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The Development of Construction and Equipment Standards to Promote Tanker Safety and Pollution Prevention

Kathleen M. Daly

University of Rhode Island

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THE DEVELOPMENT OF
CONSTRUCTION AND EQUIPMENT STANDARDS
TO PROMOTE
TANKER SAFETY AND POLLUTION PREVENTION

Kathleen M. Daly

A Paper Submitted in
Partial Fulfillment of the
Requirements for the Degree
of
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INTRODUCTION

Upstaged by a dramatic series of tanker accidents in the winter of 1976-77, the Carter Administration responded by meeting drama with drama - the President proposed a bold set of recommendations that, if adopted, would surely improve tanker safety but would, at the same time, impose considerable economic hardship on an already faltering tanker industry.

The purpose of this study is to examine the specific construction and equipment requirements put forth in the Presidential Initiatives, as they later became known, and trace the modifications made to them before they were incorporated into the tanker safety laws of the U.S. and of the international maritime community.

First, I will examine the tanker operations and accidents that were at issue in the 1970s, and the adequacy of the international and domestic standards in addressing them. I will then discuss each one of the construction and equipment requirements and how they were expected to improve tanker safety and pollution prevention. Finally, I will analyze the methods used by both the U.S. and the International Maritime Organization in setting their respective standards. It is interesting to note the part that public opinion played in the process, the role of governments and of the industry, and the various reasons for which compromises and alterations were made.
BACKGROUND

In 1976, barely a month went by without a major tanker accident, or sometimes two, three or four, occurring somewhere in the world. In fact, there were fifteen significant tanker casualties that occurred between December 15, 1976, the date of the grounding of the ARGO MERCHANT off Cape Cod, and March 27, 1977, when the MARINE EAGLE, carrying 9,000 tons of ammonia, ran aground in the Delaware River near Philadelphia.¹

Increased size was considered a major reason for the increase in groundings, collisions and explosions associated with tankers. The maximum theoretical risk for accidents doubled between 1970 and 1980 due to the number of significantly bigger tankers built during that decade.² Very Large Crude Carriers (VLCCs), i.e., those over 200,000 deadweight tons (dwt)³, were first built in the late 1960s; Ultra Large Crude Carriers (ULCCs), able to carry more than 400,000 dwt, were a product of the 1970s.

But the smaller, older tankers were as accident-prone as the larger ones. Many were registered under a flag-of-convenience⁴ after having been in service for several decades; equipment onboard was often unreliable, and the qualifications of the officers and crew were questionable. The ARGO MERCHANT, a 27,000 dwt tanker sailing under the Liberian flag, was considered a small tanker. During the investigation after it grounded and caused a 100-mile slick in the Atlantic Ocean, the vessel's Master declared that vital navigation equipment had been inoperative and had contributed to the cause of the accident.⁵

The offshore accidents were devastating, but those occur-
ring in port were, in some ways, worse. The SANSINENA, a 71,763 dwt U.S.-flag tanker, exploded in Los Angeles harbor on December 17, 1976, killing nine people and causing millions of dollars worth of damage to the harbor facilities there.

The safety and environmental issues associated with these accidents were well-covered by the media; public interest in the U.S. was raised to a level that demanded government action. Actually, environmental groups had been alerted to the hazards of tankers well before this rash of accidents. In February, 1976, seven environmental organizations had brought suit against the Coast Guard for that agency's failure to use its legislated authority to create regulations which would improve tanker safety and pollution prevention. This case, Natural Resources Defense Counsel et al. v. Coleman et al. (District Court, Washington, D.C., Civil Action 76-1081), was in litigation at the time.

Senator William Magnuson, an environmentalist of some repute, and the new Secretary of Transportation, Brock Adams, led the way in their respective arenas. Magnuson convened hearings of the Senate Commerce Committee and Adams appointed a Marine Safety Task Force to address the problems of tanker safety. However, the Council on Environmental Quality (CEQ), an independent government body, probably played the leading role in policy formation at this time. Recommendations were rather quickly developed and, by March, 1977, were ready to be presented.

President Carter had been in office for little more than two months when he announced the Initiatives on March 17, 1977. In a nationally televised message to Congress, and, in effect, to all other maritime countries in the world, he was firm; the U.S. would act - unilaterally, if necessary - to upgrade standards in
the tanker industry with stricter construction, design, equipment, manning and operating requirements than had ever before been in effect. Five specific standards, relating to tanker construction and equipment, were recommended for vessels of 20,000 dwt or more, to become effective within five years. Before the standards can be discussed, however, it is important to examine tanker operations, the causes of accidents and the construction and equipment standards in effect at that time.

TANKER OPERATIONS

Oil tankers are normally of two types; the crude tanker, which carries only crude oil, and the product tanker, which carries an assortment of refined oils. Crude tankers have simpler piping systems because they often carry a homogenous cargo; product tankers have need of more complex piping systems to prevent contamination of the different cargoes.

Except for the great lengths of deck piping visible, tankers appear, externally, to be large yet uncluttered vessels. Inside the cargo tanks, however, are huge steel plates and beams of different shapes and sizes which are essential for strength. They provide support so that the tanks will not fail, either from the forces of the seas or from the weight of the cargo.

These internal structural members also provide a lot more surface area to which oil can cling. The steel is not smooth, but rough, uneven and pock-marked with thousands of minute pore openings. Horizontal beams and brackets catch oil and cause it to form small pools. Most of the oil is pumped out during off-loading operations, but some remains, either because it is trapped on the horizontal strength members or because it is too shal-
Fig. 1.--Tanker under construction. Cargo tank internals have added steel framing for strength. Pictured above is an artist's rendition of a large tanker being constructed, with a view of the internal framing of a row of tanks. Source: Shipbuilders Council of America, 1982 Annual Report.
Fig. 2.—Bellmouth suction on cargo tank piping. The bellmouth allows pumps to draw suction very close to the bottom of the tank. Source: Marton, Tanker Operations (Cambridge, MD.: Cornell Maritime Press, Inc., 1978).
low at the pump suction opening.

The average amount of crude oil remaining in a cargo tank after discharge is approximately 0.4 percent of the total volume of the tank. This figure increases if the oil is thicker, and decreases if the oil is thinner or more volatile. A product tanker, carrying heating oils, diesel fuels or gasoline, usually has 0.1 to 0.2 percent less clingage than a crude oil tanker.

**Ballasting**

One routine operation, occurring on every return voyage after the discharge of a load of oil, is ballasting. At the beginning of the 'ballast leg' of the voyage, approximately one third of a vessel's cargo tanks are loaded with seawater to set the ship deeper in the water and submerge the propeller. The seawater mixes with the clingage on the trip back to a loading port. At some point this oily emulsion has to be discharged to make room for the new cargo; it is a major cause of operational oil pollution.

**Tank Cleaning**

The second routine operation is tank cleaning. Unless it is removed regularly, clingage reduces the cargo-carrying capacity of the tanks. For example, if 250,000 barrels (bbls) are loaded into a crude oil tanker, almost 1000 bbls remain, eventually building up into a sludge that clogs cargo pump suction, contaminates new cargo loaded into the tanks and prevents inspections of the tank surfaces for cracks or fractures.

Tank cleaning is routinely done in conjunction with ballasting, and approximately 25 percent of the tanks are cleaned
during the ballast leg of the voyage. The tanker takes on ballast at the dock and then departs for sea. At sea, tank cleaning begins on those tanks scheduled for maintenance; once cleaned, these tanks are ballasted, and the original ballast tanks can then be emptied so that they too can be cleaned.

The traditional method of tank cleaning, 'butterworthing', utilizes seawater heated to 170-180°Fahrenheit to scrub the tanks by pumping it at about 160 pounds per square inch gauge (psig) through revolving nozzles located in the tanks. This system removes much of the built-up sludge, but it creates the same problem that ballasting operations create - oily emulsions.

**Drydockering**

The third routine tanker operation is preparation for drydockering. All tankers must be clean and gas-free prior to entering a shipyard for repairs, mainly for safety reasons but also because few shipyards have receiving facilities to accept large amounts of oily water. Consequently, as a preparation for drydockering, the ship will clean and gas-free all of its tanks before it arrives at the yard.

**Load-On-Top**

Prior to the 1960s, tankers were discharging all oily emulsions over the side without any treatment. But when it became apparent that public and government priorities were shifting, the tanker industry, led first by Shell and later by Exxon, began using a load-on-top (LOT) system which reduced the amount of oil-in-water pumped overboard. LOT required no special equipment, but made use of time and the density differences between
oil and water as follows:

1) The vessel discharged its cargo and took ballast in a third of its tanks before it departed for sea.
2) At sea, another third of its tanks were washed, or butterworthed. The washings were pumped to a slop tank, or designated cargo tank, to settle.
3) Clean ballast was pumped into the cleaned tanks.
4) The dirty ballast, taken on when the vessel was in port, had a chance to settle. The lower layer of water was pumped overboard. When oil was detected in the water, the overboard discharge valve was shut, and the remaining oil was pumped into the slop tank.
5) The mixture in the slop tank was permitted to settle, and then the lower layer of water was pumped overboard.
6) A new load of cargo was loaded into the cargo tanks, and loaded-on-top of the oily layer in the slop tank.

LOT was touted by the oil transportation industry as the solution to operational pollution problems, but subsequent studies and incidents showed that it was not. A secret study by the oil industry in 1971-72 indicated that LOT was only about 50 percent effective. The operation, when it was carried out, was conducted sloppily; only the conscientious operators were careful to close the overboard discharge as soon as oil was sighted in the water.

