DOUBLE-HULL REQUIREMENTS FOR TANK VESSELS IN THE Oil Pollution Act of 1990

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I. INTRODUCTION

In response to the Exxon Valdez incident,[1] the Oil Pollution Act of 1990 (OPA 90)[2] was signed into law on August 18, 1990 as allegedly comprehensive oil pollution legislation addressing the issues

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1) On March 24, 1989, the Exxon Valdez ran aground on Bligh Reef in Prince William Sound, Alaska, spilling approximately 240,500 barrels of crude oil into the Sound. The oil covered approximately 800 nautical miles of shoreline. See National Oceanic and Atmospheric Administration, Oil Spill Case Histories 180 (1992); and Energy Information Administration, Petroleum: An Energy Profile 1999 38 (1999).

2) Oil Pollution Act, Pub. L. No. 101-380, 104 Stat. 484 (1990) [hereinafter OPA 90].

of oil pollution cleanup, response, compensation, liability, and prevention. As comprehensive legislation, OPA 90 employs direct regulation as well as liability to control oil pollution risks associated with marine oil transportation. OPA 90 provides numerous tanker safety and pollution prevention regulations, such as standards for tank vessel manning, operation, and construction requirements. It is claimed that double-hull requirements were introduced due to political pressure without sufficient consideration. As a result, there have been concerns about cost-inefficiency of double-hull requirements. More than ten years have elapsed since the passage of OPA 90. The time is ripe to review and analyze cost effectiveness of double-hull requirements.

This paper first reviews double-hull requirements in OPA 90. There follows an examination of their cost effectiveness. Then the last section argues that as a form of regulation, double-hull requirements should be supplemented by financial responsibility rules.

Ⅱ. DOUBLE-HULL REQUIREMENTS

OPA 90 requires new tank vessels operating in U.S. waters to be constructed with double hulls and the existing single-hull or double-bottom or double-side vessels to be phased out under a timetable based on the tank vessel"s age and tonnage that began in

1995 and runs through 2015. OPA 90 requires compliance from vessels engaged in oil trade in U.S. waters irrespective of their country of registry. Single-hull vessels of at least 5,000 gross tons are excluded from U.S. waters beyond 2010 (See Appendix I). Double-hull requirements do not apply to vessels operating at low risk areas, deepwater ports or designated offshore lightering areas until 2015.[3)]

OPA 90 sets requirements for the interim structural and operational measures for tank vessels of 5,000 gross tons or more without double hulls until 2015.[4)] The U.S. Coast Guard has implemented three-phased scheme to reduce oil pollution from existing single-hull tank vessels. On August 5, 1994, the Coast Guard published, as the first phase, a final rule effective November 3, 1994, requiring the owners or operators of tank vessels of 5,000 gross tons or more without double hulls to carry emergency lightering equipment on board.[5)] The principal benefit is to ensure rapid oil transfer from a stricken tank vessel to another, minimizing the risk of further spillage. It addresses ex post spill actions rather than prevention or reduction of oil spills. As a result of this final rule, early vessel retirements are not anticipated.[6)]

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3) See 46 U.S.C. § 3703a.

4) See id.

5) See Emergency Lightering Equipment and Advanced Notice of Arrival Requirements for Existing Tank Vessels without Double Hulls, 59 Fed. Reg. 40,186, 40,189 (1994).

6) See id. at 40,188.

The second phase was a final rule issued on July 30, 1996, requiring operational measures such as the under-keel clearance requirement, maneuvering performance capability tests, and enhanced survey program. This final rule was effective November 27, 1996.[7) This rule focuses on reducing the risk of groundings, collisions, or fires.[8) The minimum under-keel clearance is designed to reduce oil spills as a result of groundings during transit to and from port. The owner, master, or operator of a tank vessel of 5,000 gross tons or more, is required to calculate the vessel"s anticipated under-keel clearance prior to entering or leaving port. A tank vessel is not allowed to proceed with the anticipated under-keel clearance less than 0.5 meters (2 feet), or without the express permission of the Captain of the Port designated by the Coast Guard. Under-keel clearance requirement would incur a loss in cargo carrying capacity because vessels are forced to carry less cargo, lighter before entering port, or offload cargo prior to departing.[9)]

