one-half the distance of its visibility. The Board concludes that a speed in excess of 11 knots was not necessary to maintain steerage way and, under the existing condition of reduced visibility (less than 500 yards), the speed of the ARIZONA STANDARD was immoderate.

The OREGON STANDARD was abeam buoy 2SS Southampton Shoal Channel at 0053 and was abeam Point Blunt Light at 0111. Her average speed for this distance of 3.1 nautical miles was about 10.5 knots. Between Point Blunt (0111) and Harding Rock (0125), a distance of approximately 2.2 nautical miles, the vessel averaged about 9.5 knots. Between Harding Rock (0125) and a position approximately 0.3 mile off Point Cavallo (about 0131), her average speed was about 11.5 knots. Between Point Cavallo and when she passed under the bridge (0138), she averaged about 7 knots. For the 3 minutes just prior to the collision the vessel's average speed was about 4 knots. Taking into consideration the prevailing conditions of very restricted visibility and the failure to use fully the radar capabilities which were available, the speed of the OREGON STANDARD was immoderate.

Use of Radar

On the ARIZONA STANDARD, the chief mate was assigned to the radar set to provide information to assist the master in safely piloting the vessel into Long Wharf at Richmond. The mate testified that he considered his primary responsibility was to observe the natural range of Harding Rock Buoy and the rocks off Point Blunt on the radarscope to determine whether the vessel was making good its desired course. He initially observed the OREGON STANDARD as a contact on the scope at a range of approximately 6 miles. He plotted on the face of the scope three positions of the OREGON STANDARD. However, these were of little value since times were not recorded. Hence, no determination of course or speed of the OREGON STANDARD was made.

The mate stated the last time he observed the pip of the OREGON STANDARD was when the OREGON STANDARD was approximately 1 mile northeast of the center of the Golden Gate Bridge in the vicinity of Yellow Bluff. This raises the question of whether a contact will blend into the image of the Golden Gate Bridge and, if so, at what distance. No expert witnesses were called to testify concerning such a blending effect. The testimony of the two masters, the chief mate of the ARIZONA STANDARD, and the second mate of the OREGON STANDARD all indicated such a phenomenon does occur. Their estimates as to how close a contact had to be to the bridge before it would blend with the image of the Golden Gate Bridge varied from 200 to 400 yards.

Exhibits 33-A and 34-c (photographs of HAR radarscope) show a definite radar pip for the OREGON STANDARD when it is approximately 100 yards west of the bridge. (See Attachment B-2.) The bridge image is approximately 150 yards wide. Any target on the HAR scope whose pip width is less than 150 yards will momentarily disappear as it passes under the bridge.

Neither the testimony nor the exhibits substantiate the fact that a loss of a contact 1 mile from the bridge was the result of the contact blending with or being hidden by the bridge image. Thus, such a phenomenon is not considered to have been a causal factor in this casualty. Nevertheless, there is insufficient evidence in the record to determine positively how much of a blending or blocking effect exists and whether it could create a potentially hazardous condition for the mariner.

On the OREGON STANDARD, the master was using the Raytheon radar set to pilot the vessel through the Bay. Upon departure and until the Harding Rock Buoy was approximately 4 points (45°) on the port bow, the radar presentation was kept on the 5-mile range scale. At this point, the ARIZONA STANDARD would have been slightly more than 5 miles away and therefore could not have appeared as a target on the scope. The master then switched to the 1 1/2-mile scale and kept the set on that scale until the vessel was about to pass under the bridge. On this scale the ARIZONA STANDARD would not have appeared as a target until the OREGON STANDARD was off Lime Point. The master testified that at that time he was attempting to line up the bridge piers, determine when he was abeam of Lime Point, and make his course change to pass under the bridge. Being so preoccupied, the master could have failed to note the ARIZONA STANDARD's image on the edge of the 1½-mile scope presentation even if the image was in fact present.

The second mate was observing the Decca radarscope. He had the presentation set on the 3-mile or l 1/2-mile range scales from buoy 2SS, Southampton Shoal Channel, until the vessel was near Harding Rock Buoy. The ARIZONA STANDARD was over 5 miles away during this period and would not have appeared as a target on the scope. When the OREGON STANDARD was off Harding Rock, the presentation was placed on the 6-mile range for about 2 or 3 minutes. During this interval, the ARIZONA STANDARD was close enough to appear on the scope. The mate testified that he did not observe the ARIZONA STANDARD on the radar. However, he also testified that he was very busy logging bearings and distances off important navigational points, supervising the helmsman, tending the engine order telegraph, listening for fog signals, acting as an extra lookout, and performing other duties of a deck watch officer. As a result, he said, "I don't think I was on the radar too much." He also said that he observed some cluttering along the starboard side of the heading flasher. This clutter disappeared when he switched to the 3-mile scale. Between Harding Rock Buoy and Point Cavallo, the set was on the 3-mile range. It is very questionable whether the ARIZONA STANDARD was close enough during this interval to appear as a target on the outer edge of the scope. When the OREGON STANDARD was off point Cavallo, the mate switched to the 1 1/2-mile range scale. As a result, both the Raytheon and the Decca radar sets were on the 1 1/2-mile scale until just prior to passing under the bridge.

The most probable reasons for the failure of the master and second mate to observe the ARIZONA STANDARD as a target on either of the OREGON STANDARD's radar sets were: 1 The fact that neither set was placed on a range scale greater than 6 miles. As a result, most of the time, the ARIZONA STANDARD was at too great a distance to appear as a target on the scopes. 2. The fact that both officers were occupied with other tasks which included determining the vessel's position and maintaining the desired trackline.

The problems encountered in observing, collecting, and evaluating data from the radar on both vessels illustrate the need for development and implementation of more sophisticated electronic systems to assist the operating personnel in solving such problems. Such a system would be one which would sound an alarm to alert the operator of an impending dangerous situation, provide continuously updated courses, speeds, and CPA's of other vessels in the area, and provide a simple, easily understood, visual presentation of the movement of all targets in the area. This type of system would alert the pilot or watch officer of a dangerous situation if he were otherwise occupied and failed to observe the target on radar. It would also eliminate the need for time-consuming manual plotting in order to extract all useful information from the radarscope. The Board made similar recommendations in its special study of "Collisions of Radar-Equipped Merchant Ships and Preventive Recommendations."

Radiotelephone Communications

The role of the VHF radiotelephone in this casualty is of particular interest. Despite the fact that the Standard Oil Company policy stated all of its vessels were to participate fully in the voluntary Harbor Advisory Radar System, the OREGON STANDARD elected not to guard the designated frequency (channel 18A) during its outbound transit of the Bay. The master testified that he switched to channel 10 because he had no traffic or pips on his radarscope. As a result, neither HAR nor the ARIZONA STANDARD was able to establish communications with the OREGON STANDARD. This collision may well have been prevented if the vessels had established radio contact and informed each other of their position and intentions. The Safety Board has noted in previous collisions, such as the one involving the UNION FAITH and WARREN J. DOUCET and the one involving the AFRICAN STAR and MIDWEST CITIES, that the vessels did not have a common frequency available, which precluded establishment of communications. In both of those casualty reports, we indicated the need for and our support for the bill recently passed by Congress, which requires a radiotelephone on certain vessels navigating upon specified waters of the United States. This casualty illustrates the need for the specific provision of the enacted bill which makes the guarding of the designated frequency mandatory.

The OREGON STANDARD was guarding channels 10 and 16. Despite this fact, the ARIZONA STANDARD was unable to establish contact with her on either of these two frequencies. Since all the evidence available indicates the radio equipment on both vessels was functioning properly, possible reasons for the failure that were not ruled out by the investigation were either the volume was turned down too low, or the bridge personnel were preoccupied with the navigation of the vessel.

Harbor Advisory Radar System

The Coast Guard established the Harbor Advisory Radar as a test for evaluation purposes. This casualty has provided an evaluation; namely, that due to lack of authority, the system was unable to prevent the collision. There are two inherent weaknesses in the HAR System, both of which were contributory factors to the inability of the system to prevent the collision. The first is the voluntary nature of the system. As soon as the OREGON STANDARD shifted from channel 18A to channel 10, a breakdown in the desired system operation occurred. The master of the OREGON STANDARD testified that he did not guard channel 18A because he did not observe any traffic on his radar, so he did not think HAR's assistance was necessary. As a result of the master's failure to participate, the primary purpose of the system was defeated. The voluntary nature of the system also means that there may be vessels within the working area of the system which are not providing position and movement information. If the HAR operator cannot identify the targets on his radarscope, he cannot warn them of impending dangerous situations nor can he advise participating vessels of the intentions of the nonparticipating traffic.

