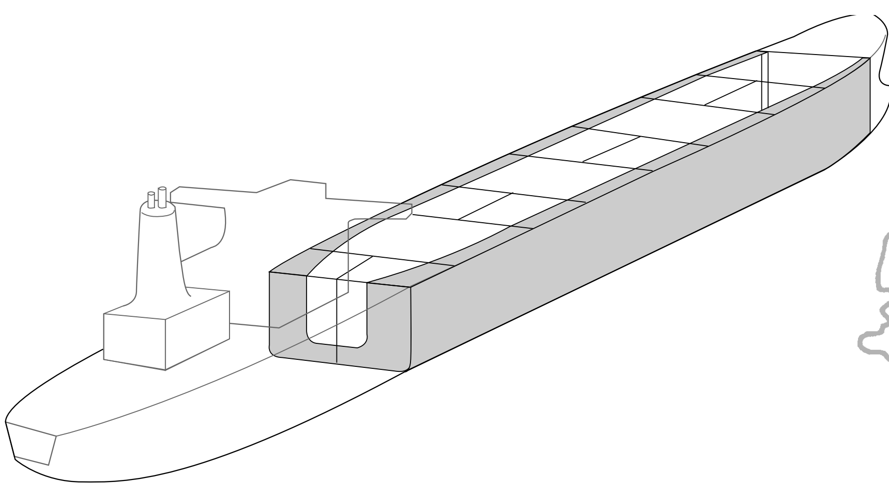
THE DOUBLE HULL ISSUE AND OIL SPILL RISK ON THE PACIFIC WEST COAST



DICKINS

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The Double Hull Issue and Oil Spill Risk On the Pacific West Coast

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ABBREVIATIONS AND DEFINITIONS

Ballast	refers to a substance, usually sea water, carried when the vessel has no cargo in order to load the vessel down and maintain its stability.
Beam	refers to the greatest breadth of a vessel.
Canada Shipping Act (CSA)	governs the design and operation of all commercial ships in Canadian waters including issues of pollution prevention. The Act is administered by the Canadian Coast Guard.
Deadweight tonnage (Dwt)	is essentially equal to the carrying capacity of a ship. It is the difference in weight between a ship loaded with stores and fuel and the same ship empty but with stores and fuel. Deadweight tonnage is a useful measure of the absolute cargo capacity (within 5%). Deadweight tonnage is used to determine the retirement schedule for single-hulled vessels by the Canada.[9]
Gross Tonnage	is a measure of registered tonnage not directly related to cargo capacity. For most tankers and barges, the gross tonnage is approximately 1/2 the deadweight tonnage. Gross tonnage is used to determine the retirement schedule for single-hulled vessels under the United States *Oil Pollution Act* of 1990 (OPA 90).
Hydrostatically Balanced Loading	refers to the practice of partially filling cargo tanks only to the point where, at the bottom, the pressure inside (oil) and outside (water) the tank are equal. In the event of a grounding, sea water will flow inward with minimal oil escape. Another term used is partial loading.
International Maritime Organization (IMO)	is a United Nations agency that sets international shipping standards for safety and pollution prevention at sea. It is up to individual countries to adopt the standards set by IMO as they see fit. For example, the United States has not adopted the re cent IMO standards regarding double hulls and the mid-deck concept. Canada has adopted many of the IMO standards through the *Canada Shipping Act*.

MARPOL 73/78	refers to the IMO convention governing the installation of segregated ballast tanks on all new tankers built after 1982. Regulations 13F and 13G to Annex 1 of this convention were adopted in March 1992 and establish the standards governing the adoption of double hulls for member nations.
Oil Pollution Act of 1990 (OPA '90)	refers to an act passed by the American Congress in 1990 that covers a broad range of oil spill prevention and response issues. Aspects of OPA 90 dealing with vessel safety and design are administered by theUnited States Coast Guard.
Refined Petroleum Product (RPP)	refers to products produced from crude oil through a refining process. Products can range from extremely light and easily evaporated substances such as distillate and gasoline to heavy and persistent oils such as Bunker C used as main engine fuel in many deep sea vessels.
Segregated Ballast Tanks (SBT)	refers to dedicated tanks, used only for ballast, never for oil.
Trans-Alaska Pipeline System (TAPS)	refers to the pipeline and tankers that transport crude oil from the Prudhoe oil fields through Alaska to the southern US states.

Oil Volumes:	1 barrel = 35 Canadian gallons = 42 US gallons = 0.159 m^3
Dimensions:	1 statute mile = 1.6 kilometre = 0.87 nautical miles 3.28 feet = 1metre 1 inch = 2.5 centimetres

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SUMMARY

In the wake of the 1989 *Exxon Valdez* oil spill disaster, a multitude of government studies, workshops and independent reviews recommended double hulls as the single most effective technology to prevent many future oil spills from tankers. Most ship classification societies and legislative bodies accept that total replacement of all existing tankers with double-hulled vessels will result in a 50% reduction in the total amount of oil spilt from tanker casualties.

It is important to realize that double-hulled tankers do not mean the end of oil spills; there will always be exceptional accidents such as fires and explosions which result in the loss of oil. Since double hull construction is a design spill prevention measure (not an operational measure), it will not reduce the likelihood of a vessel accident (collision or grounding). Nevertheless, double hulls will result in an appreciable reduction in risk, simply by having a second hull within a hull.

Where are we after years of deliberations about the urgent need to protect our pristine environment? When will we realize the benefits of new tanker designs?

Some 250 million barrels of crude oil and refined petroleum products are moved each year by tankers and barges in Puget Sound, the Juan de Fuca Strait, and British Columbia coastal waterways. Of this total, over 200 million barrels, or approximately 80% of the total, is still carried in single-hulled vessels.

In essence, "single hull" means that in the event of a collision or grounding there is a single layer of steel, 20 - 35 mm, or about an inch thick, separating the oil cargo and the marine environment. By far the greatest risk of a large crude oil spill in our waters comes from the daily passage of single-hulled tankers into the Strait of Georgia/northern Puget Sound regions delivering Alaskan and foreign oil to the Washington State refineries. These refineries are located within 15 to 60 kilometres of the Canada/United States border. There are about 380 tanker trips annually.

With over 10,000 other transits of major vessels such as container ships, bulk carriers, ferries and cruise ships each year through the Juan de Fuca Strait, there is always the potential for a collision or grounding. Most of the risk of small to moderate spills (less than 10,000 barrels) can be attributed to these passenger and general cargo vessels as they often carry more than 5,000 barrels of engine and system (bunker) fuel against a single hull.

Another contributor to the risk of marine oil spills comes from the many American and Canadian single-hulled barges carrying refined petroleum products such as bunker fuel oil, diesel, and gasoline to different coastal communities and mills.

Canadian tanker movements make a small contribution to the regional risk: for example, only three oil tankers carried crude oil out of Vancouver in 1994. Canada is an exporter of oil on the west coast from terminals located in the Port of Vancouver.

Most of the oil destined for the Washington refineries is carried in 19 older ships built between 1969 and 1974. It is the replacement of these single-hulled tankers dedicated to the Alaskan trade which drives the timing of when new double-hulled tankers will provide any substantial relief from the present level of spill risk in our local waters.

The timing of when older US flag tankers must be retired is controlled by a schedule established by the United States Coast Guard in their administration of the *Oil Pollution Act* (*OPA '90*) passed by the American Congress in 1990. Canada and the rest of the world has adopted a schedule for large tankers developed by the International MaritimeOrganization (IMO).

Under OPA '90, approximately 18 of the older single-hulled tankers carrying 78% of the Alaskan oil to Puget Sound will be forced to retire by 1999. Unfortunately, this mandatory retirement is unlikely to result in direct replacement with new double-hulled vessels. Industry is delaying placing new orders in view of the depressed state of the world tanker market, high cost of new construction, and uncertain crude oil supply.

The US *Jones Act* of 1920 is one of the key factors preventing American tanker owners from voluntarily retiring and replacing their older vessels. This act prohibits any foreign built vessel from trading between two American ports such as between the States of Alaska and Washington. Without the US *Jones Act* restriction, industry would have many more options available to charter or purchase foreign double-hulled tankers to replace the aging American fleet and still remain US owned and operated.

There are significant benefits for reducing the risk of a spill. These benefits include avoided response (clean up) costs, natural resource damages, and restoration costs. A 1995 study comparing the benefits and costs of accelerating the current retirement schedules by 15 years to year 2000, revealed that the cost to the Alaska (TAPS) fleet to be $240 million ($US) with the US Jones Act, or <u>half</u> this cost without construction location restrictions stipulated by the act. The estimated benefits to British Columbia and the shared waters of the State of Washington for accelerating the TAPS oil tanker double hull schedule is about $147 million. Benefits accrued to other regions, such as Alaska and California, were not estimated, but would no doubt be substantial. The analysis of Canadian-flag oil barges showed that an accelerated schedule to replace the single-hulled barges could result in regional benefits exceeding the cost.

The benefit estimates are both reasonable and conservative when considering that the damages for one moderate spill, such as the the *Nestucca* barge spill in 1988, may range from tens to hundreds of millions of dollars, and the damages from a large spill may reach several billions of dollars, as in the case of the *Exxon Valdez* spill in 1989.

It is important to consider the distributional consequences of **who loses** and **who gains** for not undertaking (or conversely for undertaking) the expeditious retirement of aging single-hulled tankers and barges and their replacement with double-hulled ones. If the oil industry delays the retiring of their single-hulled vessels, then the risk and cost of spills are borne locally on the west coast, while the savings of not converting to double-hulls at an earlier date are realized through out North America and abroad.

The time period before double hulls will substantially reduce the number and severity of oil spills is troubling. Economic factors such as the depressed tanker market, lack of financial incentives for safer vessels, and laws protecting shipbuilding interests all act to preserve the *status quo* for as long as possible. Economic incentives, or if need be, legislative change are required to expedite the replacement of aging, single-hulled oil tankers and barges before the turn of the century.

TIME FOR ACTION

The length of time before the west coast is likely to see any substantial benefits from double-hulled vessel construction in reducing the number and severity of oil spills is unacceptable when one weighs the severe environmental and economic consequences of a spill. Current requirements indicate that it will be another 10 years before double hulls make a real difference in reducing the risk of oil spills in our local waters.

The following activities to speed-up the process of eliminating single-hulled tankers and barges that pose a risk to our shared waters are recommended:

1. That British Columbians and our neighbours in the United States realize the shortcomings of current laws regarding the retirement of existing single-hulled tankers and barges, the implications of delayed replacement of these vessels, and the continued risk to our vulnerable Pacific west coast.
2. That the United States and Canadian federal governments seek meaningful ways to accelerate the single-hulled tanker and barge retirement schedule currently established under the US *Oil Pollution Act* and the *Canada Shipping Act* through economic incentives for safer vessels, changes to the scheduling legislation, establishing special marine areas, or combinations thereof.
3. That the Canadian government with their United States counterparts determine what steps tanker owners and charterers are taking to expedite the retirement of aging, single-hull tankers on the west coast that pose a risk to our shared waters, and to ensure there is a net improvement in oil spill protection.

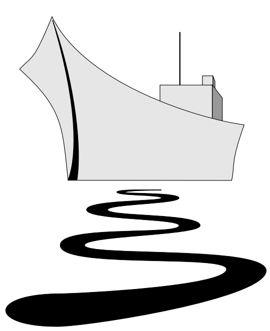
INTRODUCTION

Some 250 million barrels* of crude oil and refined products (bunker, gasoline, diesel fuel, jet fuel) are moved each year by tankers and barges in Puget Sound, the Juan de Fuca Strait, and other British Columbia coastal waterways. Following the now famous *Exxon Valdez* oil spill (1989), a host of national and international bodies dissected every possible safety issue affecting tanker transportation. Many of these studies recommended some form of double hull to create an additional shield between the oil and the sea in the event of an accident. These recommendations are only now being implemented as part of new standards developed by the International Maritime Organization (IMO) and the United States and Canadian Coast Guards.

Of most concern, and the focus of this report, is the timing of when the older single-hulled tankers that pose a risk to our waters will be replaced under the new standards. Questions arise such as: how much reduction in environmental risk can be expected from the latest tanker designs; how long do we have to wait until a sufficient number of vessels are replaced to substantially reduce the risk of spills; what can be done to speed up the process; what are the costs compared to the benefits of acclerating the retirement schedule; and how can we make people aware of the implications of recent US, Canadian and international regulations on the future security of our marine environment? The purpose of this document is to answer these questions.

A series of related topics are developed to understand the issue of double hulls – what they can achieve and when:

- the new tanker designs;
- comparisons of United States, Canadian and international regulations;
- the timing for double-hulls;
- the benefits and costs of an acclerated retirement schedule;
- the tanker and barge industry now and in the future; and,
- actions to speed up the process of improving tanker standards.