Some tankers could not utilize LOT because their voyages were too short to allow the emulsion to settle and separate. And in bad weather, no matter how long the voyage, LOT was ineffec-
'Load on top' system of controlling pollution at sea

After discharging cargo, a tanker requires quantities of sea-water in some of its tanks to serve as ballast. When the water is loaded it mixes with oil residues in the tanks and becomes 'dirty'. During the voyage this dirty ballast water has to be replaced by clean ballast which can be pumped back to the sea without risk of pollution when the tanker reaches the loading port. Some empty tanks must therefore be cleaned at sea to ensure that the sea-water pumped into them as ballast remains clean and free of oil.

1 During the voyage tanks to be filled with clean ballast water are washed and the oily washings are collected into one slop tank. The oil in the neighbouring 'dirty ballast' tanks floats to the top.

2 The now clean tanks are filled with ballast water which will remain clean and suitable for discharge at the loading port. In the 'dirty ballast' tanks, the clean water under the oil is discharged to the sea and the oily layer on top is transferred to the slop tank.

3 In the slop tank, the dirty washings and the oil from the dirty ballast settle into a layer of oil floating on clean sea-water.

4 This clean water under the oil is carefully pumped back into the sea and the oily waste left on board. The next cargo is loaded on top of the remaining oil and all of it is discharged when the tanker berths at the refinery.

Fig. 3.--Load-on-Top. The Load-on-Top system was promoted by Shell International Petroleum in the early 1960s, as a means of decreasing operational oil pollution and also as a way to reclaim more cargo. Source: Marton, Tanker Operations, (Cambridge, MD.: Cornell Maritime Press, 1978).
tive because the emulsion was constantly being mixed.

One author from outside the industry called LOT "little more than a commercially technical subterfuge and an historical anachronism." He stated that after agitation by tank cleaning, the emulsion contained secondary dispersions which were less susceptible to separation, and that the water decanted from the slop tank could contain anywhere from 100 to 900 parts per million (ppm) of oil.

There was little incentive to utilize LOT for two reasons: if cargo was loaded-on-top in the slop tank it could become contaminated and acquire an unacceptably high salt content; or, if the Master tried to avoid contamination by discharging the slops at a reception facility in port, he could incur extra costs for the use of the facility and the time it took to discharge the slops.

Exact figures regarding the effectiveness of LOT are impossible to obtain because the operation was conducted in the middle of the oceans, unrecorded by tanker officers. It is obvious that if the system had been used most diligently, oil discharges would have dropped significantly. But there wasn't a way to measure a decrease of discharges in the middle of the ocean. The question of use remained unanswered except for one fact - oil in the ocean persisted.

A 1975 report by the National Academy of Sciences (NAS) estimated tanker operational discharges as follows:

<table>
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<tr>
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<th>Million Metric Tons</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOT Tankers</td>
<td>0.31</td>
<td>14.5</td>
</tr>
<tr>
<td>Non-LOT Tankers</td>
<td>0.77</td>
<td>36.2</td>
</tr>
<tr>
<td>Drydocking</td>
<td>0.25</td>
<td>11.7</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1.33</td>
<td>62.4</td>
</tr>
</tbody>
</table>
The rest of the vessel-source discharges were attributed to tanker accidents, and non-tankers operations and accidents.

TANKER ACCIDENTS

According to the 1975 NAS Report, which is by no means definitive but which can serve as a general reference, tanker accidents accounted for 9.4 percent of ship-generated oil discharges in 1973. This figure is much smaller than the one for discharges from tanker operations, admittedly, but accidents have severe environmental and safety impacts far more intense than operational discharges. Consider the opening paragraph of the National Transportation Safety Board's (NTSB) report on a tanker explosion:

On April 9, 1974, the tanker M/T ELIAS (Greek), while discharging crude oil, exploded, burned, and sank at the Atlantic Richfield Company Fort Mifflin Terminal on the Delaware River at Philadelphia, Pennsylvania. The ELIAS was destroyed; five crewmembers and three visitors were killed; four crewmembers and one visitor are missing and presumed dead. The tanker S/S STEININGER (Liberian) at the next berth was slightly damaged, and surrounding waters were polluted with oil. Damage to the ARCO terminal was estimated to be $2 million. The sunken hulk of the ELIAS obstructed use of the berth for 19 months.14

Explosions

Tankers are explosion-prone because of the cargo they carry, which is usually either flammable or combustible and which must be kept away from all sources of flame, sparks or extremely high temperatures. The cargo is most hazardous in its vapor
form, when it is mixed with oxygen in the air. The explosive range of petroleum vapors occurs between the Lower Explosive Limit (LEL), where the air-vapor mixture is too lean to burn, and the Upper Explosive Limit (UEL), where the mixture is too rich to burn. The oxygen content in the air, however, must be at least 11.0 percent by volume when the vapors are between the LEL and the UEL concentrations.

Explosive concentrations depend on several variables such as the type of oil, i.e., crude or refined products, the season of the year, the amount of empty space in a cargo tank and the method used to move cargo into or out of a tanker. Typical UEL and LEL concentrations for some petroleum oils and gases are shown below:

<table>
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<tr>
<th>Product</th>
<th>Lower (LEL)</th>
<th>Upper (UEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>1.3</td>
<td>7.6</td>
</tr>
<tr>
<td>Kerosene</td>
<td>0.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Kuwait Crude</td>
<td>2.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Ethylene Oxide</td>
<td>2.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Ammonia</td>
<td>15.5</td>
<td>27.0</td>
</tr>
</tbody>
</table>

A tanker is at its safest when it is either gas-free, i.e., empty of cargo and purged of all petroleum vapors, or loaded. A loaded tanker has little room in its tanks for vapors to accumulate; their atmospheres are too rich. Instead, explosions are most likely to occur when there is some type of cargo or tank cleaning operation being conducted. Then, vapors are exposed to air and can be ignited by an ignition source as seemingly inane as a crewmember dropping a metal tool on the main deck.

When the ELIAS exploded, it was discharging its load of crude. In its report, the National Transportation Safety Board documented ten different ignition sources for the explosion,
Fig. 4.-- The flammable envelope for concentrations of hydrocarbons. Hydrocarbon vapors are flammable in concentrations approximately between 1.0 percent and 12.0 percent by volume in air, as long as the oxygen content in the air is at least at 11.0 percent. Source: Rutherford, Tanker Cargo Handling, (London: Charles Griffin and Company, Ltd., 1980).
ranging from the operation of laundry equipment in the living spaces of the vessel to spontaneous combustion of an oily rag left on the warm deck. The hull and stern of the vessel were relatively intact after the explosion; major explosion damage occurred in the center surrounding the living spaces. Examinations after the accident showed that ventilation ducts from the living spaces were wasted, providing ample opportunity for crude vapors, which can travel considerable distances from a tank, to enter the living quarters and be ignited from several sources.

When vapors travel from a tank and are ignited, the flame front can travel back to the tank and explode it. To prevent this from happening, flame screens (also known as flame arrestors), of 30 X 30 mesh or smaller, are fitted on top of cargo tank openings. Heat from the flame dissipates on the screen material and the flame dies. Although these screens are vital safety devices, they are routinely removed to measure the remaining cargo in a tank. Sometimes, through carelessness, they are not put back on the tank top after measurements are taken. The NTSB report on the ELIAS infers that some of the flame screens must have been removed from the tank tops, causing ignited vapors to propagate back into the cargo tanks, because several tanks exploded in quick succession.

Collisions and Groundings

Although tanker explosions cause extreme damage, especially when they occur in port, collisions and groundings constitute about 56.0 percent of tanker accidents and account for 47.0 percent of the accidental outflows of oil into the oceans.

Collisions and groundings are examined together because
The failure to keep a proper lookout, both visually and by the use of radar, contributes to the cause of most collisions. An officer-on-watch is responsible for maintaining a proper lookout at all times; he has use of binoculars, radar, the compass and any electronic equipment for collision avoidance that is installed on the bridge, as well as unlicensed crewmen he can station on the bridge wings or on the bow to maintain a visual lookout. Yet collisions - even between two lonely ships in the middle of an otherwise empty ocean - continue to occur.

In his book Normal Accidents, sociologist Charles Perrow calls marine transportation an "error-inducing" system, in which operator error is often cited as the cause of accidents. Perrow argues that other components of the industry, such as the social organization of ship personnel, economic pressures, technological developments and difficulties of national and international regulation, also cause accidents to occur.

In the authoritarian structure aboard ship, the Captain is Master. While it is conceivable that a junior officer might question the Captain if he appears to be making an error in a close situation, it is unlikely that an unlicensed member of the crew would do such a thing. Just prior to the collision of the Chesapeake Bay in 1978 involving the Coast Guard training vessel CUYAHOGA and the freighter SANTA CRUZ II, the lookout and another seaman aboard the CUYAHOGA recognized the approaching danger, were befuddled by the Captain's apparent unconcern with it, yet did not re-report their sightings because there did not seem to be any point in notifying the Captain of the obvious. The Captain, however, had completely misinterpreted the situation,
thinking that the SANTA CRUZ II was a small fishing vessel proceeding along in the same direction as his own ship instead of being a several-hundred-foot-long vessel coming toward him on a collision course. There was multiple loss of life aboard the CUYAHOGA and complete loss of the vessel.

Economic pressures often develop, especially as marine transportation costs increase; tankers can cost between $30,000 and $50,000 a day to operate. The quietest time on a tanker voyage is the time at sea (although there may be tank cleaning and ballast shifting operations being conducted), and if a vessel is steaming at its maximum speed, there is not much more it can do to meet its scheduled arrival time. However, once a vessel arrives in port, pressure increases to get the cargo transfer completed and achieve the fastest possible turn-around time. This is when the crew is the busiest and several operations are going on at once. A ship's crew should be fresh and alert for departure from port; instead they are often exhausted.