The second weakness in the system is the limitation as to the type and amount of information the HAR operator is allowed to provide the vessels. He is allowed to provide only a word picture of the position and general direction of movement of vessels which he observes on the radar. He is not allowed to provide any interpretative information. The HAR operator, when questioned as to why he did not provide the ARIZONA STANDARD with any more position reports on the OREGON STANDARD after his 0130 report, testified:

> "I had reported it (the OREGON STANDARD) to the ARIZONA STANDARD so she could identify it on her radar. I brought it to her attention and she had identified it, and I had done my job."

Apparently, the instructions which prohibit the operators from providing any interpretative information influenced his decision. Since the ARIZONA STANDARD had acknowledged the operator's reports concerning the OREGON STANDARD, he felt he had done all he was allowed to do. This situation points out the weakness of the HAR system in that it is a completely passive one which does not allow the operator to direct or regulate traffic movements in any manner or even provide interpretative information.

These weaknesses exist in the system due to a lack of statutory authority for the Coast Guard to operate such traffic regulation systems. If the HAR operator had been authorized to direct or regulate traffic, the collision probably would have been avoided. This casualty illustrates the need for such authority and the establishment of effective systems in the congested ports and waterways in the United States.

Fog Signals

Despite the fact that both vessels were sounding fog signals, neither vessel heard the other's signal. The signals of the powerful diaphone and two fog horns located on the bridge, which the personnel on each vessel were specifically listening to, undoubtedly contributed to the failure of the vessels' signals to be heard. A vessel, upon hearing apparently forward of her beam a fog signal of a vessel whose position is not ascertained, is required to, as circumstances permit, stop her engines and then navigate with caution until danger of collision no longer exists. The effectiveness of this requirement is nil if a vessel's fog signal is not heard. This casualty is another example of the inadequacies of the whistle signal system and the need for more positive and reliable means for vessels to determine the position and intentions of other vessels in their vicinity. The Board previously noted the inadequacies of the whistle signal system in its report on the collision of the SS UNION FAITH and the M/V WARREN J. DOUCET.

Systems Failures and Traffic Regulation

In the past, such causal factors as failure of the vessels to keep to their starboard side of the channel, immoderate speed, and failure to utilize fully the radar generally have been attributed to or classified as personnel errors. These factors also can be classified as systems failures.

However, the important question is, why were these errors committed and what can be done to prevent the repetition of such errors in the future?

The problems of determining a vessel's position and ensuring that the vessel remains in and to its side of the channel become much more difficult when a dense fog is encountered and visibility is reduced to a matter of a few hundred yards. A strong fair tide, such as the one the inbound ARIZONA STANDARD was experiencing, compounds these problems.

The initial decision, which must be made when such adverse conditions are encountered, is whether to initiate or continue the voyage or to delay departure or heave to and await more favorable conditions. Traditionally, this has been the decision of the master. Despite the fact that company policy may, and in this casualty did, indicate the

46-406 O- 75 - 19

ultimate decision to sail or continue a voyage rests with the master, and that the safety of the vessel should be the paramount factor considered, other factors influence the master's decision. The economic aspects such as maintenance of schedules and adherence to ETA's may tend to influence the decision.

Perhaps in the past, leaving the decision entirely up to the master was appropriate. Today, with the tremendous increase in the size and speed of vessels, the proliferation of hazardous cargoes, and the much greater traffic density, the risk levels have increased enormously. In this casualty involving two small, 10,000 GT, World War II vintage tankers, over 800,000 gallons of bunker fuel escaped into the Bay.

The master alone should no longer be required or allowed to bear the burden of such decisions. He should receive assistance and, when necessary, authoritative direction in making the decision. Traffic regulation systems with mandatory participation, shipboard collision avoidance systems, and mandatory bridge-to-bridge radiotelephone communications are some methods which are available to provide the desired assistance or regulation. Such systems have proven effective in the Great Lakes, the St. Lawrence River, Rotterdam, and several other areas throughout the world.

Pilothouse Workload, Task Organization, and Organization of Controls

In this accident, there were no fewer than four elements in the sequence of events which raise questions of the adequacy of the organization of the responsibility for tasks on the bridge of the vessels involved, the workload, and the organization of the pilothouses for the performance of the controller's tasks. When the master of the OREGON STANDARD was attempting to determine the timing of his turn, he relied upon the sound of the fog horn at Lime Point, a relatively inaccurate indication, and he did not rely upon the available radar. Obviously, the master could not be on the wing of the bridge to listen for the fog horn and in the wheelhouse observing the range and bearing of Lime point on radar at the same time, yet he apparently failed to assign either task to the second mate. When the radar in the OREGON STANDARD was set on the 6-mile range, there would have been an opportunity to observe that the ARIZONA STANDARD was ahead in the channel; however, the mate of the OREGON STANDARD testified that he was busy with many other conflicting duties, some of which, under many bridge layouts, cannot normally be accomplished while within view of the radar screen. when, later, the OREGON STANDARD detected a target at a range of 0.8 miles, the master attempted to raise the ARIZONA STANDARD on the radiotelephone, but he erroneously set the radio on channel 6. Rather than take the time to switch channels and try again, he returned to the conning of his vessel in an effort to avoid the collision. He could not continue his efforts to contact the other vessel because the normal bridge layout does not allow simultaneous talking and visual search, and he did not assign either task to someone else.

Aboard the ARIZONA STANDARD, three officers were at work on the bridge during the approach to the Golden Gate, one of whom was placed on duty for the specific reason that the task was considered to require three persons. In addition, it was known that the OREGON STANDARD was somewhere in San Francisco Bay and would be exiting through the channel. This represented a hazard to the **ARIZONA STANDARD, as was indicated by its repeated efforts to raise the OREGON STANDARD on normal radio channels. Despite the presence of three officers on the bridge to man the radar and corm the vessel, no plot was made of the vessel's track in the channel. The question is whether the plotting of position could have been accomplished, even by the three officers on the bridge, under the conditions of the n-knot speed of the ARIZONA STANDARD, or whether the task was accomplishable, but** simply not performed.

There is enough evidence available to imply that there may have been underlying difficulties in task organization, bridge layout, and workload, but there is not sufficient evidence to draw definite conclusions.

Close study of this aspect of the accident *beyond normal* investigation seems most desirable because of the general questions concerning task Organization, workload, and bridge design which have been raised by general studies in recent years. Studies by competent students of the man-machine relationship and human factors in operational safety have indicated that there are many shortcomings in traditional operations and bridge layout, if judged by the practices developed in other fields. These problems are discussed in great detail in the recent study, "Human Factors in Ship Control." This study was made in 1969 by General Dynamics for the Maritime Administration.

It is at least appropriate to raise these questions, since the organization of authorities, tasks, and controls has developed only by step-by-step changes, not analysis, and is strongly influenced by the traditional arrangement of command authority on vessels. For example, it is traditional that the master or other senior on watch remain standing during the whole time he is on the bridge. If it is assumed that the master is always on his feet, then it might be considered not illogical that he be required to circulate over the entire scope of the bridge wings, pilothouse, and chartroom in order to perform the necessary tasks of operation. Comparisons have been made between this form of organization

and the control organization of a large transport aircraft. In the air-craft, the organization of instruments and controls is analytically developed to allow rapid scanning, observation of a great many instruments in sequence, and instantaneous response. The pilot of the airborne vessel can observe any of his key instruments at any moment, simply by glancing at them, and he can simultaneously communicate with other vessels or the aircraft control tower while maintaining surveillance.

The absence of this form of rapid, close-at-hand, virtually simultaneous surveillance, control, and communication in the marine field has sometimes been justified by the statement that the much slower speeds of marine vessels do not require it. This accident affords scant support for that rationale.

The design of aircraft control work stations has been subjected to many cycles of development, and aviation accident investigations routinely search out very detailed errors in workspace arrangement and task organization which could have contributed to accidents.

