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Insuring cleaner oceans: the economics of oil pollution prevention

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INSURING CLEANER OCEANS:
THE ECONOMICS OF OIL POLLUTION PREVENTION

by

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Submitted in Partial Fulfillment of the Requirements of the
Senior Scholar’s Program

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1993
Abstract
Donald E. Bindler Jr.

The current system of controlling oil spills involves a complex relationship of international, federal and state law, which has not proven to be very effective. The multiple layers of regulation often leave shipowners unsure of the laws facing them. Furthermore, nations have had difficulty enforcing these legal requirements. This thesis deals with the role marine insurance can play within the existing system of legislation to provide a strong preventative influence that is simple and cost-effective to enforce.

In principle, insurance has two ways of enforcing higher safety standards and limiting the risk of an accident occurring. The first is through the use of insurance premiums that are based on the level of care taken by the insured. This means that a person engaging in riskier behavior faces a higher insurance premium, because their actions increase the probability of an accident occurring. The second method, available to the insurer, is collectively known as cancellation provisions or underwriting clauses. These are clauses written into an insurance contract that invalidates the agreement when certain conditions are not met by the insured. The problem has been that obtaining information about the behavior of an insured party requires monitoring and that incurs a cost to the insurer.

The application of these principles proves to be a more complicated matter. The modern marine insurance industry is a complicated system of multiple contracts, through different insurers, that covers the many facets of oil transportation. Their business practices have resulted in policy packages that cross the neat bounds of individual, specific insurance coverage. This paper shows that insurance can improve safety standards in three general areas - crew training, hull and equipment construction and maintenance, and routing schemes and exclusionary zones. With crew, hull and equipment, underwriting clauses can be used to ensure that minimum standards are met by the insured. Premiums can then be structured to reflect the additional care taken by the insured above and beyond these minimum standards. Routing schemes are traffic flow systems applied to congested waterways, such as the entrance to New York harbor. Using natural obstacles or manmade dividers, ships are separated into two lanes of opposing traffic, similar to a road. Exclusionary zones are marine areas designated off limits to tanker traffic either because of a sensitive ecosystem or because local knowledge is required of the region to ensure safe navigation. Underwriting clauses can be used to nullify an insurance contract when a tanker is not in compliance with established exclusionary zones or routing schemes.
APPROVED:

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CHAIR, DEPARTMENT OF
Economics

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READER

[Signature]
CHAIR, COMMITTEE
To my parents, Don and Cora Bindler, for all the support they have given me. I have still not grasped the magnitude of this undertaking. I owe my father a special debt of gratitude for all that he has taught me about writing. The eternity spent arguing, while he edited my papers, provided me with the knowledge to put these words on paper with a semblance of grammatical proficiency and style.

I want to thank Prof. Tietenberg for the endless hours of his time devoted to this project. He was always there to assist with, discuss and often lead me through the research process. His teaching went well beyond the bounds of this thesis and has shown me a love of economics and the environment.

Finally, I would like to thank Profs. Meehan and Gernery for the time they spent reading my final drafts and Prof. Donihue for his assistance with developing and simply understanding the mathematical model I used in this text.
On January 5, 1993, the *Braer*, a Liberian registered but U.S. owned, single-hulled supertanker, followed a westward course through a 22 mile wide, international shipping lane just South of the Shetland Islands in route from Norway to Canada. The Shetland Islands, belonging to Scotland, are rocky outcroppings 200 miles off the Scottish coast in the wind-swept and storm-battered North Sea. The *Braer* carried 26 million gallons of light crude oil. Battling a fierce winter storm, the tanker’s fuel lines became contaminated with water, causing engine failure. At the time, she was 11 miles South of the Shetland Islands. The crew was unable to lower the anchor due to the engine failure. Rescue teams on tugs and in helicopters were successful in saving all 34 crew members, but after 5 hours of attempts they failed to secure a line to the tanker and drag it to safety. Within an hour, the southwesterly winds had swept the ship into Garth’s Ness, a rocky headland at the southern tip of the island, and impaled it on the rocks.

On this rocky coast, the *Braer* came to rest, spilling millions of gallons of oil into the ocean. Heavy seas and hurricane force winds beat upon the tanker, preventing a salvage attempt. The majority of the cargo still on board, locals and officials prayed that she would remain intact and not break apart. Four days later, on January 9, the stern succumbed to the storms and broke off. However, officials remained hopeful, because some of the cargo holds still had not broken up and the majority of oil still remained in the ship. By this time, the storm had spread the spilled oil 25 miles up the coast and distributed an oily spray over 15 square miles of the island. The saga was to continue for another three days. Finally on the 12th, after several hours of 30’ surf and 95 mile/hour winds, the *Braer* split apart and spilled the rest of its 26 million gallon cargo into the sea. By now a slick spread across 45 miles of coastline.

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1 One ton of oil is approximately equivalent to 300 gallons. As such, the *Braer* was carrying 85,000 tons of oil.
The Shetland Islanders are a tough, rugged people, resembling the coastline they inhabit. During the winter months, fierce storms that would drive most people behind closed doors become a common part of their daily lives. However, the wreck of the *Braer* and its effects were a test even for these people. Throughout the week-long drama, massive waves of brown oil thundered into the rocky beaches, sending a mist of oil across the southern end of the islands. Up to 25 miles away, a sheen covered the environment. The air took on the stench and taste of the crude. The residents began to complain of stinging eyes and throats, headaches, and nausea. A concern for human health grew, and officials recommended that children, pregnant women, and people with respiratory diseases remain indoors. Respiratory masks were handed out free of charge, and residents were advised to use them when out of doors.

The highly toxic light crude had untold additional effects on the surrounding environment. The area chiefly affected by the spill, especially Sunburgh Head, is a rich natural environment on the flyway of numerous bird species. It also supports a rich marine estuary that provides a home to seals and sea otters. The beaches were laid to waste, while death tolls rose. The estimates reported that up to 6,000 birds died from the spill (Wells 1993f, p. A10). Seals and sea otters began to turn up dead or contaminated and suffering from the toxicity of the oil. The disaster also wreaked havoc on other marine species, possibly threatening the vital Salmon stocks. For all this damage, the true catastrophe is that the oil may contaminate the ecosystem for up to a decade as toxins work through the food chain (Clancy 1993b, p. 7).

The spill caused additional damage to the local economy. Sixteen local salmon farms were temporarily barred by the government from selling fish (Wells 1993b, p. A11). This presents an estimated $15 million of immediate losses (Wells 1993b, p. A11). Furthermore, the major food retail chains of Marks & Spencer and Tesco temporarily stopped buying Shetland Islands salmon (Clancy and Hornsby 1993, p. 1). These sanctions could have potentially crippled the £34 million a year industry that is life blood to the islands (Clancy and Hornsby 1993, p. 1). Commercial fishermen also suffered lost revenues from a restriction prohibiting
fishing within a 50 mile radius of the spill (Wells 1993b, p. A11). Farmers were forced to move sheep herds inland, and 11 vegetable farmers had their crops condemned due to oil contamination. Regardless of the long term consequences, the local residents suffered economic damages from the immediate impact of the spill.

As is typical, numerous questions arose in the aftermath of the spill. Did the crew abandon the tanker too early? Did the captain wait too long before seeking help? Should the captain have chosen this route through an environmentally sensitive area during severe weather conditions? For that matter, being in legal international shipping lanes, did the captain have any incentive to follow a safer but longer and more costly route? Would a small independent generator to operate the anchor in emergencies have kept the ship from drifting into the rocks? Finally, would the tanker have been better off turning back? All these questions lead to a central unanswered issue: Could the spill of the *Braer* have been prevented? And, if so, why wasn’t it?

The flood of criticism and questioning forced the British Government to search for answers. The track of questioning focused on whether or not British shipping laws provide sufficient environmental protection. Should older ships be banned from British waters? Should the 22 mile lane South of the Shetlands be open to tanker traffic? Does the government need to establish stricter standards? But these are all details of the larger issues, and the answers are in knowing the right questions to ask. At a news conference on the day after the *Braer* broke apart, Prince Philip directed his attention at the important issues. He asked, “Are the crews properly trained? Are they [ships] maintained properly? To what extent do flags of convenience mean you can opt out of regulations?” (Schmidt 1993d, p. A14). To these, we must add one other issue: Should tankers be restricted from using waters near environmentally sensitive ecosystems?

The *Braer* spill is just one incident of a larger, more serious problem to which an adequate solution has not been found. Although a considerable reduction in marine oil pollution has occurred over the last decade, the volume of spilled oil still remains far too high. In the last
four years alone, spills from the Exxon Valdez and Mega Borg, two other supertankers, have again drawn the world’s attention to this visible problem. By their very nature, accidents involve uncontrollable risks and can never be completely eliminated. As such, our goal in reducing accidental pollution to acceptable levels must be to minimize the controllable risks. This leads to the central focus of this thesis: Can international regulations and national legislation adequately enforce more rigorous safety standards, and if not, what means do we have of ensuring greater environmental protection?

Recognizing the pivotal role of national legislation in the global approach to controlling oil spills, this paper uses the United States as a case study. The U.S. leads the way in landmark oil pollution legislation with the Oil Pollution Act of 1990 (OPA). The OPA takes a giant step forward in requiring higher safety measures and achieves some of the goals discussed above. However, the act has already come under criticism. Many tankers are refusing to transport oil to the U.S. for fear of the tremendous liability limits outlined by the OPA. The act is also insufficient in establishing stringent enough standards in some areas and difficult to enforce. Clearly, legislation alone is not the answer. What then will enable us to achieve and enforce our standards?

The focus of this thesis is the role marine insurance can play in reducing maritime oil pollution by enforcing higher levels of safety. As stated above, insurance is not a solution in itself but rather must work with established international treaties and national legislation. Under these conditions, insurance can satisfy its primary purpose of providing compensation to injured parties and still act as a strong preventative influence. This paper looks at where insurance fits into the existing international framework. Furthermore, I show what safety conditions insurance can and should improve upon and how it can influence these aims. Finally, I demonstrate that insurance can meet these aims in an economically cost-effective way that can benefit the environment, the insured and the insurers.
Ultimately, I generalize the results of the U.S. case study to the global context. The lessons learned are applied to suggest legislation foreign governments must enact to provide an efficient means of pollution control when used in conjunction with insurance. Furthermore, I will analyze the potential role of insurance in enforcing legislation and, where necessary, in substituting for government imposed standards.

Overview

I attempt to achieve two goals by the end of this thesis. The first is to recommend a means of achieving and enforcing improved safety standards. Specifically, I offer two suggestions: The modifications that must be made to existing legislation, and the structure of effective insurance contracts. I conclude this paper by answering the two questions posed in the opening paragraphs: (1) What role should marine insurance play in controlling pollution from marine oil spills? (2) How closely does our current system approximate this ideal? The analysis begins with a look at insurance on a theoretical basis. By obtaining an understanding of how liability and premiums affect risk, the principle can better be applied to our real world model of marine oil pollution. This can be accomplished by incorporating the theoretical concepts with a discussion of regulatory provisions and marine insurance contracts.

The next section examines the causes and consequences of oil spills. This discussion motivates my thesis by providing an understanding of the magnitude and severity of the marine oil pollution problem. The two causes of pollution, operational and accidental losses, are briefly outlined. By definition, accidental losses are self-explanatory. Operational losses result from the normal operations of the tanker. This thesis is primarily concerned with accidental losses. Oil pollution has both economic and non-economic effects. Economically, spilled oil can directly affect the community through lost resources, but it also has indirect effects in many forms, such as medical bills from health problems relating to a spill. People also suffer psychological effects
from lost natural resources that cannot be quantified in economic terms. The section concludes by providing a brief overview of the international shipping industry.

The next section of the thesis describes the regulatory history and structure of oil pollution legislation and enforcement. Flags of convenience, monitoring agencies and insurance registers are explained. Furthermore, I focus on the inadequate control they provide in preventing oil pollution. Important international treaties, such as The International Convention on Civil Liability for Oil Pollution Damage and The Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, are discussed. These conventions relate directly to the establishment of liability limits, insurance standards, and inspection requirements for tankers. The Oil Pollution Act of 1990 is also outlined here. The inadequacy of legislation alone as a control method is reviewed.

At this point, the paper turns its attention to a conceptual model of insurance's ability to prevent pollution by minimizing risk. The core of this discussion is Steven Shavell's model of risk, liability and insurance. I have incorporated into this a model of insurance with the threat of bankruptcy. The issues of moral hazard and adverse selection are also debated. This results in a theoretical example of the interaction of regulation, liability and insurance in reducing risk. I deal with both the preventative influences of this interaction and the incentives to the insurance industry.

It is necessary to include a description of the marine insurance industry and the complicated nature of the contracts. By incorporating this with our knowledge of the regulatory history, they can be applied to the theoretical model so as to achieve a real world means of control. The thesis specifically focuses on the improvement of personnel, hull and construction standards and the establishment of routing schemes and avoidance clauses. With our concepts established, an application of the policies to a specific situation is presented. In conclusion, I apply the findings to answer the questions that have already been posed.
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The Causes and Consequences of Oil Spills

According to the US National Academy of Sciences, 81% of the oil spilled into the sea originates from maritime transport (OECD 1991, p. 74). In other words, of the 1.84 million tons/year of oil spilled on average, 1.49 million tons come from tanker transport [Figure 1]. Tanker pollution can be divided into two categories - accidental and operational losses. The majority of pollution results from the latter. In general, these spills can result in extensive environmental and economic damages. Beyond the obvious clean-up costs, the loss of valuable marine species and lost tourism and commercial revenues can cause a negative economic impact on local communities. The pollution also results in abundant environmental damage that is difficult to monetize. ²

Figure 1 - Marine Origin of Oil Pollution of the Seas

![Figure 1](image-url)

Erosion, natural flows 0.30 (16%)
Production platform 0.05 (3%)
Accidental transport losses 0.41 (22%)
Operational transport losses 1.08 (59%)

From US National Academy of Sciences.

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² Cleanup and containment methods are important, and often debated, issues in the oil pollution problem. However, a discussion of them has intentionally been excluded from this thesis and left for other authors. This paper is concerned with preventative means of reducing oil pollution. For a detailed analysis of oil spill cleanup measures see U.S. Congress, Office of Technology Assessment, Coping With An Oiled Sea: An Analysis of Oil Spill Response Technologies.
Accidental and Operational Causes

Deballasting and tank washing, the major causes of operational discharges, contribute 59% or about 1.08 million tons/year of the marine oil pollution from tankers (OECD 1991, p. 74). In contrast, accidents account for only about 22% or approximately 0.41 million tons/year [Figure 1] (OECD 1991, p. 74). To quote Abecassis, "The tarball on your beach is far more likely to have been caused by an operational discharge of oil from a ship than by oil from casualty" (Dowling, p. 3). However, the concentrated nature of accidental spills can inflict environmental disaster on affected areas. As such, they often draw greater attention from the world media (Timagenis 1980, p. 3). The increased volume of oil transported at sea compounds both problems. In this paper, I am concerned with insurance’s effect on controlling accidental losses.

Although the number of accidental oil spills decreased dramatically in the 1980’s compared with the 1970’s, accident rates have been increasing since 1989 (“Britain In Brief” 1993, p. 7). In 1984, 10,360 spills were reported to the US Coast Guard (Council 1989, p. 48). This is down from the 15,330 reported in 1977 (Council 1989, p. 48). Included in these statistics are the handful of major spills annually that can have devastating effects on the local environment. These few incidents often account for the majority of the oil spilled accidentally (Council 1989, p. 48). Throughout the 1980s, on average approximately ten spills were over 700 tons/year (OECD 1991, p. 74). Table 1 is a list of selected accidental oil spills throughout the world. The U.S. Congress reports that usually no more than 10 to 15 percent of the oil is recovered from a large spill, and with technical improvements we still cannot expect that our response efforts will typically lead to even half the oil being recovered from a large spill in the future (U.S. Congress 1990, p. 1).
Operational Losses

Operational pollution arises during normal tanker procedures. It occurs from both automatic releases in response to safety mechanisms as well as intentional discharges (Timagenis 1980, p. 18). Tankers traditionally wash cargo holds of remaining oil or 'clingingage' with sea water; furthermore, the tanks are often used to hold water as ballast on return journeys. During deballasting and washing, the water is jettisoned back into the sea along with accumulated oil residue. The Load On Top (LOT) system has significantly reduced pollution from 'clingingage' (Abecassis 1976, p. 5), but greater improvements in ship design and on-shore reception facilities for waste residue are needed to fully combat the problem (Timagenis 1980, p. 18).

Under the LOT system, a slop tank is incorporated in a tanker's construction. Ballast and washing residue gets stored in the slop tank; here the oil settles on top and can be removed to reception facilities (Abecassis 1976, p. 16). While the introduction of this technique significantly reduced operational pollution, it was estimated that as of 1976 105,000 tons of oil were still discharged annually (Abecassis 1976, p. 16). Several shortfalls exist within the system. On short hauls the oil does not have time to settle in the slop tank (Abecassis 1976, p. 16). In addition, even the LOT process still discharges some oily/water mixtures into the sea (Abecassis 1976, p. 16), in part due to the lack of existing operational reception facilities.