Both collisions and groundings have occurred because of steering gear failures, when a vessel is at the mercy of the seas. Steering gear is the term given to a series of units involved in maneuvering a ship. It includes: (1) the wheel; (2) the steering engine-connecting device which transmits movement of the wheel to the engine; (3) the engine; (4) the helm, which transmits movement from the engine to the rudder; (5) the rudder; and (6) the rudder indicator, an instrument connected to a transmitter on the rudder stock so that rudder movement is shown on the indicator face at the steering station.

If any one of the steering units fail (except for the rudder indicator) the officer-on-watch must resort to an alternate
or emergency steering arrangement. Failures can occur without warning, leaving insufficient time to utilize alternative steering methods, and have been responsible for some of the most damaging tanker accidents. Failure of the steering gear on the 50,000 dwt AMOCO CADIZ caused this vessel to ground off the Brittany coast in March, 1978, and spill its full load of crude into the waters there.

A further cause of accidents is over-reliance on technological improvements in navigation equipment, inducing vessel operators to take more risks. To prevent collisions and groundings, other ships and shallow bottoms have to be seen in advance in order to be avoided. Radar and collision avoidance systems have improved one's capacity to see, but they have also encouraged Masters to steam full-speed ahead and trust technology to keep them from danger.

Structural Failure

Although they do not occur as frequently as collisions and groundings, structural failures, when they do occur, usually cause very large oil spills because the tanks become open to the seas.

This type of casualty can have one of several causes: welding or construction defects, poor design, metal fatigue or corrosion. Although three major studies conducted in the 1970s found a marked preponderance of structural failures among older vessels (the break-point being about fifteen years)\textsuperscript{24}, the newer, larger VLCCs and ULCCs have had significant structural problems as well.

A 1982 Position Paper by Exxon Corporation entitled "Large Oil Tanker Structural Survey Experience" documents the results
of a year-long program involving the largest tankers in the Exxon fleet. The Paper concludes that corrosion is the greatest problem facing the VLCC operator and that corrosion control systems, in the form of tank coatings, cathodic protection using sacrificial anodes, or both, must be installed in cargo tanks.25

Another conclusion put forth by Exxon is that reduced scantlings have reduced the corrosion margin of safety that the older tankers have. Scantlings, the dimensions of the steel used in the construction process, were reduced by Ship Classification Societies26 as the quality and strength of steel improved, and as vessel design improved. The hulls of newer tankers are considerably thinner and, as Exxon reports, have a lower tolerance for corrosion. Exxon's recommendation regarding this problem is not to increase the scantlings, but to "establish more rigorous standards and procedures for ongoing surveys of all tankers to detect conditions that could affect their structural integrity and pollution-free operation". Exxon prefers the cost of surveys and steel plate renewals to the added costs of constructing thicker hulls.

A final word about tanker accidents is that no matter how safe an operator might be, unless everyone is playing by the same rules, one always has to look out for the other guy. Perrow sums it up well when he says:

"The safe, well-designed Shell tanker can still be rammed by an itinerate cargo ship with a long list of violations; better radio communication can mean less communication because of the chatter; collision avoidance systems are swamped by higher speeds; larger tankers, which would reduce occasions for arrivals and departures where
the biggest dangers lie, mean more and bigger explosions because of mysterious processes inside the huge tanks..."27.
EARLY ATTEMPTS AT INTERNATIONAL STANDARDS

The purpose of international standards for tanker safety and pollution prevention is to ensure that all nations play according to the same rules.

The International Maritime Organization (IMO), established by the United Nations in 1948, is charged with fostering maritime safety generally and encouraging compliance with international maritime conventions.

International Convention for the Prevention of Pollution of the Sea by Oil - 1954

The Pollution Convention of 1954 regulated operational discharges, i.e., those resulting from normal tanker operations in port and at sea. It prohibited deliberate discharges of oil or oily mixtures containing 100 ppm or more of oil in designated zones which included all areas 50-nautical miles (nms) from the coast, certain special areas defined in Annex A of the Convention, and any area within 100-nms from the nearest land along the coast of a nation which had declared such a zone. Both tankers and non-tankers alike were required to carry an Oil Record Book onboard to record the loading and discharging of all fuel and cargo oils.

1962 Amendments

By 1962, when an amending conference was convened, the operational pollution problem was much worse. The 1954 guidelines had backfired; because there were undesignated zones in the mid-
dle of the Mediterranean Sea, tankers running between North Atlantic ports and the Middle East discharged their slops in these zones - at an approximate rate of one million tons of crude oil per year.\textsuperscript{30} Other conference participants were able to document increasing oil pollution off their coasts.

The solution proposed in 1962 was to extend the prohibited zones from 50 to 100-nms for new ships greater than 10,000 dwt. New ships were defined as those "...for which the building contract is placed on or after the date on which [the Convention would come into force]."\textsuperscript{31}

The effectiveness of the 1954 and 1962 Conventions depended on the availability of oil reception facilities, i.e., receiving centers in ports to take a vessel's dirty ballast, slops, and oily residues, treat them, and reclaim the oil.\textsuperscript{32} These facilities required considerable investment and their profitability was questionable. Countries were not inclined to require their domestic oil industry, nor the government itself, to provide them.

Industry response at this point in time is worth noting. Industry sensed the growing, global efforts to regulate tank vessels, and it responded by seizing the initiative and adopting practices which appeared to achieve the same objectives as international regulations.

Instead of developing reception facilities in ports\textsuperscript{33}, industry, led by Shell Oil in the mid-60s, began using the LOT system. LOT actually violated the provisions of both the 1954 Pollution Convention and the 1962 Amendments to it; it was almost impossible to pump out the water in cargo tanks without exceeding the 100 ppm limit of oil when the oil-water interface
was reached. But the international maritime community chose to look the other way. Industry was strong; public awareness of the issues was weak in the 1960s. By 1969, LOT was accepted as the best available method of oil pollution control.

1969 Amendments

Amendments to the Pollution Convention in 1969 provided for the use of LOT as long as the following conditions were met:

(i) the tanker was proceeding en route;
(ii) the instantaneous rate of discharge of oil did not exceed 60 litres per mile;
(iii) the total quantity of oil discharged on a ballast leg did not exceed 1/15,000 of the total cargo-carrying capacity; and
(iv) the tanker was more than 50-nms from the nearest land when it discharged.34

Simple mathematics demonstrates that if clingage on a crude oil tanker was 0.4 percent, and it could not discharge more than 1/15,000 of its cargo, it would have to retain about 98.0 percent of its slop oil onboard under the 1969 Amendments. These Amendments, however, did not mandate reception facilities - under Article VIII, governments were required to "take all appropriate steps to promote the provision of facilities."

Much has been written about IMO's inability to be effective in international maritime affairs. Some observers make more serious charges, that IMO "has been regarded by many people as a forum dominated by shipowners who want to minimize their capital outlay and operating costs despite the greater risk of chronic pollution and accidents."35 But IMO's actions, especially in the 1960s, can also be seen as weak, reactionary standard-set-
ting on the part of a relatively young regulatory body appointed to watch over a wealthy, cutthroat industry. The industry could, and did, overwhelm IMO whenever it took the initiative—as was seen in the LOT issue, and as will be examined later in the crude oil wash issue.

1971 Amendments

One of the first of the construction/design regulations to be discussed in the 1970s was the limitation of cargo tank size. The 1971 Amendments were aimed at reducing the oil pollution from accidental causes; by setting limits on the size of tanks, the hypothetical oil outflow that would result in the event of a collision, for example, that ruptured a vessel's tanks, would be reduced.

A pattern developed in these negotiations that continued years later when other construction/design regulations were suggested. Those against a proposed regulation would cite studies that proved exorbitant costs would result and safety margins would decrease if it were adopted. Those in favor would show studies indicating that the costs were not so significant, and that vessel safety and pollution prevention would increase. The final proposal would, of course, be a compromise.

The French and the Japanese, able to accommodate ULCCs in their ports, wanted no size limitations on tanks; they cited studies showing that the proposed size limitations would add over 10.0 percent to construction costs of tankers and would increase the risk of explosion due to increased surface and corner areas within the cargo tanks. The U.S. and the U.K. studies showed actual construction costs would increase 2.0 to 3.0 percent.
The compromise which was finally chosen was to restrict cargo tank size on tankers up to 400,000 dwt, but to allow increasingly larger tanks for tankers above that size.\textsuperscript{37}

The significance of the 1971 Amendments was that a regulatory measure to intervene in the building process of a tanker, to reduce oil pollution, was unanimously approved and had a definite impact: vessels for which a building contract was signed after January 1, 1972 were required to comply with the resolution. Tanker tonnage on order had been increasing steadily throughout the early 1970s and reached a peak at 200 million dwt in 1974. The impact of the tanker size limitation, regulation, was great.

1973 Convention for the Prevention of Pollution From Ships (MARPOL)

In the early 1970s, only the 1954 Convention and the 1962 Amendments were in effect, the latter having received the required number of state ratifications in 1968. LOT, of course, was in use even though the 1969 Amendments regarding it did not take effect until 1978. The 1971 Amendments regarding cargo tank sizes were not in effect, but they were being complied with as new ships were constructed. Under this sketchy international regime, oil pollution and tanker accidents continued to increase.

In 1973, in London, another IMO-sponsored conference was convened, this time to address operational oil pollution.