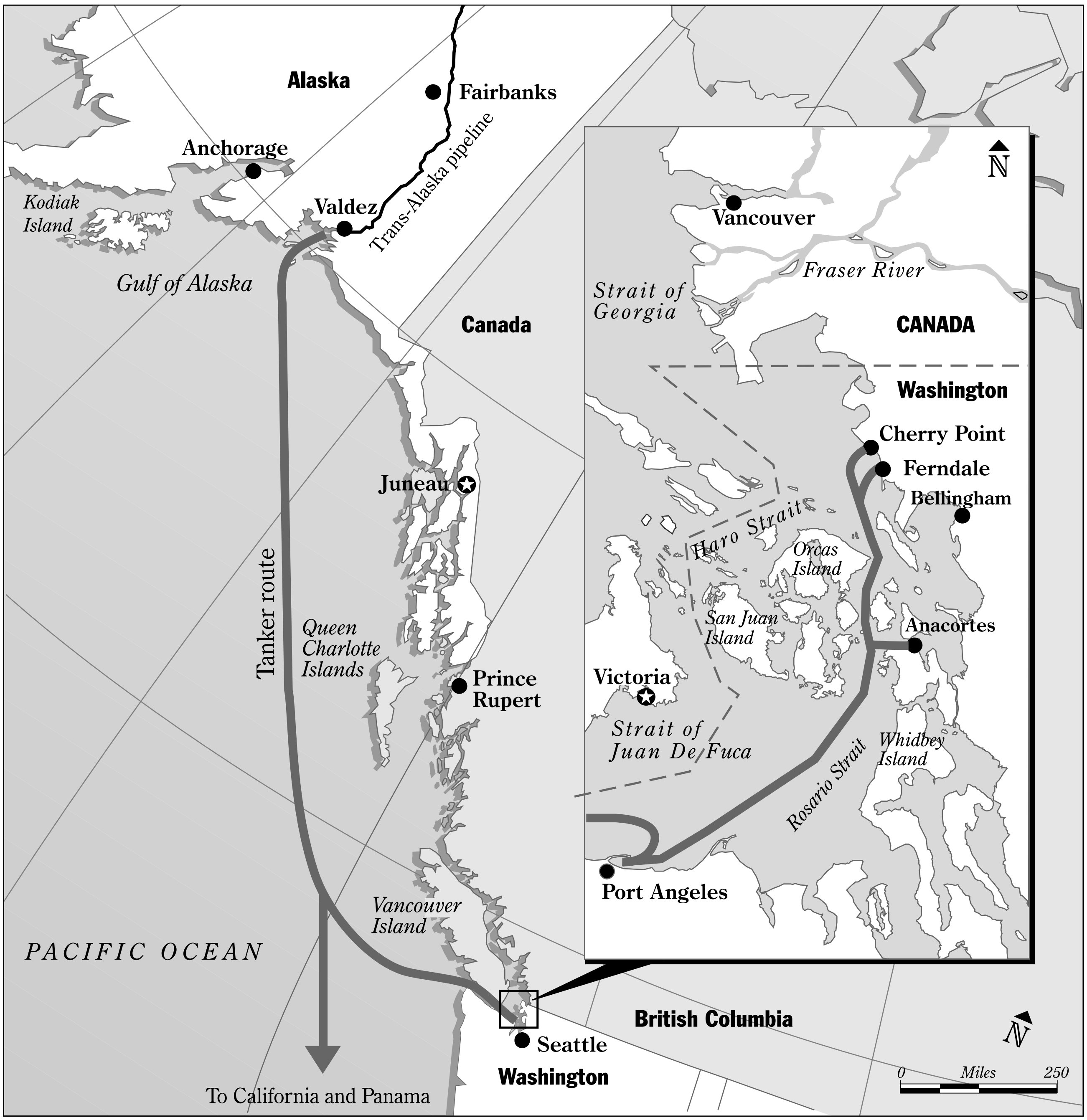


250 Million Barrels of Marine Oil Cargoes Each Year –

The risk of spills can be greatly reduced by using double hulls. How long do we have to wait before every tanker and oil barge in local waters is fitted with a double hull?

* Refer to the foreword for common conversions to other units; barrels are used here as a convenient and familiar universal measure.

The map shows the main routes of tankers travelling down the west coast and into the Strait of Georgia/Puget Sound area.



JAMES McFARLANE / SEATTLE TIMES

PART 1: EXISTING OIL MOVEMENT PATTERNS & VOLUMES

Approximately one tanker each day enters the Juan de Fuca Strait and threads it way through narrow passages to oil terminals located 15 to60 kilometres south of the US/Canada border. Each year, these tankers cross paths with over 2,000 other major vessels, such as container ships, ferries, and bulk carriers that make over 10,000 trips to or from British Columbia and Washington State ports. This level of traffic density leads to the ever present danger of collision between a tanker and another vessel. Hundreds of barges and a few small coastal tankers carrying refined petroleum products (RPP) also contribute to the risk of a spill along inside passages as well as the outer coast.

About 75 per cent of Canada's oil product barge movements is on the west coast, both in terms of the number of trips and total tonnage carried.

The table (below) and pie chart (next page) show trading patterns to highlight the relative contributions of foreign, American and Canadian tankers and barges to the overall risk of oil spills in our local waters. These oil imports and exports to and from both countries, lead to a combined oil spill risk as we share common borders between the Strait of Georgia and Puget Sound, in the Juan de Fuca Strait and in Dixon Entrance.

In addition to the local oil vessel traffic shown on the chart below, laden tankers

Overview of Marine Petroleum Cargo Movements in the Strait of Georgia/Puget Sound Basin and Along the British Columbia Coast

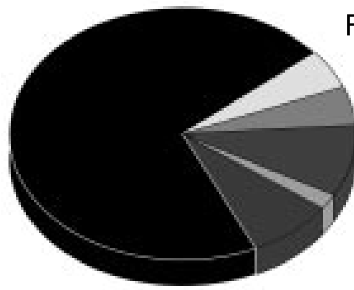
From	To	Oil Type	Total # Trips/year	Vessel Sizes Dwt	Est. % Total Regional Volume PIE CHART
1. Alaska	Puget Sound	Crude	351 - tankers[1]	70 - 125,000[2]	68%
2. Puget Sd.	California Panama	Crude (Partial loads)	33 - tankers[1]	70 - 125,000	3%
3. Foreign	Puget Sound	Crude	17 - tankers[1]	40 - 90,000[3]	5%
4. Puget Sd.	Washington, California	Refined Products	178 - tankers[4]	20,000 - 40,000[5]	9%
5. Puget Sd.	Washington, California	Refined Products	213 - barges	1,300 - 20,000	5%
6. Vancouver	Foreign Ports	Crude	3-10 - tankers[6]	65,000	2%
7. Vancouver	B.C. Destinations	Refined Products	600 - 800 mostly barges[7]	200 - 4,900	8%

Superscript numbers refer to notes on the following page.

from Alaska travel daily about 160 kilometres (100 miles) off the west coast *en route* to Panama and California.

Of 250 million barrels of oil moved annually through coastal waters in close proximity to British Columbia, approximately 190 million barrels is crude oil, and 57 million barrels is refined petroleum products (RPP) covering a wide ranging from

Per Cent of Annual Oil Volumes Moved by Tankers and Barges



RPP: Refined Petroleum Products
*Includes out-bound partial loads

Explanation of Cargo Movement

1 Figures for 1993 provided by Washington State Office of Marine Safety and Tofino traffic Services. A portion of this Alaska traffic (about 33 tankers according to 1994 figures) is partially unloaded at Puget Sound refineries then leave for southern US ports on the west coast.

2 Typical range of sizes from list of American Flag vessels calling at Puget Sound Refineries in 1990.[1] Some smaller tankers down to 40,000 Dwt make a limited number of trips.

3 Range of sizes derived from 1994 list of foreign flag tankers allowed to operate in Alaska State Waters with approved contingency plans, published in Marine Digest, November 1994.

4 Number of tanker and barge shipments for the transport of refined products (bunker, heavy fuel oil, jet fuel, distillates) - from Table 1 of Reference 2. Not of all these Puget Sound refined product trips pose a direct risk to British Columbia waters depending on location and routes. Numbers in the table exclude tanker or barge movements involving transfers and shipments within Puget Sound and any shipments for bunkering; these are assumed to be small volumes and far enough removed in most cases from British Columbia waters to eliminate most spill risk.

5 The typical tanker size associated with refined products was derived by converting average shipment volumes from barrels to tons, and multiplying by 1.2 to account for trips at less than full capacity. Refined Petroleum Products (RPP) barge sizes were derived from a separate list of typical oil barges operating in the Puget Sound area.[3]

6 Tanker exports out of Vancouver were highly variable in the past few years due to market conditions favouring the export of oil by pipeline to the US rather than shipment to foreign countries (e.g. fourteen in 1993 down to three in 1994).

7 The estimated annual number of barge trips in British Columbia waters carrying refined products was derived by reducing the number of trips quoted by the States/British Columbia Oil Spill Task Force [2]; 200 trips were eliminated to account for the reduced volumes of bunker oil being delivered to Vancouver Island pulp mills following the completion of the gas pipeline (bunker volumes are down by approximately 75%). The figure shown in the table includes a small number of exports of refined product from Vancouver to Puget Sound by barge. There is some uncertainty as to the total number of barge trips in British Columbia as many movements cover very short distances to provide bunkering to deep sea vessels in Vancouver Harbour and Prince Rupert. A realistic number of annual trips is probably less than 600.

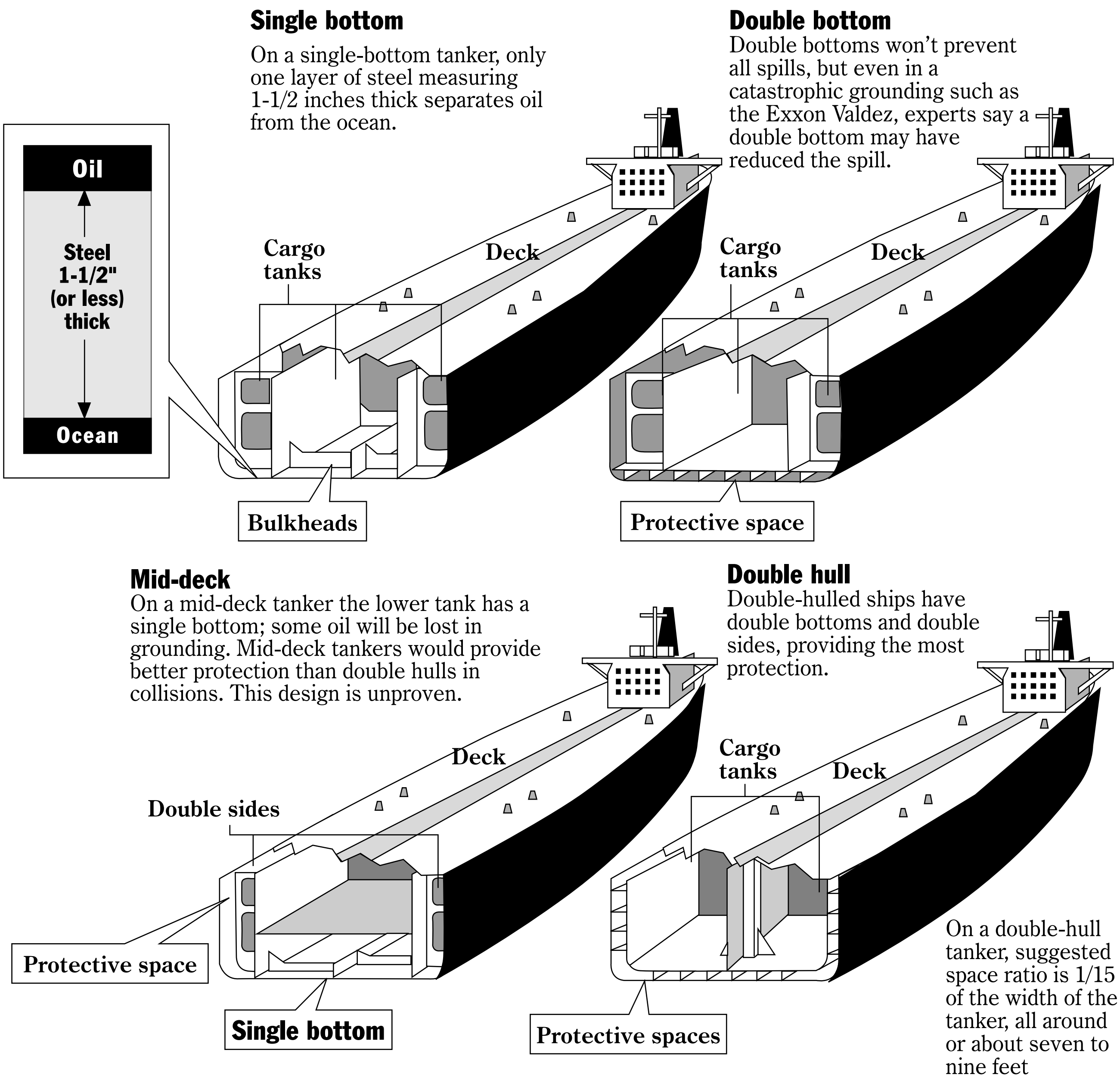
heavy fuel oil to light distillates.[1] The total oil volume is dominated by the Trans-Alaska Pipeline System (TAPS) crude oil tankers (about 92% of this crude oil movement is by American registered tankers).