Accidental Losses

The Marine Directorate of the British Department of Transport uses the following definition for marine accidents:

"Shipping casualties are that special class of notifiable accident in which a ship is involved in any incident that results in injury to persons or damage to property..." (1991, p. 1)

Accidents can be further classified as collisions, strandings or foundering. Collisions have been found to cause the greatest amount of pollution (Abecassis 1976, p. 19). The Directorate, in their
study of The Human Element in Shipping Casualties, has found that human error plays one of the largest roles in marine accidents (Marine 1991, p. v). In 90% of all collisions and groundings

Table 1 - Selected Accidental Oil Spills

<table>
<thead>
<tr>
<th>Year</th>
<th>Date</th>
<th>Name of Ship</th>
<th>Flag</th>
<th>Country Affected</th>
<th>Quantity Spilled (1,000 tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>March</td>
<td>Torrey Canyon</td>
<td>Liberia</td>
<td>UK, France</td>
<td>121.2</td>
</tr>
<tr>
<td>1968</td>
<td>June</td>
<td>World Glory</td>
<td>Liberia</td>
<td>South Africa</td>
<td>45.0</td>
</tr>
<tr>
<td>1969</td>
<td>November</td>
<td>Keo</td>
<td>Liberia</td>
<td>USA</td>
<td>25.0</td>
</tr>
<tr>
<td>1970</td>
<td>March</td>
<td>Ennerdale</td>
<td>UK</td>
<td>Seychelles</td>
<td>49.0</td>
</tr>
<tr>
<td>1971</td>
<td>January</td>
<td>Oregon Standard</td>
<td>USA</td>
<td>USA</td>
<td>7.7</td>
</tr>
<tr>
<td>1971</td>
<td>February</td>
<td>Wafra</td>
<td>Liberia</td>
<td>South Africa</td>
<td>63.2</td>
</tr>
<tr>
<td>1971</td>
<td>March</td>
<td>Texas Oklahoma</td>
<td>USA</td>
<td>USA</td>
<td>35.0</td>
</tr>
<tr>
<td>1972</td>
<td>July</td>
<td>Tamano</td>
<td>Norway</td>
<td>USA (Maine)</td>
<td>3.6</td>
</tr>
<tr>
<td>1972</td>
<td>December</td>
<td>Sea Star</td>
<td>South Korea</td>
<td>Gulf of Oman</td>
<td>120.3</td>
</tr>
<tr>
<td>1974</td>
<td>June</td>
<td>Imperial Sarnia</td>
<td>Canada</td>
<td>Canada, USA</td>
<td>6.0</td>
</tr>
<tr>
<td>1974</td>
<td>August</td>
<td>Metula</td>
<td>Dutch Antilles</td>
<td>Chile</td>
<td>53.5</td>
</tr>
<tr>
<td>1974</td>
<td>August</td>
<td>Yugo Maru 10</td>
<td>Japan</td>
<td>Japan</td>
<td>50.0</td>
</tr>
<tr>
<td>1975</td>
<td>January</td>
<td>British Ambassador</td>
<td>UK</td>
<td>Japan (Pacific)</td>
<td>45.0</td>
</tr>
<tr>
<td>1975</td>
<td>January</td>
<td>Jakob Maersk</td>
<td>Denmark</td>
<td>Portugal</td>
<td>84.0</td>
</tr>
<tr>
<td>1975</td>
<td>January</td>
<td>Corinthos/E.M. Queeny</td>
<td>USA, Liberia</td>
<td>USA (Delaware)</td>
<td>40.0</td>
</tr>
<tr>
<td>1975</td>
<td>April</td>
<td>Spartan Lady</td>
<td>Liberia</td>
<td>USA</td>
<td>25.0</td>
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<tr>
<td>1975</td>
<td>April</td>
<td>Shell Barge No. 2</td>
<td>USA</td>
<td>USA</td>
<td>...</td>
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<tr>
<td>1975</td>
<td>April</td>
<td>Epic Colocoltroni</td>
<td>Greece</td>
<td>St. Dominique</td>
<td>57.0</td>
</tr>
<tr>
<td>1976</td>
<td>May</td>
<td>Urquiola</td>
<td>Spain</td>
<td>Spain</td>
<td>101.0</td>
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<tr>
<td>1976</td>
<td>June</td>
<td>Nepco 140</td>
<td>USA</td>
<td>USA, Canada</td>
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<tr>
<td>1976</td>
<td>December</td>
<td>Argo Merchant</td>
<td>Liberia</td>
<td>USA (MA)</td>
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<td>1977</td>
<td>February</td>
<td>Hawaiian Patriot</td>
<td>Liberia</td>
<td>Honolulu (Pacific)</td>
<td>99.0</td>
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<td>1977</td>
<td>December</td>
<td>Grand Zenith</td>
<td>Panama</td>
<td>USA (MA)</td>
<td>29.0</td>
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<tr>
<td>1978</td>
<td>March</td>
<td>Amoco Cadiz</td>
<td>Liberia</td>
<td>France</td>
<td>228.0</td>
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<tr>
<td>1978</td>
<td>July</td>
<td>Cabo Tamar</td>
<td>Chile</td>
<td>Chile</td>
<td>60.0</td>
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<tr>
<td>1978</td>
<td>December</td>
<td>Andros Patria</td>
<td>Greece</td>
<td>Spain</td>
<td>47.0</td>
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<tr>
<td>1979</td>
<td>April</td>
<td>Gino</td>
<td>Liberia</td>
<td>France</td>
<td>42.0</td>
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<tr>
<td>1979</td>
<td>July</td>
<td>Atlantic Express</td>
<td>Greece</td>
<td>Tobago</td>
<td>276.0</td>
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<tr>
<td>1979</td>
<td>September</td>
<td>Chevron Hawaii</td>
<td>USA</td>
<td>USA</td>
<td>2.0</td>
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<tr>
<td>1979</td>
<td>November</td>
<td>Burmah Agate</td>
<td>Liberia</td>
<td>USA (Texas)</td>
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<td>November</td>
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<td>Romania</td>
<td>Turkey</td>
<td>94.6</td>
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<td>1980</td>
<td>February</td>
<td>Irene's Serenade</td>
<td>Greece</td>
<td>Greece</td>
<td>102.0</td>
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<td>1983</td>
<td>August</td>
<td>Castello de Belver</td>
<td>Spain</td>
<td>South Africa</td>
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<td>Assimi</td>
<td>...</td>
<td>Oman</td>
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<td>1985</td>
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<td>Pericles GC</td>
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<td>Qatar</td>
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<td>1985</td>
<td>February</td>
<td>Nepumably</td>
<td>Liberia</td>
<td>Iran</td>
<td>60.0</td>
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<td>1985</td>
<td>December</td>
<td>Nova</td>
<td>Liberia</td>
<td>Iran</td>
<td>71.1</td>
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<td>1989</td>
<td>March</td>
<td>Exxon Valdez</td>
<td>USA</td>
<td>USA (Alaska)</td>
<td>35.0</td>
</tr>
<tr>
<td>1990</td>
<td>June</td>
<td>Mega Borg</td>
<td>Norway</td>
<td>USA</td>
<td>...</td>
</tr>
<tr>
<td>1992</td>
<td>December</td>
<td>Braer</td>
<td>Liberia</td>
<td>UK (Shetlands)</td>
<td>85.0</td>
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<tr>
<td>1993</td>
<td>January</td>
<td>Maersk Navigator</td>
<td>Singapore</td>
<td>Indonesia</td>
<td>26.0</td>
</tr>
</tbody>
</table>

(From OECD 1991, p. 75 and A Spill A Minute 1993, p. 43)
and 75% of all contacts and explosions where enough information was available to make a judgment, the human element contributed, at least in part, to the resulting casualty (Marine 1991, p. 2). However, the entire problem cannot be blamed on the crew. Investigations following the Exxon Valdez spill, for example, have indicated that equipment and procedures are often highly contributing factors.

The likelihood of an accident increases greatly in ports, rivers and approaches due to increased traffic and more difficult navigation (Marine 1991, p. 17). Vessels operating in short-sea trades have the highest accident rates due to their close proximity to land (Marine 1991, p. 25). Adverse weather conditions have also been found to play a part in accident causality (Abecassis 1976, p. 18). Experts have suggested the need for higher standards of safety, construction and manning (Timagenis 1980, p. 19). According to a Marine Directorate study, the most important current need is for supervised practice of skills as opposed to increasing formal training (1991, p. 18). Furthermore, while crews have sufficient access to navigation information, radar misinterpretation still remains common (Marine 1991, p. 17). This calls for an improvement in the terminals relaying data and supports the need for increasing practice of skills.

Environmental Effects and Economic Impact

To coastal residents, the physical effects of marine pollution are overwhelmingly evident, as they can see, feel and smell the petroleum products that permeate global coastlines (Abecassis 1976, p. 1). The UN Department of Marine Pollution defines pollution as, "the introduction by man, directly or indirectly, of substances or energy into the marine environment resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water, and reduction of amenities" (UN Doc. A/CONF 48/8, para 1197). It damages on three levels: biological,
economic and amenity. The Council on Environmental Quality (1989, p. 50) lists seven pathways by which spilled oil can effect a living organism:

1. Direct lethal toxicity;
2. Sub-lethal disruption of physiological or behavioral activities;
3. Direct coating;
4. The contamination of the food chain by hydrocarbons;
5. Changes in biological habitats;
6. Changes in species diversity and density patterns;
7. Coating of the air/water surface.

Economically, marine pollution has the most serious effect on fisheries and recreation (Fallon 1973, p. 1). The U.S. Environmental Protection Agency estimates that commercial fishing, navigation and recreation lost between $61.9 - $110.8 million in 1970 alone as a result (Fallon 1973, p. 2). Petroleum products biodegrade but often never completely, and very little is known about the long-term biological effects (Abecassis 1976, p. 27). These damage estimates, as large as they are, understate the true damage since they fail to take into account the loss of 'quality of life' suffered by local beach residents and fishermen. To illustrate a spill's deleterious consequences, it is useful to consider the effects of one large spill.

During the early morning hours on the night of 16-17 March 1978, the *Amoco Cadiz* drove aground 1.5 nautical miles off the coast of Portsall, France. Over the course of a mere 14 days, the *Cadiz* spilled all 230,000 tons of light petroleum, its entire cargo, into the sea off the Brittany coast (Lauber 1982, p. 93). The spill affected diverse oceanic and tidal ecosystems, destroying marine and shore life in its path. Unfortunately, the ecological effects were only part of the suffering. With regional industry based on the sea, economic hardship followed in the spill's wake.

West to east winds carried the cargo from the *Amoco Cadiz* ashore over more than 300 kilometers of the French Coast (Grigalunas 1982, p. 91). Of the 230,000 tons of oil on board, 32% (74,000 tons) evaporated, 33% (76,000 tons) were lost at sea, and 35% (80,000 tons)
washed ashore (Grigalunas 1982, p. 91). Thirty to 35% of the entire cargo consisted of highly toxic, aromatic petroleum (Lauber 1982, p. 95). Studies concluded that coastal pollution in mudflats and abers\(^3\) could persist for up to 10 years (Lauber 1982, p. 97).

The area suffered, as Lauber terms it, a "sharp mortality crisis" that killed sea urchins, cockles, razor-clams, clams and crustaceans, to name a few (1982, p. 100). Within a several kilometer radius of the wreck all species died out, including waterfowl and shore birds (Lauber 1982, p. 100). The oyster beds of the region became heavily contaminated, and 6,000 tons of oysters had to be destroyed (Lauber 1982, p. 103). The economic costs were appallingly evident to this region which was heavily dependent on the industries of oyster production, fishing and tourism. Of those surveyed, many Bretons reported job loss for up to two months (Sorenson 1982, p. 107). In purely quantitative terms, the spill cost:

- The fishing industry up to 20 mil. Francs;
- 350,000 man-days of army labor and 35,000 of voluntary labor;

**France, in total, an excess of 500 million Francs**

(Sorenson 1982, p. 110-112).

The psychological costs, though very real, can never be quantified.

The *Amoco Cadiz* was not the first major spill and is certainly not the last. As such, it provides a helpful understanding of the impact that a major spill can have on a geographic and economic region. The people of Valdez, Alaska and the Shetland Islands will all tell the same story of economic and psychological hardship.\(^4\) But, statistics can never tell the whole story. Innumerable damages arise from the pollution caused by accidental and operational losses of oil that are difficult to monetize.\(^5\) The tarball we encountered on the beach or the soiled wetlands where we frequently enjoyed an afternoon of birding both diminish the utility\(^6\) we receive from the use of these ecosystems but do not necessarily impose a financial cost. Suffice it to say, oil

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\(^3\) An aber is the mouth of a river or convergence of two rivers.

\(^4\) The regions were effected by the spill of the *Exxon Valdez* and *Braer* respectively.

\(^5\) The method of contingent valuation attempts to impose a monetary value on these losses. For a discussion of this concept see Tietenberg, *Environmental and Natural Resource Economics*, p. 80-1.

\(^6\) Pindyck defines utility as, "the level of satisfaction that a person gets from consuming a good or undertaking an activity" (p. 81). For a more detailed discussion of utility see Pindyck and Rubinfeld, *Microeconomics*, p. 81-6.
pollution from tankers, although reduced, remains at an unacceptable level that causes significant
economic and psychological hardship. As Zagaski states, “Carrying deadly cargo in massive
bulk through biologically important waters, the supertankers of today are fragile and unwieldy
vessels capable of mass destruction” (1992, p. 144).

The Transport of Oil by Sea

From the late 1970’s until the mid-80’s, the percent of oil transported by sea steadily
decreased. A low of 44% of oil was transported by sea in 1986 compared with 58% in 1977
(Walder 1990, p. 642). This represents a decrease of 430 million tons (Walder 1990, p. 642).
However, since then the trend has reversed itself, reaching highs in the late 1980’s and early
1990’s. Imports of crude oil into the United States was at a high of 2,151 million barrels
Furthermore, a low of 10.61 quadrillion BTU’s of petroleum were imported into the U.S. in
In 1990, 16.94 quadrillion BTU’s of petroleum were imported into the United States (Statistical
Abstract 1992, p. 563). Oil shipping rates have fallen to a low of $12.00 a ton in 1991 from a
high of $69.40 a ton in 1973 (“Britain In Brief” 1993, p. 7).

The Middle East is the largest annual exporter of crude oil and finished petroleum
Western Europe, likewise, is the largest importer, bringing in 435.4 million tons in 1986 (Walder
1990, p. 653). The United States, Japan and Latin America follow in second, third and fourth
place respectively in imports of oil products (Walder 1990, p. 643).

7 Approximately 42 gallons of oil are in a barrel.
8 A BTU is the amount of energy required to raise the temperature of 1 pond of water 1 degree Fahrenheit at a
temperature of 39.2 degrees Fahrenheit. The conversion for the production of petroleum is 5.800 million BTU’s per
As of 1989, the world fleet of registered tankers over 1,000 gross tons numbered 5,133 (Statistical Abstract 1992, p. 637). The United States is currently ranked sixth in number of registered tankers with 239 (Statistical Abstract 1992, p. 637). Panama has the greatest number at 590, followed closely behind by Liberia with 574 (Statistical Abstract 1992, p. 637). The average age of the U.S. fleet is 19 years, compared with 14 years for the world’s fleet (Statistical Abstract 1992, p. 637). The flagships of this fleet are known as Ultra Large Crude Carriers (ULCC) and often referred to as “supertankers”. They can reach up to 1/4 mile long, draw up to 90 feet, and displace 640,000 tons (Zagaski 1992, p. 145). From a top speed of 15 to 16 knots, it takes up to 20 minutes and 3 miles to bring to a complete stop (Zagaski 1992, p. 145).

The tremendous volume of oil transported by this international fleet often leads to congested ports and harbors, where petroleum is an important commodity. On average, U.S. harbors experience daily traffic of 50 tankers and 450 million gallons (“Big Drop..” 1992, p. 31). New York alone transfers more than one million barrels of oil daily to and from storage facilities (Zagaski 1992, p. 146). This exceeds 18 billion gallons per year transferred through New York (Zagaski 1992, p. 146). The Strait of Dover is an excellent example of the congestion in shipping lanes. It is not unknown to have up to 20 ships passing in each direction at one time through the Strait (Abecassis 1976, p. 39).