Development of such aspects when they appear in marine accidents is also important because analytical design of some marine vessel controls has been initiated, and the need for the concept is being closely observed. The pilothouses of some naval minesweepers now tend to resemble, in internal arrangement and external appearance, a typical centralized airport control tower rather than the elongated room having widely distributed instruments and controls, placed athwartships, which represents the most frequent bridge designs.

SUMMARY

Ecological losses which affect the general population, in addition to the economic losses incurred by the vessels' operators, resulted from this casualty. The results might have been even more catastrophic if two supertankers of more than 100,000 GT had been involved, or if the cargo of the OREGON STANDARD had been gasoline in lieu of bunker fuel.

These damages are suffered to a large extent by the third party or innocent bystander, which was the general public in this casualty. Potential losses which would follow casualties to large tankers would also impinge to a large degree on the general public.

The current theory of control of vessel movements in harbors relies strongly upon the presumption that individual masters are competent and that by employing their skills in their own best interests, they will succeed in avoiding collision. However, the fact that economics also enter into master's decisions is inescapable. Both vessels were moving at immoderate speeds, determined necessary by the masters for their own reasons, and the individual efforts of each master were insufficient to prevent an enormous loss to the general public. The fact that this type of accident is repeatable, and on a far larger scale, makes valid the question of what degree of public control is necessary. Does service to the public welfare still properly permit **such decisions, fraught with great public risk, to be made only by the two privately motivated individuals, or is a firmer degree of control, responsible to the general interest, necessary?**

In this casualty, four different systems or subsystems were in effect which could have avoided the collision, had any one of them functioned properly. Under the control system prescribed by the Inland Rules of the Road, the vessels could have avoided each other by keeping to their starboard side of the channel, establishing their positions by their own radar. They could have avoided each other by seeing each other on radar, and maneuvering accordingly to insure a safe passage. They could have avoided each other by hearing the whistle signals and then maneuvering accordingly. They could have avoided each other by voluntarily employing the services of the Harbor Advisory Radar. None of these systems operated to achieve the function needed for individual reasons already described.

The most significant of these systems, the Board believes, is the potentially controlling Harbor Advisory Radar. The HAR is a publicly funded facility which lacks the corresponding public authority needed to insure that the weaknesses of privately operated systems or private motivations would not produce great public loss. This potentially protecting public radar system should no longer be placed in the position of recording the minute stages of a public disaster while powerless to prevent it. The Safety Board believes that, responsive to the public interest, the authority to control this traffic should be provided.

PROBABLE CAUSE

The National Transportation Safety Board determines that the **cause of** this collision was the failure or inadequacy of four different systems or subsystems, any one of which could have prevented the collision had it functioned adequately.

> The regulatory system prescribed by the Inland Rules of the Road failed in that neither vessel complied with the rules by keeping to its starboard side of the channel. **This** non-compliance was contributed to by in-moderate speed for prevailing conditions on the part of both vessels, failure of both vessels to use the radar capabilities

available to maintain an accurate plot, and the absence of a positive indication of the center of the main ship channel through the Golden Gate.

The radar system by which the vessels could have avoided each other failed because the ARIZONA STANDARD did not obtain and evaluate correctly information from radar pertaining to the movements of the OREGON STANDARD, and the OREGON STANDARD did not check periodically at least one of the radarscopes, set on a sufficiently long range scale, to ensure the prompt detection of the ARIZONA STANDARD.

The whistle signal system of avoiding collision failed because neither vessel heard the other vessel's fog signals. A contributing factor was the high noise level caused by the diaphone and fog horns located on the Golden Gate Bridge.

The Harbor Advisory Radar system was inadequate to prevent the collision. The inadequacy arose from the decision of the OREGON STANDARD not to guard channel 18A, which precluded its participation in the system, and the prohibition of Harbor Advisory Radar operators from providing interpretative information or direction to vessels. The underlying and most significant inadequacy of the Harbor Advisory Radar was the lack of authority of the Coast Guard to regulate this traffic, which prevented a publicly financed facility from protecting the public against loss.

RECOMMENDATIONS

The National Transportation Safety Board concurs in the action planned by the Commandant with respect to Recommendation No. 2 of the Marine Board. With regard to Recommendation No. 1, this is the third major marine casualty report in which the safety Board has commented upon the need for legislation to require bridge-to-bridge radio. In our special study of "Collisions of Radar-Equipped Merchant Ships and Preventive Recommendations," we referred to the effectiveness of this type of communications on the Great Lakes.

The Safety Board commends Congress for the recent passage of the "Vessel Bridge-to-Bridge Radiotelephone Act." This Act will provide a very helpful tool for the prevention of collisions.

The Safety Board further recommends that:

1. Congress enact legislation such as the proposed "Ports and Waterways Safety Act of 1971" (H.R. 8140) which would

provide explicit statutory authority for the U.S. Coast Guard to establish and operate marine traffic regulation systems in the congested port waters of the United States.

2. The Coast Guard continue to develop the Marine Traffic System in San Francisco Bay. Successful development of this system should lead to the eventual establishment of similar effective systems in other congested ports and waterways in the United States.

3. The Coast Guard study the feasibility of developing a method of traffic separation for inbound and outbound traffic in the Golden Gate Channel,

4. The Radio Technical Commission for Marine Services actively support and encourage the maritime and electronic industries' efforts to develop and utilize collision-avoidance systems.

5. Vessel operators, the American Institute of Merchant Shipping, and the Society of Naval Architects and Marine Engineers give due consideration to the development of coordinated bridge workspace arrangements and task assignment in the formulation of vessel specifications and designs as highlighted in the recent General Dynamics study.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

Adopted this 28th day of July, 1971:

Oscar M. Laurel

Oscar M. Laurel, Member

Francis H. McAdams

Francis H. Mc Adams, Member

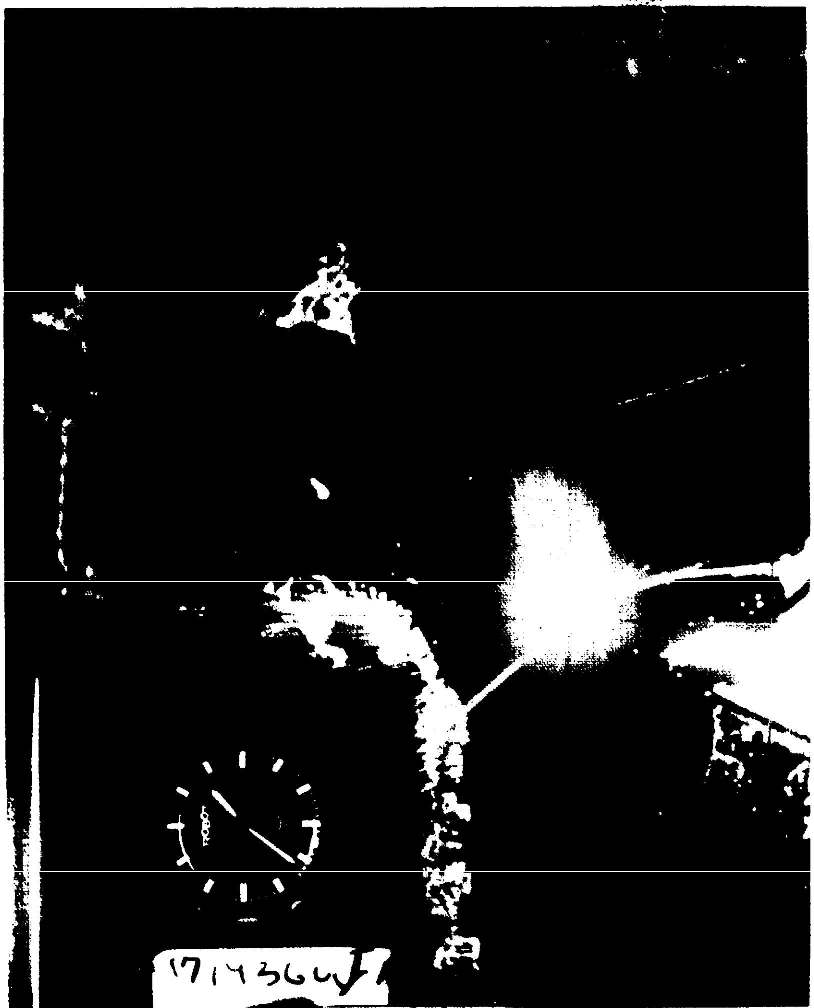
Louis M. Thayer

Louis M. Thayer, Member

Chairman Reed and Member Burgess were-absent, not voting.