The majority of the refined petroleum products are moved by a mix of Canadian and American barges, while almost all of the crude oil is transported by American-flag tankers. This mix of products, volumes, type of vessel and ownership will become important later in the discussion. The sources of local spill risks are international in nature. Spilled oil, driven by surface currents and winds, does not recognize international borders.

American and foreign tanker deliveries of crude oil to Puget Sound Refineries account for over 75% of the total volume of oil and refined products moved in Washington and British Columbia coastal waters. One tanker per day brings crude oil into terminals located as close as 15 kilometres south of the sensitive Fraser River estuary. An accident to any one of these tankers could result in a spill the size of the Exxon Valdez spill or greater.

There are a range of hull designs in current use or proposed: single bottom, double bottom, mid-deck, double hull, such as illustrated below. Compared with the traditional single-hulled tanker, each of these designs are more effective in reducing the number of oil spills and/or the amount of oil spilled in certain types of accidents. This section clarifies the relative merits and drawbacks of each design option beginning with the *status quo*, single hulls, followed by interim protection measures, then double hull design.

It is important to realize that, while double hulls and other designs to protect the cargo can reduce or eliminate oil spill-



James McFarlane / Seattle Times

age after a grounding or collision, such designs do not reduce the likelihood of a marine casualty. Measures such as crew training, electronic chart navigation systems, vessel traffic systems, and double pilotage are some of the many other spill prevention measures which need to be introduced along with safer ship designs.[2]

Single-Hulled Tankers Represent the Status Quo

Most of the world's marine oil trade is still carried out in single-hulled vessels. Locally, the majority of the crude oil and refined products is still moved in single-hulled tankers and barges: approximately 200 out of the 250 million barrels (or about 80%).

Only a thin layer of steel, 4 cm (or about 1 1/2 inches) thick, separates the cargo of oil in a single-hulled tanker from the sea water outside. This layer can be easily torn or punctured during collisions, groundings, and other accidents.

The cut-away view on the next page shows a single-hulled tanker that is representative of a tanker carrying oil from Alaska to Puget Sound.[5] For comparison, the tanker is approximately twice the length of a large British Columbia or Washington State ferry.

Variations on Single Hulls

Single-hulled tankers can be divided into two groups based on their date of construction, <u>conventional</u> and <u>MARPOL</u> tankers.

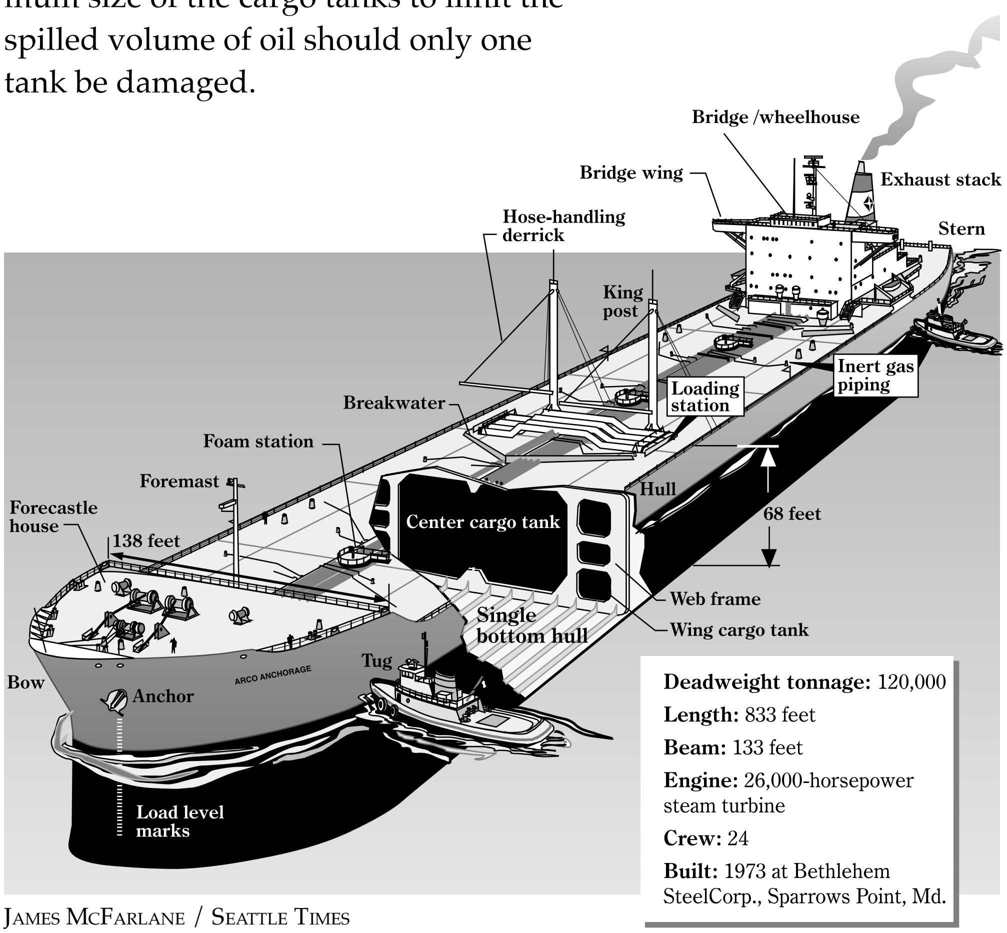
Conventional single-hulled tankers have some segregated ballast tanks, but the amount of ballast tankage is often less than current international standards and is not required to meet any minimum percentage of the hull area. Most of the Alaskan (TAPS) crude oil imported into Puget Sound is still carried in conventional tankers built prior to 1974. These single-hulled tankers are most susceptible to oil spills in any kind of accident involving damage to the outer hull. Unfortunately, the timing of when these vessels will be replaced is quite uncertain.[6] Please refer to a further discussion of this critical issue in Part 3.

The majority of the world's tankers are still single-hulled; only one layer of steel less than 4 cm thick (about one 1 1/2 inches in many cases) separates the oil from the ocean. There are a number of design options available for new tankers which offer a great deal more protection and actually prevent any oil from leaking in some situations.

Locally, 80% of crude oil and refined products are still transported in single-hulled tankers or barges.

MARPOL tankers are so named because they are built to the specifications of the International Maritime Organization's International Convention for the Prevention of Pollution from Ships, 1973 and its associated Protocol of 1978, known as MARPOL 73/78.[7] According to this protocol, tankers completed after May 1982 are required to have segregated ballast tanks (SBT) arranged to cover 30% of the side or bottom area of the tanker, thereby providing a measure of protection during a collision or grounding. Depending on the loaded state of the tanker, these ballast tanks are maintained empty, or with sea water, to achieve the required stability. The protocol of 1978 also prescribed a maximum size of the cargo tanks to limit the spilled volume of oil should only one tank be damaged.

Estimates are that less than 40% of tankers worldwide currently qualify as MARPOL tankers.[8] The majority of tankers still fail to meet even the minimal protective measures mandated in 1978, highlighting the difficulty in making substantial changes to thousands of tankers in even a few decades. The current situation regarding replacement of these older tankers is made more serious by the steady decline in tanker freight rates. Recent estimates show that the available daily charter income from a new double-hulled tanker is less than half that required to break-even on its capital and operating costs. The result is that the rate of actual replacement of older single-hulled vessels is likely to fall far short of their mandated rate of retirement. Furthermore, there are few direct economic incentives on the west coast for employing safer vessels, such as reduced port, pilotage, harbour and other fees/charges. One exception is the recent (November, 1994) US Coast Guard requirement for tug escorts of all single-hulled tankers in Puget



James McFarlane / Seattle Times

Sound and the Juan de Fuca Strait east of Port Angeles. The Canadian Council of Ministers of the Environment report (May 1995) strongly recommends that there be economic incentives for safer vessels.[9] Suggested incentives are reduced port and marine service fees for vessels having additional spill prevention design or technology measures (e.g. double-hulls, electronic charting).

It is important to note that there are no equivalent requirements for oil barges to have segregated ballast tanks or protective spaces.[10] Most such barges carry the oil directly against a single hull.

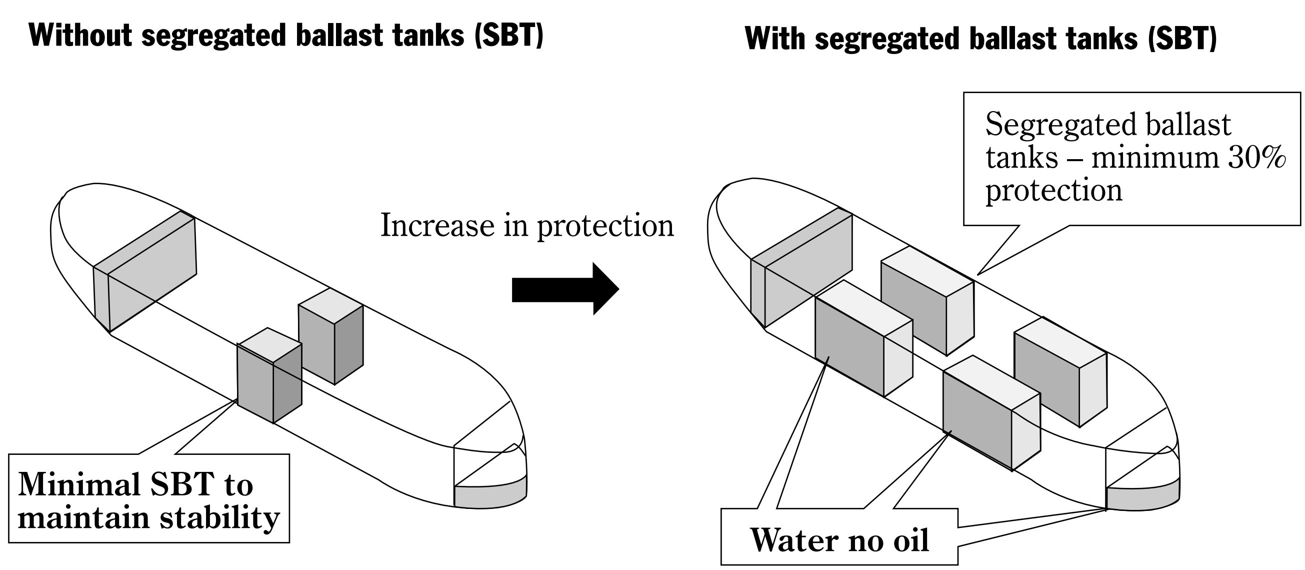
Interim Protection Measures

Two interim measures are being seriously considered in the United States and internationally as possible spill prevention improvements which can be applied to existing single-hulled tankers:

- protectively located spaces; and,
- hydrostatically balanced loading.

These interim protection measures are being put forward as a means of providing some improvement during the 10-15 year phase-out of most existing single-hulled vessels. Neither measure provides the degree of protection afforded by double hulls.[11] After several years of public discussions, the United States Coast Guard is not expected to recommend and approve any specific measures until early in 1996.

"Protectively located spaces" is essentially a new term to describe segregated ballast tanks as shown below, originally called for by the International Maritime



Older single-hull: “Pre MARPOL”
Built prior to 1982
(Over 60% of worlds fleet)

Newer single-hull: MARPOL
built since 1982

Organization in 1978. Protectively located spaces provide some measure of protection by ensuring at least 30% of an oil tanker's hull are either ballast or spaces free of oil. In theory, a random collision has a chance of damaging a ballast tank instead of an oil tank. In such a case, provided the damage was limited to the ballast tank, no oil would be spilled. These protective spaces are much less effective in preventing oil loss in a grounding situation.

On the plus side, the allocation of protectively located spaces on existing pre-1982 vessels is relatively inexpensive and can be quickly implemented; on the negative side, this measure provides only minimal protection on a "hit or miss" basis and will also reduce cargo capacity.

