CONTENTS

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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

LIST OF FIGURES

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.