Attachment A

Attachment B-1



0136:08 Photograph of HAR Radarscope

Attachment B-2

0139:02 Photograph of HAR Radarscope

Attachment B-3

0141:58 Photograph of HAR Radarscope

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDANT (MVI-3)
U.S. COAST GUARD
WASHINGTON, D.C. 20591

21 APR 1971
5943/ARIZONA STANDARD - OREGON STANDARD
C-12 Bd

Commandant Action

on

The Marine Board of Investigation convened to inquire into the circumstances surrounding the collision between the SS ARIZONA STANDARD and SS OREGON STANDARD at the entrance to San Francisco Bay on 18 January 1971

1. The record of the Marine Board of Investigation convened to Investigate subject casualty has been reviewed, and the record, including the Findings of Fact, Conclusions and Recommendations, is approved subject to the following comments and the final determination of the cause of the casualty by the National Transportation Safety Board.

SYNOPSIS OF FINDINGS OF MARINE BOARD OF INVESTIGATION

1. **During the early morning of 18 January 1971 at the entrance of San Francisco Bay, the arriving loaded tankship** ARIZONA STANDARD **and the departing loaded tankship OREGON STANDARD collided in dense fog. Each vessel was severely damaged.** There was extensive pollution.

2. These ships, each **T-2 type tank vessels, were equipped with two radar installations, multi-channel radiotelephone, and other similar navigational aids. All equipment was in good operating condition. Viability in the heavy fog at the time of the collision** was estimated to be **200-300** yards.

3. The OREGON STANDARD departed Standard Oil Dock, Richmond, California, at 0021 on 18 January 1971. At 0049 the radiotelephone was used to inform Harbor Advisory Radar that the vessel was underway and departing the dock. The radiotelephone channel was changed to one used to communicate with the home office and so remained until just prior to the collision. The extremely poor visibility permitted only

one aid, the Southampton Shoal Lighted Bell Buoy No. 1, to be sighted visually. After this time the vessel was piloted on various courses by use of radar ranges and bearings.

4. At 0135 the course of the vessel was altered to 270 degrees and the scale on the radar PPI scope was changed from l 1/2 miles to five miles. A contact, later identified as the ARIZONA STANDARD, was seen bearing two points off the port bow at an approximate range of eight-tenths' mile. The Master intended to make a port to port passing with the ARIZONA STANDARD. Fog signals were being sounded by the OREGON STANDARD. The Master determined that his vessel was in the middle of the channel when passing under the Golden Gate Bridge. He had intended to be much further to the right during the passage of this channel. When the ARIZONA STANDARD was first sighted visually coming out of the fog at a distance of about 250 yards, two points on the port bow, collision was imminent and impact occurred at 0140.

5. Bridge personnel of the ARIZONA STANDARD heard the departure report of the OREGON STANDARD transmitted to Harbor Advisory Radar on the radiotelephone at 0049. No further communication was heard from the OREGON STANDARD. At 0058 the ARIZONA STANDARD, advised Harbor Advisory Radar of its ETA and approach to San Francisco Bay. Harbor Advisory Radar repeatedly called OREGON STANDARD via radiotelephone without any response. The ARIZONA STANDARD was informed by Harbor Advisory Radar of the OREGON's position at 0120 and 0131.

6. Shortly before the ARIZONA came abeam of Mile Rocks a contact later identified as the OREGON STANDARD was observed on the PPI scope. Attempts by the ARIZONA to raise the OREGON on various channels of the radiotelephone were unsuccessful. The ARIZONA continued to track the OREGON until the contact was lost from the radar screen in the return of the Golden Gate Bridge. The ARIZONA had been sounding fog signals in accordance with the Inland Rules of the Road. No signals were heard from the OREGON. At about C139 the navigation lights of the OREGON came into view on the starboard bow at an estimated distance of 300 yards. The collision occurred about one minute later with the ARIZONA on a heading of 055 degrees and the OREGON on a heading of 270 degrees.

7. The ARIZONA had reduced engine speed to half ahead from full ahead at 0130 when abeam of Mile Rocks. From the point of speed reduction until the moment of collision the average speed over the bottom was 10.5 knots including an estimated 2.3 knot current caused by the flooding tide. The OREGON made successive engine speed changes from full ahead to half ahead at 0134, half to slow ahead at 0138 and from slow ahead to full speed astern at 0140. The average speed over the ground determined by Harbor Advisory Radar from 0130:16 to 0139:08 was 8.2 knots.

8. There was extensive damage to each vessel with resulting pollution from the oil spilled from the damaged cargo tanks on the OREGON. There were no injuries or loss of life.

9. The experimental Harbor Advisory Radar installed for use in San Francisco Bay and operated by the Coast Guard is being tested and evaluated. The track of the OREGON was followed by HAR from the oil dock in Richmond until the collision. The ARIZONA STANDARD was observed by HAR upon entering the main ship channel to San Francisco Bay until the collision.

REMARKS

1. Concurring with the Marine Board of Investigation, it is considered that the primary cause of the casualty was the failure of the SS ARIZONA STANDARD and the SS OREGON STANDARD to proceed at a moderate speed during a period of reduced visibility, thus violating Article 16 of the Inland Rules of the Road.

2. In further concurrence with the Board's Conclusion No. 2, it is considered that it was particularly essential in view of the reduced visibility for each vessel to keep on its own side of the channel. Failure to do so is a violation of Article 25 of the Inland Rules of the Road.

3. Various frequencies on the radiotelephone to communicate with the ARIZONA STANDARD and the Harbor Advisory Radar were available to the Master of the OREGON STANDARD. Failure on the part of the Master of the OREGON to fully utilize all navigational aids, particularly radiotelephone, to safely navigate and position his vessel constitutes evidence of negligence.

4. It is further concluded that failure to use radar information correctly on both vessels contributed to the casualty.

ACTION CONCERNING THE RECOMMENDATIONS

1. Legislation for bridge-to-bridge voice radio communication between vessels is now pending in Congress.

2. A program exists to continue the experimental Harbor Advisory Radar in San Francisco Bay. The title of the operation is being changed to Marine Traffic System anticipating involvement with future harbor traffic control. There are plans that call for the installation

of new equipment (radar, computer, and visual display) specifically designed for traffic control capability. Mandatory voice radio communication is essential to the success of the present or planned system.

3. **Further investigation under the administrative procedures provided by the Suspension and Revocation Proceedings Regulations concerning the evidence of negligence and violations of the Inland Rules of the Road has been initiated.**

C R Bender

CR. BENDER

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER
TWELFTH COAST GUARD DISTRICT
.. O SANSOME STREET
SAN FRANCISCO, CALIFORNIA 94126

5943/Mar. Board,
OREGON STANDARD-
ARIZONA STANDARD,
12 March 1971

From: Marine Board of Investigation
To: Commandant (MVI)

Subj: SS OREGON STANDARD, SS ARIZONA STANDARD; collision at entrance to San Francisco Bay, 18 January 1971; No Loss of life

1. At or about 0140 (PST) on 18 January 1971, the outbound loaded tanker OREGON STANDARD and the inbound loaded tanker ARIZONA STANDARD, navigating in dense fog, collided in mid-channel at the entrance to San Francisco Bay, approximately .2 of a mile west of the Golden Gate Bridge. Both vessels sustained extensive damage and the Oregon Standard lost approximately 20,000 barrels of her cargo of bunker fuel. There was no loss of life or injury to personnel.