7) See Operational Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 61 Fed. Reg. 39,770, 39,770 (1996). The provision regarding the under-keel clearance requirement was suspended and revised. The final rule revising the provision is effective Jan. 21, 1998. See Operational Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls; Partial Suspension of Regulation, 61 Fed. Reg. 60,189, 60,190 (1996); and Operational Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 62 Fed. Reg. 49,603, 49,608 (1997).

8) See Structural Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 62 Fed. Reg. 1,622, 1,622 (1997).

9) Reg. 55,904, 55,918, 55,923-24, 55,930 (1995); Operational Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 61 Fed. Reg. 39,770, 39,791 (1996); and Kevin E. Lunday & Stephen J. Darmody, Using

The final phase was to require structural measures. However, the U.S. Coast Guard"s final rule, issued on January 10, 1997, does not require structural measures because the Coast Guard has determined that there are no interim structural measures both technologically and economically feasible for existing tank vessels without double hulls. The Coast Guard has determined that while protectively located void spaces (PL/Spaces)[10] are technologically feasible, they are economically infeasible for pre-MARPOL tank vessels.[11] The Coast Guard also determined that hydrostatically balanced loading (HBL)[12] is technically feasible for single-hull tank vessels but has difficulties of implementation with respect to vessels dealing with heterogeneous cargoes and engaged in multi-port voyages.[13]

The double hull is also required in the world fleet. As a result of the U.S. proposal to the International Maritime Organization"s (IM

Financial Markets to Protect the Environment: U.S. Coast Guard Leads Modern Approach, 10 U.S.F. Mar. L.J. 173, 182, 184-85 (1998)

10) A PL/space includes any tank or void space that is not used for the carriage of cargo, cargo residue, slops, dirty ballast or fuel oil. Protectively located refers to the distribution of these spaces along the length of the vessels hull. See Structural Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 60 Fed. Reg. 67,226, 67,228 (1995).

11) Pre-MARPOL tank vessels mean single-hull tank vessels built before 1980.

12) HBL means limiting the level of oil cargo to ensure that the hydrostatic pressure exerted outward by the oil at the tank (and ship) bottom is lower than the external pressure exerted inward by the seawater. If the tank is breached, seawater will flow in rather than oil flowing out. See Steven L. Crookshank, Modifying Single-Hull Tankers: Costs and Benefits 6 (1998); and National Research Council, Double-Hull Tanker Legislation 266 (1998).

13) See Structural Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 62 Fed. Reg. 1,622, 1,622-23, 1,626, 1,636 (1997).

O)[14] for establishing an international double-hull requirement, MARPOL 73/78 regulations I/13F (MARPOL 13F) and I/13 G (MARPOL 13G) establishing international requirement for double-hull oil tankers[15] became effective July 6, 1993.[16] The proportion of double-hull tankers in the world fleet increased from four percent in 1990 to ten percent in 1994. The international fleet is to consist entirely of double-hull vessels by 2026 because tankers are required to have double hulls at the age of 30 years, as reviewed later in this section[17]. MARPOL 13F specifies the hull requirements for new tankers contracted on or after July 6, 1993, of 600 deadweight tons or above. Tankers between 600 and 5,000 deadweight tons must be fitted with double bottoms or double sides. A tanker of over 5,000 deadweight tons are required to have a double hull, a mid-deck with double sides, or an alternative arrangement specifically approved by

14) A convention was adopted in Geneva in 1948 establishing IMO, originally called the International Maritime Consultative Organization (IMCO). The name was changed to IMO in 1982. The convention entered into force in 1958. IMO has 162 member states. IMO promotes maritime safety and ensures international cooperation in regulation of international commercial navigation. In recent years IMO has dedicated a considerable part of its activities to the problem of marine pollution. See Alexandre Kiss & Dinah Shelton, International Environmental Law 68-69 (Supp. 1994); IMO, IMO About (visited July 5, 2002) <http://www.imo.org/home.asp>; and IMO, Structure and Purpose (visited May 3, 1998) <http://www.imo.org/imo/structur.htm>.