The second interim measure, hydrostatically balanced loading (HBL), is an *operational* rather than a *design* measure; on most vessels. It will not require structural modifications, but it will require different loading procedures. With HBL, the cargo tanks are filled with oil only to the point where the pressure at the bottom of the cargo tank remains less than the sea water pressure outside the tank. This procedure is also called *partial loading*. If the tank bottom is ruptured, sea water will flow into the tank to equalize the pressure instead of oil flowing out as illustrated on the next page. However, some oil will always be swept out of the tanker.

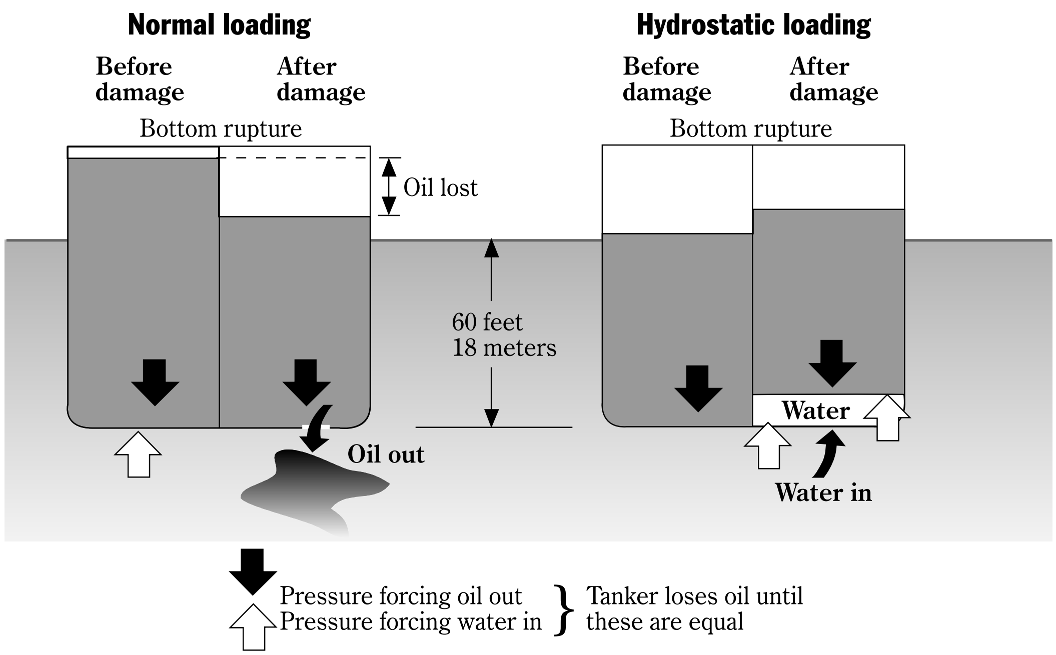
A number of shipping companies on the west coast already use HBL as a matter of convenience when their vessels partially unload at Puget Sound refineries and then proceed onto California with the remainder of their oil cargo.[12] The motivation here is strictly one of economics rather than environmental concern. In fact, these partial shipments pose an additional risk factor caused by the additional crude oil movement out of the Juan de Fuca Strait on the Canadian side *en route* to California.

Single-hulled tankers can't help but leak oil when there is any structural damage to the outer hull. Segregated ballast tanks were required on all tankers built after 1982 but over half the world's fleet still lacks even this minimal degree of protection.

Fully 70 % of the Alaskan crude oil imported in to Puget Sound is still carried in tankers built prior to 1974. These single-hulled tankers are most susceptible to oil spills in any kind of accident involving damage to the outer hull. Most oil barges in local waters are single-hulled. A depressed tanker market does little to encourage the rapid replacement of older vessels.

In summary, HBL is a potentially effective interim measure for grounding accidents. Its success in practice would depend on the diligence of the operators in maintaining the more complicated loading procedures and accepting the reduction in cargo capacity. Some of the advantages would be offset by the increased number of sailings required to achieve the same volume throughput with an HBL fleet compared with conventionally loaded tankers. These many uncertainties could reduce the effectiveness of HBL in day to day operations. Any wide-scale adoption of HBL may prove to be counterproductive when applied to the overall risk of a major spill in local waters.

Principle of Hydrostatic Balance Loading



Interim measures *are really just a stop-gap solution which do little to address the overall problem of too many single-hulled tankers still sailing. It is better to apply all available resources to replacing the older tankers rather than relying on "bandaid" solutions.*

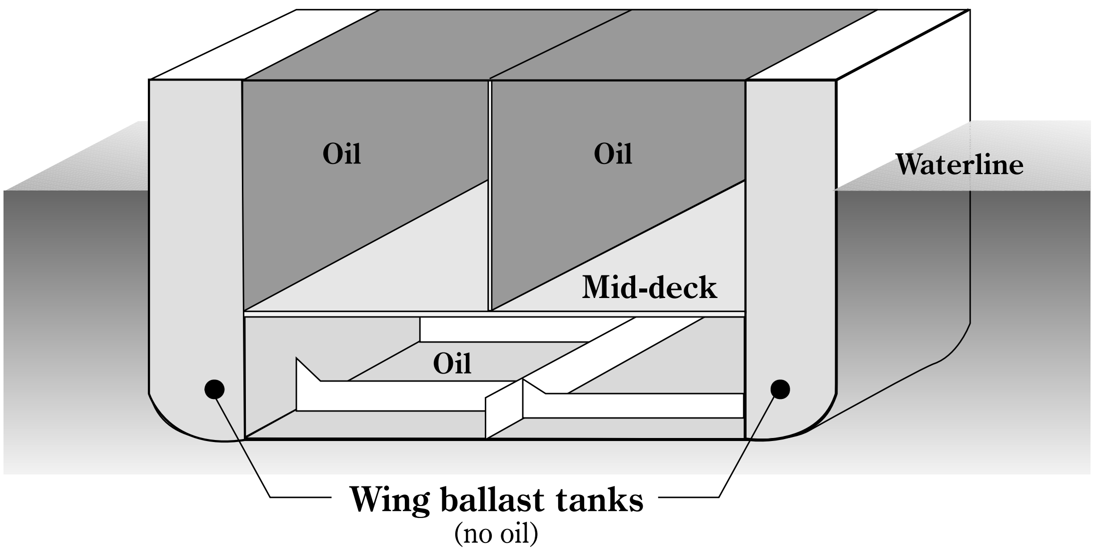
Mid-Deck

The mid-deck concept is a new design, developed in Japan, as an alternative to double hulls. This concept is also known as the *intermediate oil-tight deck*. As yet unproved, it is expected that construction and operational costs will be comparable to the double hull.

The mid-deck tanker has a very high double bottom, typically $^1/_5$ – $^1/_4$ of the tanker beam, that is filled with oil and double sides with no oil as illustrated below. The double sides are approximately twice as wide as in a normal double hull in order to meet the ballast space requirements.

The deck between the lower and upper tanks is water- and oil-tight. Although some oil will always be lost if the bottom is torn, the amount will be considerably less than from a single-hulled tanker for two reasons: first, less oil is available in the lower tank than in a conventional tanker and second, the oil in the lower tank is at a hydrostatic advantage such that in the event of a bot-

Mid-Deck Tanker



The mid-deck concept *is a new design, developed in Japan, as an alternative to double hulls. Although theoretically superior in collisions and high speed groundings, the mid-deck design is unproved in service. The design measure has been accepted by the IMO and the Canadian Coast Guard, but not the United States Coast Guard. The most significant drawback of the mid-deck is that it will always spill some oil in a grounding situation which damages the bottom outer hull.*

tom rupture, outside water will tend to flow *in* rather than oil flowing *out.*

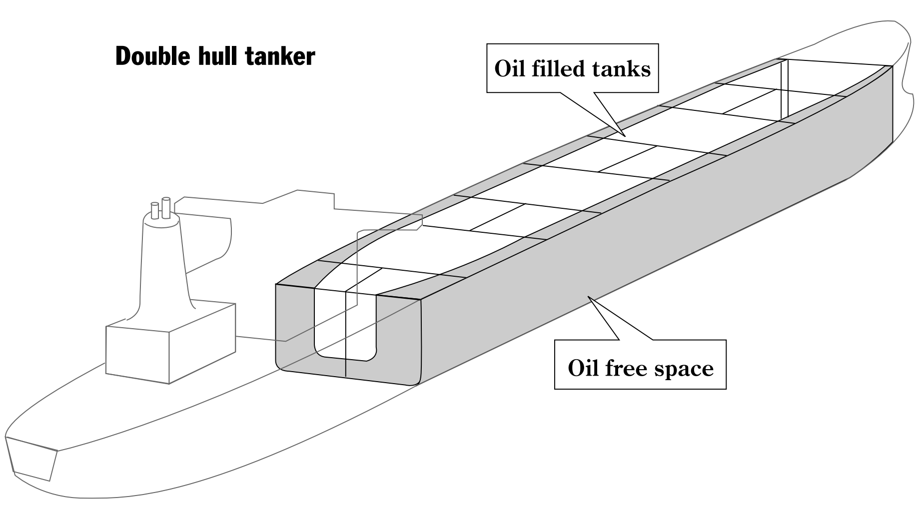
The mid-deck design is potentially superior to the double hull in two situations:

- During Collisions: full penetration of the wider side tanks of a mid-deck tanker will be less likely; and,
- During High-Speed Groundings (over 15 knots): the mid-deck will theoretically spill less oil than a double hull. At such high speeds, the inner bottom hull of a double-hulled tanker would likely be damaged anyway, giving the advantage to the mid-deck tanker with its shallow tanks.

The main difference between the two designs, mid-deck *versus* double hull, is that in low speed groundings the mid-deck design will always spill some oil where a double hull would spill none. The United States Coast Guard considers this to be a fatal defect of the mid-deck design. Estimates are that 65% of oil spilled from tankers has historically occurred during groundings.[12] Current United States rules *do not* consider mid-deck tankers an acceptable alternative to double hulls.[6]

The International Maritime Organization on the other hand, has judged the mid-deck design to be comparable to the double hull in its potential for reducing the *total amount* of oil spilt in marine accidents.[14] Canada has adopted the IMO standards for new construction, meaning that the Canadian Coast Guard will accept both double hulls and suitable mid-deck designs for any new ships calling at Canadian ports.[15] Part 3 deals with the regulations in more detail.

In conclusion, although the mid-deck design has a number of theoretical advantages, its lack of operating experience and lack of acceptance by the United States Coast Guard rules against any wholehearted acceptance of the mid-deck design as a real alternative to double hulls. The inability of the mid-deck to avoid a small spill in almost any grounding is a significant drawback. The mid-deck will never reduce *total number* of oil spills to the same extent as double hulls.



Double Hulls

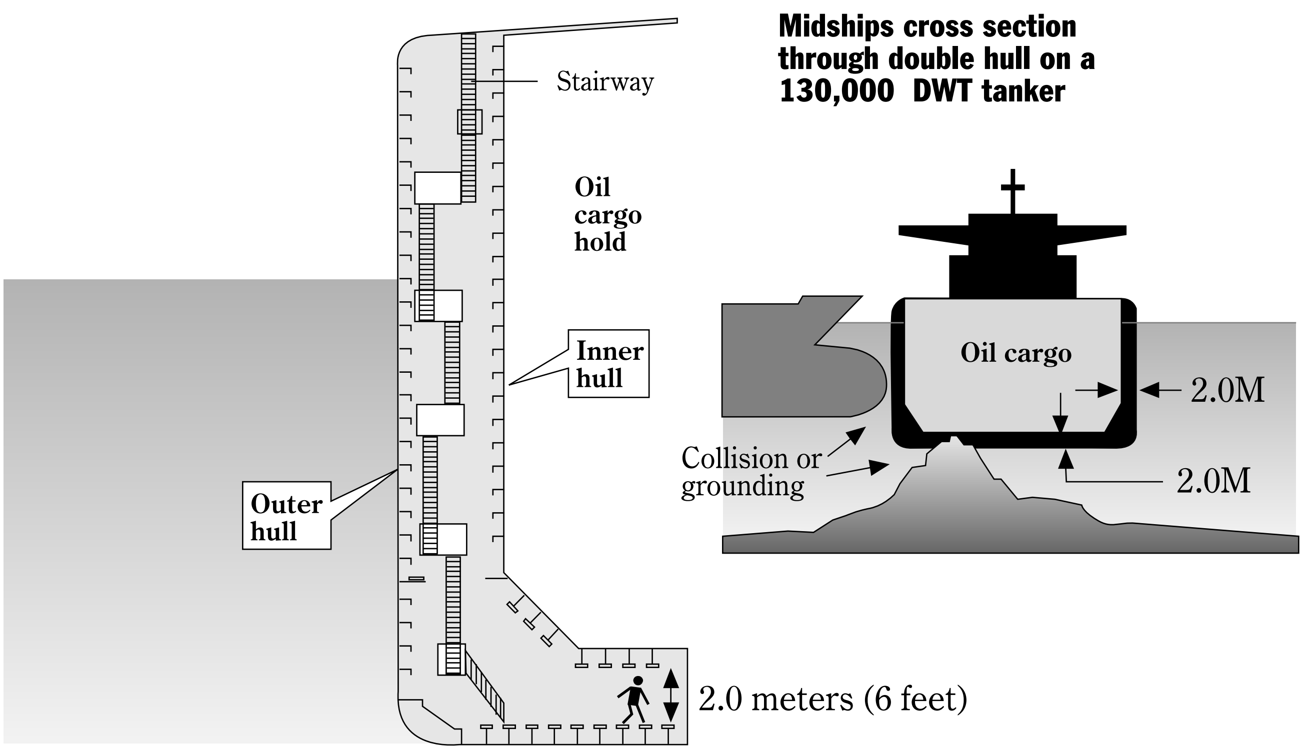
Double hull construction provides a proven solution to the problem of how best to reduce oil leakage after a ship strikes another object or touches the bottom. Double hulls provide a tank within a hull, thus providing two steel barriers between the oil and the ocean as illustrated.