2. VESSELS INVOLVED

Name	SS ARIZONA STANDARD	SS OREGON STANDARD
Official No.	248736	246773
Service	Tankship	Tankship
Gross Tons	10,553	10,448
Net Tons	6,361	6,301
Length	504 Ft.	504 Ft.
Breadth	68.2 Ft.	68.2 Ft.
Depth	39.2 Ft.	39.2 Ft.
Year Built	1945	1944
Propulsion	Steam, Turbo-electric, 6,000 HP	Steam, Turbo-electric, 6,000 HP
Document	Consolidated Cert. of Enrollment and License, Permanent, No. 45, issued at San Francisco, Calif., 11 October 1970	Certificate of Registry, Permanent, No. 33, issued at San Francisco, Calif., 15 January 1971
Owners	Standard Oil Company of California 225 Bush St., San Francisco, Calif. 94104	Standard Oil Company of California 225 Bush St., San Francisco, Calif. 94104
Operators	Chevron Shipping Co. 555 Market St., San Francisco, California	Chevron Shipping Co., 555 Market St., San Francisco, California

Master	Harry Hamilton Parnell, License No. 361511, Master, Steam and Motor vessels, any gross tons, any oceans, radar observer; First class pilot on San Francisco Bay and Tributaries, Issued on 17 April 1969 at San Francisco, California. USMMD Z-743825, endorsed for any unlicensed rating in the deck dept. including able seaman.	Morris Emerson English License No. 384228, Master, Steam and Motor vessels, any gross tons, any ocean, radar observer; First class pilot, Honolulu Harbor to sea and return; San Pedro Bay; Los Angeles Harbor; San Francisco Bay; Puget Sound and adjacent inland waters between Seattle and Angeles Point via main ship channels; Columbia River, Astoria to sea; Waters of Resurrection Bay, Prince William Sound to Valdez and Cordova; Southwestern Alaska to and including Dutch Harbor; Issued 12 August 1969 at San Francisco, California. USMMD Bk. 053551 endorsed for any unlicensed rating in the deck dept. including able seaman.

Last Inspected for Certification:

Date	26 August 1970	23 October 1970
Port	San Francisco, Calif.	San Francisco, Calif.
Capacity of cargo tanks	141,158 Bbls	141,158 Bbls

Both ships were standard T-2 tankers, essentially unchanged since built, inspected and certificated for carriage of grade "A" liquid in cargo tanks and grade "E" in the deep tanks. Each ship was divided by transverse bulkheads into 9 cargo tanks numbered from forward to aft. #1 tank was divided into port and starboard compartments by a centerline bulkhead and the other tanks were divided into port, center, and starboard compartments by two longitudinal bulkheads.

Both ships are capable of a maximum speed of approximately fifteen knots. The pitch of the propeller of each ship was 17.6 feet. The following revolutions per minute of the propeller were used for maneuvering. Full 80, Half 60, Slow 40, Dead Slow 20.

46-406 0- 75 -20

3. RADAR

Each vessel was equipped with two radar installations. On both ships a DECCA, Type **RM 426 was** located near the forward wheelhouse bulkhead on the port side and a RAYTHEON MARINERS PATHFINDER was installed in a similar location on the starboard side.

RADAR DATA

DECCA, Type RM 426
10 1/2 inch (265mm) effective diameter screen
Gyro Stabilized

RANGE SCALES	CALIBRATION RINGS
0.5 NM	0.25 NM
0.75NM	0.25 NM
1.5 NM	0.25 NM
3.0 NM	0.5 NM
6.0 NM	1.0 NM
12.0 NM	2.0 NM
24.0 NM	4.0 NM
48.0 NM	8.0 NM

RAYTHEON Mariners Pathfinder

Screen Size:	7 inch diameter cathode ray tube
Range Scales:	1.5, 5, 15, and 50 miles
Ranging:	Range marks spaced 1,000 yards, 1 mile, 3 miles, and 10 miles

4. Radio Telephone:

Each vessel was equipped with a RAYTHEON VHF Radiotelephone (Mod. Ray. 40) located in the wheelhouse. Both were fitted for channels "A" through "J" and capable of automatically monitoring channel 16, 156.80 MHZ, the calling and distress frequency. The OREGON STANDARD was also fitted with channel "K". The channels were marked on the vessels' radio equipment as follows:

LETTER	NUMBER	FREQUENCY (KHz)
A	19A	156.95
B	7A	156.35
C	18A	156.90
D	10	156.50
E	6	156.30
F	16	156.80
G	26	156.30
H	28	157.30
I	12	156.60
J	13	156.65
K	Blank	Weather (No frequency marked)

5. WEATHER AT THE TIME OF THE CASUALTY

Heavy fog; calm seas; light ESE airs; flood tide, current approximately 2 knots.

6. The SS OREGON STANDARD completed loading operations at the STANDARD OIL DOCK at Richmond, California shortly before midnight on 17 February 1971. The cargo consisted of 103,349 barrels of heavy bunker fuel destined for Bamberton, British Columbia. All tanks were full with the exception of number 6 center and number 8 port and starboard, which were empty, and numbers 3 and 5, port, center, and starboard, which were slack. The draft was 30'-01" forward and 32' aft.

All navigation gear was tested by the chief mate and 2nd mate and found satisfactory. The deck and engine room clocks were synchronized and the "course recorder time was adjusted. The radars were then tuned and made ready for use. The master was called at 2340 and after discussing the weather and tide with the 2nd mate he ordered the ship made ready to sail. Visibility at this time, was two or three hundred yards due to heavy fog. The master was aware that the ARIZONA STANDARD was due at Point Orient at 0200 or 0230.

At 0006 the cargo hose was disconnected, the mooring lines were taken in and at 0021 the vessel, with the mooring master aboard, left the dock assisted by two tugs. At 0048, when the OREGON STANDARD was shaped up on her course in Southampton Shoal Channel, the mooring master and the tugs departed and the vessel proceeded outbound stemming the flood tide at half speed ahead with the master at the corm. At 0049 the master contacted Harbor Advisory Radar on VHF channel 18A and advised that the OREGON STANDARD had departed Richmond Long Wharf, bound for sea. The radio telephone was later switched to channel 10, the channel used for communicating with the owner's office.

At 0053, Southampton Shoal Lighted Bell Buoy No. 1 SS (LL 804) was abeam. This was the only aid to navigation observed visually on the passage outbound. As the vessel went by it the second mate saw its qreen flash from the starboard bridge wing. Navigation from that point on was by radar ranges and bearings. The master for the most part conned the vessel by information obtained from the Raytheon radar and from the 2nd mate who assisted in the navigation. The duties of the 2nd mate included answering the telephone, logging bells in the bell book, logging aids passed and courses steered, observing the helmsman and, as time permitted, observing the scope of the Decca radar on the port side of the bridge. The helmsman, was steering true courses by hand telemotor.

At 0054 speed was changed to full ahead. Southampton Shoal Light (LL 795) was abeam to port at 0.6 mile at 0103. At 0108 speed was reduced to half ahead. When Point Blunt was abeam to starboard at 0111, at a distance of 0.6 mile, the master started a right turn to 260° to pass north of Harding Rock. The bow lookout stationed on the foc'sle head at departure from the dock was relieved at 0115.

Full speed ahead was resumed at 0116.2. At 0125 Harding Rock Lighted Buoy (LL 653) was abeam to port at 0.2 mile. After passing Harding Rock the master ordered a course of 231 degrees. At about 0131 the master found by radar observation that the vessel had been set somewhat to the north of the intended track and was 0.3 mile off Point Cavallo. The course was changed to 220°. When three tenths of a mile off Lime Point the fog horn on the point (LL 646) was heard. At 0134 the engine order telegraph was put on half ahead. At 0135 the master ordered the rudder hard right for a course change to 265 degrees and almost immediately thereafter amended that order to 270 degrees. While making this turn the master switched the Raytheon radar from the 1 1/2 mile scale to the 5 mile scale and the contact later identified as the ARIZONA STANDARD was observed on radar at range of .8 mile, approximately two points off the port bow. The radar presentation of the Raytheon radar, which was not gyro stabilized, was somewhat blurred by the swinging ship. The OREGON STANDARD was on heading of 270 degrees by 0138 when it was under the Golden Gate Bridge. The master intended to make a port to port passing with the ARIZONA STANDARD. The yellow loom of the lights on the bridge span was visible and the diaphone (LL 645) located in the center of the bridge span was heard overhead. The horn on the south pier of the bridge (LL 643) was also heard.