Up until this time, the U.S. was against expensive pollution controls, favoring voluntary cooperation between government and industry in establishing zones where the dumping of oily ballast and tank washings was prohibited.\textsuperscript{38} By the early 1970s, however, environmental awareness peaked, demonstrated by the es-
Fig. 5.--Worldwide tonnage on order in the 1970s. Orders for tankers peaked in 1974 at 200 million deadweight tons, but began a decline dramatically in 1975. Source: Meese, "When Jurisdictional Interests Collide: International, Domestic and State Efforts to Prevent Vessel Source Pollution," Ocean Development and International Law (12:1/2) 1982.
establishment of the Environmental Protection Agency and by the enactment of environmental legislation such as the 1972 Federal Water Pollution Control Act Amendments, the 1972 Coastal Zone Management Act and the 1972 Marine Protection, Resources and Sanctuaries Act. Vessel-source oil pollution was high on the list of concerns and, in a message to Congress in May, 1970, President Nixon urged the secretaries of state, commerce, and transportation to press for effective multilateral action, demanding "more effective international standards for both the construction and the operations of tank vessels." The role of the U.S. in international conferences changed; instead of favoring a laissez-faire policy with the oil industry, it began advocating stricter regulatory control over it.

Dissatisfied with LOT because it could not be enforced, and because it was not being used as widely as had first been expected, the U.S. delegates went to London with a recommendation for segregated ballast tanks on tankers to prevent operational oil pollution. Segregated ballast tanks (SBTs) kept ballast water clean by using independent pipes, pumps and tanks, segregated from the cargo system, to take on and carry ballast. After intense debate, a compromise was reached. Resolution 13 of the MARPOL Convention required segregated ballast tanks for all new tankers greater than 70,000 dwt. This was the second major construction/design requirement agreed to in an international forum; although it was estimated to cost more than the cargo tank size limitation requirement approved in 1971, its scope was much smaller because it only affected tankers over 70,000 dwt built after 1976. By then, the tanker-building boom was over.

Other resolutions developed from this 1973 Conference, but
they were hardly different from the resolutions from previous conferences. Once again, reception facilities were addressed; Resolution 12 required reception facilities for all ports where tankers and nontankers would have to discharge oily wastes. But there was no agreement as to who would be responsible for providing the facilities, and no mandatory requirement for them. "Special areas" were permitted to be created under Resolution 9 of the Convention. The Mediterranean, Baltic, Black and Red Seas were to become special areas where no oily discharges were permitted. There was an important caveat, however. A special area could only become one after there were sufficient reception facilities for the vessels transiting these seas. The onus was on the littoral states who were suffering the ill effects of oil pollution - not on the oil transportation industry that was causing them.

**Safety of Life at Sea Conventions**

The first International Convention for the Safety of Life at Sea (SOLAS) was created in 1948; the second was created in 1960; the third, created in 1974, is now in force today.

SOLAS Conventions lay down the basic international standards relating to the navigation of all ships on the high seas and, although they have as their prime objective the saving of life, it is clear that they are directly relevant to the prevention of collisions and strandings, and so are environmentally important. There were no particular regulations relating to tankers in the 1960 SOLAS Convention, but by the time the third one convened in 1974, special regulations regarding tankers were considered and adopted.
Part E, Chapter II of the Convention addressed construction requirements for fire protection aboard tankers. Tankers built on or after the date of coming-into-force of the Convention, greater than 100,000 dwt, had to have fixed systems onboard capable of combating fires and explosions in cargo tanks. Two systems are required; they are detailed in Regulations 61 and 62 of the Convention, and they include a fixed deck froth system and an inert gas system, respectively.

The fixed deck froth system was to be operated by ship personnel to control fires on the decks of tankers. Fire-fighting froth, or foam, would be hosed onto the deck from fixed monitors or applicators. This was a relatively inexpensive system; foam was merely injected into the vessel's already existing fire-fighting system of pumps and on-deck piping. Most tankers were equipped with a working deck froth system, anyway.

The inert gas system, however, was much more complex and more expensive. It is fully described later in this study. Most countries participating in the conference believed that it was the only effective method for preventing explosions on tankers, but they did not believe that its high installation and operating costs could be justified on smaller ships.

Summary

Although international regulations concerning tanker safety and pollution prevention were developing in the 1960s and 1970s, it was at a much slower rate than that for the number of oil spills and tanker accidents. The successful attempt to reach agreement on construction/design standards, however, made it more likely that similar standards could be developed in the future.
Standards developed through international conventions are typically very general ones that facilitate agreement among sovereign nations. Domestic standards, in contrast, are more specific; a nation develops rules and regulations by which all must abide, and enforces them upon everyone within its territory.

Development and enforcement of standards on pollution prevention and tanker safety is the bailiwick of the U.S. Coast Guard, within the Department of Transportation. These standards are codified into federal regulations under Title 33, Navigation and Navigable Waters, and Title 46, Shipping. Although the regulations overlap, pollution is generally covered under Title 33 and tanker safety is covered under Title 46.

Pollution Prevention

Coast Guard authority to regulate tankers was greatly expanded in 1972 with the passage of the amendments to the Federal Water Pollution Control Act (FWPCA)\(^4\). The FWPCA had set water quality standards and provided technical assistance and funds to encourage state and local pollution control programs. The emphasis had been on addressing oil in the water after, not before, it had been spilled. But the 1972 Amendments, known as the Ports and Waterways Safety Act (PWSA)\(^\text{42}\), provided for the direct control of vessels to reduce the likelihood of spills.

Under Title II of the PWSA, the Coast Guard received a mandate to create regulations for ship design, construction, alteration and repair with the express purpose of protecting the marine
environment. Under Title I, it received authority to control the movement of vessels in ports and in areas where hazardous conditions existed.43

Although the 1972 PWSA provided this legislative groundwork for preventive control over vessel-source pollution and for improved safety equipment, the Coast Guard hesitated in using the authority to establish stricter standards than those in effect at the time. The Chief of the USCG Office of Marine Environmental Protection expressed a common Coast Guard opinion in 1973 when he said:

"I would like to see exclusively international standards that all ships, regardless of their owner, regardless of their builder, would have to comply with; I feel that this is the best way of reducing pollution in the oceans. I also feel that this is the fairest way to allow ships of all flags to compete equally."44 (Emphasis added.)

The U.S. was an active participant in ongoing IMO-sponsored international conferences on marine safety, and the U.S. representatives were none other than senior Coast Guard officers. The Coast Guard headed U.S. delegations for the 1973 Law of the Sea Conference, the 1973 MARPOL Convention and the 1974 SOLAS Convention. Rear Admiral R.Y. Edwards, USCG, for example, was a member of the U.S. delegation to IMO on numerous occasions and served as Chairman of the IMO Council for four terms. He was elected president of the IMO Assembly in 1979.45

The political pressure on the Coast Guard was great. Its top officers were deeply involved in the 'quid pro quo' of international negotiations, yet they were being prodded by Congress and the American people to exceed international standards so that
other nations would follow suit. As a further complication, industry was quick to protest stricter standards that would put them at an economic disadvantage in the international marketplace.

**Tanker Safety**

Instead of using Title II authority it had gained from the 1972 PWSA to regulate vessel construction, design, etc., above international standards (if necessary), the Coast Guard concentrated on Title I of the Act and began to develop vessel traffic control systems in U.S. territorial waters. In a 1973 study entitled "Analysis of Port Needs", the organization evaluated all vessel casualties between 1967 and 1972 and rank-ordered 22 U.S. waterways according to each one's need for some form of vessel traffic control.46

As a result of the study, the Coast Guard began establishing vessel traffic systems (VTSs) that ranged from passive-type traffic separation schemes to active, advisory-type traffic surveillance systems using television and high resolution radar. There was already a law in effect, unique to American navigable waters, which required operators of vessels greater than 300 gross tons to maintain a listening watch on VHF radio while underway.47 This regulation enabled VTS personnel to keep in constant touch with vessel operators.

VTSs were not established solely to improve tanker safety, but to improve maritime safety generally, tankers included.

By 1977, only a few systems had been established. Simple, voluntary traffic separation schemes were operating in New York, Los Angeles and Seattle, and an advisory system was in effect in San Francisco Bay. While these systems relieved some of the
congestion in heavily transited waters, and therefore had a positive effect on accident prevention, they were not far-reaching enough; offshore pollution from tanker operations, and accidental spills from collisions and groundings outside the controlled areas remained unaffected by the creation of vessel traffic systems.

Summary

Domestic laws on tanker safety and pollution prevention, because they were developed largely from inadequate international standards, were inadequate as well. The move by the Coast Guard to regulate vessel traffic in busy U.S. ports circumvented this problem for a time, but did not solve it.
THE CARTER INITIATIVES

The most significant international standards on tanker safety and pollution prevention, SOLAS 74 and MARPOL 73, had not yet been ratified by the late 1970s. Some countries, however, taking their cue from the IMO, had incorporated the requirements into their domestic laws; the U.S. was one of them. But a series of tanker accidents in late 1976 and early 1977 caused the roles to be reversed among the international and national players - this time the U.S. acted, and it became the country from whom the IMO took its cues.

In his message to Congress on March 17, 1977, President Carter announced six measures designed to reduce the risks associated with tanker transportation. They included:

1. Ratification of MARPOL 73 and SOLAS 74 by the U.S. Congress;
2. Improvement of crew standards and training;
3. Development of a tanker boarding program and a Marine Safety Information System;
4. Approval of strict liability legislation for oil spills;
5. Improvement of federal ability to respond to oil pollution emergencies; and
6. Reform of ship construction and equipment standards.48

It is this last measure, the reform of ship construction and equipment standards, that will be examined in the following pages. These were the most controversial recommendations because they were costly and affected all maritime countries.