The IMO design standards for double-hulled tanker construction (adopted by United States and Canada) will ensure that tankers greater than 65,000 Dwt, such as tankers delivering oil to Puget Sound refineries, will have a minimum gap of approximately 2 metres between the inner and outer hulls. Only clean ballast water, never oil, can be carried in the spaces between the hulls. Groundings, collisions, and other accidents which only damage the outer hull, will result in no oil spill.

Some idea of the scale of double hull spacing can be gained from the following sketch of the midships ballast tanks on a typical 130,000 Dwt double-hulled tanker. The insert shows the same vessel as it might appear in a grounding or collision situation.

Double hulls, are the best design improvement for reducing tanker oil spills:

- IMO and the US Coast Guard place double hulls at the top of their list of possible designs and use them as a yardstick to evaluate other designs.
- The double hull design was identified as one of the most cost effective for all accident scenarios by the US National Research Council.[7] They estimated that double hulls would eliminate half of the annual spillage from vessels in the US.
- IMO estimated in their 1992 study that the inner hull would not have been penetrated in 84% of historical groundings worldwide if vessels had been double hulled.[14]



- The US Coast Guard has not identified any other design which is superior to the double hull for prevention of oil outflow due to groundings.[16] Groundings account for 65% of the total volume of oil spilled from tankers in the US.[7]
- Double hulls will also reduce oil spillage from collisions and situations of structural failure.

The double hull design is a proven design. In 1989, 18 per cent of the world's tanker fleet was either double-hulled or double bottomed.[17] All ships carrying hazardous chemicals or dangerous products such as Liquefied Natural Gas (LNG) are already required to have double hulls to provide protection for their cargo.

None of the tankers carrying oil from Alaska to Puget Sound are currently double-hulled, although a few have double bottoms.

Double-hulled tankers are usually built as new construction; double hulls can be retrofitted into existing vessels but this is rarely done. Estimates are that double hulls will cost 15-20% more for construction over equivalent single hulled tankers. However, the additional construction and operating cost of double-hulled tankers will add a relatively minor cost of less than 0.15 cents per litre to the cost of oil. [17, 6]

The international requirements for double hulls have only been put in place after a fifteen year debate between industry, regulators, and environmentalists. Three operational concerns were continually raised as reasons not to implement double hulls: too difficult to inspect, increased risk of fire and explosion, and difficult to salvage. Experience with existing double-bottomed and double-hulled tankers, though still quite limited by the few number of such vessels, has led to general agreement that these issues are manageble. Further discussion of these issues is provided in Appendix A.

The fears surrounding inspection, fire and explosion, and salvage have been further put to rest by two large independent tanker owner associations who have stated that double hulls, although more difficult to maintain than single hulls, can still be operated in a satisfactory manner.[14]

Considering the dramatic rise in spill liability following the *Exxon Valdez* oil spill settlements, the long-term benefits of double hulls will be realized in both economic and environmental terms. Double hulls are the preferred design for future tanker construction; every effort needs to be made to ensure that the process of replacing older single-hulled tankers proceeds as quickly as possible.

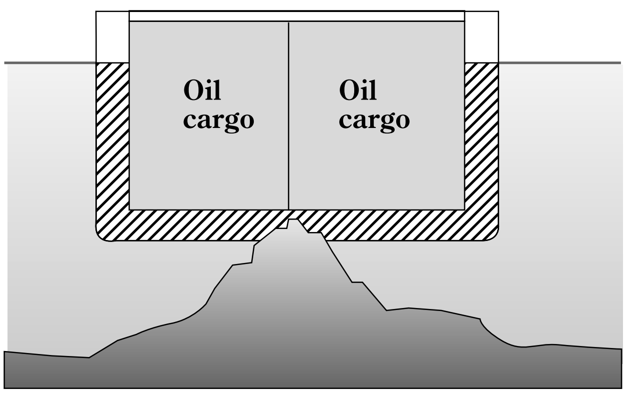
Design Comparison

The double hull offers the dual advantages of *halving the oil volumes* spilled in tanker and barge accidents, and *reducing the number* of oil spills. The overall cost involved in achieving this protection amounts to approximately 0.15 cents per litre of oil transported. The double hull will avoid oil spills in over 80% of groundings while the mid-deck tanker, like the existing single hulled fleet, will always spill some oil as shown in the sketch on the next page.

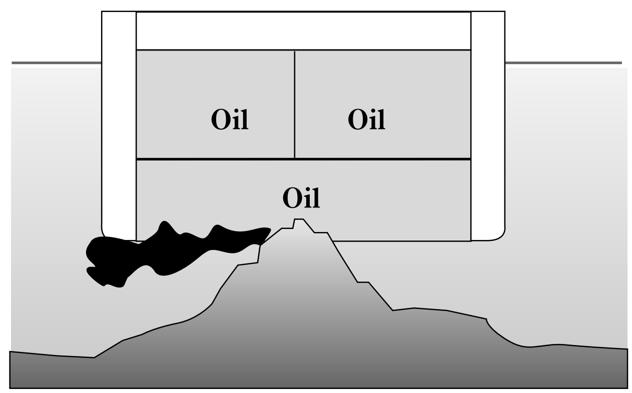
The bar graphs on the following page compare the different new designs with old single hulled tankers in two ways:

- first, the volume of oil spilled over a range of accidents which match the pattern of historical events in terms of the proportion of groundings and collisions; and,
- second, the absolute number of spills prevented in situations where the ship may be damaged but the new design prevents any oil from spilling into the environment.

Not surprisingly given the wide range of circumstances surrounding marine accidents, no one design appears as the only possible solution. The effectiveness of any given design solution depends to a large extent on how we view the problem and the spill location. If our main goal is to



Double hull
After grounding

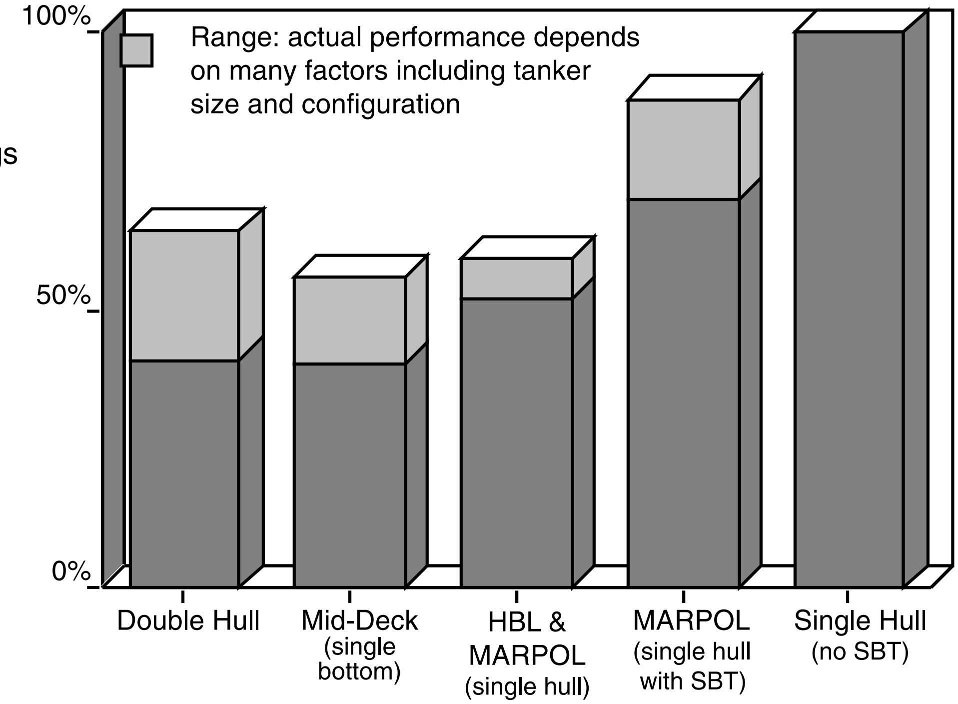


Single hull or mid deck
After grounding

Double Hulls–Half the Pollution: *Double-hulled construction provides a solution to reduce oil leakage after a tanker or barge strikes another object. Double hulls provide a tank within a hull, thus providing two steel barriers between the oil and the ocean. Double hulls are widely accepted as the best proven design.The International Maritime Organization estimates that the inner hull would not have been penetrated in 84% of historical groundings worldwide if vessels had been double hulled. Additional construction and operating cost of double-hulled tankers are estimated to add less than 0.15 cents per litre to the cost of oil. The US National Research Council claims that salvers actually prefer double bottoms, countering the early arguments that a double-hulled tanker would be more unstable in an accident.*

Oil Outflow for Different Tanker Designs

Potential oil outflow in collisions & groundings compared to single hull tankers



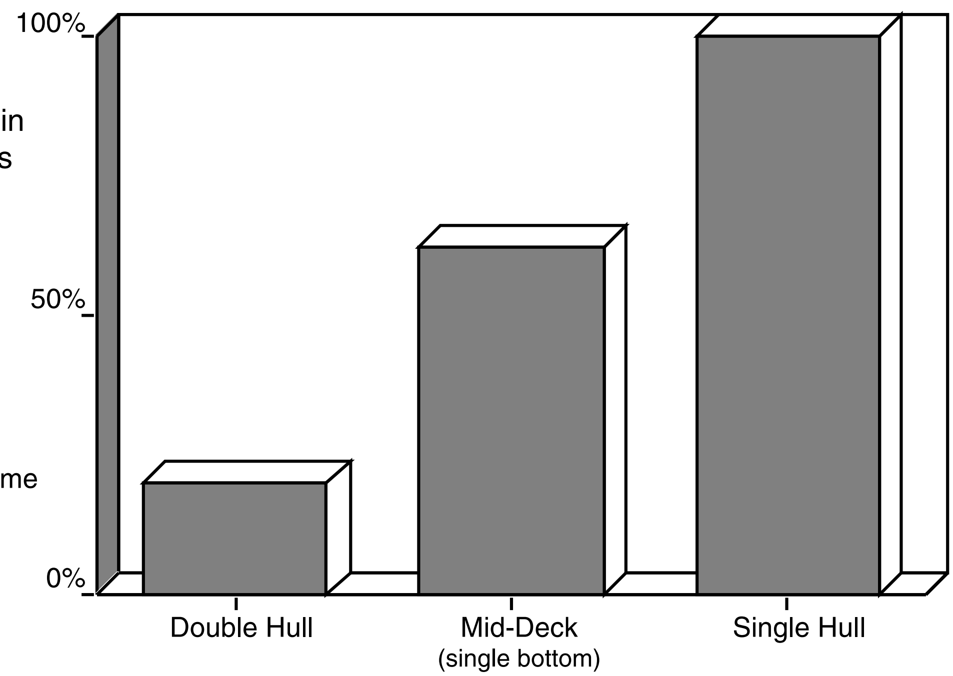
HBL:	Hydrostatically balanced loading
MARPOL:	Tanker built to IMO's MARPOL 1978 standards – 30% of hull area covered by separate ballast spaces with no oil (SBT)

Sources: National Academy of Sciences, 1991; Federal Register, Vol 59, No. 203, Oct. 22, 1993.