At 0138.2 speed was reduced to slow ahead. The vessel had up to this point been sounding fog signals in accordance with the Inland Rules of the Road on automatic. Switching the fog signal from automatic the master went to the port wing of the bridge and began blowing fog signals by hand. The master was joined by the second mate who advised him that the contact on radar was on the port bow approaching rapidly and that the bearing was not changing. He had intended to be well north of the center but found himself in the middle of the channel. After obtaining a flashlight from the second mate the Master went over to the VHF radio telephone, switched it from channel 10 to channel 16 so he would have been able to call the ARIZONA STANDARD. The approaching vessel appeared out of the fog at a distance of approximately 250 yards about 2 points on the Port bow. Two white lights, the masthead and range lights, were seen first and then the green running light. Full astern was rung and the general alarm was sounded. The collision occurred at 0141 with the OREGON STANDARD making approximately three knots headway. No whistle signals were heard from the ARIZONA STANDARD.

7. The ARIZONA STANDARD was bound from Estero Bay, Calif. to Richmond, Calif. with a cargo of San Joaquin Valley Heavy crude oil and a draft of 31 feet forward, 31 feet aft. After encountering fog down the coast about 25 miles south of San Francisco the ship started sounding one prolonged blast every two minutes. The vessel continued to sound this fog signal prescribed by the international rules of the road until she passed the line of demarcation into inland waters and started sounding one prolonged blast every minute. The ARIZONA STANDARD continued to sound this fog signal in accordance with the inland rules of the road until the time of collision. After passing Mile Rocks the fog signals were blown by hand by the second mate.

The approach to the main ship channel was made on course 343 degrees True. The engine speed was reduced from full ahead to the full ahead maneuvering speed of 80 revolutions per minute. At 0049, the ARIZONA STANDARD heard the OREGON STANDARD report to Harbor Advisory Radar on VHF Channel 18A that she had departed Richmond Long Wharf for sea. At 0058 and 30 seconds, the ARIZONA STANDARD advised Harbor Advisory Radar on Channel 18A that she was entering the main ship channel, bound for Point Orient. At 0059 and 30 seconds, Harbor Advisory Radar called the OREGON STANDARD on Channel 18A, but there was no response. A repeated attempt to call the OREGON STANDARD on Channel 18A at 0059 and 50 seconds was also unsuccessful.

At 0100 with San Francisco Main Ship Channel lighted Whistle Buoy #2 (LL 625) approximately one-half mile on the starboard beam the ARIZONA STANDARD started a starboard turn to enter the channel. At 0104 the ARIZONA STANDARD was in the main ship channel with Buoy #2 abeam to her starboard. At 0107, San Francisco Main Ship Channel lighted Buoy #4 (LL 627) was abeam. At 0110, San Francisco Main Ship Channel Lighted Buoy #6 (LL 629) was abeam. At 0114, San Francisco Main Ship Channel Lighted Buoy #8 (LL 631) was abeam. While transiting the channel the red lights of the buoys on the south side could not be seen visually, however the white lights of the buoys on the north side were observed.

At 0116 and 50 seconds, Harbor Advisory Radar again called the OREGON STANDARD, but there was no reply. An attempt by Harbor Advisory Radar to call the OREGON STANDARD was repeated at 0117 and 10 seconds. At 0120, Harbor Advisory Radar advised the ARIZONA STANDARD that “Radar Shows The OREGON STANDARD Passing North of Alcatraz, Bound for Sea”. The course of the ARIZONA STANDARD was at this time, changed to 065 degrees True, to line up with the channel under the Golden Gate Bridge. At 0125 the lookout reported the loom of a flashing light on the starboard bow. The master determined that the loom was from Mile Rocks Light (LL 640), which was at a range of 1 mile on , radar, three points on the starboard bow. Approximately two minutes later, before coming abeam of Mile Rocks, a contact later identified as the OREGON STANDARD was observed on radar in a position approximately one-half mile off Point Blunt. The chief mate of the ARIZONA STANDARD made a plot of three positions of the OREGON STANDARD with a grease pencil on the PPI scope, at increments of less than one-half mile. The times of these observations were not noted; however they indicated a relative movement line of 264 degrees. Attempts by the ARIZONA STANDARD to contact the OREGON STANDARD on channel 18A, channel 10 and channel 16 were unsuccessful.

At 0130 the ARIZONA STANDARD had Mile Rocks Light abeam at one-half mile. The course was changed to 056 degrees True, and the engine was reduced to half ahead. Further unsuccessful attempts to call the OREGON STANDARD were made by Harbor Advisory Radar at 0130 and 30 seconds and 0130 and 40 seconds. At 0131 and 10 seconds Harbor Advisory Radar advised the ARIZONA STANDARD that "The present position of the OREGON STANDARD is east of the Golden Gate Bridge 1 mile". Soon thereafter, when the OREGON STANDARD was approximately three tenths of a mile off Point Cavallo the contact disappeared from the radar scope of the ARIZONA STANDARD. By this time the ARIZONA STANDARD had passed abeam of Mile Rocks and was about three-tenths of a mile further along her track line towards the center of the Golden Gate Bridge span.

At 0138 and 50 seconds Harbor Advisory Radar advised the ARIZONA STANDARD that they "had been unable to contact the OREGON STANDARD on 18A". At 0139 and 20 seconds (By Harbor Advisory Radar Time) the ARIZONA STANDARD advised Harbor Advisory Radar that her position was one half mile west of the Golden Gate Bridge and that she had been trying to contact the OREGON STANDARD. Soon thereafter the masthead light, range light and red running light of the OREGON STANDARD were observed approximately two points on the starboard bow at a range of about 300 yards. A hard left rudder order was then given. The collision occurred approximately one minute later (at 0140 by the ARIZONA STANDARD'S clock). At 0143 the engine of the SS ARIZONA STANDARD was placed at half astern. No whistle signals were heard from the OREGON STANDARD.

8. The impact as the vessels came together was described as a soft grinding crunch. It was not severe enough to cause crewmembers of either vessel to lose their footing nor were any injuries sustained on either vessel as a result of the collision. The ARIZONA STANDARD, on a heading of about 055 degrees, struck the OREGON STANDARD on a heading of about 270 degrees, just aft of the foc'sle head, penetrating the port side of the ship and rupturing #2 port, #3 port and #4 port tanks. Numbers 3 center and 4 center remained intact. The cargo from the damaged tanks spilled into the bay. Number

1 port and #3 center lost a small amount of oil through fractures. The overhang of the bow of the ARIZONA STANDARD slid aft, shearing ullage trunks and external fittings from the deck of the OREGON STANDARD. Damage to the ARIZONA STANDARD was in way of the lower bow areas forward of the collision bulkhead. The cargo tanks of the ARIZONA STANDARD remained intact but there was some minor flooding in way of the forward dry cargo space.

Immediately after the impact the foredecks of both vessels were illuminated and the crews were ordered to lay out fire hose. The crew of the OREGON STANDARD cleared lifeboats, ready for launching. Harbor Advisory Radar and the Company office were notified of the incident by radio telephone. Communication between the vessels was then established. After examination of the damage the masters attempted to back free without success. The vessels were securely locked together, and drifting toward Angel Island on the flood tide. The starboard anchor of SS OREGON STANDARD was let go with 9 shots of chain out. The vessels continued to drift toward Point Knox, dragging anchor until the arrival of several tugs which held them clear of shallow water. Shortly thereafter barges and oil removal equipment arrived and an oil retention boom was rigged around the ships. The effectiveness of the boom was at first impaired due to the wheel wash of the maneuvering tugs which caused oil to be washed from the boom enclosure. The skimmers and the vacuum barges began to remove oil from the surface of the water immediately after their arrival on the scene.

About 7 hours after the incident both vessels had shifted or off loaded sufficient cargo to change trim enough to permit them to be separated. The ARIZONA STANDARD went to the Standard Oil Dock to off-load. The OREGON STANDARD waited off Point Knox for a favorable tide and then went to the Standard Oil Dock to off-load preparatory to gas freeing and repairs. While at the refinery the boom was re-rigged around the vessel to protect against further oil pollution.

9. The total amount of oil spilled from the SS OREGON STANDARD was estimated at 20,000 barrels. There was no loss of oil cargo from the SS ARIZONA STANDARD. Due to the flooding tide at the time of the collision oil flowed into and contaminated portions of San Francisco Bay. Subsequent tidal action dispersed the oil and caused contamination of adjacent coastal areas. Surface and aerial surveys by the Coast Guard on-scene commander indicated that oil contamination in the Bay extended eastward from Yellow Bluff through Raccoon Strait to Bluff Point and eastward from Yellow Bluff to a line between Point Blunt and Alcatraz Island and from there to North Point in San Francisco. Traces of oil were observed in South Bay extending to the Hunters Point area. The northernmost movement of oil along the coastline was to Double point near Kellam Beach in the Point Reyes National Seashore area. The southernmost point was off Pillar

Point in Halfmoon Bay. The seaward extremity of oil contamination west of the Golden Gate was approximately eight miles to the east of the Farallon Islands.