15) Oil tanker means a ship constructed or adapted primarily to carry oil in bulk in its cargo spaces and includes a combination carrier and any chemical tanker when it is carrying a cargo or part cargo of oil in bulk. See MARPOL 1(4).

16) See Resolution MEPC.52(32) of the Marine Environment Protection Committee of IMO adopted on Mar. 6, 1992; and National Research Council, supra note 12, at 26, 29.

17) See MARPOL 13G; and National Research Council, supra note 12, at 1, 142.

IMO as being equivalent to the double-hull design (See Table II.1).[18] Unlike OPA 90, which requires all vessels to be designed with double hulls, MARPOL 13F authorizes vessels built to an alternative design that provides the same level of protection against oil outflow as the double-hull design. Following the reservation procedures of MARPOL by which a party to the convention may except to amendments, the U.S. expressed its intent to not be bound by MARPOL amendments permitting alternatives to the double-hull requirement.[19]

Table II.1 Requirements of OPA 90 and MARPOL 13F for New Vessels

	OPA 90		MARPOL 13F[b]	
size	< 5,000 GT	≥ 5,000 GT	600 - 5,000 DWT	> 5,000 DWT
hull requirements	double-hull or double-containment systems[a]	double hull	double bottom or double sides	double hull, mid-deck with double sides, or equivalent
enforcement date	• contracted after June 30, 1990 • delivered after Jan. 1, 1994		• new construction or major renovation begun on or after Jan. 6, 1994 • delivered after July 6, 1996	

a : No double-containment system has been approved by the Secretary of Transportation.

b : Regulation 13F does not apply to tankers of less than 600 DWT.

Source: National Research Council, Double-Hull Tanker Legislation (1998).

18) See MARPOL 13F.

19) Any party which has declined to accept an amendment to an Annex shall be treated as a non-Party only for the purpose of application of that amendment. See MARPOL art. 16(4)(b); and Craig H. Allen, Federalism in the Era of International Standards:Federal and State Government Regulation of Merchant Vessels in the United States (Part III), 30 J. Mar. L. & Com. 85, 133 (1999).

MARPOL 13G specifies a schedule for retrofitting and retiring existing single-hull tank vessels 25 or 30 years after delivery. It applies to crude oil tankers of 20,000 deadweight tons or above and to oil product carriers of 30,000 deadweight tons or above. MARPOL 73/78 directly addresses the prevention of pollution from ships. MARPOL 73 requires ballast to be carried only in clean or segregated ballast tanks (SBT).[20] MARPOL 78 requires segregated ballast to be located so as to provide protection against collisions and groundings(protectively located segregated ballast tanks [PL/SBT]).[21] Tankers not fitted with PL/SBT must designate protectively located double-side (PL/DS) or double-bottom (PL/DB) tanks or spaces when they reach 25 years of age. MARPOL 13G also permits HBL and other operational or structural alternatives to protectively located spaces. Tankers must be converted to double hulls or an acceptable equivalent when they reach 30 years of age.[22]

On the other hand, the rule of the U.S. Coast Guard does not require structural modifications of single-hull vessels before they are phased out, as reviewed above. Because OPA 90 limits the operating life of single-hull vessels by setting a retirement date up to which the vessels are allowed to operate in U.S. waters, while MARPOL 13G comes into

20) Segregated ballast means the ballast water introduced into a tank which is completely separated from the cargo oil and oil fuel system and which is permanently allocated to the carriage of ballast or to the carriage of ballast or cargoes other than oil or noxious substances. See MARPOL 1(17).

21) Protectively located segregated ballast tank means SBT providing a measure of protection against oil outflow in the event of grounding or collision. See MARPOL 13E; and National Research Council, supra note 12, at 26.