Number of Spills: New Designs Relative to Single Hulls

Number of of oil spills in collisions & groundings compared to single hull tankers

Source: International Maritime Organization, Feb. 1992.



prevent oil spills, then double hulls are the winner by far (up to an 80% reduction in numbers of spills for groundings). On the other hand, if our main concern is to decrease the overall volume of oil entering the marine environment from large spills, accepting that there will always be unavoidable smaller spills, then double-hulls and mid-decks offer similar theoretical benefits. In practice, no interim measure for existing vessels offers the protection of double hulls. Such measures as protectively located spaces (or segregated ballast tanks) and hydrostatically balanced loading can only be considered as a minimum cost approaches as opposed to the *best available technology*.

In the end, economics and practical considerations of operations and maintenance favour double hulls as the preferred and proven solution for new construction of both tankers and barges.

In extreme accidents, it is impossible to predict whether any design will prevent a total loss. In order to achieve their full potential, the new double-hulled tankers will still require the highest standards of crew training and vessel traffic systems to maintain safe navigation corridors.

***Double hulls** are the preferred and proven solution for new construction of both tankers and barges. We need to remember that even the most advanced tanker design cannot prevent spills in extreme conditions of weather or negligence. There is no substitute for the highest standards of crew training and vessel navigation.*

PART 3: COMPARISON OF UNITED STATES, CANADIAN AND INTERNATIONAL REGULATIONS

Following the *Exxon Valdez* oil spill in 1989, a large number of national and international inquiries, panels and studies examined the oil spill problem from the perspectives of both prevention and response. Prevention ideas took many different forms including new routes, crew training, navigation systems, terminal designs and operations, and tanker design. Our concern in this report is with tanker and barge design. Part 3 looks for answers to two questions:

- What recommendations concerning double hulls surfaced from the many investigations and hearings over the past several years?
- What is actually happening now or about to happen as a result of recent laws and international agreements requiring the replacement of single-hulled tankers still carrying most of the oil in British Columbia and Washington State waters?

Scheduling Recommendations

First, lets take a look at some of the federal, provincial and US state recommendations which followed lengthy hearings and reports in the aftermath of the *Exxon Valdez* spill:

The Canadian government *Public Review Panel on Tanker Safety and Marine Spills Response Capability* , 1990,[18] commonly referred to as the Brander-Smith report, made the following recommendation specific to Canada’s west coast:

“All Canadian tankers and barges carrying oil or petroleum products in British Columbia's coastal or inland waters must be double hulled within seven years. The use of single-skinned tankers and tank barges between the mainland and Vancouver Island should be permitted to continue until the new gas pipeline under construction in this area has been completed and petroleum consumption levels diminished. This waiver must not extend beyond seven years, at which time all tankers and barges must be double hulled” (Rec. #6-47).

As of 1993 the gas pipeline between the mainland and Vancouver Island has been completed and oil consumption diminished. Accordingly, there should be no domestic coastal barges or tankers of sin-

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RECOMMENDATION: That all oil barges and tankers in Canada be double hulled by 2000

STATUS: Single hulled barges allowed to operate until 2015, and many tankers being allowed to operate well into the next century.

gle-hull construction after year 2000. Nationally, the Brander-Smith report recommended: "Canada should require that in 10 years time all tankers and tank barges entering its water be double hulled (Rec.#3-2). Again, according to this recommendation, mandatory retirement of single-hulled tankers and barges ought to have occurred by year 2000.

The federal government's final response to the panel recommendations (June 1993) agreed in principle to these regional and national scheduling recommendations. However, in their final response to the Brander-Smith recommendation on funding to expedite replacement of the Canadian-flag fleet with doubled-hulled vessels, the final report stated: "... that existing single-skinned tankers be retrofitted or phased-out on a schedule that is consistent with requirements imposed by other countries. Similar requirement will be applied to oil barges..." (Rec.#2-1) As the following comparision of double-hull schedules will show, the matter of international consistency took precedence over the more expeditious national and regional recommendations.

The Province of British Columbia's *Report to the Premier on Oil Transportation and Oil Spills, November 1989* commonly referred to as the "David Anderson Report",[19] recommended: " In the event of the Secretary of Transportation (United States) or the National Academy of Sciences (United States) reporting in favour of double bottoms, greater use of ballast sides, or reduced tank sizes for tankers or tank barges, Canada serve notice that within four years such design features will be required for tankers and tank barges calling at Canadian ports". (Recommendation #20). The National Research Council in Washington recommended in favour of such designs in 1991.[13]

The *Final Report of the States/British Columbia Oil Spill Task Force,* 1990 [2] recommended unanimously that double hulls be required for all new tank vessels designed to carry oil or other petroleum products as cargo. No time was specified.

By 1992, federal governments on both sides of the border as well as the governments of individual States and British Columbia were all in complete agreement on the need for double hulls.

In terms of reducing the risk of oil spills, the critical question is not the date after which all new tankers have to have double hulls, or the dates when the existing single-hulled fleet is forced to retire but the timing when owners are willing to build replacements. Of particular concern is the continued operation of old single-hulled tankers carrying Alaskan oil, and aging single-hulled barges carrying refined products within our waters.

Scheduling Implementation

In November 1992, Canada acceded to the International Convention for the Prevention of Pollution from Ships, known as the MARPOL 73/78 convention of March 1992.[7] Agreements reached at this meeting are critical, in that, they define the international standards and schedules to be used for the design of new tankers and the retirement of the existing world single-hulled fleet. Under the new IMO rules any tanker older than 25 years as of July 1995, without segregated ballast tanks must be replaced or have a new double hull. Tankers with SBT are allowed to be 30 years old before replacement. Canadian oil barges less than 10,000 Dwt that are single hull do not have to be retired until year 2015. No Canadian tank barges on the west coast exceed this size (average size is approximately 2,000 Dwt).

Under these rules, the last year in which a single-hulled tanker can call at any port in the world where the government has acceded to the International Maritime Organization's MARPOL convention will be 2007 in the case of a tanker with no segregated ballast tanks, or 2025 in the case of tankers which have this added measure of protection. As over half of the larger tankers were build during the early 1970's, most of the world tanker fleet will be forced to retire by the turn of the century under the MARPOL, *Canada Shipping Act* (CSA) and *US Oil Pollution Act* (OPA '90) schedules.

For tankers calling at US ports, that country has established its own independent schedule under the (OPA '90) which differs from the world standard (see chart below). Canada, through the CSA has adopted a mix of replacement schedules,

Comparison of New Regulations Requiring Double Hulls or their Equivalent for New Construction of Oil Tankers or Barges (7,9,14)

	calling at US Ports	calling at Canadian Ports
Relevant Legislation	*US Oil Pollution Act*, 1990	*Canada Shipping Act*
Affected tanker and barge sizes	all	all
Designs Allowed	double hull only except for vessels less than 5,000 gross tons	double hull *or* mid-deck
Interim Standards for Existing Vessels	not finalized – rule expected by 1996	as acceptable to IMO (e.g., protectively located spaces, HBL)
Dates in effect	vessels contracted after June 30, 1990 and delivered after January 1, 1994 (delivery takes precedence)	vessels contracted after July 6, 1993 and completed after July 6, 1996 (completion takes precedence)

following the IMO standards for tankers over 20,000 Dwt, and following the United States retirement schedule for smaller tankers and barges.[15,10] In practice, given the size of the market, the OPA '90 schedule will dictate the mandatory retirement date for many tankers trading in the world, and for most tankers posing a risk to the west coast.

The OPA '90 provides the US Coast Guard with the authority to develop their own standards for new tanker construction as well as a mandatory retirement schedule for existing single-hulleded tankers calling at US ports.[6] The OPA '90 requirements and timetables for double hulls have far reaching implications for a large proportion of the world's tanker fleet. The US Coast Guard has estimated that these rules will affect some 3000 tankers worldwide, mostly foreign flag ships.[6]

The Real Issue

In terms of reducing the risk of oil spills the critical question is not the date after which all new tankers have to have double hulls nor the dates when the existing single hull fleet is forced to retire, but **when** and **if** new double-hulled US flag tankers will be constructed as replacements for the aging single-hulled tankers carrying Alaskan (TAPS) crude oil. With the current low return on investment associated with the tanker charter market, very few new tankers will likely be built over the next ten years. Even with the MARPOL and OPA '90 requirements for mandatory retirement, the natural aging of the world's fleet is of grave concern to shipping organizations like the IMO and the Coast Guard.

Most foreign flag vessels will have to adhere to whichever regulation is stricter to be able to continue trading worldwide and to North America. In practice, the differences between international and United States schedules for retiring single-hulled tankers would be important to British Columbia only if many more foreign tankers started to call at Port of Vancouver. This is an unlikely situation since British Columbia does not generally import oil by vessel, and is reducing its oil export by vessel. Foreign tankers calling at Puget Sound (United States) will have to satisfy both OPA '90 and MARPOL whichever is more stringent.

It may take until well into the next century before sufficient number of new double-hulled tankers are built to provide any substantial reduction in spill risk.

In an effort to understand this issue, the retirement schedules called for under OPA '90, MARPOL, and CSA were applied to the actual mix of sizes, ages and numbers of tankers trading on the Alaska oil route, between foreign ports and Puget Sound (via the Juan de Fuca Strait), and tankers within British Columbia coastal waters. The objective was to produce a clear and realistic picture of the earliest dates when we could start to see a substantial reduction in spill risk from new double-hulled tankers and barges. An assumption is that new double-hulled tankers are introduced at the same time the older single-hulled ones are forced to retire. In order to apply the various retirement schedules to actual vessels, six different oil trading categories were used (see Part 1 of this report).

Trade 1 **US flag tankers delivering Alaskan (TAPS) crude oil:** There are over 30 vessels engaged in this trade in any given year. However, 78% of the oil is carried in 18 ships which are now more than 20 years old (built between 1969 and 1974). Under OPA '90, these 18 tankers will all be forced to retire between 1996 and 1999. Industry has announced no plans for new construction and it remains unclear how the potential **capacity** shortfall in the US flag TAPS tanker fleet will be met. See Part 4 on expected future trends regarding export of Northslope Crude oil from Alaska, and the use of foreign flag vessels (Trade 2) to meet potential oil **supply** shortfall.

Trade 2 **Foreign flag tankers delivering crude oil to Puget Sound refineries:** Based on the age of tankers on this trade in 1993, replacement with double-hulled vessels may occur between year 2003 and 2010 according to OPA '90 schedules. (Note: IMO standards would allow the same vessels to continue operating until year 2007 for the oldest or 2023 for the newest.)

Trade 3 **Tankers carrying refined products out of Puget Sound:** Tankers in the refined product trade calling at Puget Sound tend to be approximately half the average size of crude oil tankers in our area (42,000 vs. 88,000 Dwt.). The exact ages of individual vessels in this trading category were not available. In 1992, it was reported that approximately 1/3 of the oil refined in Washington State goes to foreign countries (mostly in foreign flag ships) and the rest goes to other west coast states in US flag tankers.[1] A 1994 list of tankers approved to operate in the Pacific Northwest showed that 20% of the tankers engaged in the refined product trade are already double-hulled. The rest are new enough that retirement is not mandatory until after 2005.[20] The US Navy Sealift Command plans to retire its single-hull fleet and begin replacement with double-hulled tankers in 1995.

Trade 4 **US flag barges carrying refined products out of Puget Sound:** Most Puget Sound barges are less than 5,000 gross tons meaning that under OPA '90 they can operate until 2015 before needing double hulls. According to a 1990 listing of 44 tank barges in Puget Sound,[3] there are only two vessels which are large enough to fall into the next size category under OPA '90 (5 - 15,000 gross tons.

Trade 5 **Canadian flag barges carrying refined products in B.C. waters:** Under the recently released Canadian Coast Guard Oil Barge Standards,[10] all barges used locally will be allowed to operate with single hulls until 2015 - another 20 years. This replacement schedule is a direct copy of that required by the US Coast Guard for American oil barges such as those in the states of Washington and Alaska. Even with the reduction in bunker fuel volumes being moved to Vancouver Island, the movement of refined oil products by barge in British Columbia waters still accounts for approximately 8% of the total volume of marine oil cargoes on the west coast. Much of this oil is carried through narrow passages adjacent to highly sensitive areas, particularly up the Inside Passage (including Johnstone Strait, Discovery Passage, Chatham Sound).

On the positive side, the west coast oil barge fleet has a very good safety record and has greater mechanical redundancy than the larger tankers through the use of twin-screw (propeller) tugs.

Trade 6 **Crude Oil Tankers Exporting Alberta Crude from Vancouver (Westridge Terminals):** Due to changing market conditions and economics, the numbers of tankers leaving from Vancouver has fallen far short of what was projected in the early 90's.

The Canadian Coast Guard standards allow all single-hulled oil barges to operate until 2015 before having to be replaced with double-hulled vessels.