President Carter instructed the Secretary of Transportation
to develop new rules, applying to all tankers - U.S. and foreign - of 20,000 dwt and above, which called on American ports. The regulations included:

- Inert Gas Systems on all tankers;
- Double Bottoms on all new tankers;
- Segregated Ballast on all tankers;
- Improved Emergency Steering Standards on all tankers; and
- Backup Radar Systems, including Collision Avoidance Systems, on all tankers. 49

Each of these systems, as determined by the interagency task force which developed them, was to improve tanker safety or promote pollution prevention.

INERT GAS SYSTEMS

An inert gas system (IGS) is designed to improve tanker safety by preventing the possibility of an explosion in a cargo tank.

Explosions (or fires) can only occur if there are three elements in a tank: an ignition source, flammable material, and oxygen in correct proportion to the volume in the tank.

As discussed in an earlier part of this study, ignition sources are varied and can occur easily during tanker operations. Lightning has caused tank explosions; static charges set up by the flow of a stream of water onto a tank bulkhead have been suspect of causing explosions also. 51 Flammable materials are always present on tankers unless the entire vessel is gas-free - a rare occurrence if a vessel is in service carrying oil. The only positive way to avoid the possibility of fire or explosion is to ensure that the oxygen content is below the level which would enable ignition to occur. 52
An IGS uses exhaust gases from a ship's boilers, or inert gases from a generating plant installed on the ship, to blanket the cargo in each tank, thereby creating an oxygen-deficient atmosphere. Boiler exhaust gases can be expected to have approximately the following components:

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>12.0 to 14.5% by volume</td>
</tr>
<tr>
<td>Oxygen (O₂)</td>
<td>2.0 to 4.0%</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO₂)</td>
<td>0.2 to 0.3%</td>
</tr>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>Traces</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOₓ)</td>
<td>Traces</td>
</tr>
<tr>
<td>Water Vapor</td>
<td>2.50 mg/m³ (Maximum)</td>
</tr>
<tr>
<td>Solids</td>
<td>Traces, in the form of soot</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>Balance (about 80% by volume)</td>
</tr>
</tbody>
</table>

Similar proportions will result from inert gas generators, although the SO₂ content will be considerably lower if a low-sulphur fuel is used.

Before inert gas can be piped into a cargo tank, it must be cleaned of its corrosive solids and sulphur dioxides, and cooled. This is done in the scrubber, a compartment stacked with ceramic or quartz filters and capped with a saltwater spray system, that cleans the gas and leaves the corrosive particulates behind. A demister is fitted to the far end of the scrubber to remove the entrained water from the gas after it has been cleaned. The inert gas is then sucked through high velocity fans, or blowers, and a series of non-return valves and seals, to prevent backflow into the boilers.

There are two blowers in the IG system; together they must provide at least 125 percent of the ship's total cargo pump capacity, so that if cargo is being discharged there will be sufficient pressure in the system to keep the tank inerted while the discharge operation is being conducted.

The IG main distribution line runs the length of the ship.
Fig. 6.-- Diagram of major components of inert gas system. Source: Video Library Systems, Inc., Tanker Operations, New York, 1982.

Fig. 7.-- Two methods of atmosphere replacement. With dilution, the hydrocarbon gases are mixed with inert gas coming in through high velocity lines, whereas displacement involves slow, steady streams of inert gas layered on top of the hydrocarbon gases in the tank to gradually push them out. Dilution utilizes venting from the top of the tank while displacement uses a purge pipe that vents from the bottom of the tank. Source: Video Library Systems, Inc., Tanker Operations, New York, 1982.
It is fitted with pressure/vacuum valves to prevent excess pressure (which would cause a tank explosion) or excess vacuum (which would cause a tank implosion or collapse). Branch lines run off the main to carry inert gas to individual cargo tanks. Each tank is fitted with an isolating valve so that it can be isolated for maintenance, guaging of cargo or any other routine operation. Venting is accomplished either through individual tank vents, or back through the branch lines into the main and up a common mast riser above the deck.

The IGS can be used in three different operations: inerting, purging and gas-freeing. The purpose of inerting a tank is to make it non-explosive by getting the oxygen content below 11.0 percent. Without sufficient oxygen, combustion, or an explosion, can not occur. The inerting operation is conducted in port while the vessel is discharging its cargo. As the cargo level goes down in the tank, inert gas is piped in from the top to blanket it.

Purging operations are conducted on already-inerted tanks to get the hydrocarbon concentrations down below the Lower Explosive Limit. Inert gas continues to be piped into the tank until, either by dilution or displacement, the LEL is below 2.0 percent. Purging is really an intermediate step to gas-freeing; once a tank is purged, fresh air can safely be blown into a tank without the danger of an explosion. A tank is totally gas-free when its oxygen level is back up to 21.0 percent.

**IGS Proposals**

At the time of the Carter Initiatives, international agreement had already been reached on the requirement for IGS on
tankers of 100,000 dwt and above, at the 1974 SOLAS Conference. The Convention, however, was not yet in effect because it had not been ratified by the required number of countries. At the urging of the IMO, many countries had already codified the requirement into their domestic laws. The U.S., for example, published final rules on the IGS requirement in January, 1976.

Although there were significant installation costs connected with the system, proof if its effectiveness, if properly used, in preventing explosions, was undeniable. The U.S. Navy had used an inerting system for decades when it had carried its most volatile petroleum products. Sun Oil Company, too, had developed its own inerting system and had been using it on the Sun Tanker Fleet since the 1920s, with no incidences of tank explosions since that time.54

So in the wake of the serious tanker explosions of the middle 1970s, especially on vessels less than 100,000 dwt, IGS was generally accepted as a vital solution to the problem. The U.S. proposal for IGS on new and existing tankers of 20,000 dwt and above was expected to meet with little controversy.

DOUBLE BOTTOMS

Of the various construction and equipment recommendations announced by Carter, the most controversial was the call for double bottoms on all new tankers. New tankers, as defined in the package proposal that the Coast Guard developed after the announcement of the Initiatives, were those constructed under a contract awarded after December 31, 1979; all other vessels would be existing vessels.

Double bottoms are tanks in the bottom of a ship, located
between the hull plating and an inner bottom plating. They have so many advantages for conventional ships, i.e., passenger vessels, freighters and ore carriers, that few are constructed without them. In fact, conventional vessels greater than 300 feet are required to have double bottoms, while tankers, small ships and other special-type vessels are not.

Double bottoms strengthen a ship's hull, making it well-adapted to withstand the upward pressure from the sea and the bending stresses from the ship's cargo reacting with the force of the waves. They provide space for the storage of liquids, such as fuel oil, ballast and fresh water. And finally, they can provide a margin of safety in case of a grounding - as long as the inner skin is not punctured, the vessel will still float.

Tankers are not required to have double bottoms because their internal structural members can provide adequate strength. There are not the same design constraints on them as there are on cruise ships and freighters - no need for rooms with a porthole view nor for flat-bottomed floors. Stiffening bars and bulkheads can be laid out all along the cargo tanks, and the oil will simply flow around them.

The Controversy

Increasing instances of tanker groundings which caused significant oil spills suggested that double bottoms might be an effective pollution prevention device for tankers. The U.S. first proposed this at a 1970 meeting of the NATO Committee on the Challenges of Modern Society, and then lobbied for a double bottom requirement at the 1973 MARPOL Convention. This proposal was defeated by a majority at the Convention.
Fig. 8.-- Single bottom and double bottom. A tanker with a single bottom has more surface area to which oil can cling. Double bottom tankers have smooth cargo tank floors. Source: Sullivan, *Supertanker!*, (New York: Dodd, Mead & Company, 1978).
Proponents of double bottoms argued that the standard would reduce operational discharges. Pump suctions could be located on the very bottom of a cargo tank, with piping running through the double bottoms, providing much better drainage than that offered by the bellmouth suctions in use. Also, sludge would not be trapped as easily in a tank because the strength members could be located on the underside of the inner plating in the double bottoms.

Likewise, accidental spills would decrease. Groundings would not always involve an oil spill if a vessel was equipped with double bottoms because of the approximate six-foot margin of safety provided by them. Structural failures would be reduced due to the added strength and extra support from the inner plating.

Arguments against double bottoms on tankers concerned safety, salvage and costs.

If the inner skin leaked, the opposition argued, there was a potential for a build-up of explosive gases. The compartments would require special venting arrangements and would need to be inspected and cleaned.

In the case of a grounding, punctured double bottoms would fill with water and cause a tanker to lose buoyancy, making the salvage efforts more difficult. This argument was not a solid one, however, because it could also be said that a firmly grounded tanker was easier to salvage than one that was only partially grounded and swinging about on the water's surface.

The question of costs was hotly debated in the 1970s. During the period 1970-75, estimates for the increased cost of double bottoms ranged from three to twenty-two percent of the cost of a
vessel's construction. 57

By the time the Carter Initiatives were announced, the subject had been bantered about for over seven years. The Coast Guard itself had reversed its opinion in 1975 and was skeptical about the advantages of double bottoms on tankers. Industry and the maritime countries in Europe had long been opposed to the measure.

An IMO working group met in October, 1977, to prepare a basic working document for the upcoming international conference. 58 It was here that the double bottoms proposal was decidedly rejected. In its place was a call for protectively located segregated ballast tanks (PL/SBT). With little hesitation, the U.S. delegation altered its proposal in accordance with this alternative, and did not push for double bottoms at the conference. It did, however, submit that the double bottom concept had merit and should be considered when deciding where to locate segregated ballast tanks.

SEGREGATED BALLAST TANKS

Segregated ballast tanks (SBTs) are tanks constructed and used solely for the carriage of ballast. The tanks are coated, and they are served by separate piping and pump arrangements; the total cost of SBT includes these initial installation costs as well as costs associated with the decrease in cargo-carrying capacity on the tanker.