Regulatory History and Structure

The discharge of oil from tankers over the last half decade has brought publicity to the growing problem of marine oil pollution as a serious environmental threat (International Environment 1992, p. 324). Numerous international treaties and national legislative acts have been enacted to address this growing concern. As is typical of international law, the international agreements often carry very little inherent enforcement power and mainly serve to set precedents for standards of pollution prevention. To have any effective power, the treaties need to be ratified by the national governments of the signatory nations, with the agreement that the flag
nation of a ship will enforce the international standards in a national court. Since the majority of marine oil pollution occurs in Exclusive Economic Zones (EEZ) and not the international ocean, national legislation of the state within which a ship is operating, incorporating the principles of the international conventions, creates the most powerful legal structure to enforce the agreements. 9 As will be discussed below, this potential is not always fulfilled.10

The general principles can be applied to foreign and international waters without consequence provided that two conditions are met. To have legal control within their EEZ, a nation must incorporate a marine pollution act into national legislation. Secondly, accidents occurring in international waters can only be properly dealt with if the principal multilateral treaties are ratified by the majority of shipping and coastal nations and signatory nations agree to legally enforce the established standards.

**International Agreements**

*International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC)* - The CLC (8 ILM 453) sets an important precedent in defining liability and insurance standards for tankers (specifically those carrying more than 2,000 tons bulk oil). The convention states that owners are held strictly liable for pollution damage from their ship, with three exceptions: (1) An act of war; (2) third-party intent to cause harm; (3) negligence on the part of a government in maintaining navigational aids (Article III). The convention applies to “any persistent oils such as crude oil, fuel oil, heavy diesel oil, lubricating oil and whale oil,” (Article 1.5). Furthermore, limits to liability are set at 210 million Francs per accident (Article V, Subsection 1), unless the accident occurs due to the owner’s negligence or willful intent to cause harm (Article V, Subsection 2). Additional compensation must be paid by the owners of the oil (Inter-

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9 Only 3.5% of the mean volume of oil spilled between 1976 and 1984 occurred in the open ocean, according to the Council on Environmental Quality, *Environmental Trends*, 1989.

10 Numerous prominent international conventions on maritime concerns, such as the United Nations Conference on the Law of the Sea, 1982, have intentionally been left out of the discussion for their lack of relevant concern with issues of liability or limited effectiveness due to the fact that they have not been ratified by the United States.
Departmental Group 1979, p. 4). The CLC also requires proof of insurance or financial security (Article VII, Subsection 1) and gives permission to national governments to ensure that such proof is met (Article VII, Subsection 11). However, in practice the CLC has very little effective force and was never ratified by the United States government.

Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78) - Annex 1 deals with oil pollution of the marine environment. MARPOL 73/78 (17 ILM 546), significantly, outlines survey and inspection requirements (Regulation 4), establishing design, construction and operation standards for all ships. It also sets up the use of an International Oil Pollution Prevention Certificate in accordance with the safety standards of Regulation 4 (Regulation 5, 8 and Appendix II). The certificate serves as a means of assuring compliance with the outlined standards and has a five year duration. A flag state is required to inspect all ships for certification purposes and conduct two additional inspections during the certification period (International Environment 1992, p. 16). Furthermore, regulation 13 requires the use of segregated ballast tanks on new tankers carrying over 20,000 tons. MARPOL has greater international legal significance particularly for the United States. The U.S. ratified Annex 1 of the treaty, putting it into force in October 1983. Annex 1 has been ratified by a total of 61 nations (International Environment 1992, p. 14).

National Legislation

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) - The intention of this U.S. law (42 USC §§9601-9675) was to establish the authority and financing for cleaning up hazardous waste sites in the United States. The act holds private parties responsible for clean-up costs. Though not directly concerned with oil spills, CERCLA is significant because Subchapter IV establishes an important precedent by authorizing the sale of pollution liability insurance in the United States.

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Oil Pollution Act of 1990 (OPA) - The Act (33 USC 2701) sets all statutory precedents for oil pollution damage occurring within the Exclusive Economic Zone of the United States. The intent of the OPA was, "To establish limitations on liability for damages resulting from oil pollution, to establish a fund for the payment of compensation for such damages, and for other purposes." It defines "responsible party" for a vessel as the person owning or operating the vessel (Sec. 1001, 32). Furthermore, it states, "each responsible party for a vessel...is liable for the removal costs and damages" (Sec. 1002, a). Damage costs are defined as damage caused to natural resources, real or personal property, subsistence use, revenues, profits and earning capacity and public services (Sec. 1002, b). However, liability for damages and removal costs is limited to $10,000,000 for vessels greater than 3,000 gross tons and $2,000,000 for vessels 3,000 gross tons or less (Sec. 1004, a, 1). The limitation only applies to vessels exercising due care, showing no form of gross negligence or willful misconduct and operating under all Federal regulations (Sec. 1004, c). The Act also incorporates the precedent set by the CLC into U.S. law and requires all tank vessels to maintain evidence of financial responsibility. Financial responsibility is demonstrated by proving a capability to meet the maximum liability standards established by section 1004 (a) (Sec. 1016, a). The United States reserves the right to either withhold clearance from, deny entry to, detain or seize any vessel not possessing such evidence of financial responsibility (Sec. 1016, b). The OPA preserves the right of states to impose additional liability requirements in addition to those that must be demonstrated in accordance with Federal law (Sec. 1018). Finally, the Oil Pollution Act sets construction, safety and crew standards for all vessels including foreign ships (Title IV, Subtitle A) and initiates a study to investigate the use of traffic routing schemes in U.S. waters (Sec. 4107). Specifically, all vessels greater than 5,000 gross tons operating in the EEZ of the U.S. must have double hulls by Jan. 1, 2015 (Sec. 4115). In addition, the OPA mandates another study to determine whether existing standards (including standards for crew size, training, inspections and navigational equipment) are sufficient for safe navigation in U.S. waters (Sec. 4111).
State Law

Maine, Massachusetts, and New York State Law - Legislation in these three states illustrates the complications arising from the interaction of state and Federal legislation. In contrast with the OPA, both Maine and Massachusetts impose unlimited liability on the responsible party for all damages and cleanup costs resulting from a spill (Zagaski 1992, p. 153). New York law goes even further and has more intricate requirements regarding environmental damages. It has established a compensation fund for spill cleanup and removal costs (Zagaski 1992, p. 148). In turn, responsible parties are liable for reimbursing the fund, additional penalties and additional costs (Zagaski 1992, p. 148). Furthermore, due to the high volume of tanker traffic in New York Harbor, the state has established a separate set of requirements that are deemed necessary for transit in the harbor (Zagaski 1992, p. 148). According to Zagaski, “A common element in these laws was to establish strict liability for pollution damages and to set limits of liability to be backed up by insurance or some other allowable means of security,” (1992, p. 149).

The Inadequacy of Control

The overlapping and inconsistent jurisdictions of international agreements and Federal legislation causes untold complexities and confusion. Furthermore, this patchwork of approaches results in greater cost burdens. As such, in the United States a tanker is faced with Federal and state regulations, as well as international agreements, all of which are often making contradictory demands (Anderson 1992, p. A14). As Anderson points out, it is not any particular regulation that is harmful, but the multiple layers of regulation (1992, p. A14). Under such conditions, a tanker operating in the U.S. EEZ often faces almost unlimited liability (Anderson 1992, p. A14).

The Royal Dutch/Shell Group has stopped using tankers that they own or manage to transport heavy oil to the U.S. (Wald 1990a, p. A27). As a company spokesman stated, “A shipowner who is involved in a pollution incident in the U.S.A. even when he has behaved
properly, responsibly and without negligence may face largely uninsurable exposure to claims
which far outweigh the potential commercial reward for such trade,” (Wald 1990a, p. A27). By
using independent tankers, Royal Dutch reduces its risk because the OPA places no liability on
cargo owners. Oil owners are actually encouraged to minimize costs by hiring the cheapest
tankers, often with lower standards. Furthermore, Protection and Indemnity clubs have also
begun to rethink the risk of insuring tankers operating in U.S. waters (Anderson 1992, p. A14).

Unfortunately, the relatively recent enactment of the Oil Pollution Act means that we
have no long term data with which to monitor its effectiveness or problems. However, as we can
see it has already come under considerable fire. Chief among the criticisms is its failure to take
in the former considerations and work within the established framework. Rather, the OPA exists
in a vacuum. The act has also received criticism for allowing claimants to directly sue
underwriters for clean-up costs and damages (Anderson 1992, p. A14). This has lead to nearly a
doubling of insurance premiums and a 10% increase in shipping charges, as insurers and tanker
owners respectively try to cover the higher cost of increased risks. In addition, it is worth noting
that while the OPA prohibits vessels from foreign countries with lenient standards from
operating within U.S. waters, it does not have the ability to ensure that established standards are
actually enforced. As such, the open registry system allows foreign ships to operate in U.S.
waters that do not meet the minimum requirements established by the OPA.

The problem is exacerbated when the maritime nations are failing to inspect ships. Oil
companies, at the inquiry into the Braer spill, reported that “20% or more of the world’s tankers
do not meet existing internationally agreed standards,” (“Britain In Brief” 1993, p. 7). With
decreasing shipping rates, many owners are cutting corners on safety, because both flag and port
states are failing to inspect adequately (“Britain In Brief” 1993, p. 7). Furthermore, governing
international organizations, such as the International Maritime Organization (IMO), have
difficulty monitoring compliance with multinational treaties like MARPOL. Only about 23% of
the participating nations met MARPOL’s reporting requirements and submitted the proper

In summary, the existing policy context fails in four ways. It fails to establish jurisdiction in many situations. This is partly because legislation like the OPA does not adequately consider the existing legislative context in which it operates. The result is that tankers often face unlimited liability and uninsurable risks, which causes the costs of operation to become prohibitive. Finally, both national governments and international organizations have had difficulty enforcing and monitoring established standards.

Regulatory Structure

I conclude by discussing the institutional structure within which insurance must operate. Enforcement agencies (such as the U.S. Coast Guard), insurance registries and flags of convenience for ships all play a major role in the potential effectiveness of insurance. In order to concentrate on insurance’s precautionary incentives, it is necessary to discuss the role that public policy plays along with insurance in the regulatory framework. The Coast Guard and insurance registries are the two most prominent monitoring structures in this country. Flags of convenience are hotly debated, because they provide a loophole for shippers trying to cut costly safety standards. With each, I review the inadequate means of control it offers in promoting increased safety standards on ships.

Flags of Convenience

The 1958 Geneva Convention on the High Seas obligates all states to set conditions for ships to gain nationality and registration but requires a “genuine link” between the ship and state (Article 5). The issue of defining “genuine link” was hotly debated and resolved by allowing each state to decide on its meaning. As Stopford explains, “Ship registration conveys nationality to a ship and brings it within the regime of the national law of the country of registration,” (1988,
Furthermore, this, "process makes the ship an extension of national territory while it is in international waters," (Stopford 1988, p. 157). This declaration of nationality is necessary for legal and commercial purposes when ships are engaging in international trade (Stopford 1988, p. 159).

A nation's registry can be separated into one of two categories - open or closed. A closed register is open only to shipowners with the same nationality as the register. On the other hand, open registers are available to anyone provided that the provisions of the registry are met (Stopford 1988, p. 159). Furthermore, there are two sub-categories of open registers - national and international. A national register treats a shipowner the same as any other business in the country (Stopford 1988, p. 160). An international register offers special competitive terms to attract shipowners, with the goal of earning additional revenue for the state (Stopford 1988, p. 160). International open registers are what is commonly referred to as "open registers" or "flags of convenience". Due to the vast differences in the enforcement of international standards between flags of convenience, they have become an important issue in pollution control.

Ships have increasingly turned to using these international open registers either for their tax incentives or because they are unable to meet the safety requirements of a more stringent nation. The flags of convenience offer advantages in four areas - tax, crewing, company law, and safety standards. Stopford (1988, p. 161) discusses these issues below:

* **Tax** - No taxes are placed on profits or fiscal controls. The only tax is the subscription tax per net registered ton.

* **Crewing** - The shipping company has complete freedom to recruit internationally. It is not required to employ high-wage nationals, as either officers or crew. However, regulations regarding crew standards and training may be enforced, depending on the policy of the register.

* **Company Law** - As a rule, the shipping company is given considerable freedom over its corporate activities. For example, ownership of the stock in the company need not be disclosed; shares are often in 'bearer' form, which means that they belong to the person who holds them; liability can be limited
to a one-ship company; and the company is not required to produce audit accounts. Few regulations address the appointment of directors and the administration of business.

* Safety Standards - International open registers vary widely in the extent to which they enforce safety standards for the ships on the register. Some enforce high standards, while others leave safety entirely to the shipowner.

Any of these four advantages may motivate a shipowner to register in a nation that enforces lax standards, but it is specifically crewing requirements and safety standards that are of concern when it comes to marine oil pollution. The loopholes found in using flags of convenience enable ships to circumvent to some degree the stringent standards found in international legislation and in much of the national legislation of prominent industrial nations. As the prominent industrial nations have made a move to place even greater restrictions on crew and safety standards, flags of convenience have become ever more attractive to shipowners, which causes even greater concern. Roger Kohn of the International Maritime Organization points out that, “There is a concern about standards generally. The number of countries operating ships are increasing and they have not had the experience of the maritime nations,” (“Accident Highlights...” 1993, p. 2).

Numerous safety issues can be affected by flags of convenience from ship construction to training standards. For example, by not requiring officers or crew from a specific nation, a shipowner operating under a flag of convenience has greater freedom to pick a crew from a country with less stringent training requirements. Flags of convenience can negatively affect the operation of a ship as well. It has often been observed, for example, that vessels registered under international open registers tend to purchase three-day weather forecasts as opposed to the more expensive ten day forecasts (Jenkins 1993b, p. 2). The possible disastrous results of limited weather forecasts are self-evident. The International Transport Workers Federation (ITF) also has numerous complaints with international open registers because owners have greater freedom in choosing and compensating crews (Stopford 1988, p. 163). The ITF has established a recommended wage scale for crews and offers a “blue card” to all ships in compliance with the
Many ships operating under flags of convenience do not possess blue cards. The ITF has compiled a list of nations classified as flags of convenience.

The two most prominent and widely used international open registries are Liberia and Panama. Liberia has a total of 1,587 ships and Panama a total of 5,203; combined this amounts to 23% of the world fleet (Stopford 1988, p. 164). Both nations developed registers for the purpose of attracting foreign shipowners and did so by establishing economically attractive requirements. Liberia has been a popular register since 1949, when many shipowners were attracted to it by the low fees, absence of Liberian taxes, and no crew or operating restrictions (Stopford 1988, p. 158). Unlike many flags of convenience, Liberia enforces some operational safety standards, but even these can vary widely. Liberia does not conduct the necessary surveys and examinations of ships but contracts them out to foreign commercial organizations (Jenkins 1993b, p. 2). This creates a problem because these organizations, known as classification societies, have varying standards and the international community has no confidence in the actual safety of the vessels (Jenkins 1993b, p. 2). Add the fact that Liberia is a nation without a maritime tradition and is in a political state of anarchy, and it is not difficult to see why control is lax. However, it is easy to see why a country such as Liberia is an attractive register. According to Jenkins, a ship registered in the UK with a UK crew would cost approximately £2,300/day (1993b, p. 2). This is a dramatic difference when compared to the £800/day it would cost to operate a ship under Liberian registry with a Filipino crew (Jenkins 1993b, p. 2). After the Braer disaster, Andrew Linington, a spokesman for the merchant navy officers’ union Numast, pointed out that, “...65% of losses occur with ships over 16 years old and Liberia has one of the worst casualty records of the 150 maritime nations.”

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11 These figures are from Lloyd’s Register of Shipping.
The U.S. Coast Guard and Other Enforcement Agencies  

Most of the 150 maritime nations have an established agency which enforces maritime law, including national and international legislation regarding oil pollution. The duties of these organizations involve both preventative and cleanup measures. They are required to monitor and inspect ships operating within the EEZ of the nation, as well as play a supervisory role in cleanup after an accident. The Coast Guard serves this role in the United States. Many of the major maritime nations, such as England and Germany, have similar organizations, but some of the international open registers, such as Liberia, do not have a federally appointed monitoring agency and are forced to rely on commercial inspection agencies. In Britain, only 30% of foreign ships that come into port are inspected (Jenkins 1993b, p.2). At the inquiry into the Braer spill, the Chamber of Shipping, representing UK operators and owners, “accused governments of lacking the resources and the will to police ship safety properly,” (“Britain In Brief” 1993, p. 7).

With regard to oil pollution prevention in the United States, the Coast Guard carries out the provisions outlined in the OPA. They not only monitor and inspect ships of U.S. registry but are also entitled to carry out inspections of all tankers operating in U.S. waters. The Coast Guard carries out annual official examinations of all tankers and further random unofficial examinations (Belkin 1990a, p. D12). Unfortunately, the resources of the Coast Guard are far too limited to effectively implement all the standards outlined by the OPA (“On The Agenda” 1993, p. 4). The time and money dedicated to oil pollution prevention is severely limited and must be shared with the other duties of the Guard, such as marine safety and drug enforcement. Furthermore, when dealing with oil pollution, prevention is not even their primary concern. After the disastrous response by the Coast Guard after the Exxon Valdez spill, media and government attention has turned to developing a comprehensive spill response and cleanup program. As such, the Guard

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13 Of this 30%, 60% are found to have defects (Jenkins 1993b, p. 2).
has diverted valuable time and money away from prevention towards developing and implementing this cleanup program ("On The Agenda" 1993, p. 4).