According to Trans Mountain Pipelines Limited, fewer than 10 vessels per year are expected in the future. This level of traffic would constitute only about 2% of total marine oil cargo movements in our region. Tankers used in this trade tend to be much newer than the world average; for example, the oldest tanker calling in the past year was built in 1980. Strict standards are applied in selecting vessels for charter into Vancouver and no tankers are accepted without segregated ballast tanks; most have fully protected cargo spaces along the sides (essentially double sides). Double-hulled tankers will be phased in to this service between 2015 and 2020 according to the schedule set by IMO for tankers with segregated ballast tanks. This phase-in may be sooner as the availability of double-hulled tankers for charter increases.

The results of the analysis shows that unless American ship owners begin a massive program of acquiring new double-hull tankers by 1996 (whether built in the US or purchased from foreign ship-yards), we will have to wait until well into the next century before double hulls start to make substantial contribution to reducing the risk of spills on the west coast.

Foreign flag tankers leaving from Vancouver carry only 2% or less of the total regional oil cargo on an annual basis. Consequently, the retirement schedule set by the International Maritime Organization and adopted by the *Canada Shipping Act* has little or no impact on the timing of double hull benefits in our waters.

The average age of the US flag oil tankers trading along our coast is now 21 years and the newest tanker in regular use, the *Kenai*, is 15 years old.[20] In contrast, fully half of foreign flag tankers, similar in size to vessels in the US Alaska (TAPS) fleet, were built since 1980.[8] The reasons for this age difference are primarily economic.

Under the US *Jones Act* (also known as the *Merchant Marine Act* of 1920) only tankers built in United States shipyards are permitted to carry cargoes between two American ports. The cost of tanker construction in the United States has traditionally been much higher, up to double, than in many other shipbuilding nations (China, Korea, Japan). The result is that

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If double hulls could be depended upon to prevent a spill in half of all accidents on average, then the simple act of retiring all US flag tankers older than 25 years in 1998 will result in approximately 12% fewer spills in the future.

new tankers built in the United States will have great difficulty in operating economically.

Companies are understandably reluctant to replace their older single-hulled TAPS tankers until either the vessels become too difficult to maintain due to aging, or until called for under the OPA '90 legislation. At the same time, the production of oil from the Prudhoe Bay oilfield is in steady decline with no future replacement clearly projected. The US *Jones Act* restrictions forces tanker owners to maintain their aging tankers for as long as possible and to delay plans for their replacement. This economic strategy places the environment at risk.

A study on TAPS tanker structure failures done in 1991 indicated that these vessels account for 59 per cent of the hull fractures reported to the US Coast Guard, though the TAPS tanker fleet comprise only 13 per cent of the US tankers. [20] The hull cracks were generally attributed to: inadequate design of structural details, poor workmanship and quality control, use of high tensile steel, lack of maintenance, harsh marine environment, and combinations thereof. This 1991 study noted that "... TAPS operators revealed that there are no plans for replacement of this fleet by new construction." Four years later, no plans for replacement tankers have been made public.

It appears that the time is right to consider foreign-built double-hulled tankers, but still American owned-and-operated, to travel on the Alaskan (TAPS) route. This will require either a special waiver under the existing US *Jones Act* or new legislation in United States.

In conclusion, the timing of the benefits (spill risk reduction) from double-hull design is of significant public and environmental concern. The gap between what was recommended under various public enquiries and the realities of real-world economics should be reduced by whatever legislative or incentive means possible.

Unless ship owners elect to replace their older tankers according to the retirement schedule, we may have to wait another ten years before double hulls start to make substantial contribution to reducing the risk of spills on the west coast.

The average age of the Alaskan tanker fleet is now 21 years and the newest tanker in regular use is 15 years old. In contrast, fully half of the foreign tankers were built since 1980. The high cost of oil tanker construction in the United States, compared to Asian ship yards, is a significant deterrent to replacing the TAPS oil tanker fleet.

Recent changes in market forces, economics and carriage liability are all having an effect on both the volume and distribution of marine oil movements in and adjacent to British Columbia waters, and whether double-hull construction will occur:

- The rate of growth in the demand for petroleum products is expected to remain fairly flat. The effects of the increasing population and relatively robust economy of the Pacific Northwest is being offset by such factors as more efficient motor vehicles and environmental regulations favouring alternative energy sources such as natural gas and cleaner air quality.

- The decline in Alaska North Slope oil reserves will lead to an increasing reliance on foreign oil to supply Puget Sound refineries. In 1992, the Washington State Energy Office estimated that this effect would begin to be felt by 1996, and that by the year 2000, Alaska would supply only 60% of regions' crude supply, down from 90% in 1990. Furthermore, new US legislation has been prepared(Senate Bill 395 - passed May 15th, 1995) that authorizes the export of crude oil from Alaska, dropping the requirement that all TAPS crude oil be processed in the United States. The difference is likely to be made up by tanker imports from Indonesia, and other countries, and pipeline exports from Canada, which is already happening. More vessels will be foreign-flag oil tankers which is both good and bad news for the environment. While many of these ships are much newer than the existing American flag TAPS tankers, the majority still only have single hulls or at best, segregated ballast tanks. Operationally, there is the risk of sub-standard foreign-flag tankers transiting the hazardous passages of Puget Sound, such as Rosario strait. For example, the Washington Office of Marine Safety reported that, of the 13 foreign flag tankers the visited the state in 1993, six were identified as high safety risk by the US Coast Guard. This new legislation essentially takes the pressure off of the oil industry to replace the TAPS fleet.

- Future tanker traffic out of Vancouver (primarily Westridge Terminals) is expected to be much less than projected four years ago. Only three vessels sailed in 1994, down from the 12 to 14 loads more typical of the past few years. The trend is towards more "specialty shipments" from Vancouver which could lead to between 6 and 10 tank vessels per year calling to pick-up such cargoes as gas field condensate and synthetic crude.[22] These cargoes pose less risk to the marine environment than the more persistent crude oils.

- There is a recent oil transport practice of parially unloading TAPS crude oil tankers at Puget Sound refineries and then having them return, via Canadian waters, to off-load their remaining oil at southern US ports on the west coast. In 1994, there were 33 such partially loaded shipments involving TAPS tankers.[23] These outbound vessels essentially double the risk because traffic movement involves two loaded transits in local waters.

- Increasing amounts of Alberta crude oil are being moved *via* pipeline from British Columbia to Washington State. As of November 1994, Canadian crude imports were meeting approximately 20% of the Puget Sound daily refining needs, up from around 1% five years ago. This supply situation is highly desirable from and environmental standpoint as it reduces the overall risk of a marine spill. The pipeline supply is very dependent on pricing and market pressures from other geographic areas.

- The transport of refined products in British Columbia waters by Canadian barges has declined by approximately 15% overall since the completion of the natural gas pipeline to Vancouver Island (bunker volumes were reduced by up to 75%). Trends in the Canadian oil barge industry indicate little or no growth in petroleum product deliveries and probably a slight decline with fewer destinations being served by sea as a result of new regulations under the *Canada Shipping Act* governing shoreside oil handling facilities and the requirement to have adequate oil spill response capability. [24]

The rate of growth in the demand for petroleum products is expected to remain fairly flat; in terms of marine traffic, the overall number of tankers will probably remain about the same or decrease somewhat, while the proportion of foreign tankers delivering crude oil to Puget Sound is expected to increase.

There are significant benefits for reducing the risk of a spill. These benefits include avoided response (clean up) costs, natural resource damages, and restoration costs. A 1995 study commissioned by the BC Ministry of Environment, Lands and Parks compared the benefits and costs of accelerating the current retirement schedules by 15 years to year 2000.[25] The estimated cost of accelerating the replacement of the Alaska (TAPS) fleet (28 vessels) is $240 million (1995 $US) with the US Jones Act. The US Jones Act doubles the cost of tanker construction. The estimated benefits to British Columbia and the shared waters of the State of Washington to is about $147 million. Benefits accrued to other regions, such as Alaska and California, were not estimated in the study, but would no doubt be substantial. The analysis of the TAPS fleet indicated that a waiver of the US *Jones Act*, which would allow the use of less costly foreign-built vessels on the route, would decrease the cost by 50 percent of the accelerated replacement, whereby a net benefit of $27 million (US) or greater would be realized.

The study's benefit-cost analysis of Canadian-flag oil barges (21 vessels) showed that the benefits of expediting the current retirement schedule under and CSA exceed the costs by $154 million. This outcome largely reflects that even small spills of persistent fuels can be expensive both in cleanup and damages. The benefit-cost analysis did not, however, count in regional spills from deep sea vessels or that most Canadian barges on the west coast carry lighter and less damaging diesel and gasoline fuel than crude oils. As such, a full regional analysis of small spill risks, from all sources, and by all types of fuels will likely show that the benefits of accelerating the single-hulled barge replacement would be more towards equating with the cost of such a program.

For foreign-flag tankers such as from Asian Pacific and Europian countries (16 vessels), the study showed that the cost of expediting the retirement schedule exceeded the benefits. This outcome largely reflects the situation of only a few foreign-flag vessels transit British Columbia and Washington State waters each year. The reduction of the regional risk of a spill is therefore low. However, the increased availability of double-hull tankers for chartering at lower rates, and the rise in foreign flag traffic to off-set reductions in Alaskan crude oil production will narrow this gap. Furthermore, the benefits world-wide by using double-hulled tankers were not fully accounted owing to lack of risk values that could be applied to the benefit-cost analysis.

The benefit estimates of this study are both reasonable and conservative when considering that the damages for one moderate spill, such as the the *Nestucca* barge spill in 1988, may range from ten to hundreds of millions of dollars, and the damages from a large spill may reach billions of dollars, as in the case of the *Exxon Valdez* spill in 1989. There is more latitude for costs to decrease and benefits to rise based on future changes in tanker chartering and construction practices and rising environmental values.

It is important to consider the distributional consequences of **who loses** and **who gains** for not undertaking (or conversely, for undertaking) the expeditious retirement of aging single-hulled tankers and barges and their replacement with double-hulled ones. If the oil industry delays the retiring of their single-hulled oil vessels, then the risk and cost of spills are borne locally on the west coast, while the savings of not converting to double-hulls at an earlier date are realized throughtout North America and abroad.

Who bears the cost has significant relevance to British Columbia. A 1995 study on the financial preparedness for a major marine spill in British Columbia commissioned by the BC Ministry of Environment, Lands and Parks looked at two aspects: 1) funding to pay for response to marine spills and 2) compensation for environmental and property damages.[25] The study revealed that:

• Though under the *Canada Shipping Act* oil tankers and major vessels must contract with a Response Organization (RO) to provide response services, there is no legal obligation by the vessel owner to fund or use the RO services in the event of a spill;

• In Canada, the combined amounts of two international compensation schemes, the Canadian Ship-source Oil Pollution Fund and private-sector oil tanker compensation schemes are not sufficient to compensate for the cost of cleanup of a major marine oil spill, yet alone natural resource damages;

• Though the US level of financial responsibility for oil pollution damage by a vessel owner is about 10 times that of Canada, there is no treaty or other legal obligation to compensate for natural resources damages or costs incurred by provincial or federal government; and

• Canada does not have a natural resource damage assessment requirement or the capability to fully determine economic and social losses due to impact to the environment from a marine oil spill.

Based on the above short-comings, British Columbia is particularly vulnerable to bearing the cost of a major marine spill, particularly if it originated out-side of Canadian waters from a TAPS tanker or other foreign-flag vessels.

How the US oil industry will meet current retirement schedules has not been explained. There is indications that these decisions are being pushed as far into the furure as possible or that alternative solutions are being sought such as allowing Alaskan North Slope oil to be sold abroad. The consequences of the latter strategy may be more foreign-flag oil tankers servicing Puget Sound refineries to off-set the reduced supply of the Alaska crude oil transported by the TAPS fleet.

The issue of "economic" *versus* "environmental" protection is on the horizon.

CONCLUSION

The Pacific west coast is a rich environment of constantly changing tidal currents, convoluted coastlines, archipelagoes, and an abundance of marine life. There are shared borders, a dynamic maritime commerce, and vibrant coastal communities. The spectre of a grounding or collision involving an oil tanker or oil barge, raises the image of drifting oil that respects no international borders, and oil that threatens our sensitive shores with their unique diversity of marine birds, and intertidal organisms. The public are deeply concerned about these consequences of oil spills and the need for spill prevention. Research on environmental issues showed that in 1994, British Columbia residents placed the highest priority on the prevention of oil spills (compared to other environmental concerns); and ranked highest such measures as double-hulled tanker construction (84% in favour), marine spill prevention plans (89% in favour) and spill prevention funding (82% in favour).[26] Spill prevention must not be an afterthought, but a priority in its own right, along with efforts to improve our ability to respond and to recover spilt oil.