SBT is aimed at decreasing operational oil pollution by eliminating oil contamination of ballast water. A ship would be required to have an adequate number of tanks dedicated to segregated ballast so that it would never have to ballast cargo
tanks except in the most severe weather. But SBT can also reduce accidental oil pollution by being protectively located, i.e., located within the cargo tank length of a tanker, outboard of or below the cargo tanks. If they are protectively located outboard of cargo tanks, as wing or side tanks, they would reduce accidental outflows resulting from collisions or rammings. If they are protectively located below the cargo tanks, as double bottom tanks, they would reduce accidental outflows resulting from groundings.

The SBT Controversy

There was little argument that SBT would decrease operational pollution, and the protective location of the tanks was a logical consideration; but, the costs, except on the larger tankers, was considerable. International agreement on the SBT requirement for new vessels of 70,000 dwt and above had been relatively easily reached at the MARPOL 73 Conference because the associated costs could be recouped during the good operating years of the vessel. President Carter's recommendation, however, to require SBT on both new and existing tankers of 20,000 dwt and above, were a serious threat to the older, smaller tankers in the world fleet. These ships did not have many good operating years left in them. They would not have the chance to recoup retrofitting costs - those costs of undergoing extensive alterations in a shipyard. Their small size already put them at a disadvantage in an industry where economy of scale was a big consideration - further cuts in cargo-carrying capacity would ruin them. Even the larger tankers in existence were threatened with prohibitive costs.

Prior to the 1978 International Tanker Safety and Pollution
Prevention Conference, the oil industry presented the U.S. and IMO with an alternative to SBT that, it claimed, would be just as effective in reducing operational oil pollution: crude oil wash.

CRUDE OIL WASH

Like the introduction of load-on-top a decade earlier, crude oil wash (COW) was a product of the commercial dexterity of the oil industry. British Petroleum and Exxon developed the system in the early 1960s, and now in the late 1970s they offered it as the alternative to segregated ballast tanks.

The System

A crude oil wash system makes use of the ship's cargo of crude oil to wash down the overhead, bulkheads and bottom of the cargo tanks, cleaning these surfaces of the sediment, sand and oil that accumulates there in the form of sludge. A pump draws crude oil from a designated tank, carries it through fixed piping on deck and delivers it to one or more rotating nozzles in each cargo tank, where it hits the tank internals at pressures greater than 100 psig.

The rotating nozzles are run by washing machines, most of which are mounted on deck. There are submerged machines as well; they spray up from the bottom of the tank.

The fixed portion of a deck-mounted machine is clearly visible on deck and is usually of the programmable type, i.e., the angle of spray, the cycle speed and the rotation pattern for the nozzle can be adjusted. Submerged machines are normally non-programmable.

One full cycle is the path traced by a nozzle from its up-
Fig. 10.--Typical crude oil wash system. Crude is pumped through a main line which branches off to each deck-mounted machine and into nozzles located within the tanks. Source: Video Library Systems, Tanker Operations, New York, 1982.

Fig. 11.--Washing cargo tanks. On programmable machines, the angle of spray can be adjusted to perform both top washing and bottom washing operations. Source: Video Library Systems, Tanker Operations, New York, 1982.
permast position to its lowest position, while rotating through 360°. The size and structure of the tanks will determine the number of cycles necessary to clean them. Tank tops are most easily cleaned, due to gravity, and require fewer cycles than the bottoms. But there are also numerous shadow areas in the tanks - areas not hit by direct impingement of the crude oil due to interference from internal structural members - that can only be cleaned by jet deflection or splashing. For this reason, wing tanks, with their greater amount of internal structural members, are more difficult to clean than center tanks.

The two methods of COW are the single-stage and the multi-stage methods. In the single-stage method, the tank is emptied of the bulk of the cargo before COW begins. In the multi-stage method, COW begins after the cargo has fallen below the level of the tank washing machines. The nozzles are adjusted to spray at decreasing angles as the cargo level goes down in the tank. With the tank nearly empty, bottom washing starts where top washing left off. The cycle is repeated several times as the residue is pumped out through the stripping pumps.

Advantages of COW

Crude oil is considered to be a more effective cleaner than the heated water that has been used to clean tanks. Instead of water scrubbing the tank internals, the crude cuts the oil residues from tank surfaces and puts them back into suspension, enabling them to be discharged along with the cargo.

The normal amount of crude oil cargo remaining in the tanks after COW is less than 0.085 percent of the total volume of the tank, compared to the 0.4 percent or more that is normally left
after water washing, or butterworthing. For a tank carrying 250,000 gallons of crude (about the amount carried by a 70,000 dwt tanker) this translates into reclamation of almost 800 gallons, or approximately 80.0 percent of what would have normally remained in the tank after butterworthing. For this reason, COW is considered to be practically as effective as segregated ballast tanks in reducing operational oil pollution resulting from ballasting operations.

Further, as industry pointed out, SBT had no effect on operational oil pollution caused by tank cleaning and cleaning associated with shipyard entry. The tanks still had to be cleaned. COW, however, would decrease the amount of oily emulsions resulting from these two operations as well.

Industry was willing to put up with the disadvantages of COW if it was allowed as a substitute for SBT. For example, retrofitting costs for COW installation on existing ships averaged about $1 million per ship (although this was still cheaper than the costs for SBT, which could run from $2 to $3 million for installation). There were also the added costs that resulted from increased port time for vessels. COW could only be conducted while a vessel was off-loading cargo. A vessel which normally took twenty hours to discharge its load would require another ten hours to operate COW while discharging.

Industry and the European maritime countries geared up to present an attractive proposal at the 1978 Tanker Safety and Pollution Prevention Conference that would allow COW to be utilized in place of SBT on crude oil tankers.
IMPROVED STEERING STANDARDS

The entire steering gear assembly runs the length of a ship, from the control station on the bridge to the motors, helm and rudder in the steering compartment at the stern.

The major steering gear improvement proposed by the U.S. was the requirement, on existing ships, for either manning of the steering compartment, or the provision of two separate and independent steering gear control systems. The requirement for new ships was higher; the U.S. proposed either manning, or the provision of two or more independent units including both the control components and the power components. Additionally, there was a requirement for an audible and visual alarm installed in the pilothouse, and powered by a source separate from the source supplying power to the steering gear, that would automatically activate in the event of a failure, for all ships.

The reasoning behind these equipment requirements, or in the alternative, these manning requirements, was that there could be an immediate response to a steering gear failure. In a manned steering gear compartment, a crewmember could immediately activate an emergency steering system or remedy a problem; if two independent systems were available, the alternate system could be activated from the pilothouse (bridge) in response to the audible/visual alarm.

The Controversy

The requirement for manning of the steering gear compartment was a very unpopular proposal for two reasons: (1) there was no method of enforcing such a requirement, and (2) there was no training program included along with the proposal. Yet the
other U.S. proposal, the requirement for two differential control units on existing vessels, was just as unpopular.

Steering gear designs on foreign vessels were different from most U.S. designs. Many were powered by two hydraulic pumps working together, instead of singly as in U.S. designs. Duplication of pump control was difficult to design for foreign vessels so that both systems could operate in tandem over the full range of control.63

COLLISION AVOIDANCE SYSTEMS

Collision avoidance systems (CAS) process data from radar aboard ship and theoretically give back enough information to the vessel operator so that collisions can be avoided in time. The system reads the vessel's radar, gyrocompass and speed indicator to determine its own ship's course and the courses of any other ships picked up on the radar screen. It sounds alarms when any ship gets too close, and the more sophisticated models recommend alternative courses to avoid collision.

When CAS was recommended in 1977 the technology for it was still quite new, although the U.S. Maritime Administration (MARAD) had been requiring CAS installation on all subsidized American vessels since 1970.64 MARAD specifications for CAS were extremely complex, however, and despite the fact that U.S. studies indicated that CAS could make dramatic contributions to tanker safety65, other maritime countries wanted to delay requirements for CAS until the specifications could be considered separately, and then standardized by the IMO.

CAS met the same fate as the U.S. proposal for double bottoms: it never made it to the conference floor. Instead, at
the working session in October, 1977, preceding the 1978 Tanker Safety and Pollution Prevention Conference, CAS was shelved pending development of an internationally-approved set of specifications and a common performance standard. 66
GENERAL PROVISIONS

The Carter Initiatives proposed international action to improve tanker safety and pollution prevention. The international response, made by the IMO, was to convene an International Conference on Tanker Safety and Pollution Prevention (TSPP) in February, 1978, in London. Conference participants agreed that all resolutions would be packaged into Protocols, because the two major conventions which had already been developed to address these issues, SOLAS 74 and MARPOL 73, had not yet been ratified. Protocols, legal instruments designed to enable changes to be made to conventions which are not yet international law, were used so that further improvements could be developed without having to wait for the entry-into-force of the conventions.

All safety-related resolutions would come under the 1978 Protocol to SOLAS 74, and all pollution-related resolutions would come under the 1978 Protocol to MARPOL 73. When a country ratified SOLAS 74, for example, it would be ratifying the Convention in its entirety, i.e., including the 1978 Protocol. The Protocol would automatically come into effect one year after the entry-into-force of the parent Convention.

Polarization of Participants

Fifty-eight countries attended the 1978 TSPP Conference - twenty-two from the developed Western group, four from the East European bloc, and thirty-three developing countries. At one
extreme, opposing retrofitting of SBT on existing tankers, were the oil companies. The United Kingdom was the leader of this group, and the allies included the majority of the developed European countries and the developing countries of Africa and South America, as well as the Soviet bloc.

The U.S. led the environmentalists, although its allies had commercial, not environmental, interests. Norway, Sweden and Greece, for example, supported a resolution for the retrofitting of SBT on existing tankers because of the shipyard work it would generate, and because of the laid-up tankers that would be brought back into service to make up for the loss in cargo-carrying capacity.