**Insurance Registers**

Insurance registers are private regulatory organizations that act independently of insurers and are popularly known as classification societies. They "classify" ships by monitoring their design, construction and maintenance in order to ensure that minimum standards are met (Cheit, p. 13). In turn, insurers rely on this information when writing contracts on vessels. Lloyd’s Register (LR) was the first and is still the most prominent classification society in the world. It maintains a database that includes a register of over 74,000 vessels (Cheit, p. 13). Furthermore, information on shipowners, new ship construction and reported casualties are kept in the database, and it tracks the movement of 30,000 ships across the world’s oceans (Cheit, p. 13). The U.S. version of Lloyd’s Register is the American Bureau of Shipping (ABS). Since its inception, the ABS has shifted its attention to vessel standards alone and now largely ignores personnel standards (Cheit, p. 14). Including these two principal societies, approximately 30 insurance registers exist worldwide (Cheit, p. 15).

In 1939, the major classification societies banded together to form the International Association of Classification Societies (IACS), which has nine full and three associate members (Cheit, p. 16). The IACS has been helpful in many ways. It has made significant progress in establishing global safety standards and, in many situations, is able to enforce international agreements faster than participating nations can (Cheit, p. 16-7). The effectiveness of the IACS is due to the support of the insurance industry. Many marine insurers require that their insured ships be classified by an IACS member, and the majority of the world’s oil tankers are classified by members of the IACS (Cheit, p. 16).

Insurance registers provide a valuable service when monitoring ships. However, this monitoring often comes at a significant cost. By requiring ships to be classified within an
approved society, insurers can obtain valuable and costly information about the safety standards of a vessel. Unfortunately, the cost of monitoring actually acts as a negative incentive to classification societies. They do not obtain any significant advantage by ensuring that ship minimizes its risk. Being independent profit-maximizing firms, classification societies naturally desire to minimize their costs. This provides a positive incentive for them to require fewer qualifications for a ship to meet classification standards and also promotes the use of cost-cutting procedures when surveying a ship. The final influence for higher safety standards in order to prevent oil pollution must still rest with the insurers, and they are entailed to ensure that the registers monitor for such standards. The bottom line is that the insurer must have the incentive to reduce risks.

It is easy to see many examples of classification societies having insufficient standards or monitoring procedures. The simple fact is that many sub-standard ships are classified and at sea (Cheit, p. 17). Part of the problem results from the fact that many IACS standards are left to the interpretation of the on-site surveyor. This naturally leads to a wide fluctuation in the safety level of classified ships despite global standards. Furthermore, the registers are primarily concerned with vessel standards and often fail to inspect onboard equipment, design or crew training safety levels (Cheit, p. 19). Ironically and sadly, crews and equipment failure are often the primary causes of many accidents (Cheit, p. 19-20). The societies also completely fail to provide any form of comparative safety information that is extremely valuable in determining risk-based premiums. The Tanker Advisory Center (TAC) points out the differences in standards between IACS members; the Bureau Veritas of France has twice the loss record of other IACS registers (Cheit, p. 18). In addition, in 1988 the London Maritime Association published a list of “ships that had been found to be wasted or seriously defective though recently surveyed and still in class with their classification society,” (Cheit, p. 18).
The Control Policy Framework: A Conceptual Overview

The interaction of regulation, liability and insurance potentially creates a highly effective means of reducing pollution generated by the maritime transport of oil. Regulation, the collective implementation of international treaties, national legislation and state legislation outlines enforceable strategies for preventing pollution and accidents. It also serves to assign liability in situations where pollution occurs. Liability, likewise, internalizes the costs of pollution damages. Insurance not only assures financial compensation for victims of pollution damage, since most liable parties do not possess sufficient capital to ensure payment, but it also can play a role in preventing accidental and operational pollution and through contractual means in preserving precautionary incentives. The preventative and compensatory roles of insurance traditionally have been viewed as mutually exclusive - a problem known as moral hazard.

Before we look at the specific ways in which marine insurance can interact with legislation to reduce maritime oil pollution, the concepts of moral hazard and adverse selection must be reviewed. Both of these issues are central to any consideration of insurance and in many ways the focus of this paper. By minimizing both problems through the careful design of insurance contracts, many of the desired solutions are automatically achieved. An economic model derives the precise relationships among efficient risk allocation, liability and insurance, in general. The theory outlines the behavior of the insurer and insured in the context of taking precautions in the face of an environmental risk.

Moral Hazard

The moral hazard problem arises when the insured, through their level of care, can affect both the magnitude and the probability of risk that an accident or other event requiring an insurance payment will occur. Without information by the insurer on the level of care maintained by the insured, a fully insured party may engage in riskier behavior after acquiring insurance because the more hazardous behavior provides no additional risk to the insured and
indeed may lower their costs. Theft is an excellent example of how moral hazard can effect a person's behavior. Without insurance, they are inclined to bear certain costs to reduce the risk of the uninsured object being stolen. However, if a policy can be purchased with a premium less than the cost of self-insurance, the insured party is less inclined to take the same precautions to guard against the theft of the object. In fact, a fully insured party that cannot be monitored by the insurer bears no uninsured risk at all; the risk is initially felt by the insurance company in the form of increased claims and eventually passed to all insured as higher premiums. Therefore, a profit-maximizing insurer must compensate by setting premiums that reflect the higher probability of loss due to moral hazard (Cooter 1988, p. 66).

The solution to the moral hazard problem requires that the insurers have the capability to monitor the behavior of the insured party. In such a way, the insurer has four means of minimizing the moral hazard dilemma. Coinsurance and deductibles minimize the problem “by having the insured participate in coverage of his potential losses and thus to induce him not to change his behavior after the purchase of insurance,” (Cooter 1988, p. 66). Coinsurance is where the insured bears a fixed percentage of the loss, and deductibles are where the insured bears a fixed amount of the loss and the insurer covers losses above and beyond the deductible. Cancellation provisions are a third means of solving moral hazard. These are situations written into the policy where the insurer is not liable for the loss.14 Moral hazard can also be minimized when insurance premiums can directly reflect the level of care taken by the insured in reducing risk. Once premiums reflect risk, riskier behavior provides additional cost to the insured through higher premiums. 15

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14 Two examples of this are when life insurance is not paid in the case of suicide, or fire insurance is not paid when losses are a result of arson.

15 For example, the insurer lowers fire insurance premiums when smoke detectors are installed in a building.
Adverse Selection

A second problem that insurers must face when writing insurance contracts is known as adverse selection. Insurers use a technique in determining premiums known as the law of averages, that is to say that their ability to predict the probability of a certain loss for a group is based on the average for that group. It is difficult for insurers to distinguish accurately between low- and high-risk individuals. However, let us assume that an individual seeking insurance knows better than the insurer his risk of a loss. In such a way, a premium set on the average may impel only high-risk parties to buy insurance. This is because the premium will be too high for low-risk people and too low for high-risk. Adverse selection occurs when the sale of insurance leads only to high-risk individuals purchasing policies. This can result in no insurance being sold because the costs to the insurer of distinguishing between parties' risk behavior is too high (Cooter 1988, p. 67). Fire insurance is a good example of the effect of adverse selection. A fireman, for example, who has taken every available safety precaution in his home, including fire extinguishers and smoke detectors, may be inclined not to purchase fire insurance because he feels the premiums are too high. This is because the premiums are set on the average and compensate for high-risk individuals who have not taken the same precautions. However, an arsonist, planning to torch his home, will certainly seek to insure it for more than the market value. If the premium is based on the average probability of a loss, then the arsonist will certainly find it to be an excellent value, but the fireman will not. As a result only arsonists will buy the policy.

Insurers can use the same methods to combat adverse selection as used for fighting moral hazard. Coinsurance and deductibles are effective because high-risk parties find policies containing them less attractive (Cooter 1988, p. 67). Exclusionary clauses are also potent in that they exclude the insurer from outlined risks. For example, our fire insurance policy may contain a provision that the insurer is not liable to compensate for damages caused by arson. Finally, by monitoring the behavior of the insured, it is easier for an insurer to tie higher premiums into
higher-risk individuals. In this case, the fireman would receive premium reductions for implementing and maintaining these safety precautions.

An Economic Model of Insurance, Risk and Liability

The model used in this paper is adapted from models by Steven Shavell and Robert Cooter. They explicitly deal with the relationships among insurance, risk and liability, and insurance and bankruptcy respectively. Together, they create a mathematical model that can be applied to answer many of the fundamental questions concerning the appropriate allocation of risk and precautionary behavior. These questions are the motivating influence behind the application of the model. As such, the presentation of the following section builds upon itself in an attempt to answer successive questions. What is the insured’s likely behavior toward risk? Given this risk behavior, can insurance effectively minimize moral hazard and adverse selection? Is it in the economic interest of utility maximizing insurers and insureds to minimize these problems? How will cancellation provisions affect the behavior of the insured? How will bankruptcy affect their behavior as it pertains to the purchase of insurance?

Shavell’s Model of Risk, Liability and Insurance

In Economic Analysis of Accident Law, Steven Shavell of Harvard University presents a theoretical model of the allocation of risk by means of liability and insurance. The propositions proven by the model offer interesting answers to many of the questions posed in the preceding section. This section presents some of Shavell’s conclusions and relates them to my thesis. For any proof, please consult the aforementioned text. The majority of the mathematical results are the direct work of Shavell and should be attributed as such, except where noted. The numbers pertaining to the formulas and propositions in the text have citations that differ from Shavell’s work so as to provide the reader with a text that flows easier.
I have presented the model in a slightly different format from when it was originally published. Shavell looks at all conditions and compares them to the socially ideal solution. I have tried to adapt the model to provide an analysis closer to the real-world. Latter parts of the model build upon the conclusions of earlier sections.

**The Optimal Allocation of Risk.**

How will a rational person behave toward risk? To find an answer to this question, it is necessary to consider the effects that wealth and changes in wealth have on a person's behavior. Suppose risk is allocated between two parties, U and V. The following definitions apply:

\[
\begin{align*}
    u_\alpha &= \text{wealth of } U \text{ if there is no loss, } u_\alpha \geq 0; \\
    u_\omega &= \text{wealth of } U \text{ if there is a loss, } u_\omega \geq 0; \\
    U &= \text{utility function of } U; \\
    v_\alpha &= \text{wealth of } V \text{ if there is no loss, } v_\alpha \geq 0; \\
    v_\omega &= \text{wealth of } V \text{ if there is a loss, } v_\omega \geq 0; \\
    V &= \text{utility function of } V; \\
    w &= \text{total wealth to be allocated if there is no loss}; \\
    w - l &= \text{wealth to be allocated if there is a loss, } w - l > 0; \\
    p &= \text{probability of a loss, } 0 \leq p \leq 1; \\
    l &= \text{the total amount of the loss};
\end{align*}
\]

Formulas 1 and 2 have straightforward meanings. 1 says that the total wealth allocated when there is no loss is equal to the wealth of U and V together. The total wealth after a loss is equal to the total wealth before the loss minus the amount of the loss. As defined by 2, this is equal to the wealth of U and V after the loss.

The expected utilities will be:

\[
\begin{align*}
    EU &= (1 - p)U(u_\omega) + pU(u_\omega) \\
    EV &= (1 - p)V(v_\omega) + pV(v_\omega)
\end{align*}
\]
In this model, utility is a function of wealth. In other words, to maximize her utility she maximizes her wealth. Therefore, the expected utility for both U and V is the probability of a loss (in terms of a percentage) times their utility after a loss plus the probability of no loss times their utility before a loss.

The desired solution is to:

\[
\max EV \text{ subject to } EU = k \text{ and (1) and (2)}
\]

Substituting we get:

\[
EU = (1 - p)U(w - Vx) + pU(w - l - v)
\]

Optimization Conditions

Solving this maximization problem is achieved by setting up a Lagrangian function and deriving the first-order conditions. The Lagrangian function is:

\[
Z = EV - \lambda [EU - k] \\
Z = (1 - p)V(Vx) + pV(v) - \lambda [(1 - p)U(w - Vx) + pU(w - l - v) - k]
\]

Taking the partial derivatives with respect to \( \lambda \), \( Vx \), and \( v \) we arrive at:

\[
Z_\lambda = (1 - p)V(Vx) + pV(v) - \lambda[(1 - p)U(w - Vx) + pU(w - l - v) - k] = 0 \\
Z_{Vx} = (1 - p)V'(Vx) + \lambda(1 - p)U'(w - Vx) = 0 \\
Z_v = pV'(v) + \lambda pU'(w - l - v) = 0
\]

Setting the partial derivatives equal and solving we arrive at the result:

\[
\frac{V'(Vx)}{V'(v)} = \frac{U'(w - Vx)}{U'(w - l - v)} = \frac{U'(w)}{U'(w)}
\]

Proposition 1: In a Pareto optimal allocation, (a) if one party is risk adverse and the other is risk neutral, the risk-neutral party will bear all the risk of loss, whereas (b) if both parties are risk-adverse, each will bear a positive part of the loss. (c) If both parties are risk-neutral, then any allocation is Pareto-optimal. (Shavell 1987, p. 201)

Corollary (to Proposition 1): Both parties, U and V, will behave as if risk-adverse.

Since a risk-neutral party is forced to bear all losses, a person is essentially forced to behave as if risk-adverse. The threat of greater liability, in this case losses, is sufficient threat to
modify a person’s behavior. This conclusion supports the logical and hypothetical assumption that a rational person is adverse to risk. This result brings us to our next question.

**The Theory of Insurance**

Assuming that all rational parties behave as if risk-adverse, can insurance minimize moral hazard and adverse selection by basing premiums on the amount of risk taken by the insured? To answer that question, I begin with the following assumptions made for this section:

1) All parties face independent risks.
2) There are no administrative costs.⁶
3) The insurer covers costs by charging premiums equal to the expected payments.
4) As shown in the previous section, we will assume the insured to be risk-adverse.

The following definitions also apply:

\[
\begin{align*}
W & \text{ utility function of the insured;} \\
\omega & \text{ initial wealth of the insured, } \omega > 0; \\
\pi & \text{ premium for insurance, } \pi \geq 0; \\
q & \text{ level of coverage, } q \geq 0;
\end{align*}
\]

To derive a benchmark, consider the first case where:

**The Insured Cannot Influence Risk**

\[
\begin{align*}
W - \pi & = \text{ wealth without a loss} \\
W - \pi + q - l & = \text{ wealth with a loss}
\end{align*}
\]

This says that an insured person’s wealth before a loss is equal to his initial wealth minus the premium paid for insurance. His wealth after a loss is equal to his wealth before the loss minus the amount of the loss plus the amount of coverage (the wealth reimbursed by the insurer).

The expected utility of \( W \) will be:

\[
EW = (1 - p)W(w - \pi) + pW(w - \pi + q - l) \tag{7}
\]

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⁶ As stated above, this model simulates the real world, but still abstracts certain conditions. In a real-world situation insurers would likely face administrative costs. Furthermore, separate parties might face the same risk in some situations. However, this does not reduce the usefulness of our model. Theoretical conditions often produce results startlingly applicable to the real world.
Since the insured cannot influence the risk of a loss, the premium must equal the insurers expected payments which are the level of coverage times the probability of a loss occurring and the coverage being paid out. As such:

\[ \pi = pq \]

Optimization is derived by maximizing expected utility subject to this constraint. As such, \( \pi = pq \) is substituted into (7) for which \( q \) is chosen to maximize the equation. The utility maximization problem, assuming the second-order conditions hold, becomes:

\[
\max_q EW = (1 - p)W(w - pq) + pW(w - pq + q - l)
\]

Maximizing this function with respect to \( q \), the level of coverage, yields:

\[
EW_q = (1 - p)W'(w - pq)(-p) + pW'(w - pq + q - l)(1 - p) = 0
\]

Therefore

\[
\begin{align*}
    w - pq &= w - pq + q - l \\
    q - l &= 0 \\
    q &= l
\end{align*}
\]  

(8)

**Proposition 2:** Under the expected utility maximizing insurance policy, when the insured cannot influence the level of risk, the level of coverage \( (q) \) will be full. In other words, the level of coverage equals the loss. (Shavell 1987, p. 203)

**Corollary 2:** With more than one insured party, the total level of coverage equals total losses.\(^{17}\)

This motivates the question: Can the insured influence the level of risk? We can answer this without the model. For our purposes, the answer is yes. While not being able to eliminate all risks, insured parties can sufficiently effect the level of risk and being risk-adverse minimize the risks they face. For example, installing fire extinguishers certainly reduce the risks of a home being destroyed from a small kitchen fire getting out of control. In terms of oil transportation, a crew with better knowledge of local waters reduces the risk of a tanker running aground. As such, we turn the attention of the model to the situation where the insured can influence risk. We are now more concerned with the behavior of the insurer. This motivates the next question.