Cleanup of the oil which reached the shore was effected by crews hired by the vessel's owners, local authorities and by volunteers. Methods used varied from employment of laborers using hand tools and straw to vacuum trucks and bulldozers. The work involved removal of oil from beaches and waterfront areas and delivery of contaminated waterfowl to designated treatment centers. On 20 January the total labor force controlled by the vessel's owners was in excess of 350 hired laborers and 450 volunteers. There were numerous other volunteers working under the auspices of local authorities and conservationist groups. Additional manpower and equipment were provided by nearby military commands. Control and operation of waterborne equipment including barges, skimmers and vacuum barges was also exercised by the owners of the vessels. Surveillance of Bay and offshore areas was conducted several times daily by Coast Guard, company chartered aircraft and other military aircraft.

The regional and national response teams were activated in accordance with the Hazardous Material Contingency Plan and coordinated assessment, evaluation, and recording of the effects of the spill and the progress of the cleanup operations were made by the primary agencies. The persons principally involved in notification, containment, countermeasures, cleanup, disposal, and restoration included representatives of the Commander, Twelfth Coast Guard District, Environmental Protection Agency, California Fish and Game Department, and the regional Water Quality Control Board. There was concerted participation by a great number of national and local agencies and organizations. Other interested agencies were kept advised of events by daily situation reports.

10. Average speeds of the ARIZONA STANDARD and the OREGON STANDARD while navigating various reaches of the channel and bay have been calculated from approximate positions, distances, and running times established by the evidence. These speeds are set forth in tabular form below:

ARIZONA STANDARD AVERAGE SPEED OVER GROUND

AID	TIME	AID	TIME	MIN	MILES	AV SP
BUOY R'2'	0104	Buoy R"8'	0114	10	2.12	12.7
Buoy R"8'	0114	Mile Rk Lt.	0130	16	3.75	13.8
Mile Rk.	0130	Collision Pt.	0140	10	1.8	10.5

OREGON STANDARD AVERAGE SPEED OVER GROUND

AID	TIME	AID	TIME	MIN	MILES	AV SP
BUOY R2SS	0053	Southampton Shoal light	o103	10	1.6	9.5
Southampton Shoal light	0103	Pt. Blunt	0111	8	1.5	11.2
Pt. Blunt Buoy	0111	Harding Rk	0125	14	2.3	9.75
Harding Rk	0125	Pt. Cavallo	0131	6	1.23	12.5
Pt. Cavallo	0131	Collision Pt.	0141	10	1.0	6.0

11. The movement of the OREGON STANDARD as observed by Harbor Advisory Radar and photographs of the radar scope presentation were taken at intervals of approximately three minutes. The ARIZONA STANDARD also appeared in the radar scope when she approached the Golden Gate Bridge and came into range of the inner harbor radar. The average speed of the OREGON STANDARD calculated between observations recorded by Harbor Advisory Radar are set forth in the following table:

OREGON STANDARD AVERAGE SPEED OVER GROUND
BY HARBOR ADVISORY RADAR PLOT

TIME		RUNNING TIME	DIST	AV SPEED
0118:23	0130:16	11 Min 53 Sec	2.1 Mi	10.9
0130:16	0133:11	2 Min 55 Sec	.5	10.2
0133:11	0136:07	2Min 56 Sec	.4	8.
0136:07	0139:08	3 Min 1 Sec	.32 Mi	6.2

Harbor Advisory Radar, operated by the Coast Guard as an experiment to investigate the desirability of Harbor Advisory . Systems in the United States, maintains surveillance over San Francisco Bay and the Bay channel approaches. Vessel movement information within the Harbor Advisory Radar area of responsibility is provided over the navigation radio channel (18A) from U. S. Coast Guard Harbor Advisory Radar Operations Center located at Pier 45. In general, traffic information is provided for the channel segment which vessels are about to enter and in response to vessels reporting their departures or passing a reporting point. Additional information will be provided only upon request from a vessel or, if in the interest of safety, such information is felt to be particularity meaningful to the vessel. Voluntary position reports are essential for satisfactory operation of the Harbor Advisory Radar which must be able to compare a position report with a contact in order to identify that contact. There is no requirement that vessels stand watch on VHF channel 18A. The Harbor Advisory Radio Operations Manual recommends however, that the set be switched on and tuned to the navigation channel (18A) in order that contact can be made with any vessel sighted and a safe passing arranged. The masters of both the SS OREGON STANDARD and the SS ARIZONA STANDARD were aware of the provisions of the HAR operations manual.

CONCLUSIONS

1. The casualty was caused by faulty navigation of the SS ARIZONA STANDARD and the SS OREGON STANDARD. Both vessels proceeded at an immoderate speed in dense fog and failed to keep to the starboard side of the channel prior to the collision. There were several other factors that may have contributed to the casualty.

a. Failure to establish radio-telephone communication.

Although the vessels were equipped with compatible radio equipment, and both masters were aware that the other vessel would be navigating in the area, the radio-telephones were tuned to different channels.

b. Navigating narrow channel in dense fog.

Both vessels were committed to navigation in the channel by the masters, also acting as pilots, with full knowledge of the conditions of reduced visibility.

c. Failure of OREGON STANDARD to make timely radar contact.

The OREGON STANDARD was approximately 1/10 of a mile from the Golden Gate Bridge before the ARIZONA STANDARD was observed on radar at a range of approximately 8/10 of a mile. The sharp right turn of the OREGON STANDARD before passing under the Golden Gate Bridge may have been a contributing factor in the failure of that vessel to pick up the ARIZONA STANDARD on the Raytheon Radar which was not gyro stabilized, however, the presentation of the gyro stabilized Decca Radar should not have been blurred by the swinging of the ship.

d. Loss of radar contact by ARIZONA STANDARD.

At a position about 1 1/2 miles from the Golden Gate Bridge the ARIZONA STANDARD lost radar contact with the OREGON STANDARD at a range of approximately 2 1/2 miles. There is no evidence of radar equipment failure and the interference by the bridge span as the radar images of vessels passing under the Golden Gate Bridge merge with the image of the bridge span is only momentary. The blanking effect on the radar presentation of the inbound vessel caused by the high land mass at Lime Point near the north end of the bridge was not a material factor in this case since the vessels were in line of sight. This masking effect persists until the ship is approximately 1 1/2 miles from the Golden Gate Bridge when Pt. Cavallo shows up as a single distinct pip resembling a ship contact.

2. There is evidence of negligence on the part of the masters of both the ARIZONA STANDARD and the OREGON STANDARD for failure to go at a moderate speed in fog, and for failure to remain on the starboard side of a narrow channel. Failure to go at a moderate speed in fog is a violation of Article 16, of the Inland Rules of the Road, and failure to keep to that side of the fairway or channel which lies on the starboard side of a vessel is a violation of Article 25 of the Inland Rules of the Road. This evidence of negligence and violations of the Inland Rules of the Road has been referred to the Commander, Twelfth Coast Guard District for appropriate action under the Revocation and Suspension provisions of RS 4450, as Amended.

3. The casualty might have been prevented:

a. If the master of the OREGON STANDARD had started his right turn to line up with the channel under the bridge in sufficient time, or had otherwise directed his course to assure that his vessel would remain on the starboard side of the channel instead" of in the middle of the channel.

b. If the master of the ARIZONA STANDARD had set his course to take his vessel closer to the South pier of the Golden Gate Bridge, instead of making good a course down the middle of the channel.

c. If communications on the radio-telephone had been established in order that the vessels could have ascertained the course and intentions of the other. This would have allowed the vessels to take evasive action to prevent both vessels from passing under the Golden Gate Bridge in the center of the channel at the same time.

do If the ARIZONA STANDARD had been picked up on radar at a distance greater than 8/10 of a mile, in sufficient time for the OREGON STANDARD to take evasive action. Closer attention to the PPI scope, better adjustment of the radar, operation of the radar at intervals on a greater range scale, and an additional radar observer may have facilitated earlier radar contact.