There were also some countries present who favored a compromise; they included Japan, Liberia, France and Kuwait. They had substantial tanker fleets, so they were concerned about the economic hardship that retrofitting would cause, but they were also facing a slump in tanker trade; the prospect of extra tonnage was attractive.

PROTOCOL OF 1978 RELATING TO MARPOL 73

There were five sections to the MARPOL 73 Convention but only the first section, Annex I - Regulations for the Prevention of Pollution by Oil, was affected by the 1978 Protocol. These changes incorporated some of the recommendations from the U.S., and rejected others.

The construction and equipment requirements regarding pollution prevention were contained in Regulation 13 of the Protocol. The oil industry scored a major victory in that COW was accepted as an alternative to SBT on existing crude oil tankers.
A simplified picture of the requirements in the Regulation follows:

For NEW VESSELS:

<table>
<thead>
<tr>
<th>Product: 20-30 dwt</th>
<th>Required: NONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product: 30+ dwt</td>
<td>PL/SBT</td>
</tr>
<tr>
<td>Crude: 20+ dwt</td>
<td>PL/SBT and COW</td>
</tr>
</tbody>
</table>

For EXISTING VESSELS:

<table>
<thead>
<tr>
<th>Crude: 20-40 dwt</th>
<th>Required: NONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product: 20-40 dwt</td>
<td>NONE</td>
</tr>
<tr>
<td>Product: 40+ dwt</td>
<td>CBT or SBT by 1982</td>
</tr>
<tr>
<td>Crude: 40+ dwt</td>
<td>SBT or COW by 1982; CBT can be substituted for SBT until 1986</td>
</tr>
<tr>
<td>Crude: 70+ dwt</td>
<td>SBT or COW by 1982; CBT can be substituted for SBT until 1984</td>
</tr>
</tbody>
</table>

The concept of 'Clean Ballast Tanks' (CBT) was incorporated into the regulations. These were tanks which formerly carried cargo, but which would be dedicated solely to the carriage of clean ballast in the future. The associated pipes and pumping could be common with the cargo system. However, it was an operational measure, not a design measure like SBT; before clean ballast could be pumped into a CBT, the cargo piping system would have to be flushed so that oil was not dumped back into the tank when ballast was taken onboard.

At the TSPP Conference, CBT was considered an acceptable alternative to SBT on existing product carriers of 40,000 dwt and above. The reasoning behind this was that the tanks on product carriers were usually cleaned after each voyage to insure purity of the next cargo to be loaded; this would result in a minimum amount of oil clingingage in the cargo system and therefore a mini-
mum amount of oil in the CBTs.\textsuperscript{68}

CBT was not accepted as an alternative to SBT on existing crude carriers because of the greater percentage of clingage, but it was permitted as an interim measure which would provide a vessel with an immediate method of reducing oil pollution at very little cost, and would give a shipowner additional time to plan or schedule the installation of SBT or COW.\textsuperscript{69}

Overall, the requirements developed for new tankers were similar to the recommendations of the Carter Initiatives, except that there was no standard set for new product tankers between 20,000 and 30,000 dwt. This was not as distressing to the U.S. delegation, however, as was the omission of standards for existing crude and product tankers between 20,000 and 40,000 dwt. For the U.S. firmly believed that these smaller existing tankers, the most common size in the world fleet, presented serious pollution hazards that needed to be addressed.

\textbf{PROTOCOL OF 1978 RELATING TO SOLAS 74}

There was little, if any, argument about the need for inert gas systems aboard both crude and product tankers. All of these vessels of 20,000 dwt and above were to be affected by Regulation 60 of the Protocol of 1978, with a few exceptions.

Crude tankers in the 20,000 to 40,000 dwt range could be granted an exemption from the IGS requirements if it could be proved that installation was unreasonable or impractical. Product tankers in the same size category would be exempt from IGS requirements if they did not utilize high-capacity washing machines (HCWM) to clean their cargo tanks. HCWMs were considered a cause of tank explosions due to the static charges set up in
the tanks when water hit the tank bulkheads. Many small product tankers did not use HCWMs because they carried less viscous petroleum products that could be butterworthed with low-capacity machines. The risk of explosion was less in these instances, and so the requirement for IGS was dropped.

Steering Gear Improvements

Steering gear improvements, because they directly affected the safety of a vessel and only indirectly affected pollution prevention, were covered in the Protocol to SOLAS 74, under Regulation 29 in Chapter II - Construction and Installations.

The U.S. proposal for the manning of steering gear compartments was soundly defeated. Duplication of control systems from the pilothouse to the power units in the compartments was approved for both new and existing tankers, but duplication of hydraulic pump controllers, a central part of the U.S. proposal, was not.

On new vessels, however, a resolution was passed which accepted the U.S. recommendation for two identical power units to supply the steering gear. Additionally, several operational requirements for all vessels regarding testing of steering gear were required under Regulation 19 in Chapter V - Safety of Navigation.

Collision Avoidance Systems

Although requirements for collision avoidance systems were left out of discussions, a resolution was approved which urged IMO to develop performance standards and specifications for them no later than July 1, 1979, and to prepare, within the same time
period, requirements for the carriage of such aids on all ships of 20,000 dwt and above.

An equipment requirement usually associated with CAS, the installation of two independent radars in the pilothouse, was discussed and unanimously approved at the Conference.

The average cost of a second radar system was estimated to be $30,000 per ship, but Conference participants agreed that its potential benefits were worth the cost. Primarily, it would provide a 'back-up' in case of failure of the primary radar, but it would also improve the amount and quality of information available by permitting each radar to be set on different bands or different ranges. 70

The easy passage of the dual radar requirement and the resolution to implement CAS standards as early as possible satisfied the U.S. delegation, but, as it will be shown, failed to satisfy Congress and the American public.
GENERAL PROVISIONS

Since the Carter Initiatives had been announced, the U.S. Congress, led by the House Merchant Marine and Fisheries Committee, had been developing legislation to incorporate them. The result was the Port and Tanker Safety Act (PTSA), which was signed into law in October, 1978. Among other things, the Act required the Secretary of Transportation to prescribe, as a minimum, "certain construction and equipment standards, including many that are identical to requirements adopted by the international community."71

Legislators did not adopt the same deadlines that the international community adopted, but established earlier dates on which certain standards would go into effect whether or not the Conventions and Protocols were in effect at the time. This was in keeping with the request of the IMO, made at the TSPP Conference in London, that countries enact domestic legislation to implement the Convention and Protocol standards as soon as possible.

The effective date for the construction and equipment requirements of the U.S. Act was set at June 1, 1981, at which time the SBT, CBT, COW, IGS and improved steering gear standards would be required on both U.S. tankers, and foreign tankers, except for those in innocent passage through U.S. waters.

'New vessels' were defined in the Act the same as in the international conventions, i.e., they were vessels contracted for after June 1, 1979. All new vessels, then, had to meet the exact
same standards as set forth in the 1978 Protocols and their parent conventions.

Some significant standards, however, exceeded those developed by the international community. In House Report No. 95-1384 accompanying the legislation, this action was addressed:

"The committee considers that any feelings that this action on the part of the committee in any way represents "bad faith" on the part of the United States ignores the constitutional authority of the Congress in the legislative process. The committee has elected to impose additional requirements on all U.S. vessels beyond those which, present indications are, would be imposed by international agreement. It makes the same additional requirements applicable to foreign vessels which elect to operate within the navigable waters of the United States."^{72}

**U.S. POLLUTION PREVENTION STANDARDS EXCEEDING INTERNATIONAL STANDARDS**

Congress indicated its concern over the international community's failure to require certain modifications on existing vessels that it required on new vessels. It cited statistics indicating that aging vessels posed a serious safety and pollution threat, and noted that Lloyds of London recognized the same problem by imposing a fifty percent surcharge to the cargo insurance premiums of certain tankers older than fifteen years. Congress believed that these vessels should be required to meet construction and equipment requirements similar to those required on both younger and larger vessels.
Paragraph (E) of the Act applies to existing crude oil tankers of 20,000 dwt or above, but less than 40,000 dwt, which are fifteen years or older. It requires the installation of segregated ballast tanks or a crude oil wash system by January 1, 1985, or by such subsequent date on which it reaches fifteen years of age. Paragraph (H) applies to product tankers in the same size category - 20,000 to 40,000 dwt - and requires installation of SBT or, in the alternative, the use of CBT, by the same time.

The Act also exceeded international standards in provisions relating to the safety of navigation. Although the international community, at the TSPP Conference, established the requirement for dual radars and other navigation safety equipment, the U.S. Congress was convinced of the need for collision avoidance systems and wanted to enact legislation which would insure installation of these systems aboard ships.

In Paragraph (J) of the Act, the installation of computerized relative motion analyzers on all vessels of 20,000 dwt and above was to be required by July 1, 1981. The House Report addressed this deviation from the international requirements:

"...this act would require a computerized relative motion analyzer, the type of equipment envisioned internationally, but for which specifications have not yet been established. It is anticipated that such specifications will be agreed upon by June, 1979, and therefore the requirement for a relative motion analyzer is postponed until July 1, 1981, in order to provide sufficient leadtime for compliance. Should it later turn out to be necessary, there
can be a future reconsideration of this requirement."73

Impact of Higher U.S. Standards

Discrepancies between U.S. and international requirements for collision avoidance systems cleared by 1980. By that time, IMO had developed minimum standards that met the statutory test of functional equivalency with the U.S. Maritime Administration's specifications. The U.S. had greatly assisted in this project. The resulting equipment standards went into effect July 1, 1982.