22) See MARPOL 13F(5).

effect in two phases when vessels reach 25 and 30 years of age and thus extends their operating life, they have opposing objectives in this respec t.[23] As a result, tankers in compliance with MARPOL 13G will be allowed to trade in international waters even when they reach 30 years of age, while most vessels 25 or older will be excluded from U.S. waters by OPA 90 (See Table II.2).[24] The U.S. has rejected the equivalent design alternative under MARPOL 13G as well as under 13F.[25]

Table II.2 Requirements of OPA 90 and MARPOL 13G for Existing Vessels

	OPA 90			MARPOL 13G	
size	< 5,000 GT	≥ 5,000 GT		crude carriers > 20,000 DWT and product carriers > 30,000 DWT	
hull requirements	double-hull or double-containment systems	double hull	operational measures	double hull or equivalent	PL/DS or PL/DB or PL/SBT or HBL or equivalent
enforcement date	after Jan. 1, 2015	per schedule starting in 1995	Nov. 27, 1996	30 years after date of delivery	25 years after date of delivery

PL/DS = protectively located tanks, double sides; PL/DB = protectively located tanks, double bottom; PL/SBT = protectively located tanks, segregated ballast tanks; HBL = hydrostatically balanced loading.

Source: National Research Council, Double-Hull Tanker Legislation (1998).

23) See Structural Measures to Reduce Oil Spills from Existing Tank Vessels without Double Hulls, 62 Fed. Reg. 1,622, 1,623 (1997).

24) See National Research Council, supra note 12, at 27-29.

25) See 46 U.S.C. § 3703a; and Craig H. Allen, Federalism in the Era of International Standards: Federal and State Government Regulation of Merchant Vessels in the United States (Part II), 29 J. Mar. L. & Com. 565, 588 (1998).

Ⅲ. COST EFFECTIVENESS OF DOUBLE-HULL REQUIREMENTS

The double-hull tanker has an inner hull, separated from the outer by approximately ten feet. Over the past two decades, collisions and groundings have been responsible for approximately 70% of the oil spillage from tank vessels. In the case of a collision or grounding, double-hull tankers are four to six times less likely than single-hull tankers to spill oil. Average outflow is three to four times less with a double-hull compared to a single-hull tank vessel. If the current fleet predominantly comprising single-hull vessels is all replaced with double-hull vessels, it is projected that the double-hull requirements would eliminate four out of every five oil spills and realize a two-thirds reduction in the total volume of oil spills attributable to collisions and groundings. Therefore, the requirements will have a positive effect on reducing the risk and the severity of oil spills.[26] However, it is claimed that double-hull requirements were introduced due to political pressure from the public and environmental organizations just after the Exxon Valdez oil spill. The double-hull tankers may not be able to contain oil in the case of high-energy casualties and are also likely to be more susceptible to fires and explosions because of accumulation of volatile gases between the two hulls of the tank vessels.[27]

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26) *See* National Research Council, *supra* note 12. at 24, 139.

In particular, double-hull tank vessels suffer cost disadvantages in comparison with single-hull tank vessels. The following review is based mostly on the research results of National Research Council. When comparing construction costs between double-hull and single-hull tankers, the increase in cost per deadweight ton for double-hull tankers is estimated at between 9 and 17% (See Table III.1).[28]

Table III.1 Tanker Construction Costs as of April 1, 1996

		double hull		single hull		cost increase	
size	DWT	$ M	$/DWT	$ M	$/DWT	$/DWT	%
Product	47,000	33.5	713	30.5	649	64.0	9.9
Product	67,000	40.0	597	36.0	537	60.0	11.1
Aframax	105,000	42.0	400	36.0	343	57.0	16.7
Suezmax	153,000	51.5	337	44.0	288	49.0	17.0
VLCC	300,000	80.5	268	70.0	233	35.0	15.0

Source: National Research Council, Double-Hull Tanker Legislation (1998).