RECOMMENDATIONS

1. That effort be continued to obtain legislation requiring the installation and use of bridge-to-bridge radio-telephone equipment on all merchant vessels in the navigable waters of the United States.

2. That the Harbor Advisory Radar be continued if legislation is passed to require bridge-to-bridge radio-telephone communications. The value of such Harbor Advisory Radar is greatly enhanced when it is used in conjunction with radio-telephone communications between vessels.

3. That further investigation be conducted under the Revocation and Suspension provisions of RS 4450, as Amended, concerning the licenses of the masters of the SS ARIZONA STANDARD and the SS OREGON STANDARD.

J E Gould

CAPT J. E. GOULD, 3387, USCG
Chairman

C. T. Newman

CAPT C. T. NEWMAN, 5024, USCG
Member

F E Stewart

CDR F. E. STEWART, 4276, USCG
Member & Recorder

47214

Attachment 7

3. Torrey Canyon - A polar case in accidental oil pollution[4]"

Torrey Canyon has two claims (at least) to being a polar case in accidental oil pollution, namely (i) that it is the most costly tanker accident to date, though not one suspects for all time, and (ii) that it represents a classic example of an accident in circumstances where property rights were very much on the side of the polluter. A brief review [Beynon (n.d.)] of this important. watershed in the international treatment of accidental oil pollution by tankers provides an invaluable insight into the conceptual matters raised above and a useful basis for evaluating subsequent actions both at the national and at the international level.

On Saturday March 18th, 1967, at 08.50 hours, the Torrey Canyon, en route to Milford Haven with 119,000 tons of Kuwait crude oil, ran aground on Pollard Rock, part of Seven Stones, approximately 11 miles south-west of Lands End at a speed of 16 knots, rupturing all six starboard tanks, as her Italian master, anxious not to miss high tide at Milford Haven, attempted a short-cut between Seven Stones and the Scilly Isles and misjudged his position. This commenced the *most* serious single case of oil pollution ever experienced in European waters. For approximately 30,000 tons of oil spilled out from the Torrey Canyon at the time of the grounding, a further 20,000 tons spilled out during the following seven days of high seas and gale force winds until March 26th when the ship's back was broken on the rocks, releasing a further 50,000 tons. By March 27th, the British Government abandoned all hope of a salvage solution and a bombing exercise was mounted between March 28th and March 30th in a partially successful attempt to burn the remaining 19,000 tons of oil. Torrey Canyon oil proceeded initially to pollute extensively some 100 miles of British coastline until early in April a 'fortuitous' shift in the prevailing wind swept it seawards eventually to pollute the holiday beaches of Guernsey and Brittany. In Britain, France and the Channel Islands, Torrey Canyon oil pollution became overnight a major political and economic issue.

[4]For a detailed cost analysis of the Torrey Canyon affair, see Burrows et al. (1974b).

In a separate study [Burrows et al. (1974b)], we have evaluated in some detail the cost both for Britain and for France, in terms of 1967 prices,[5] of the Torrey Canyon grounding. The cost data derived are subject to fairly wide" errors bars and are to be viewed as approximations only to the real costs involved. Furthermore, it proved impossible despite careful application to attribute monetary valuations to the ecological damage sustained as a consequence of Torrey Canyon oil. Nevertheless, a number of important policy implications appear to flow from the 'cost of damage' estimates and therefore the cost data are reported in this study as table 1.

Table 1
The cost of Torrey Canyon.

Internal cost	*£ million*	
(a) The hull of Torrey Canyon	5.89	
(b) The cargo	0.60	
(c) The salvage operations	0.05	
		6.54
External cost of prevention and control (U. K.)		
(a) The cost of avoiding coastal pollution	2.00	
(b) The cost of clean-up	2.70	
		4.70
External cost of control (France and Guernsey)		
Minimum estimate based on compensation claims		3.00
External cost of damage		
Extensive but unquantifiable		
Total quantifiable cost		14.24

The real significance of table 1 is not to be found in the global cost estimate of £14.24 million for the Torrey Canyon grounding, nor even in the minimum estimate for external costs of prevention and control of £7.70 million, though these are startling enough even in terms of' the inflated standards of 1973. Rather it lies in the comparison between the insurance value of the Torrey Canyon and its cargo (£6.49 million) and the ex-post cost of preventing and controlling the oil-spill (£4.70 million for the United Kingdom alone and at least £7.70 million for the United Kingdom, France and Guernsey combined). Perhaps for the first time in maritime history, the cost of preventing and controlling an oil-spill (without reference to the ecological damage sustained) substantially exceeded the value of the ship and cargo. The potential public

[5] Wherever possible opportunity cost estimates were obtained. In cases of doubt, conservative estimates were applied.

policy relevance of this comparison for handling tanker accidents in the future is further discussed in a subsequent section of this paper, as are the implications for the mix of control techniques adopted at that time by the British Government in its attempt to minimize coastal pollution. In the meantime, some discussion is necessary of the problems encountered in attempts by the national governments' concerned to negotiate a compensation settlement with tile owners of the Torrey Canyon.

Despite the very considerable costs imposed upon the United Kingdom, Guernsey and French economies by the wrecking of the Torrey Canyon, extreme difficulties *were* envisaged from the outset in obtaining any substantial compensation from the tanker company concerned. For the Terre)' Canyon was owned by the Barracuda Tanker Corporation of Bermuda, a subsidiary of the Union Oil Company of Wilmington, California, was chartered out by the subsidiary to the parent company, was registered in Monrovia and flew the Liberian flag, principally for fiscal considerations. The tanker owners, from the outset, denied all liability for damage and *relied* upon the acknowledged complexity of international law for their protection.

The property right problem was particularly treacherous for the damaged nations in that the Torrey Canyon, owned by a foreign national, had grounded-outside United Kingdom territorial waters. Maritime lawyers agreed that those whose livelihood had been adversely affected could sue the shipowners in the tort of negligence for compensation. But, under an international convention, liability would be limited in British courts to 66 dollars per ton of tanker, i.e., in the Torrey Canyon case to a maximum of 4 million dollars or £l,430,000. Furthermore, there was a real problem as to who should act as plaintiff, since for a judgment in tort, it would be necessary to establish a proprietorial interest in the threatened coastline. The central Government could establish no such interest, and although the Cornish foreshore was owned by the Duchy of Cornwall, the Prince of Wales was a minor. It might be necessary, therefore, for the Queen to sue to protect the rights of a minor.[6]

In the event, the British and French Governments circumvented the legal process by direct action – the twentieth century counterpart to gunboat diplomacy. The only substantial assets of the Barracuda Tanker Corporation were the Torrey Canyon's sister ships the Lake Palourde and the Sansinena. Writs

[6] The property right situation was further complicated by the defence put forward by the tanker company to the effect that (i) all reasonable precautions had been taken after the grounding to prevent or minimise the discharge of oil and that the 11ow of oil to the beaches had been the result of wind and tide and therefore was an Act of God for which they were not responsible in law, (ii) that if the Torrey Canyon had not been bombed it was probable that the main bulk of her cargo would have remained sealed in her cargo tanks and as such would have been innocuous, and (iii) that the British Government was not empowered in international law to destroy a ship which was still in the open sea and subject to the freedom of the high seas, in which case the bombing was an Act of State and any claim by Britain should bc made against the Republic of Liberia.

against the Corporation were taken out by the British Government naming these ships on May 4th 1967, and an additional writ was issued in Singapore. On July 5th the Lake Palourde was arrested on behalf of the British Government in Singapore harbour and was released on July 19th in exchange for a bond of £3 million as security for the damages and expenses claimed by Britain in its writ against the tanker company. Following suit, the French Government seized the same ship in Rotterdam harbour in April 1968 and successfully requested a security of £3.2 million against her own claim.

Following protracted negotiations, the underwriters to the Barracuda Tanker Corporation on November 11th 1969 settled out of court for a total compensation of £3 million to be divided equally between the United Kingdom (with Guernsey) and France. Although the compensation received by the United Kingdom represented only one-third of the cost of preventing and controlling the oil-spill, without reference to the ecological damage sustained, the British Government expressed satisfaction with the settlement – a sufficient testimony to the parlous state of the property right situation at that time.