Discrepancies concerning SBT, CBT and COW on tankers between 20,000 and 40,000 dwt, however, are still outstanding.

The latest Coast Guard report on the issue, released in January, 1984,74 indicates that these standards will come into force in 1985, as planned. Final regulations are being developed.

In its report, the Coast Guard identified several impacts, both direct and indirect. The direct impacts were determined to be:

(a) a 107,000 metric ton reduction in operational oil outflows, primarily on the high seas, incurred by the year 2020, when the last of these tankers are expected to be in service, and

(b) a total cost, in 1982 U.S. dollars, of 1.4 to 2.5 billion for U.S. tankers and 0.0 to 1.1 billion for foreign tankers.

Indirect impacts include:

(a) modernization of the U.S. tanker fleet, because high costs of retrofitting would encourage replacement of older tankers,

(b) shipyard utilization, because most of the tankers affected are in the U.S. coastal trade, and under the Merchant Marine Act of 1920, replacement of vessels in coastwise trades must be built in the U.S.,
(c) absorption of sunk costs incurred by U.S. owners who have, since 1978, acted in good faith to retrofit or construct vessels in compliance with proposed regulations,

(d) improved U.S. domestic competition because owners with a large amount of older tankers may be forced out of the market, allowing new companies to enter, and

(e) a negative effect on U.S.-foreign competition because U.S. tankers will be at an economic disadvantage from bearing the installation and operating costs of these unilaterally-imposed standards. 75

Finally there is the obvious effect on international relations that accompanies unilateral action on the part of any country. The Coast Guard Report only cites that "unilateral standards complicate international trade." 76

These predicted impacts are a fair estimate of what is likely to come to pass. Older tankers are being replaced, although more often by pipelines than by newly-constructed tankers. As soon as the 1978 Port and Tanker Safety Act was passed, American oil companies took steps to either sell or scrap their older tankers in the 20,000 to 40,000 dwt range.

Sun Oil Company, for example, had four U.S.-flag tankers in that size category in 1978: the DELAWARE SUN, the NEW JERSEY SUN, the EASTERN SUN and the WESTERN SUN, all of which had been built in the mid-1950s. All of these were expected to be sold by 1986 or 1987, but when the regulations for SBT or COW were announced, Sun Oil made the decision to get rid of all four of these ships before 1985, either by selling or scrapping them. The WESTERN SUN is the only one of the four remaining in the fleet, and it is expected to be scrapped by the end of 1984. 77

The U.S.-foreign-flag competition has, for at least a decade,
been characterized as unbalanced, with the foreign flag vessels in the better position due to cheaper construction and operating costs.\textsuperscript{78} The 1978 PTSA only makes the gap greater.

While unilateral standards may complicate international trade, the stringent design, construction and equipment standards required on smaller, older tankers by U.S. laws are in keeping with the latest international approach to a law of the sea.

Port-state enforcement - i.e., enforcement of laws by the country into whose port a vessel sails - in matters of vessel-source pollution was addressed at the Third United Nations Law of the Sea Conference (UNCLOS III); international law on this subject was codified under Article 211(3), and gives authority to states to establish "requirements for the prevention, reduction and control of pollution of the marine environment as a condition for the entry of foreign vessels into their ports or internal waters or for a call at their offshore terminals...but without prejudice to the continued exercise by a vessel of its right of innocent passage."\textsuperscript{79} The 1978 PTSA explicitly states that vessels engaged in innocent passage through U.S. territorial waters will not be subject to these standards.\textsuperscript{80}
CONCLUSION

The Carter Initiatives were a bold attempt to coerce the international maritime community into acting to improve tanker safety and pollution prevention. In the two-year period following the announcement of these Initiatives, the international community created two far-reaching Protocols, and the U.S. created the 1978 Port and Tanker Safety Act.

These instruments imposed construction and equipment standards aimed at reducing both operational and accidental oil spills. The standards were the result not only of intense intergovernmental negotiations, but of persistence by the American public and innovation on the part of the international oil industry.

The standards have the potential to meet the objectives for which they were established. Some of the systems, such as crude oil wash and collision avoidance, are relatively new; others, such as inert gas, have been in use for years with results indicating that they should have been required long ago.

International standards, by their very nature, are difficult to achieve because of the many interests involved. Although the U.S. was able to meet many of its tanker safety and pollution prevention goals in the international forum, it could not meet all of them. In those cases, the U.S. acted unilaterally, but within the constraints of contemporary international law.
NOTES


3. Deadweight tons, in metric tons, is equal to the weight of cargo, fuel and water on a fully loaded vessel.

4. A flag of convenience, as defined by B.A. Boczek, Flags of Convenience: An International Legal Study, (Harvard University Press, 1962) is "...the flag of any country allowing the registration of foreign-owned and foreign-controlled vessels under conditions which, for whatever reasons, are convenient and opportune for the persons who are registering the vessels." The reasons are usually economic ones, i.e., no taxes to pay, and the freedom to use the cheapest crews available with no regard for nationality.


6. R. Michael M'Gonigle and Mark W. Zacher, Pollution, Politics, and International Law, (Berkeley: University of California Press, 1979). The authors refer twice to this secret study in their book.


9. One barrel of oil is equal to 42 U.S. gallons.

10. The term 'butterworthing' is derived from the name of the British company that manufactures the tank cleaning equipment - Butterworths.

11. M'Gonigle and Zacher, supra, note 6, p.110.


14. Abstract from the National Transportation Safety Board Marine Casualty Report, NTSB-MAR-78-4. The NTSB is an independent government agency. Under Public Law 93-633, it has the responsibility to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations.


18. Abecassis, supra note 8, p.46.

19. Ibid.


22. Ibid., p.125.


26. Classification societies certify that vessels meet construction and equipment standards by carrying out periodic inspections and issuing certificates. All U.S. -flag vessels must be classed by ABS, the American Bureau of Shipping, one of the largest classification societies in the world.

27. Perrow, supra note 21, p.205.

28. The International Maritime Organization (IMO) was formerly known as the Intergovernmental Maritime Consultative Organization. It is headed by Secretary-General C.P. Srivastava of India. IMO is a specialized agency of the United Nations system, dedicated to maritime affairs. IMO promotes maritime safety and efficiency of navigation, prevents and controls marine pollution from ships and provides technical assistance to developing countries who are members of the organization.

30. M'Gonigle and Zacher, supra note 6, p.92.


32. There is still a dire shortage of shoreside tank cleaning and slop reception facilities today, according to an article in Marine Engineering/Log, February, 1984, entitled "Slop Reception and Tank Cleaning," pp.73-75.

33. Reception facilities are especially needed at loading ports, because it is near these ports that tankers get rid of their ballast in order to take on cargo. Most of the oil was originating in the Middle East in the early 1970s, and being transported to the U.S. and European countries. This complicated the issue of who was to be responsible for building the facilities.

34. Supra note 29, as amended in 1969, Article III (b), p.27.

35. Perrow, supra note 21, p.187.

36. M'Gonigle and Zacher, supra note 6, p.103.

37. Ibid., p.106.

38. Ibid., p.113.


40. Abecassis, supra note 8, p.51.

41. The 1948 Federal Water Pollution Control Act (FWPCA), 62 Stat. 1155.


43. Under Title I, the Coast Guard may establish vessel traffic control systems, require compliance with those systems, and control vessel movements in hazardous areas or at times of adverse weather, reduced visibility, or congested traffic. Traffic controls include establishing vessel routing plans; setting vessel size, speed limits, and operating conditions; and restricting vessel operation in hazardous areas to vessels that have particular characteristics and capabilities necessary for safe operation. Taken from the text Ocean and Coastal Law by Richard G. Hildreth and Ralph W. Johnson, (New Jersey: Prentice-Hall, 1983), p.316.


45. IMO NEWS, No. 4: 1984, p.2.

47. Cahill, supra note 20, p.160.


49 Ibid.


51. Ibid.


53. Ibid., p.4.


56. M'Gonigle and Zacher, supra note 6, p.108.


58. M'Gonigle and Zacher, supra note 6, p.131.

59. Psig denotes pounds per square inch guage, referring to pressure read from a gauge where zero psig indicates atmospheric pressure, which is itself approximately 14.7 psi.


61. A newly-installed COW system on a U.S. tanker can not be certified and operated until it passes three performance inspections. This first is a visual inspection of the tanks immediately after they ahve been washed, to confirm the cleanliness of each tank and to verify the number and location of the tank washing machines.

   The second inspection is accomplished by first taking on ballast in the tanks that have been washed and then measuring the amount of oil that floats on top of the water. The total volume of oil can not exceed 0.085 percent for the vessel to pass this inspection.

   The third inspection is conducted at the end of the
ballast leg of the voyage. Tanks that had been washed, water-rinsed, stripped and then ballasted are inspected as they discharge the ballast through a discharge monitor. The oil content of the ballast water cannot exceed 15 parts per million.

These tests are fully detailed in federal regulations enforced by the U.S. Coast Guard under 33 Code of Federal Regulations 157.140.

62. Wagner, supra note 54.


65. Ibid.

66. Ibid., p.305.

67. M'Gonigle and Zacher, supra note 6, p.135. The authors attended the 1978 Tanker Safety and Pollution Prevention Conference. They cover, in detail, the roles played by many countries and they provide an inside look at the entire proceedings and voting patterns exhibited by the countries.


69. Ibid.

70. U.S. DOT, Coast Guard, supra note 63, p.6-47.


72. Ibid., p.3271.

73. Ibid., p.3282.


76. Ibid.

77. Wagner, supra note 54.

78. Sally Meese, "When Jurisdictional Interests Collide: International, Domestic and State Efforts to Prevent Vessel Source

80. Public Law 95-474, section (1).