The estimated total increase in the construction costs of a double-hull tanker fleet comparable in size and composition to the existing tanker fleet as of April 1, 1996, is approximately $12 billion. Given a 20-year life, the annual increase would average approximately $600 million per year (See Table III.2).[29]

27) *See* Richard L. Jarashow, *Survey of State Legislation*, 5 U.S.F. Mar. L.J. 447, 450 (1993).

28) *See* National Research Council, *supra* note 12, at 88.

Table III.2 Estimated Increase in Construction Costs for the Double-Hull Fleet

	range	total tonnage	double hull	single hull	cost increase		
	K DWT	M DWT	$/DWT	$/DWT	$/DWT	%	total (B $)
Small	10-60	40.5	713	649	64.0	9.0	2.60
Aframax	60-100	48.6	400	343	57.0	16.7	2.80
Suezmax	100-200	46.9	337	288	49.0	17.0	2.30
VLCC	200+	125.4	268	233	35.0	15.0	4.40
total		261.4					

Source: National Research Council, Double-Hull Tanker Legislation (1998).

For example, construction costs for double-hull tankers would be translated into approximately $0.25 per barrel for Middle East oil delivered to LOOP in a VLCC, approximately $0.13 per barrel for Nigerian oil shipped to the East Coast in an Aframax tanker of 100,000 deadweight tons, and approximately $0.08 per barrel for Venezuelan oil shipped to the Gulf in a tanker of 60,000 deadweight tons, respectively.[30]

The clear differences in the operating costs between double-hull and single-hull tankers are found only in maintenance and repair (M&R) costs and hull and machinery (H&M) insurance premiums. The maintenance and repair costs for double-hull tankers are higher than those for single-hull tankers by 11 to 37%, depending on vessel type (See Table III.3).[31]

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29) *See* id. at 88

30) *See* Petroleum Industry Research Foundation, Inc., Transporting U.S. Oil Imports: the impact of oil spill legislation on the tanker market prepared for the u.s. department of energy 91 (1992).

Table III.3 Comparison of Maintenance and Repair Costs for Double-Hull and Single-Hull Tankers by Vessel Type ($/DWT/year)

type	double hull	single hull	cost increase	
Aframax	7.78	5.69	2.09	37%
Suezmax	7.62	5.95	1.67	28%
VLCC	4.89	4.41	0.48	11%

Source: National Research Council, Double-Hull Tanker Legislation (1998).

The costs of marine hull and machinery insurance per gross ton for a double-hull VLCC or Aframax tanker are approximately six percent higher than for a single-hull counterpart. This results from the higher purchase cost of a double-hull tanker. Discounts in P&I premium for double-hull tankers from 1992 to 1995 were terminated in February 1996. Increases in total insurance costs for double-hull tankers are one percent for VLCCs, three percent for Suezmax tankers, and four percent for Aframax tankers.[32] Total insurance premiums for a double-hull tanker is higher than for a single-hull tanker of the same size because any reduction in the P&I premiums are offset by higher hull and machinery premiums.[33] The increase in total operating costs attributable to double-hull tankers is estimated at 5 to 13%. The annual incremental operating costs of a double-hull fleet comparable to the existing fleet are estimated to be approximately $900 million (See Table III.4).[34]

31) *See* National Research Council, *supra* note 12, at 88-89.

32) *See id.* at 90.

33) *See* Petroleum Industry Research Foundation, Inc., *supra* note 30, at 92-93.

Table III.4 Increase in Total Operating Costs for Double-Hull Tankers

type	operating costs ($\$10^3$/year)		Increases		tonnage	total increase
	single hull	double hull	%	\$/DWT/year	10^6 DWT	\$ M/year
Product	3,035	3,430	13	9.86	40.5	309
Aframax	3,584	4,050	13	5.18	48.6	252
Suezmax	4,212	4,675	11	3.31	46.9	155
VLCC	5,845	6,137	5	1.04	125.4	131
total					261.4	937

Source: National Research Council, Double-Hull Tanker Legislation (1998).