**The Insured Can Influence the Level of Risk**

Can risk based premiums minimize moral hazard and adverse selection? To answer this question, the following terms must be defined:

\(^{17}\) I adapted the corollary from Shavell’s results.
\[ x = \text{the insured's level of care, measured as the cost of care} \]
\[ p(x) = \text{the probability of a loss given the level of care} \]

The expected utility function becomes:

\[ EW = [1 - p(x)]W(w - \pi - x) + p(x)W(w - \pi - x + q - l) \quad (9) \]

To carry this analysis further, it is necessary to distinguish between two cases. The first is where the insurer cannot observe the level of care taken by the insured. In the second case, the insurer can now observe the level of care of the insured.

1. **The Insurer Cannot Observe the Level of Care**

Two assumptions must hold:

1) The premium cannot depend on \( x \), because the insurer cannot observe the level of care taken by the insured.

2) This being the case, if coverage, \( q \), is purchased there is no reduction in the premium by increasing the level of care.

The expected utility function is still:

\[ EW = [1 - p(x)]W(w - \pi - x) + p(x)W(w - \pi - x + q - l) \quad (10) \]

Since care cannot be observed, \( \pi \) remains constant.

However, the following assertion must hold:

1) Although the premium is not a direct function of the probability of a loss times the coverage, it must still obey \( \pi = p(x)q \) in principle. This is necessary for the insurer to cover costs.

In other words, the insurer must set the premium to equal the average probability of a loss times the coverage. This is the concept discussed earlier known as the law of averages. The average information for a large population is readily available to the insurer. The insurer cannot base the premium on the individual’s level of care, because that information is not readily available. However, if the insurer is to stay in business it is necessary to cover costs, and that means setting the premium based on the average level of care of the population.
If we assume that the expected utility function is maximized over $x$ alone:

$$\text{max}_x EW$$

The utility maximizing function can be rewritten:

$$EW = W(w - \pi - x) - p(x)W(w - \pi - x + q - l) + p(x)W(w - \pi - x + q - l)$$

Maximizing with respect to $x$:

$$EW_x = -[1 - p(x)]W'(w - \pi - x) - p'(x)W(w - \pi - x) - p(x)W'(w - \pi - x + q - l) + p'(x)W(w - \pi - x + q - l) = 0$$

As such,

$$p'(x)W'(w - \pi - x + q - l) - W'(w - \pi - x) = (1 - p(x))W'(w - \pi - x) + p(x)W'(w - \pi - x + q - l)$$

I am assuming that initial wealth, $W$, and the amount of losses, $l$, are exogenous variables and are respectively predetermined and uncontrollable by an individual. The individual buys an insurance policy. The premium, $\pi$, and coverage, $q$, are determined and cannot be affected by the insured. The insurance policy can be referred to as $(\pi, q)$. In maximizing (10), the first-order condition tells us that (11) must hold. The level of care chosen to maximize (10) must satisfy (11) and as such is a function of the insurance policy and the chosen $q$ and $\pi$. The level of care is a function of coverage and the premium and can be written as $x(\pi, q)$.

The second assertion that must hold is that:

2) The level of care taken by the insured is a function of his coverage and premium and can be written as $x(\pi, q)$.

In fact, we can say that the level of care taken by the insured is a negative function of his coverage and premium. The greater the coverage the less care the insured is likely to take in reducing risks. Furthermore, higher premiums discourage parties, who take greater care, from buying insurance, while it encourages parties engaged in overly risky behavior.

Keeping the above assumptions and assertions in mind, the expected utility maximizing insurance policy is found by:
\[ \max_x EW \text{ subject to } x(\pi, q) \]
and also subject to \( \pi = p(x)q \).

Since \( x(\pi, q) \) we may rewrite \( \pi = p(x)q \) as:

\[ \pi = p(x(\pi, q))q \quad (12) \]

\( \pi \) is in other words a direct function of \( q \) and may be written as \( \pi(q) \).

Therefore, \( x(\pi(q), q) = x(q) \)
and \( x \) is a direct function of \( q \).

Reduced to the simple utility maximization problem:

\[ \max_q EW = [1 - p(x(q))]W(w - \pi(q) - x(q)) + p(x(q))W(w - \pi(q) - x(q) + q - l) \]

Maximizing this function with respect to \( q \) yields:

\[
\begin{align*}
EW_q &= p'x'[W'(w - \pi - x + q - l) - W'(w - \pi - x)] \\
&\quad - x'[(1 - p)W'(w - \pi - x) + pW'(w - \pi - x + q - l)] \\
&\quad - xp'q[(1 - p)W'(w - \pi - x) + pW'(w - \pi - x + q - l)] \\
&\quad - p[(1 - p)W'(w - \pi - x) + pW'(w - \pi - x + q - l)] \\
&\quad + pW'(w - \pi - x + q - l) = 0
\end{align*}
\]

From this equation it can be shown that \( q < l \) under general conditions, but that \( q \) approaches \( l \) as the cost of taking care, \( x \), falls toward zero. Furthermore, \( x \) will not minimize \( p(x)l + x \).

**Proposition 3:** Assuming that the insurer cannot observe the level of care taken by the insured, under the expected utility maximizing insurance policy, the level of coverage will generally be less than full and the level of care will generally not minimize the sum of expected losses plus the cost of care. (Shavell 1987, p. 205)

Shavell attaches the following remark:

1) With \( q < l \), the insured has an incentive to choose a positive \( x \) lowering the premium rate. If \( q = l \), then \( x = 0 \) and \( \pi = p(0)l \).

\[ \text{18 For proof of this see Shavell 1979.} \]
2. The Insurer Can Observe the Level of Care Taken

If the insurer can observe \( x \), then the premium can be based upon \( x \), as such:

\[
\pi = p(x)q
\]  
(13)

This says that the premium is a function of the probability of a loss times the level of coverage of the insurance policy.

Being so, we want to \( \max E W \) subject to (13).

Substituting (13) can be substituted into (9) the problem becomes:

\[
\max_{q} E W = [1 - p(x)]W(w - p(x)q - x) + p(x)W(w - p(x)q - x + q - l)
\]

Maximizing with respect to \( q \), the level of coverage, yields:

\[
E W_q = [1 - p(x)]W'(w - p(x)q - x)(-p(x)) + p(x)W'(w - p(x)q - x + q - l)[1 - p(x)] = 0
\]

This reduces to:

\[
w - p(x)q - x + q - l = w - p(x)q - x
\]

\[
q - l = 0
\]

\[
q = l
\]  
(14)

The level of coverage again equals losses.

By substituting \( l \) in for \( q \):

\[
E W = [1 - p(x)]W(w - p(x)l - x) + p(x)W(w - p(x)l - x)
\]

The insured now desires to maximize this equation over \( x \) given an initial wealth \( w \), which becomes a problem of:

\[
\min p(x)l + x
\]

The insured desires to minimize the sum of expected losses and the cost of the given level of care.

Proposition 4: Assuming the insurer can observe the level of care taken by the insured, if the premium is a function of the probability of a loss given the insured’s level of care times coverage, then under an expected utility maximizing insurance policy the level of coverage will
be full and the level of care will minimize the sum of the insured's expected losses and the cost of care. (Shavell 1987, p. 204)

The important implication is that full coverage does not create a negative incentive for safety if care affects the premium. Both the moral hazard and adverse selection dilemmas can be solved if premiums are determined in a particular way. The solution is that the premium structure incorporate specific information on the level of safety observed by the policy holder and not just aggregate information. As such, negative behavior increases the premium and higher premiums discourage negative behavior.

Since the premium is affected by the insured's level of care, a negative incentive to reduce care is created. Furthermore, Proposition 4 shows that the compensatory aims of an insurance contract are not reduced, because the level of coverage is full. When the insurer can observe the level of care and sets premium accordingly, moral hazard and adverse selection are minimized. Potentially conflicting aims, the preventative and compensatory goals of an insurance policy, can simultaneously be satisfied. Unfortunately, obtaining full or even imperfect information requires inspections and monitoring, which generate additional costs. Is it in the interest of the insurance agency to bear such costs?

**Corollary** (to Proposition 4): The insured is willing to pay an additional amount, beyond the cost of taking care, for the insurer to obtain information about the level of care taken by the insured.

When the reduction in premium (due to the higher level of care) exceeds the monitoring costs, the insured can actually save money even if they pay for the monitoring. Furthermore, the insured is willing to pay a positive but lesser amount for the insurer to obtain imperfect information about $x$.

The theory reveals that the monitoring costs, or at least a substantial portion of the costs, can be transferred directly to the insured. When the insurer is unable to observe the level of care taken by the insured, the insured has a lower maximized expected utility function. As such, the
insured being risk-adverse should theoretically be willing to pay an amount equal to the difference in expected utility for the insurer to observe their level of care. Logically, it follows, as Shavell states, that the insured is willing to pay a lesser amount for the insurer to obtain imperfect information about their level of care. The insured's willingness to cover the additional cost is equivalent to a person selling a chance to participate in a lottery for an amount equal to the expected value of the lottery. We can think of the difference between the two utility functions, which are lotteries in themselves, as a third lottery.

For the purpose of this analysis, this proposition suggests that the marine insurer can incorporate inspections into policy requirements and transfer the monitoring cost on to the insured without destroying the incentive to purchase the insurance. This still effectively minimizes the moral hazard and adverse selection problems by allowing premium to be directly affected by the level of care taken by the insured. Thus the economic costs of risky behavior are internalized, and the tanker owner feels the burden himself.

As we have already stated, the primary goal of insurance is to provide compensation to injured parties. This being the case, governments often impose limits on liability below the expected losses from a given accident. The aim of this is to ensure that victims receive at least some compensation for their losses. Without imposed limits, it is difficult to insure against unlimited losses, or even, as is the case with environmental liability insurance, against astronomically high expected losses. Governments often feel this defeats the purpose of insurance policies.

**The Accident Problem with Liability and Insurance**
We must ask ourselves, how do imposed liability limits affect the level of care taken by the insured and, as such, does this hurt precautionary incentives? The answer relies on the forthcoming analysis. The following assumptions will be made for this case:

1) Strict liability holds.
2) The insured is risk-adverse, as determined by the Corollary (to Proposition 1).
3) The insured can affect the level of care.
4) The insurer can observe the level of care taken by the insured. This is assumed true for two reasons. First of all, as shown for the Corollary (to Proposition 4) the insured has the incentive to pay extra to enable the insurer to monitor care taken, as long as, monitoring costs are less than the difference between the expected utility functions. As such, \( \pi = p(x)q \). Secondly, ex-post monitoring is automatic when observing the result of an accident.

The following definitions are added:
\[
d = \text{the magnitude of liability} \\
g = \text{maximum government set liability limit.}
\]

1. \( l \leq g \)

As proven for Proposition 4, \( q = l \) assuming \( d = l \). In other words, the insured will purchase full coverage against losses if the magnitude of liability is equal to losses. As such, the insured bears no risk. The level of care is chosen, as proven for Proposition 4, to minimize \( p(x)l + x \), the sum of expected losses and the cost of care.

2. \( g < l \)

\( d = g \), and the problem from above becomes:
\[
\max_{q} EW \quad \text{subject to} \quad \pi = p(x)q \\
\text{substituting } g \text{ for } l
\]

Maximizing with respect to \( q \) yields the first-order condition:
\[
EW_q = [1 - p(x)]W'(w - p(x)q - x)(-p(x)) + p(x)W'(w - p(x)q - x + g)[1 - p(x)] = 0
\]

And as expected:
\[
q = g
\]

\( EW \) reduces to:
\[
EW = [1 - p(x)]W(w - p(x)g - x) + p(x)W(w - p(x)g - x)
\]

And the problem becomes one of choosing \( x \) to minimize:
\[
p(x)g + x
\]

19 I imposed this restriction. This analysis does not appear in Shavell’s text.
If \( l \leq g \), then \( d = q = l \).
If \( g < l \), then \( d = g = q \).

It can be said in the general case that:
\[
\min p(x) d + x
\]

Maximizing the expected utility function becomes a matter of:
\[
\min p(x) d + x
\]

Furthermore, assuming that a given level of care, \( x \), is taken by the insured the logical conclusion holds that:
\[
p(x)g + x < p(x)l + x
\]
when \( g < l \)

**Proposition:** Assuming strict liability and that the insurer can observe the level of care taken by the insured and that the insured is risk-adverse, the amount of coverage will equal the insured's magnitude of liability. The maximization of the insured's expected utility function is a problem of minimizing his expected losses plus the cost of care. The insured bears no risk of losses. Furthermore, if the government set maximum liability is less than losses, the cost of care plus expected losses is less under the set liability than with full losses.

Since the liability limit is less than the assessed damage, given a level of care, the sum of expected losses and the cost of care is lower. So far the model has shown how premiums affected by the level of care of the insured can minimize the problems of moral hazard and adverse selection. However, we also asserted previously that cancellation provisions can also reduce the problem of moral hazard. Is this, in fact, the case? To answer this question, it is necessary to assume several restrictions upon the model.\(^{20}\) Assume the insured is risk-adverse and able to affect the level of care. Assume further that the government has imposed a liability limit and that the insured is strictly liable for damages. However, legislation also provides for unlimited liability for cases of negligence. The insurance policy includes a cancellation provision for negligent cases. The insured now faces a situation with a negligence standard of

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\(^{20}\) We will see later the these are indeed fair restrictions to make. They provide a highly accurate model of the marine insurance industry.
liability, no limit on liability and no insurance. An analysis of these two situations provides an understanding of how this cancellation provision would affect the insured's level of care.

$x^*$ is defined as:

$$x^* = \text{the socially optimal level of care.}$$

The first situation is identical to the model of The Accident Problem with Liability and Insurance that has already been discussed. Shavell asserts that when $d = l$, the insured, "will be induced by the terms of their policies to choose $x^*$", (Shavell 1987, p. 223). This can be stated as:

$$x = x^*.$$  

We have already shown that when $g < l$, the insured has incentive to reduce his level of care. Therefore, it must hold true in this case that:

$$x \leq x^*.$$  

To complete our comparison, we must turn to a model of the second situation.

The Accident Problem Given Liability and No Insurance

The following assumptions are being made for this section:

1) The insured is risk-adverse;
2) A negligence standard of liability is imposed;
3) The insured can effect the level of care taken;
4) $d = l$. No government limit is set on liability, so liability is equal to losses.

Assumptions hold for the same reasons as stated above.

$$\bar{x} = \text{the negligent standard of care.}$$

Since for this case (Shavell 1987, p. 222) the insured can be expected to choose the standard of care, which protects him from being declared negligent:

$$x = \bar{x}$$

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21 For a discussion of the socially optimal level of care, please see Steven Shavell, Economic Analysis of Accident Law. For the purpose of this text $x^*$ is only included so as to provide a standard of reference.
In this case, Shavell remarks that, "since \( V \) [the utility function of the injurer] is concave we would expect the solution [the negligent standard of care] to exceed \( x^* \)," (Shavell 1987, p. 222).

In this case, provided that the injurer is risk-adverse:

\[
\bar{x} \text{ should exceed } x^*.\]

Therefore, since \( x = \bar{x} \) then \( x \) should exceed \( x^* \).

**Proposition:** Taking into consideration the above assumptions, under a negligence standard the injurer should increase his level of care as compared to his level of care when faced with strict liability, insurance and a government limit on liability.

The threat of a cancellation clause coupled with a negligence standard motivates the potential injurer to increase his level of care. Therefore, cancellation clauses can potentially motivate precautionary incentives and minimize the problem of moral hazard. The complete model answers one final question: Does the insured have the same incentives when faced with losses that would result in his bankruptcy?

**A Model of Bankruptcy and Liability**

A declaration of bankruptcy protects a party from claims against it. "Consequently, corporate reorganization and bankruptcy externalize some accident costs imposed by the firm's activities," according to Cooter (1988, p. 448). Typically, a firm possesses an amount of insurance above its total assets but far below potential liability.\(^{23}\) This is a logical assumption, because at a certain point the cost of insurance will equal the insured's wealth. At this point, it is "better to run the risk of a suit than to use up all wealth to insure against it," (Cooter 1988, p. 448). Therefore, a firm will have an upper limit on its insurance coverage somewhere below the point where its premium equals its wealth. It is in the firms interest to externalize any additional liability through bankruptcy.

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\(^{22}\) Shavell points out that it is possible for the solution to be \( \bar{x} < x^* \). For a discussion a proof of both results see p. 222 of the text.

\(^{23}\) This is especially true for environmental liability where claims are potentially enormous in size. It is not unheard of firms facing billions of dollars of liability.
The use of limited liability will theoretically expand the amount of insurance coverage demanded by the insured, and thereby internalize a portion of the external costs (Cooter 1988, p. 450). Provided that the insured’s upper limit of coverage is below the point where premiums equal their wealth, the liability cap should be imposed just above the firm’s limit of insurance coverage. This increases the probability that the insured will increase his coverage to a point where it equals the liability limit. This strategy has a higher expected utility than facing bankruptcy. The liability limit is effective, as long as, the insured’s expected utility after increasing his coverage is greater than before. The liability limit is also effective if only offered in certain situations. Under these circumstances, the insured receives greater expected utility from obeying the conditions of the liability limit than facing unlimited liability and bankruptcy. Once again, the insured reaches a certain point when it is cost-effective to face unlimited liability and risk bankruptcy. Losses that exceed liability limits are not compensated, but when an organization declares bankruptcy, no losses are compensated. Unfortunately, liability limits are rarely imposed specifically on an individual firm and often fail to take into account their insurance limits. As such, they are sometimes relatively ineffective in internalizing these surplus costs. Another solution to the problem lies in closing up the escape route in bankruptcy.