Spill prevention can take many different forms. Some prevention measures focus on human performance, such as crew training: others on technology, such as electronic navigation charts. Each approach contributes to reducing the risk of a marine vessel casualty and the possibility of a catastrophic spill. A proven measure to reduce oil spills in the event of grounding or collision involves double hulls for oil tankers and barges – a structural design measure.

The *pros* and *cons* of double-hulled construction of oil tankers and barges have been debated for over 20 years by scientists, engineers, industry, governments, and concerned citizens. By 1992, there was a general consensus that double-hulled construction provides a substantial measure of environmental protection in the event that an oil tank vessel is involved in a grounding or collision. Furthermore, various panel inquries and task forces on tanker safety and spill prevention held between 1989 and 1990 recommended that the year 2000 be the target date for mandatory retirement of all single-hulled oil tankers and barges. These recommendations reflected a strong public desire for marine spill prevention.

The requirement for new construction and the phasing-out of aging tankers and barges is now embedded in our national shipping laws and international conventions. Although double hulls are required for all *new* tankers and barges built worldwide from 1995 on, the time period for actual replacement of *existing* single-hulled vessels that pose a risk to our shores could extend well into the next century.

The issue of double-hulled construction is complex, revolving around the need for international consistency and the protection of maritime commerce. Knowing the value of our coast and its vulnerability to oil spills, one must question this narrow perspective. The findings of this study clearly demonstrate that the time period presently set for achieving safer tankers and barges is too long, especially when one weighs the severe environmental and economic consequences of a spill.

Comprehensive regional analysis of the benefits of acclerating the retirement schedules by 15 years to the year 2000 has shown that the avoided response costs, natural resource damages and restoration costs conferred by double-hulls exceed the cost of replacement of our domestic double-hulled tankers and barges. The current oil industry silence and their history of procrastination on double hulls underscores our concern that we will continue to bear the regional risk of a major spill whereas the oil industry and consumers throughout North American benefit from the savings of inaction. Furthermore, Canada, and British Columbia in particular, is financially vulnerable to being inadequately compensated for damages incurred. A major oil spill within our shared waters will demonstrate the false economy of any delaying strategies.

Incentives for new construction have to be pursued immediately and all impediments fully addressed in order to encourage industry to phase out its aging single-hulled tankers and barges ahead of schedule and replace them with new, safer double-hulled vessels. The time to achieve this goal should be well ahead of that stipulated by laws and conventions, preferably before the turn of the century. We know that double-hulled tankers and barges will reduce oil spills and the risk to our valuable coastal resources and environment. Now is the time to re-examine way in which owners and operators can be encouraged to not simply retire their older tankers or barges, but replace or charter with new double-hulled ones. The goal must be one of seeking more timely and meaningful environmental protection through best available technology.

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Appendix A:
Background – Tanker Design

Hydrostatically Balanced Loading (HBL) provides more protection than protectively located spaces. Based on *idealized* theoretical accidents, the US Coast Guard estimates that HBL could reduce oil spillage by 96% during groundings and 15% in collisions.[10] Actual performance in practice under the effects of wind, waves, and currents will likely be lower. For example, a tanker grounded at high tide will lose some or all of its advantage as the water level falls to the low tide mark. HBL provides little protection in collisions: oil spills from collisions near the water line will only be slightly reduced as oil below the collision rupture will still flow out. Also the measure cannot be applied to cargoes which are heavier than sea water such as asphalt and bitumen (most oils are lighter than water).

While the outlay cost of HBL is low for the majority of tankers, it is estimated that the reduction in cargo capacity of tankers will cause the measure to be three times more expensive than protectively located spaces.[10] The US Coast Guard estimates that partial loading will reduce cargo capacity on existing tankers by 36-50%.[10] If tanker traffic increases to move the same volumes of oil, previous experience predicts that there will be an increase in the number of accidents, partly defeating the object of this interim protective measure.

HBL cannot be implemented on about 15% of existing tankers whose cargo tanks are not strong enough to withstand the sloshing of cargo back and forth.[12] Normally when a cargo tank is filled almost to the top, there is very little room for sloshing; cargo sloshing can also adversely affect the ability of the tanker to recover from wave action or other forces which cause the tanker to roll.

HBL would be difficult to implement on barges. Barges handle a variety of cargoes and the partial loading levels will vary widely depending on the density of the petroleum product. As HBL is entirely dependent on accurate loading, any errors in tank levels will largely cancel the benefits of this spill prevention measure.

Mid-deck designs: Without any real experience base to draw on, there are reservations as to how the mid-deck vessel will perform in actual service. Operationally, the mid-deck design has been met with many of the same reservations as the double hull. Although some tanker owners feel that it presents more risks to personnel, there is general agreement that the concerns are manageable.[13] A mid-deck vessel is more complex than a double hull design because of the extra piping and venting required for the lower tanks. Determining oil levels in these tanks during loading and unloading and cleaning of tanks will require extra vigilance on the part of the crew, because of the lack of direct physical access from the main deck.[12,13] Inspecting the side tanks will be less onerous than inspecting both sides and bottom of a double hull. Because a reduced steel area is open to corrosion in comparison to a double hull, the risk of undetected corrosion may be somewhat lower in the mid-deck tanker.

The mid-deck design may not be suitable for barges as the vessel must be carefully loaded and unloaded to insure that the lower tanks have sufficient cargo to prevent capsizing. Barges, such as those re-supplying fuel depots along Vancouver Island, often travel with partial loads and make multiple stops to unload cargo on the same trip.

Double-Hulls: Tankers and barges require periodic inspection of the hull and cargo tanks to check for corrosion and cracks. Double bottoms make inspection much more time consuming and expensive because in addition to the cargo tanks, all the spaces between the inner and outer hull must be visually inspected. For example, in a very large tanker (over twice the size of tankers carrying Alaskan crude), a double hull has close to three times more ballast areas, all requiring inspection, than an equivalent MARPOL tanker.[12] Inspectors run the risk of becoming lost or overcome by fumes in the maze of spaces between the hulls (typically only 2 m high in the tanker bottom). Inspection difficulties can be overcome by design and planning: the expert committee assembled by the National Research Council to study double hull design concluded that the risks to inspectors were an important concern, but were not unmanageable.[12]

Claims of increased risk of fire and explosion (as a result of undetected leaks of highly combustible oil and vapour into the between-hull spaces) are not backed up by accident statistics. The National Research Council's 1991 study concluded that there was no reliable evidence for increased risk to fire and explosion on double-hulled tankers.[12] Lloyd's Register of Shipping found, after reviewing 11 years of accident data from single and double structured tankers, that double bottoms or hulls were not responsible for any of the fires and explosions which damaged the integrity of tankers.

The third argument against double-hulled tankers claims that the vessels are more difficult to salvage after an accident because the between-hull spaces fill up, making the tanker heavier and unwieldy. In fact, this characteristic can reduce further damage in a grounding by insuring the vessel remains firmly grounded rather than continuing to move under the effect of wind and waves. It has been claimed that salvors prefer double bottomed vessels.[12] The National Research Council's report states that "there are no salvage-related concerns that should limit the use of properly designed double hulls".

The question of the spacing between the hulls in double-hulled vessels proved to be very contentious with many groups (particularly environmental lobbyists) demanding larger protective spaces. The final US Coast Guard specifications match the dimensions called for by IMO.[7] The dimensions are considered a reasonable compromise between economics, practicalities of inspection, environmental protection and proven shipbuilding technology. Interestingly, the double-hull requirements for oil barges in Canada are not completely compatible with the US in terms of the bottom spacing; the *Canada Shipping Act* adopts the MARPOL specifications which make the double bottom space equal to the side tank breadth (ending up with ~ 1 metre minimum for most barges). The USCG regulations call for a relatively deeper bottom.

Under a grandfather clause, any existing double-hulled tankers will be allowed to continue operating indefinitely even if their hull spacing falls short of the new requirements; in practice, this clause affects a small percentage of the worlds fleet as of 1994.

Interim Protective Measures: The most complex issue related to double hulls, concerns acceptable interim measures which will be required in the intervening period, before vessels are forced to retire or be double-hulleded. The IMO lists a number of design features which are considered acceptable and is considering other measures. At present, the United States has not taken a final position with respect to interim measures; the Interim Notice of Rulemaking issued by the US Coast Guard in October 1993 was highly controversial and any final Notice of Rulemaking under OPA '90 is not expected until January 1996 at the earliest.

One interim step which could provide a significant reduction in spill risk at minimal cost would involve legislating smaller individual cargo tank sizes. However the economics of making costly interim conversions of existing vessels are highly questionable. It seems highly unlikely that voluntary compliance with interim protective measures requiring expensive structural modifications will appeal to many owners already hit hard by falling revenues.

Appendix B:
Background – Regulatory Issues

Under the OPA '90 requirements, all tankers and oil barges completed building after January 1, 1994 will have to be double-hulled. Existing single-hulled tankers calling at US ports will have to be either retired or converted to double hulls by 2015 at the latest. Under a complex multi-tiered schedule based on the gross weight of the vessel, single-hulled tankers larger than 30,000 gross tons older than 28 years, 33 years if the vessel already has either a double bottom (DB) or double side (DS), will not be allowed into a US port after January 1, 1995. The equivalent maximum ages for smaller vessels between 5,000 and 30,000 gross tons are 40 to 45 years as of January 1995. Most barges are less than 5,000 gross tons and can operate with single-hulls under OPA '90 until 2015. Under the *Canada Shipping Act* Canadian Coast Guard has adopted the same standards for barges as the United States.[9]

It is important to realize that although there are close parallels between the US regulations and IMO standards, there are also important differences in terms of which designs are acceptable and in terms of when older vessels will have to be taken out of service, as follows:

- The retirement schedules called for under MARPOL and OPA '90 are very simlar for tankers built prior to 1982. For newer tankers credited with segregated ballast tanks, MARPOL tends to allow later retirements dates than OPA '90. In extreme example, MARPOL allows a single-hulled tanker completed in 1994 to operate as late as the year 2024, while OPA '90 sets 2010 as the last year of operation for any tanker not having either a double hull or side.
  Most foreign flag vessels will have to adhere to whichever regulation is stricter at any given time in order to be able to continue trading worldwide and to North America. In practice, the differences in retirement schedules between the United States and the MARPOL would only be important to British Columbia if many more foreign tankers started to call at Vancouver, an unlikely situation. Foreign flag tankers calling at Puget Sound will have to satisfy OPA '90 as being more stringent. With the present distribution of oil movements, most of the oil spill risk in local waters is linked directly to the US flag tankers which do not trade worldwide and only have to follow the OPA '90 replacement schedule.
- The United States Coast Guard does not accept the mid-deck design as an alternative to double hulls for new construction. The US Coast Guard does have the authority to consider alternatives to double hulls for vessels under 5,000 gross tons.
- The United States has not adopted either the retirement schedule or the recommended interim protection measures for existing vessels developed by the International Maritime Organization. Equivalent standards for acceptable interim protection measures have not been established

in the United States.

- The double-hull rules under OPA '90 also apply to vessels carrying animal or vegetable oils in bulk; in contrast the IMO defines oil as crude oil and petroleum products.
- OPA '90 applies ultimately to all vessels regardless of size; MARPOL, administered by the IMO, applies only to tankers and barges larger than 5,000 Dwt (~ 2,500 gross tons). For smaller vessels the IMO requirements call for either double bottoms to be fitted or individual cargo tanks to be limited to 4,400 barrels or less, but no double hulls. The Canadian Coast Guard has elected to follow OPA '90 rules for all tankers and barges less than 20,000 deadweight tonnes.[9] Still, these rules will allow most single-hulled barges to operate until 2015.

In their 1993 *Standards for the Double Hull Construction of Oil Tankers* the Canadian Coast Guard follows a mix of international and US regulations:

- for new oil tankers and existing crude oil tankers of 20,000 tonnes deadweight (Dwt) or greater and existing product (gasolines, bunker, diesel, distillates etc.) carriers of 30,000 Dwt or greater: the IMO Protocol of 1978 as amended in 1992 as already discussed;
- for existing crude tankers less than 20,000 Dwt and existing product carriers less than 30,000 Dwt: OPA '90 with reference to the US Coast Guard Interim Final Rule issued August 12, 1992 and adopted in March 10, 1995. [6]
- for tanker barges less than 5,000 gross tons (~10,000 Dwt): OPA '90 calling for double hulling by January 1, 2015; and
- for tanker barges over 5,000 gross tons (applying to only to two barges in Canada – none on the west coast): the time schedule for single-hulled tankers of applicable tonnage (meaning essentially as per OPA '90, as no oil barges exceed the 20,000 Dwt needed to place them in the MARPOL replacement schedule).