The incremental cost of both constructing and operating a double-hull fleet comparable to the existing fleet is estimated to be at approximately \$1.5 billion (\$600 million + \$900 million) per year. This is translated into approximately \$0.20 per barrel of oil transported which was obtained by dividing the annual incremental cost by waterborne trade flows of crude oil and products that were approximately 6,571 million barrels (988,233,000 short tons) in 1997.[35)] The total increase in the construction and operation cost of the double-hull fleet through a 20-year life cycle is estimated to be approximately \$30 billion.[36)] The greater increase in oil price due to double-hull requirements compared with the increase in oil price through insurance cost due to intensified liability may imply the relative cost-inefficiency of double-hull requirements in controlling

34) *See* National Research Council, *supra* note 12, at 90.

35) One short ton of crude oil equals 6.65 barrels. See id. at 91; The Water Resources Support Center U.S. Army Corps of Engineers, Waterborne Commerce of the United States Part 5 National Summaries 2-1 (1997); and Institute of Shipping Economics and Logistics, Shipping Statistics Yearbook 481 (1995).

36) *See* National Research Council, *supra* note 12, at 148.

oil pollution risks. Actually a study done by the U.S. Coast Guard shows that double-hull requirements resulted in significant costs but moderate benefits, while financial responsibility rules resulted in significant benefits and moderate costs.[37]

Ⅳ. JOINT USE OF DOUBLE-HULL REQUIREMENTS AND LIABILITY COUPLED WITH FINANCIAL REPONSIBILITY RULES

Direct regulation such as double-hull requirements is employed as a policy controlling oil pollution risks. While liability is an ex post intervention, direct regulation is an ex ante intervention. Liability focuses on the oil pollution costs after they are incurred and motivates desirable environmental behaviors by imposing on polluters the social costs of their activities. Regulation seeks to control the activities that create such costs by directly making specific requirements.[38] While liability can be applied to any sector including the shipping and oil cargo sectors which is able to exercise any form of control over oil pollution risks, regulation can only be applied to the shipping sector with

37) Double-hull requirements are estimated to cost $6,408,692,040 (compliance and enforcement costs [$6,413,027,637] avoided costs [$4,335,597]) from 1996 through 2025. Financial responsibility rules are estimated to cost - $161,2998,722 (compliance and enforcement costs [$451,440,918] avoided costs [$612,739,640]) during the same period. See U.S. Coast Guard, OPA 90 Programmatic Regulatory Assessment (PRA) 8-7, 9-6 (2001).

38) *See* James Boyd, *'Green Money' in the Bank:Firm Responses to Environmental Financial Responsibility Rules*, 18 Managerial & Decision Econ. 491, 492 (1997).

immediate proximity to oil spills. Liability can only operate indirectly but it can operate in any of the three stages reducing oil pollution risks, casualty reduction, oil outflow reduction and damage reduction by motivating responsible parties to choose appropriate pollution reduction approaches according to their conditions (See Figure IV.1).

Figure IV.1 Relation between Policy Options (Liability and Regulation) and Pollution Reduction Approaches

Control Options	Liability			
Relation	↓	↓	↓	↓
Direct Regulation ↓ Approach	Manning	Operation	Construction/Lightering	Response
Relation	↓	↓	↓	↓
Effects	Casualty Reduction		Oil Outflow Reduction	Damage Reduction
Sequence	→→→→→→→→		→→→→→→→→	

Source: Mercer Management Consulting, Inc., An Analysis of the System of Oil Pollution Control in California Marine Waters (1993).

Liability allows responsible parties to balance the social benefits and their precaution costs by imposing oil pollution costs on them. Liability can generate an incentive to reduce risks up to the point where the precaution costs become higher than liability costs.[39]

39) *See* Alain Verbeke & Chris Coeck, *Environmental Taxation: A Green Stick or a Green Carrot for Corporate Social Performance?*, 18 Managerial & Decision Econ. 507, 508 (1997); and A. Mitchell Polinsky & Steven Shavell, *A Note on Optimal Cleanup and Liability after Environmentally Harmful Discharges*, 16 Res. in L. & Econ. 17, 19 (1994).