The means of accomplishing this is through legal measures. In achieving these goals, it is important that bankruptcy laws still provide the debtor with temporary solace against claims, yet do not provide him with the opportunity to shelter his assets from the liability. Two legal remedies are available for achieving these goals. The first, “is to put more of the firm owner’s personal wealth in jeopardy in the event of a firm’s bankruptcy,” (Cooter 1988, p. 449). The second method is that when reorganizing financially, after declaring bankruptcy, the entity acquiring the assets of the original debtor also acquires the past and future claims (Cooter 1988, p. 449). This is known as the “successor doctrine” (Cooter 1988, p. 449). However, this also means that no one will want to acquire the assets.

24 For a more complete discussion of the theory behind the implementation of liability caps see Cooter and Ulen, Law and Insurance, p. 448-50.
These legal measures in theory preserve the compensatory and preventative aims of an insurance contract by protecting against the threat of bankruptcy. The victims of loss are at least still legally entitled to compensation for inflicted damages. Furthermore, the insured still has the same incentives to increase his level of care, because he is unable to externalize the additional costs. In reality, it is unlikely that all claims for environmental damages can be compensated in many situations. However, the same precautionary incentives still exist, because the debtors entire assets are still at risk. This is not a realistic solution, because reforming the entire legal structure of bankruptcy would be a nearly impossible task. The bankruptcy dilemma has no simple solution.

Interaction of Regulation, Liability and Insurance

Although it is necessary to outline the background legislation, this thesis primarily focuses on the role insurance can play and has played in preventing marine pollution from oil without exacerbating the moral hazard and adverse selection dilemmas. Through the use of inspections, premium incentives and underwriting clauses the insurance industry can control and monitor statutory regulations by partially internalizing economic costs to ship and cargo owners before an accident occurs. If the burden of payment and clean-up costs are borne directly by owners and are not completely externalized to all policy holders within the insurance industry, an increased incentive exists to maintain the highest safety standards and adhere to regulations. The effectiveness of such control depends on both the industry's ability to accurately assess risk, predict liability, and maintain inspections and monitoring at a reasonable cost (Kehne 1986, p. 403). The combination of statutory regulations, tort law and insurance constraints can form a highly effective reinforcing strategy.

25 For a discussion of the bankruptcy laws as they have been interpreted in environmental litigation see Jarred O. Taylor II, "Cleaning Up The Dirty Nest: Who Pays For Environmental Cleanup? Issues of Concern to The General Practitioner", Environmental Coverage: From Interpretation to Litigation, p. 57-76.
This section applies the aforementioned concepts of moral hazard and adverse selection directly to the marine insurance industry. I have attempted to show that the answers provided by the model are indeed applicable to this real world situation. Furthermore, in order to justify the analysis, it is also necessary to demonstrate that any modifications to the insurance system leaves the insurer better off. This section looks at the general methods that the interaction of insurance and legislation has in affecting the level of care taken within the marine oil shipping industry. By doing so, in the next section, we are free to apply these concepts to specific problems of the oil transport industry and discuss the necessary modifications to marine insurance contracts and existing legislation.

**Preventative Influences**

The problem of moral hazard, as it applies to the maritime transport of oil, deals with the incentives of the marine insurer to incur monitoring costs as a solution to minimizing the dilemma. Furthermore, it looks at the effects of limited liability and negligence underwriting clauses on the risk-incurring behavior of the insured. Without the implementation of underwriting clauses, inspections and care-based premiums, a pollution-liability contract actually increases risk by reducing individual liability for insured ships involved in an accident when in violation of legislative safety standards. If premiums are not affected by risk and contracts are valid when the tanker is engaged in negligent actions, then the insurance will be most attractive to firms posing the greatest risks and the problem of adverse selection is exacerbated. Logically, this is not in the insurer’s interest. With the use of premium incentives and contract provisions, adverse selection is minimized. The contract enforces the statutory standards on all ships with third-party insurance. Self-insured tankers have the incentive to abide by the same regulations in order to limit their maximum liability. Adverse selection occurs in favor of insured tankers if contract provisions are not used in conjunction with the statutory regulations.
Within the existing framework, legislation has the role of assigning liability for pollution damages. It is necessary to set limits on liability. By setting a limit on an injurers' liability below potential losses, in most situations innocent parties are assured of at least some compensation for damages. If shipowners face unlimited liability in most situations, the costs of operation become too high and they refuse to transport. When an accident does occur, the shipping firm is often forced into bankruptcy and the victims don't receive any compensation. However, appropriate legislation also has an obligation to promote safer practices and play a precautionary role. This can be partially achieved by removing all caps on liability for damages resulting from an institution that does not practice established safety standards and preventative measures. In a situation of pure liability without insurance, these statutory regulations provide the incentive to abide by set standards. A profit-maximizing firm will naturally adopt all cost-justified precautions. Insurance, covering all potential losses, can partially defeat the precautionary measures. As we will see, the use of care based premiums and underwriting clauses can offset the negative balance.

Liability only provides a precautionary incentive if a firm actually has the capital means to pay the cost of damages. If a shipper does not have the financial assets to pay the liability, their incentive to implement precautionary measures is diminished, because a declaration of bankruptcy can externalize any economic costs above the limit of insurance. The marginal benefit of taking additional precautions is reduced for a firm with limited assets. This means that the profit-maximizing precautionary level will be lower for firms with fewer assets. By requiring that firms demonstrate financial responsibility, legislation can confront the problem of undercapitalization. For firms with sufficient assets, self-insurance provides a realistic economic possibility. However, the potentially concentrated costs from environmental pollution damages may still encourage a firm to spread out these risks through some form of third-party insurance. Its assets are large enough to ensure compensation for damages when liability is limited. Yet, I will assert that the threat of bankruptcy, if the firms assets are still at risk, is sufficiently unattractive to provide enough incentive to establish cost-effective precautionary and
preventative practices, in order to limit liability based on legislative standards. Thus, for the self-insured, both the compensatory and preventative influences can be met.

Institutions without sufficient capital must necessarily turn to insurance as a means of demonstrating financial responsibility. "Financial responsibility provisions require firms whose activities involve risks of damages exceeding their net worth to maintain minimum levels of insurance," (Kehne 1986, p. 403). The reality is that most firms possess some form of insurance, either because of necessity or to distribute the risks. In addition to solving the under-capitalization problem for these firms, insurance also has the ability to promote precautionary behavior through exclusionary underwriting clauses and care-based premiums.

Care-based premiums are an avenue of influence. Through the use of mandatory inspections, premiums can be directly linked to the level of care taken by the tanker. The method internalizes the costs of not taking precautions. The cost of insurance is directly linked to the level of care taken by the insured. A safety-conscious ship owner, like the example of the fireman, pays a smaller premium for insurance coverage. While, on the other hand, less safety-conscious owners face higher premiums for identical coverage. Under this system, ship owners are encouraged to take all cost-justified precautions to keep the costs of insurance down. Cost-justification implies that the additional costs of implementing the precautions are less than the savings from a lower premium. This system has an additional benefit. By increasing the rate structure so that taking fewer precautions has a greater affect on premiums, the insurer can actually influence the desired level of safety standards met. The greater the difference in the premium, when the precautions taken by the insured are reduced, the greater are the cost-justified precautions.

Underwriting clauses also encourage tankers to comply with established precautions. The clause nullifies the coverage for ships involved in an accident when not in compliance with specific regulations. Failing to comply with regulations forces the owners to cover their own risks. Self-insurance internalizes the economic costs of the accident and encourages owners to
adopt all cost-justified safety standards. When used in conjunction with legislation, the effect can be even stronger. By also removing liability caps on vessels not in compliance with regulations, the owner is faced with the additional burden of self-insuring himself against all potential losses and risks. Unfortunately, this increases the risk of bankruptcy. Any costs greater than the assets of the firm are externalized. Therefore, when promoting safer practices through the use of underwriting clauses, the precautions must still be cost effective. If the additional costs over time are greater than the aggregate risks, the insurer will have a disincentive to administer the additional precautions. Fortunately, the monitoring costs are low for implementing these clauses. The monitoring is almost entirely done ex-post, at the scene of an accident. These inspections will readily reveal any regulatory noncompliance. The additional costs are negligible because in most situations ex-post monitoring already occurs.

Insurers still face the difficult decision of choosing when to use premium incentives versus underwriting clauses. As a general rule, risk-based premiums are preferred to underwriting clauses. Underwriting clauses are a very powerful weapon of the insurer and for many precautions can be too severe. Like the old cliché, they can be compared to using a bomb to kill a mouse. They also raise the risk of a shipping firm declaring bankruptcy and no money being available to compensate the victims. Premium incentives account for the risks prior to an accident and transfer the expected costs on to the insured. However, the shipowner still possesses insurance which guarantees that money is available to compensate victims in the case of an accident.

The ability to monitor ex-ante or ex-post provides a means for deciding whether to use risk-based premiums or underwriting clauses. If ex-ante (prior to an accident) monitoring is possible, then the risks should be accounted for and incorporated into the premium structure. If only ex-post monitoring is possible, then obviously the risk cannot be quantified and accounted for in the insured's premium unless the premium is adjusted after an accident. Underwriting clauses must be used, because premium adjustments after a spill are not very effective due to the
nature of oil transportation accidents. Since an accident often results in the loss of all assets, no policy is needed after the fact. If there is a new policy it will often be in the name of a new corporation. IMO routing regulations are an excellent example of a case where only ex-post monitoring is available. An insurer cannot determine if a ship will follow a traffic lane until after an accident occurs. Those which choose to use approved traffic lanes will be covered; those which don’t will not be covered.

Once the appropriate combination of required demonstration of financial capability, liability, regulation and insurance are achieved both the preventative and compensatory aims of an insurance contract can be met and the moral hazard and adverse selection dilemmas resolved. The suggested legislation and contractual standards provide a balance between both aims. In most situations, the compensatory focus reduces the insured’s maximum liability with the intent of guaranteeing that an injured party receives some compensation. However, the current limitations of personal liability provide owners extensive protection from claims in excess of liability limits (Mankabady 1980, p. 173), as is often the case with environmental pollution damages. This reduces the number of precautions that the owner is justified by cost to take. The use of care-based premiums and underwriting clauses promote the precautionary goals. These suggestions maintain limited liability in most cases, guaranteeing compensation to injured parties; yet, they prevent “gross negligence” and “willful misconduct” by placing no limitations on liability for parties not in adherence with approved safety standards. The overall effect is to reduce aggregate economic cost; the increased cost of care is offset by the reduction in losses.

Insurance Industry Incentive

The preceding section demonstrates that it is possible to design insurance contracts which lower risk. However, it is not enough to demonstrate that the insurance industry has an effective means of control. It must also be shown that it is in the best interest of the insurer and the insurance industry to implement the above contractual regulations. A continual fear of insurers
has been their inability to assess risk, liability and premiums in the pollution insurance market. Failing to do so limits the insurers' ability to minimize their costs. The use of inspections can limit insurers' losses by tying risky behavior directly to higher premiums. Contract provisions also provide insurers with the incentive to limit their liability in cases of negligence and misconduct. Minimizing the risk of an accident limits insurer's liability, which in turn minimizes their costs.

Ross E. Cheit argues that while an insurer strives to minimize risks in theory, the structure of the industry, in reality, diminishes their interest in safety (p. 29). For starters, the industry relies on market segmentation, re-insurance and limited coverage policies to spread the risks, which reduces an insurer's interest in spill prevention (Cheit, p. 29-30). Furthermore, overcapacity in the industry (supply exceeds demand) induces insurers to lower premiums to gain a greater market share. In such cases, they are unwilling to impose stricter safety standards for fear that policy holders unwilling to bear the additional costs of implementing the standards will turn to other insurers with more lenient regulations (Cheit, p. 35).

In response to Cheit's first argument, I agree that spreading risk diminishes an insurer's interest in safety, up to a certain degree. However, Cheit illustrates his argument with individual examples. In the case of the Piper Alpha platform accident, $1.5 billion of liability was divided into individual policies worth approximately $250,000 each (Cheit, p. 33). $250,000 is undoubtedly a minimal risk to a major insurer and provides little incentive to promote increased safety standards. The answer lies in the aggregate. The insurer must be more concerned with the additional liability he faces from all policies combined, as they are affected by a particular risk. The overall effect of the increased risk on all policies is not negligible. Insurers still have an incentive to increase their safety standards to minimize risks, as long as being safety conscious does not cost them market share.

Insurers, being profit-maximizing businesses, have the incentive to offer their services at the lowest cost possible. Lowering costs attracts a higher portion of the market share. Using
risk-based premiums and clauses enables the insurer to offer policies at the lowest possible premium for the level of care taken by the insured. Risk-based premiums lower premium costs by encouraging safety practices and thereby reducing the number of claims on the insurer. Underwriting clauses reduce the number and magnitude of wasteful claims, those that should have been eliminated by regulation. Implementing additional safety standards comes at a greater cost to the insured, encouraging a shipowner to seek an insurer that requires fewer safety precautions. The insurer can only have a positive effect on reducing oil pollution if the difference between the costs and benefits of the increased precautions is positive. In other words, they must be cost-effective solutions. The precaution must have a significant impact on reducing the risk of pollution, if it is to be economically feasible. It must sufficiently lower the insurer’s liability, so that he can reduce the insured’s premium enough that it outweighs the additional cost of the safety measures. In such a way, this lowers the insured’s overall costs, increasing the insurer’s market share and making them more competitive.

The oil shipping industry provides insurers with special opportunities to limit losses through the use of inspections. Statutory regulations and financial constraints require that most tanker owners turn to third-party insurers. It is in the interest of the insurer to lower its losses by requiring inspections and including exclusionary clauses in contracts. With underwriting clauses, financial liability again falls with the insured in negligence cases. The insurer only bears liability when the insured has taken all required precautionary measures.

Two problems of pollution-liability coverage arise when dealing with the maritime transport of oil. In order to set risk-based premiums, an agency must be able to predict the frequency of an event occurring and estimate the losses in such a case (Imbler 1986, p. 507). Both are essential to pricing an insurance coverage. “In pollution coverage, these two essentials are missing,” states Imbler. With the combination of statistical data and the use of inspections,

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26 Thomas D. Hopkins presents an interesting study of the cost-effectiveness of double-hulls versus alternative hull designs and operation and maintenance measures. The costs of these alternatives are compared with the economic benefits associated with the resulting reductions in pollution. (Hopkins 1992, p. 59)
marine insurance companies have a means of estimating premiums based on the care taken by the individual policy holder.

The preceding sections have outlined the theoretical means of reducing pollution and eliminating moral hazard and adverse selection with the use of insurance. The rest of this thesis concentrates specifically on the marine insurance industry. It discusses the industry’s ability to affect the behavior of insured parties within the marine transport sector, thereby controlling marine oil pollution. However, before discussing policy implications it is necessary to present an overview of the nature and details of marine insurance contracts. 27

Marine Insurance Contracts

Brent Dibner, vice-president of Mercer Management Consulting Inc., estimates that insurance comprises 4-7% of the cost of operating a tanker (“Underwriters...” 1992, p. A6). Oil tankers usually carry from four to six separate insurance policies (Cheit, p. 12), falling into the modern classifications of hull, cargo and protection and indemnity (P&I) insurance. It is useful to divide these into the categories used by all commercial insurance: property and liability (Hayden 1991, p. 314). As illustrated, the marine insurance market is one of purpose-specific policies and highly segregated risks distributed throughout the global market. This has been necessitated by the surmounting financial risks of maritime transport.

Unfortunately, modern business practices have resulted in policy packages that cross the neat bounds of individual, specific insurance coverage. This has produced intricate arrangements that are often unique to each policy holder and impede the use of standardized contractual forms. Along with the archaic language of the industry, these convoluted policies produce extensive coverage disputes that often end up within our court system. Such legal debates rarely deal with

27 The following section offers only a very general discussion of marine insurance. For a more detailed discussion of the industry see Hayden and Balick, "Marine Insurance: Varieties, Combinations, and Coverages," Tulane Law Review. Arnould, The Law of Marine Insurance and Average and Ivamy, Marine Insurance are standard texts on the industry and provide detailed information on the intricacies of marine insurance contracts.
specific coverage and are often concerned with issues affected by more than one policy. However, the industry is not about to change soon, and it is useful to discuss marine insurance policies in terms of the individual contracts.