Private economic sectors pursue ways to maximize their profits by minimizing their precaution costs. They are under pressure to reduce costs to remain competitive.[40] This makes liability fail to generate the socially desirable level of precaution. Liability also fails to provide sufficient incentives to reduce oil pollution risks due to the possible judgment proof problem of responsible parties.[41]

Financial responsibility overcomes the weakness of liability as a regulatory mechanism, the judgment proof problem due to its ex post nature. Financial responsibility is most required when the scale of possible environmental costs is large relative to the value of the firms generating risks.[42] By internalizing cost, financial responsibility generates incentives for the responsible parties to focus on the management of risks and prevents the operation of substandard or financially unsound tank vessels.[43] With financial responsibility

40) *See* United States Coast Guard, Regulatory Impact Analysis Financial Responsibility for Water Pollution (Vessels) 68 (1994); and *Shetland Island Oil Spill:Oversight Hearing Before the Subcomm. on Oversight and Investigation of the House Comm. on Natural Resources*, 103rd Cong. 38 (1993) (statement of Nina Sankovitch, senior attorney, Natural Resource Defense Council).

41) *See* Steven Shavell, Economic Analysis of Accident Law 279-80 (1987); Boyd, *supra* not 38, at 492; and Steven Shavell, *A Model of the Optimal Use of Liability and Safety Regulation*, 15 Rand J, Econ. 271, 271(1984).

42) *See* Boyd, *supra* note 38, at 492-93.

43) *See* UNITED STATES COAST GUARD, *supra* note 40, at 44;*Vassel Certificate of Financial Responsibility:Hearing Before the Subcomm. on Coast Guard and Navigation of the House Comm. on Merchant Marine and Fisheries*, 103rd Cong, 226(1994)(statement of Lisa Speer, Senior Policy Analst, Natural Resources Defense Council);and *The Federal Requirements for Vessels to Obtain Evidence of Financial Responsibility for Oil Spill Liability under the Oil Pollution Act of 1990:Hearing Before the Subcomm. on Coast Guard and Naritime Transportation of the House Comm. on*

requirements, liability can substitute for direct regulation.[44] Financial responsibility can also mitigate excessive level of activities generating risks.[45] In addition, financial responsibility can reduce the regulator"s need for continuous monitoring by allowing firms the flexibility to reduce risks under their own conditions because firms have better information on the risks posed by their activities than the regulator.[46]

Direct regulation can employ safety measures with a public goods nature, such as traffic management which would not be developed privately because of the free-rider problem inherent in public good s.[47] Regulation can also solve the problem of dilution of incentives in liability because steps to reduce risks are required to be taken as a precondition for engaging in a risk-generating activity.[48]

However, regulation fails to generate an incentive to reduce risks below the legally required levels.[49] Safety regulation does not solve the problem of excessive incentives to engage in a risky activity because it fails to impose on responsible parties the expected losses caused by the activity.[50] Regulation also does not solve the problem of inadequate oil prices and socially excessive consumption of oil, because despite optimal precautions taken by responsible parties, their assets may be insufficient to

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Transportation and Infrastructure, 104th Cong. 81(1996)(statement of Diniel F. Sheehan, Director of National Pollution Funds Center).

44) *See* Boyd, *supra* note 38, at 492.

45) *See* Steven Shavell, *The Judgment Proof Problem*, 6 Intl Rev. L. & Econ. 45, 46 (1986).

46) *See* Boyd, *supra* note 38, at 494.

47) *See* Crookshank, *supra* note 12, at 3, 21.

48) *See* Polinsky & Shavell, *supra* note 39, at 20.

49) *See* Verbeke & Coeck, *supra* note 39, at 508.

50) *See* Shavell, *supra* note 45, at 54-55.

pay for oil pollution costs that nevertheless eventuate.[51] In addition, regulation does not provide compensation for victims.[52] Because regulation is an ex ante intervention, the regulatory authority needs to balance its social benefits against its compliance costs. It requires the regulator to have detailed information on the compliance costs. The function of regulation is limited by the regulatory authority"s imperfect information and inability to distinguish ex ante the nature of individual risks and to devise appropriate control options.[53] Ex ante approaches suffer from an administrative cost disadvantage relative to ex post approaches because under the latter the costs are borne only if harm has occurred, while under the former the costs are borne whether or not harm occurs.[54]

Neither regulation nor liability motivates the socially desirable levels of precaution.[55] A combined policy format by which responsible parties are required to satisfy a regulatory standard and also to face liability is socially advantageous due to the imperfection of the two policy options as an independent environmental regulatory mechanism.[56] The joint use of alternative policy instruments could create synergetic effects.[57] To achieve superior incentive effects, the combined policy option would

51) *See* Polinsky & Shavell, *supra* note 39, at 20-21.

52) *See* Robert V. Percival et al., Environmental Regulation Law, Science, and Policy 133 (2nd ed. 1996).

53) *See* Shavell, *supra* note 41, at 281;and Shavell, *supra* note 41, at 271.

54) *See* Shavell, *supra* note 41, at 282.

55) *See* Shavell, *supra* note 41, at 271.

56) *See* Robert Cooter & Thomas Ulen, Law and Economics 281 (2nd ed. 1997); Shavell, *supra* note 41, at 285-86;Shavell, *supra* note 41, at 271;and Bernard P. Herber, *Piagvian Taxation at the Supernational Level:Fiscal Provisions of the International Oil Pollution Compensation Fund*, 6 J. ENVTL. & DEV. 110, 112(1997).

57) *See* Verbeke & Coeck, *supra* note 39, at 508.

need to discriminate among responsible parties selectively by premium rates and standard of regulation in accordance with oil spill records and compliance in both liability and regulation respectively.[58]

Appendix I

PHASEOUT SCHEDULE FOR VESSELS WITHOUT DOUBLE HULLS BY SIZE AND AGE

size of vessel (GT)	5,000 - 14,999		15,000 - 29,999		30,000 +	
year of double-hull compliance	single hull	double sides or double bottom	single hull	double sides or double bottom	single hull	double sides or double bottom
1995	40	45	40	45	28	33
1196	39	44	38	43	27	32
1997	38	43	36	41	26	31
1998	37	42	34	39	25	30
1999	36	41	32	37	24	29
2000	35	40	30	35	23	28
2001	35	40	29	34	23	28
2002	35	40	28	33	23	28
2003	35	40	27	32	23	28
2004	35	40	26	31	23	28
2005	25	30	25	30	23	28
2006	25	30	25	30	23	28
2007	25	30	25	30	23	28
2008	25	30	25	30	23	28
2009	25	30	25	30	23	28
2010	25	30	25	30	23	28
2011		30		30		28
2012		30		30		28
2013		30		30		28
2014		30		30		28
2015		30		30		28

Source: National Research Council, Double-Hull Tanker Legislation (1998).

58) *See* Kusum W Ketkar, *Protection of Marine Resources:The US Oil Pol lution Act of 1990 and the Future of the Maritime Industry,* 19 Marine Poly 391, 400 (1995).

【국문초록】

1990년 유류오염법의 유조선에 대한 이중선체구조조항 연구

김 인 호

미국은 엑슨 발데즈호 사고를 겪고 나서 이른 바 종합적인 유류오염 관련 입법으로서 1990년 유류오염법을 제정하였다. 이 법에 의하면 미국 수역을 운항하는 유류운송선박은 이중 선체구조를 갖추도록 하고 있다. 이는 유류가 유출되는 것을 방지하는 점에서는 매우 효과적이다. 그러나, 이중 선체구조를 갖추는데 많은 비용이 소요되어 그 소요비용을 고려하면 효율적이지 못한 단점을 보여준다. 또한, 일반적으로 이중 선체구조를 요구하는 등의 규제는 독립적으로 사용되어서는 유류오염 위험을 통제하는데 충분한 주의를 유도해 내지 못한다. 따라서, 이중 선체구조를 요구하는 규제는 다른 정책 수단들과 함께 시행되어야 그 효과를 거둘 수 있다.