Pollution liability insurance is the primary tool insurers have in limiting marine pollution from spills and will be of primary concern to this thesis. It has become increasingly standard for all tankers and is now required for tankers traveling in U.S. waters. An overview of hull, cargo and P&I insurance are also discussed in this section, in that they are standard contracts of the marine insurance industry and have certain control policy implications in themselves.\(^{28}\) The pollution exclusion clause in general liability insurance is also briefly considered to demonstrate how an interesting conflict that arises in general policies can be eliminated by the specific nature of pollution liability insurance.

Underwriters grade and classify premiums based on risk and maximum loss potential (Mankabady 1980, p. 161). All values of indemnity are predetermined at the outset of the contract (Lambeth 1981, p. 1) with liability distributed between separate tanker-owner and cargo-owner policies (Mankabady 1980, p. 161).

**Property Insurance**

**Hull Insurance**

Hull insurance protects owners against loss of or damage to a vessel. This contract covers damages to "furnishings, life boats, and plant, as well as unowned equipment that may be installed on the ship," (Hayden 1991, p. 315). Hull contracts usually rest with third-party, independent underwriters. In the case of a collision, the contract may include coverage of the other vessel where the insured is at fault (Hayden 1991, p. 316). Risks are specified in the contract, and the policy also indemnifies against labor, salvage, and general average expenses

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\(^{28}\) For a discussion of specific clauses (i.e. war risk) that are not of principle interest to the control of pollution, see Hayden, 1991.
Three standard contract forms are currently in use: Lloyd's, non-Lloyd's London market, and the American insurance market. The Lloyd's is the most common, but the American Institute Hull Clauses (A.I.H.C.) is the most important in the U.S. market.

An important consideration in hull contracts is the Inchmarnock Clause (or Additional Perils Clause). It extends coverage to losses resulting from negligence of the crew or latent defect in the hull and machinery. The clause provides owners with protection against claims made against accidents resulting from sub-standard crew performance and ship construction. Owners have the potential to use the clause as protection against losses resulting from cost cutting practices in the form of less stringent crew and construction standards. Placing restrictions on the clause has the potential to eliminate this loophole.

The Running Down Clause, included in hull contracts, provides protection against limited third party damages from collision liability. The clause is traditionally limited to a fraction (usually 75%) of the total claims, in order to provide an incentive for safe navigation practices (Hayden 1991, p. 318). Significant exclusions apply including pollution liability.

Cargo Insurance

In simple terms, cargo insurance provides cargo owners with protection against loss or damage to their freight. It is traditionally offered at low cost and can be obtained with relative ease (Hayden 1991, p. 319). The contracts exist with independent underwriters. The contract primarily defines three conditions: The perils insured against; the duration of the coverage; and the financial extent. Specific policies called “all risk” coverage insure against a wider range of perils than traditionally covered in cargo insurance contracts. It is important to note that the duration of coverage, in most cases, lasts from the time the cargo is loaded onto the ship until unloading. The three standardized forms exist for cargo clauses, but in use usually include extensive modifications and amendment (Hayden 1991, p. 324).
Protection and Indemnity Insurance

Protection and indemnity (P&I) insurance protects against shipowner, third party and contractual liabilities (Hayden 1991, p. 326). It fills a unique niche in the marine insurance market by providing coverage not usually obtainable in other policies. The insured is covered against liabilities arising from the operation of the “enrolled ship”, whether it be owned, operated or chartered (Hayden 1991, p. 327). Coverage may include, among other things, personal injury claims, passenger liability, collision, wreck removal, towage, and pollution (Hayden 1991, p. 327). The contracts generally do not insure against property loss, providing primarily only liability insurance.

P&I policies are often held with P&I clubs. P&I clubs are groups of ship owners who pool liability against individual loss (Abecassis 1976, p. 45). The clubs have a unique method of operation within the insurance industry. Policies are not usually issued, but rather the insured is accepted into the club as a “member”. A ship is issued with a certificate of membership, and the terms of the “policy” are detailed in the association’s “Rules” (Hayden 1991, p. 326). To complicate the issue further, clubs pay on an indemnification basis. The member must pay the obligation, and the club is in turn liable to pay the member (Hayden 1991, p. 336-7). The directors also have latitude in deciding which claims should be paid (Hayden 1991, p. 337).

P&I coverage contains significant exclusion clauses that limit their liability for claims resulting from circumstances, such as breach of contract or terminated voyages. Of particular interest, the policy excludes against liability normally covered in hull contracts, regardless of whether the member possesses hull insurance (Hayden 1991, p. 328).
Pollution Liability Insurance

While standard pollution liability insurance is available from only a handful of organizations worldwide, marine pollution liability insurance for both tanker and cargo owners of the international fleet of approximately 4,000 tankers is available from many domestic and foreign firms (Zagaski 1992, p. 155). However minimal, coverages for oil tankers have traditionally been available and at reasonable costs (Zagaski 1992, p. 155). Several conditions have helped to keep costs to a non-prohibitive level. First of all, although legislation in the past has held owners and operators liable for cleanup costs and damages to natural resources, it did not impose any liability for third party injuries or property damages. Adding to this, since spills tend to be short term occurrences, the clean-up costs are often reasonable (Zagaski 1992, p. 155).

However, legislation and spills have helped to alter the course of pollution liability insurance. The Oil Pollution Act of 1990, as stated above, has a more comprehensive definition of compensable damages. In addition to clean-up costs and natural resource damages, an owner/operator is responsible for damages to real or personal property, subsistence use, revenues, and profit and earning capacity. Furthermore, recent accidents have resulted in larger costs. The wreck of the Exxon Valdez in Prince William Sound, Alaska has already left responsible parties liable for well over one billion dollars in damages. With liability increasing, the insurance industry has seen an increase in both the magnitude of coverage and the number seeking coverage. 87% of ship owners and operators use insurance to demonstrate financial responsibility, and 62% hold their policies with London-based insurers (Zagaski 1992, p. 156). The U.S. Coast Guard statistics show that only about 15 vessels/year are stopped for not meeting liability requirements (Zagaski 1992, p. 157). Furthermore, since 1973, only two spills have occurred involving ships without proper coverage (Zagaski 1992, p. 157).

Pollution liability coverage is usually included with P&I cover, although in some cases it is excluded from the agreement and treated as a separate policy. Essentially, members then purchase pollution coverage by buying the coverage back into the P&I policy. According to
John B. Gallagher, vice-president of Frank B. Hall & Company, the American claims representatives for the Norwegian company, Assuranceforeningen Gard, the standard pollution policy is $500 million although some ships carry an additional $200 million (Wald 1990b, p. A19). The basic $500 million limit is obtained at considerable prices (Hayden 1991, p. 336). Premiums are based on the factors of risk, with a premium surcharge levied on vessels that transport “persistent oil” to the U.S. The surcharge was adapted because of the increased liability limits set by the Oil Pollution Act of 1990. If a declaration of the premium is not provided, an exclusion clause automatically applies. It is estimated that the industry, including special risk organizations discussed below, at the end of 1990, could capably deal with pollution risks of approximately $1.3 to 1.6 billion (Hayden 1991, p. 336).

The Tanker Owners' Voluntary Agreement Concerning Liability for Oil Pollution (TOVALOP) also protects against losses by assisting with the recovery of spill costs (Mankabady 1980, p. 163). This tanker industry agreement is limited to clean up costs and excludes third party claims (Hayden 1991, p. 335). Furthermore, the Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution (CRISTAL) aids in compensating third-party damage from pollution and covering clean-up costs. CRISTAL is not available to the majority of tanker owners but is intended to benefit cargo owners and the oil industry. The contract provides third-party compensation not received from tanker owners due to their successful limitation of liability (Hayden 1991, p. 335). All claims are paid by members subscriptions and the earnings from such (Mankabady 1980, p. 163). CRISTAL developed from tanker-owners' demand that the oil industry share in the pollution burden (Mankabady 1980, p. 163). With ever increasing pollution damage's claims and liability, the two agreements still only provide limited protection and financial compensation.
Comprehensive General Liability Insurance and the Pollution Exclusion Clause

The comprehensive general liability (CGL) policy was drafted by the Insurance Services Office, Inc. in 1940; primary users include many of the largest U.S. underwriters. Throughout its history, it has been continually redrafted and currently exists as the "commercial general liability program" (Hayden 1991, p. 339). The designation "comprehensive" only indicates that the policy does not contain automobile insurance. In fact, it can be wide ranging in extent, combining an array of established liability coverage into a single document (Hayden 1991, p. 339). The CGL traditionally makes use of extensive exclusion clauses. While not a form of marine insurance, the wide-reaching activities of corporations have led to the involvement of the CGL in litigation over maritime claims (Hayden 1991, p. 339). Many of the maritime disputes have been over the interpretation of exclusion clauses. While not directly involved in the litigation over maritime concerns, the pollution exclusion clause in most general liability contracts has proven to be ambiguous, and potentially instructive.

As Lathrop interprets it, "The 1970 pollution exclusion clause adopted by most American insurers bars coverage for damages attributable to the release of hazardous substances except when the release is 'sudden and accidental'," (1992, p. liv). The intent of the clause is to limit insurers' liability for intentional long-term damage from the willful misconduct of the insured. Insurers were in effect trying to eliminate their responsibility for normal damages. However, the interpretation on the term 'sudden and accidental' has resulted in a rash of litigation that at its extremes has swung in favor of either party, depending on the case. In some instances, it has been held that even if the discharge or release is intentional, coverage cannot be withheld if the pollution damages are unforeseen (Lathrop 1992, p. lv). The effect was that insurers were forced to pay claims on incidents not reflected in policy premium structure. Since 1985, insurers have clarified the clause resulting in an absolute pollution exclusion. Recent litigation pertaining to policies with the old exclusion clause has turned in favor of the insurers.
In 1989, a New Jersey judge ruled in favor of insurers against the Diamond Shamrock Chemicals Company. The court said they were not liable for the bill, possibly in excess of $20 million, that resulted from injuries from dioxin, a toxic byproduct of Agent Orange (Labaton 1989, p. D2). During the same year, Shell lost a major case resulting in their personal liability for the cost of injuries and clean-up from a site used to manufacture toxic pesticides. The cost could exceed $1.8 billion (Labaton 1989, p. D2).

The experience in the U.S. insurance market demonstrates the danger of including pollution coverage in a general liability policy. Pollution insurance is best maintained as a separate policy or well worded clause. The pollution exclusion clause, however ambiguous as it has been, could prove to be a useful model for exclusionary clauses in marine pollution liability contracts. Exclusionary clauses would serve a similar purpose in limiting insurers losses resulting from the negligent actions or willful misconduct of the insured. It also reveals the necessity of careful wording in defining the terms 'willful misconduct' and 'negligence'.

The Structure of the Industry

Marine insurance exists within the broader range of the general insurance market. It is often only part of a company's larger comprehensive insurance package. This inter-relationship, along with the complexity of marine insurance contracts themselves, often leads to maritime coverage disputes where the courts have difficulty assigning liability to a particular underwriter. Three issues require clarification. First, does an individual policy protect against the claim? Second, have the policies been layered with excess coverage? Finally, has the underwriter purchased reinsurance? The first issue is self explanatory, but a brief discussion of excess policies and reinsurance is necessary.

Excess policies exist between the assured and their original underwriter. They insure against a risk, usually under the same terms as the original policy, for an amount in excess of the initial coverage. According to the decision of Cargill, Inc. v. Commercial Union Ins. Co., excess
coverage goes into effect when the liability limit of the “primary coverage has been exhausted,” (889 F.2d 174, 179, 1990 AMC 434, 437). The issue becomes more complicated when primary and excess contracts are multi-layered with other policies, such as umbrella coverage.

On the other hand, reinsurance is a contract entered into between more than one underwriter. According to Hayden, “In essence, reinsurance is insurance purchased by the original underwriter from another underwriter,” (1991, p. 354). It is an effort to distribute the risks. Like P&I contracts, reinsurance is an indemnity contract (Hayden 1991, p. 355). The secondary underwriter is not constituted to pay part of an initial claim but to reimburse the primary underwriter after the claim has been settled. The practice of reinsurance has another benefit to underwriters. It enables them to issue policies in excess of their financial limits, in effect leveraging the firm.

As has been often stated, the multi-layers and different types of insurance cause numerous discrepancies. Three clauses are often enacted in contracts that enable the courts to reduce the confusion: Escape, excess, and pro rata (Hayden 1991, p. 356). An escape clause nullifies a policy to a loss when other coverage exists. An excess clause covers items outside of other policies (Hayden 1991, p. 357). Pro rata terms require two policies to share a portion of the loss, based on their limits of liability. The Doctrine of Mutual Repugnance, enacted by the courts, provides further clarification of the disputes. It declares that when two policies have enacted excess clauses, they will share the financial responsibility on a pro rata basis (Hayden 1991, p. 359).

Two Case Examples

It is useful to look at several cases where insurance became a complicated legal issue after a spill. This helps to present a better understanding of the intricate nature of marine insurance coverage and the difficulty courts have had interpreting policy wording. As an example of pollution coverage, the company Arco Marine typically carries $1.25 billion of
pollution liability insurance per ship, an amount far greater than the standard policy. Both the
*Mega Borg* and the *Braer*, which were involved in highly publicized accidents during the last
several years, carried $700 million in pollution liability insurance and provide excellent
examples of the discussed problem.

The *Mega Borg* is primarily owned by K.S. Mega Borg II but is managed by part-owner
A.S. Mosvolds Rederi (Wald 1990b, p. A19). Registered in its country of origin (Norway), its
$700 million of pollution insurance is through the company known as Gard of Arenda, Norway
(Wald 1990b, p. A19). Gard readily made the insurance available for cleanup and damage
claims at the time of the accident. The owners also carry approximately $20 million of insurance
on the ship (Wald 1990b, p. A19). In this case, the complication comes in the nature of the
pollution liability contract. Gard is a mutual insurance company, which means it is owned by the
investors that it insures. However, part of the pollution policy on the *Mega Borg* is owned by
other companies, which bought portions of the claim from Gard (a standard practice in the
marine insurance industry) (Wald 1990b, p. A19). The reinsurers consist of mutual maritime
insurance companies, as well as commercial insurance firms.

The wreck of the Liberian registered *Braer* off of the coast of the Shetland Islands
presents an interesting confusion in its own right when it comes to pollution liability. The facts
clearly show that the ship was owned by Bergval & Hudner Ship Management of Stanford,
Connecticut. The vessel is insured for $12.7 million of which $4 million of the insurance is with
Lloyd’s of London (Jenkins 1993a, p. 1). Its cargo, consisting of 26 million gallons of light
crude, was owned by Ultramar Corp. of Tarrytown, NY (Wells 1993d, p. A3). The cargo had an
estimated $11 million value, and Ultramar reported they had sufficient insurance to cover the
value of the cargo (Wells 1993d, p. A3). However, the confusion arises in who is held liable for
pollution damages. The New York Times reports that Bergval & Hudner had $700 million of
pollution liability insurance (Stevenson 1993a, p. A6). Michael Hudner, CEO of the firm, stated
that this money would be available for the cleanup and damages from the spill. The London
Times contradicted this stating that since under international agreements the polluter pays for damages, Ultramar is responsible for the bill having chartered the vessel from B&H (Jenkins 1993a, p. 1). Ultramar in turn carries $500 million in insurance through the Skuld Club in Oslo (Jenkins 1993a, p. 1).

These examples illustrate the difficulty in assigning responsibility for damages. In some cases, both cargo and tanker owners are potentially liable for third-party and pollution damages. Combined with the complex and inter-related nature of marine insurance policies, it becomes complicated to determine which policy covers the appropriate claims. In certain instances, more than one coverage may insure against a risk, such as, pollution or cargo liability. The result has been that in many cases the courts are left with the decision of assigning responsibility.

The Control Policy Framework: Focus on Insurance

The content of this thesis up until this point has been concerned with the theoretical means by which insurance can influence precautionary practices in the maritime transport of oil. The culmination was a model of the interrelationships among insurance, liability and legislation. Conclusions from that model have suggested ways in which insurance can promote increased safety standards, specifically in the use of care-based premiums and underwriting clauses. The rest of the thesis deals with the application of these principles and how they can be used to mitigate oil spills within the marine shipping industry. In doing so, I incorporate the preceding section, which discusses the details of the marine insurance industry. Specifically, I show how marine insurance can act to control oil spills, not only within the existing framework but also by serving as a catalyst for reforming the regulatory structure. The conclusion of this section discusses an application of the principles to a specific theoretical example.
Marine Insurance as a Control Policy

Abecassis relates that "Accidental pollution from tankers is caused by the incompetence of officers and crew manning them. This is exacerbated by very high traffic densities in some areas...." (1976, p. 26). Such a statement highlights the need for increased personnel standards, enforced routing systems and better hull and equipment standards. Premium incentives and contract provisions can have an effect in reducing pollution caused by the maritime transport of oil. On average, tanker owners, in attempts to cut costs in response to increasing economic pressures, are adhering to less stringent training and safety standards (Schmidt 1993d, p. A14).

A ship involved in a spill may be under capitalized and unable to financially meet their liability requirements. Financial responsibility, as defined by the Oil Pollution Act of 1990, confronts the under-capitalization problem by requiring that a ship's owner have the assets to cover the maximum costs they would be liable for in the case of an oil spill. Since Federal liability is limited by law to a maximum of $10,000,000, self-insurance provides an economic possibility to firms whose assets are large enough to cover these costs. For institutions with smaller capital assets, an accident might threaten the firm with bankruptcy. Thus, smaller operations have the financial incentive to purchase insurance if it were offered in order to minimize the direct liability of their capital assets. However, larger firms are often still faced with the unlimited liability imposed by states and still have many of the same incentives to purchase insurance in order to minimize the risk on their assets. Due to the simple fact that insurance spreads risks over time, most large firms still purchase some form of insurance.

I propose that for greatest effectiveness, the Oil Pollution Act of 1990 should be modified to define "gross negligence" and "willful misconduct" as they apply to oil pollution liability to include any ship not meeting certain outlined safety and construction standards or following established traffic routing and separation schemes. Then, in accordance with Sect. 1004 (c) of the Oil Pollution Act, any ship not exercising due care as it applies to the above proposals is excluded from any limitations on their liability and becomes responsible for all damages and
cleanup costs associated with an accident. In a situation of pure liability (i.e. without insurance), statutory regulations provide the incentive to abide by improved personnel, hull construction and routing standards when the economic risk of an accident outweighs the costs of improving standards.

Insurance adds an additional variable to the equation. 87% of all vessel owners and operators carry some form of third-party or mutual association insurance, even though larger firms have the financial freedom to self-insure if they so choose (Zagaski 1992, p. 156).\textsuperscript{29} Owners with less capital are required to purchase insurance to either meet financial responsibility requirements or at the very least protect the bulk of their assets. Insurance now plays the operative role in pollution prevention. It is an effective role in that marine insurance can limit oil pollution through the use of care-based premiums and underwriting clauses.

\textit{Premium Incentives}

The use of care-based premiums can effectively enforce stricter hull, equipment and construction standards, as well as tighter crew training. Both are relatively easy and cost-effective in that monitoring of both situations is a relatively simple task. A great deal of imperfect information is already available to the insurance industry. Organizations such as Lloyd’s Register maintain detailed information on all tankers. This provides immediate information when determining premiums on tanker construction standards. However, to ensure that the standards are maintained over time, periodic inspections are necessary. If carried out by the insurance industry or an independent third-party operator, the increased cost to the insurance industry will be transferred to the insured. Theoretically, as presented in Shavell’s model, this is still to the benefit of the insured as long as the increase in cost is compensated for by a greater decrease in premiums since the insurer faces lower claims. However, strict financial responsibility as defined by the Oil Pollution Act requires that most tankers possess insurance.

\textsuperscript{29} According to the U.S. General Accounting Office Report to Congress, January, 1988, only 11\% of vessel owners and operators rely on self-insurance (Zagaski 1992, p. 156).
The insured in this situation is still forced to willingly or unwillingly bear the increased costs. Premium incentives can be incorporated into virtually all forms of marine insurance contracts.

**Contract Provisions**

Underwriting clauses have the ability to impose insurance sanctions on tankers not meeting prescribed safety regulations. This forces tanker owners to weigh the costs of taking the safety precautions *versus the cost of taking fewer precautions* and facing full liability for all costs occurring from a probable accident. Their greatest effectiveness is in enforcing adherence to established routing systems and restricted areas where ex-post monitoring is necessary. However, they can also play a potential role in enforcing minimum crew and equipment standards. With legislation imposing unlimited liability on a tanker not in compliance with established minimum standards, the additional threat of having to pay all costs personally imposes an even more significant economic threat. This forces tanker owners and operators to adhere to stricter safety standards and eliminate cost cutting routes. The enforced standard must still be cost-effective. If the increased costs outweigh the additional risks, the shipowner will still not be inclined to take the extra precautions. The International Maritime Organization has documented the effectiveness of routing systems and areas to be avoided in reducing marine pollution. The United States Congress has initiated a further study in the same area (OPA, Sec. 4107). Contract provisions, enforcing crew and equipment standards, can be incorporated into hull or pollution liability contracts. Underwriting clauses, effecting IMO routing regulation, should be written into pollution liability contracts. Since pollution liability contracts are policies of indemnification, even the threat of unlimited liability alone is a tremendous risk to the insurer. The insured is still faced with the responsibility of covering the costs of all damages before being compensated by the P&I Club.
Hull, Equipment and Construction Standards

The design and construction of a tanker has been shown to affect the amount of oil lost at sea from both operational and accidental pollution (Abecassis 1976, p. 47). Segregated ballast tanks and slop tanks reduce the amounts of oil discarded during operational procedures, but moreover, along with double hulls, they can reduce losses in the event of an accident. In addition, improved equipment and maintenance standards can have a positive influence on reducing the risk of an accident occurring.

One ongoing argument concerns the necessity of double-hulls. Popular and government opinion in recent years supports their use. The argument for them is that the supertankers of today have an extremely low ratio of steel to oil which makes the ship highly vulnerable to gashing and rupturing in the result of a collision. The International Convention for the Prevention of Pollution from Ships, 1973 discussed the mandatory use of double skins or bottoms on ships (Timagenis 1980, p. 437). While the Convention did not set a precedent on the matter, the United States led the delegates supporting the use of double hulls (Timagenis 1980, p. 437). The United States OPA has lead the way by requiring all new tankers operating in U.S. waters to be equipped with double-hulls (Title IV, Subtitle A). The IMO has agreed with these precautions and also required all new tankers built after 1993 to have double-hulls (“The Wreck...” 1993, p. 49). It is amazing that while almost all of the world’s merchant fleet has double-hulls (Zagaski 1992, p. 145), only about 530 of the 3200 tankers in the world fleet are equipped with them (Zagaski 1992, p. 153). With increasing government legislation requiring their use, within approximately 20 years most ships will be equipped with double-hulls. My assumption is that few new ships are being built today that are not so equipped. The insurance industry’s greatest weapon lies in the use of significantly higher premiums on single-hull tankers, premiums which internalize the cost associated with the higher expected damages. These premiums can have a tremendous effect on getting older ships to refit with double-hulls. In this case, insurance can play a strong role in supporting the existing legislation. Insurance can also
be effective in supporting an alternative suggestion that single-hull tankers be required to use a tug in port areas (Sankovitch 1993, p. 43). A Norwegian registry has recently introduced an “Environmental Class”, which requires double-bottom hulls and various other safety features on ships (Sankovitch 1993, p. 20-1).

The Convention set a strong precedent on the use of segregated ballast tanks and oil retention systems. They found that prohibiting discharges is only effective if used in conjunction with design and construction improvements (Timagenis 1980, p. 430). The following legislation arose from the Convention. All tankers carrying in excess of 70,000 tons are required to maintain segregated ballast containers and two slop tanks (Timagenis 1980, p. 392). Tankers carrying over 150 tons gross must separate oil and ballast tanks but are not mandated to maintain segregated tanks (Timagenis 1980, p. 392-3). Furthermore, any ship over 400 tons gross when fitted must possess a slop tank, filtering equipment and a discharge monitoring system if carrying oil; new ships require systems enabling discharge to on-shore reception facilities (Timagenis 1980, p. 389). MARPOL also set requirements on separating ballast containers (Dowling, p. 6). The segregation of cargo and ballast tanks also serves to reduce potential loss in the case of an accident by reducing the percentage of the vessel containing oil or oily-water mixture (Timagenis 1980, p. 431). The effectiveness of slop systems depends on the availability of on-shore reception facilities, which unfortunately tanker insurance has little control over. Contract provisions can ensure the initial compliance with the 1973 and future standards. With industry sponsored inspections and the threat of sanctions, segregation can be monitored and maintained.

The shipping industry still needs to improve equipment and inspection standards to improve the safety of ships. The Marine Directorate suggests the use of better data displays to aid the crew in information assimilation and navigation (1991, p. 17). The IMO is calling for more rigorous and frequent inspections of ships (“The Wreck...” 1993, p. 49). In addition, the Paris Club of European Coastal Nations is considering mandatory inspections on all ships entering their ports (Prynn 1993b, p. 2). As an example for the need of inspections, corrosion
causes a ship to lose 2% of its steel per year (Cheit, p. 10). To detect this corrosion requires frequent and detailed inspections, because the corrosion can be sporadic and difficult to detect (Cheit, p. 10). Insurance can play a possible role in enforcing these inspections through the use of underwriting clauses. The industry can also encourage higher equipment standards, like design and construction standards, with risk-based premium incentives.

**Personnel Standards**

Officers and crew operating on board tankers must be sufficiently trained (Abecassis 1976, p. 41). The Marine Directorate has concluded that training needs to focus more on developing good judgment (1991, p. 25). Many accidents develop from incompetence due to a lack of practiced skill. Radar misinterpretation is still common, and fatigued crews are often blamed as the cause of human errors in shipping accidents (Marine 1991, p.17). As such, greater time at sea under experienced supervision is required (Marine 1991, p. 26), and sufficient crew sizes are necessary to ensure that people are not operating a ship under fatigued conditions. Furthermore, since pilots are ultimately responsible for the safety and navigation of their ship, greater oversight of their activities must be implemented (Sankovitch 1993, p. 43). Of the casualties which involved sufficient information to reach a judgment, 90% of all collisions and groundings and 75% of all contacts and explosions were found to be partly caused by human error (Marine 1991, p. 2). The groundings of the *Exxon Valdez*, *Torrey Canyon*, and *Amoco Cadiz* were all blamed on crew error (Cheit, p. 10).

Unfortunately, crew training and safety standards fall under the jurisdiction of a ship’s flag state (Abecassis 1976, p. 41). This logically leads to variations in standards. As stated by an analyst for a New York-based brokerage house, “If you’re a Greek, you can have a Panamanian registration and have Taiwanese or Indian crewmen, and your crew size can be substantially smaller. If you’re a U.S. corporation, it’s a lot trickier to have foreign registry and foreign crews,” (Wald 1990a, p. A27). The use of mixed crews is another issue of concern,
because in an emergency situation people have the tendency to revert to their native tongues (Jenkins 1993b, p. 2). This raises the issue of possibly enforcing stricter requirements on using English as an international language of shipping.

For the insurance industry to have effective control, internationally agreed upon standards of training must be set (Abecassis 1976, p. 44), either by the insurers themselves or through international treaties. One possibility is the use of the training standards outlined by the MARPOL convention. With such international agreements, the industry through the use of contractual provisions and sanctions have the tools necessary to enforce minimum crew training standards. Then through the use of risk-based premiums, higher crew standards can be encouraged. However, to maintain long-term influence increased inspections are necessary. The Directorate suggests on-board reporting independent of company personnel (Marine 1991, p. 24). In order to provide the necessary incentive to increase crew standards, the cost of inspections and additional training must be less than the reduction in premium received by the tanker owner.

**IMO Areas to Be Avoided and Routing Regulations**

The following of predetermined routes by mariners first originated in 1898 (IMCO30 1971, p. 4). Along with "areas to be avoided" recommendations, routing systems provide an interesting area of study. Their use and enforcement can have one of the strongest effects on the reduction of pollution at sea (Abecassis 1976, p. 37). "IMCO is recognized as the only international body responsible for establishing and recommending measures on an international level concerning routing and areas to be avoided by ships or certain classes of ships" (IMCO 1971, p. 6). Unfortunately, as a UN member IMCO only has the ability to recommend adherence and "invites" governments to enforce these regulations and restrictions (IMCO 1971, p. 5). To this extent, governments have only influenced their use as opposed to requiring it (Abecassis

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30 The International Maritime Organization (IMO) used to be called the Inter-Governmental Maritime Consultative Organization (IMCO).
Through the use of sanctions, the insurance industry has the ability to control strict adherence to IMCO principles.

Areas to be avoided are established due to insufficient aids to navigation or to prevent damage to wildlife of unacceptable consequences "which may result from a casualty" (IMCO 1971, p. 6). Tankers often use such areas as convenient or time saving measures. Although, the ability to cut time and distance off of a journey can save money and increase profits, this shortcut raises the likelihood of environmental disaster. Using IMCO statutory regulations to restrict areas, underwriters can enforce the ban by excluding any claims arising from accidents in these zones. The restriction immediately establishes fault on the wayward vessel. The economic cost of traveling in restricted regions becomes unacceptable for tanker and cargo owners. The criticism of this policy is that it focuses strictly as preventive insurance as opposed to compensatory. Sometimes such strict measures are required.

As an example, IMCO has established an area of a seven mile radius centered at 46°10'.0 N., 2°26'.0 W. on the Rochebonne Shelf to be avoided by "tankers carrying oil" because "local knowledge is considered essential for safe passage" (Figure 2) (IMCO 1971, p. 44). This area has been established to avoid the risk of pollution from an accident. The British Department of Trade mentions several areas such as Chichester and Langstone Harbor, Portsmouth Harbor, and Bembridge Ledges, Isle of Wight as fragile environmental zones providing important ecosystems for a diverse number of species (Tarpenbeck Incident 1971, p. 24-25).

"The increase in traffic density, combined with the use of ships of greater tonnage and higher speed, indicated that the wider application of the principle of traffic separation, whenever it warranted, could contribute substantially to safety at sea by reducing the number of ships meeting on opposite or nearly opposite courses and by providing an orderly flow of traffic" (IMCO 1971, p. 4). In fact, U.S. imports of oil are increasing since we have failed to implement conservation measures (Sankovitch 1993, p. 42). The State of Louisiana has estimated that tanker traffic in the Gulf of Mexico will double by the year 2007 (Sankovitch 1993, p. 42).
Figure 2 - Rochebonne Shelf

(IMCO 1971, p. 44)
IMCO has developed, adopted and applied extensive schemes throughout the world (IMCO 1971, p. 4). Five general principles were developed for the use of routing and separation schemes:

1. To be used in all ice free weather day and night;
2. To be used by all ships;
3. Shallow draught vessels should avoid deep draught lanes;
4. Ships not using lanes should avoid them;
5. Inshore zones are established for coastal traffic

(IMCO 1971, p. 10).

As far back as 1960, routing practices were recognized to reduce the risk of collisions between ships and with icebergs (Abecassis 1976, p. 37). With traffic lanes in use, navigation against established lanes exposes vessels to unreasonable risk (IMCO 1971, p. 5).

Although national governments are responsible for enforcing these routing practices, they have failed to do so. Here again, insurance sanctions have tremendous potential to enforce the usage of routing and traffic separation schemes. Fault is easily established with the ship traveling in opposition or disregard for appropriate schemes. Contract clauses inflicting sanctions on vessels involved in an accident while in disregard for a traffic scheme serve as strong preventive medicine. The economic risk becomes too high. Just as we would not drive on the wrong side of the road, it is necessary to establish lanes in high traffic waterways.

The Strait of Dover provides an excellent example of the need for and use of traffic schemes (Figure 3). The Institutes of Navigation of the UK, France and West Germany first conducted a study on traffic separation in the Strait in 1961 (IMCO 1971, p. 4). As of 1976, up to 300,000 ships per year passed through the Strait of Dover and as many as 20 in each direction at any one time (Abecassis 1976, p. 18). The need for routing and traffic separation is clear. IMCO separated the lanes by natural obstacles existing in the middle parts of the Strait (1971, p. 31). Northeast traffic is recommended to travel near the French coast, outside the inshore traffic zone, and travel in the opposite direction to proceed off the English coast (IMCO 1971, p. 31).
Blatant disregard for the schemes persist nonetheless (Abecassis 1976, p. 39). While the efficient outcome is clear, another means of enforcement is necessary to assure that outcome. Insurance can provide that means.

Figure 3 - The Strait of Dover

(IMCO 1971, p. 31)
Figure 4 - New York (IMCO 1971, p. 71)
New York - An Application of Marine Insurance as a Control Policy

This section attempts to illustrate how the principles discussed in the preceding sections can be applied to act as a method of pollution prevention. The purpose is to show that all of the recommendations are not necessarily applicable in every situation but that the means of control is still effective. I have chosen to use the area around New York Harbor as a case example. New York is one of the busiest ports in the world and sees a large volume of tanker traffic daily. The area known as New York Harbor begins roughly around Ambrose Light (Figure 4) and encompasses the ports around Manhattan, including Long Island, New Jersey and Staten Island. The larger ships, including the giant supertankers, take three principal approaches from the Atlantic - eastern, southeastern and southern. The eastern approach roughly follows the south shore of Long Island, and likewise the southern follows the east coast of New Jersey. The southeastern approach falls at roughly a 45° angle between the other two.

I am assuming, for the purpose of this example that four requirements or preferences have been deemed necessary or desirable for the safe transport of tankers to and from New York Harbor:32

1. All ships must have a pilot on board familiar with New York Harbor and who is accustomed to the heavy and congested traffic conditions;
2. All tankers must have double-sides, and double hulls are preferred;
3. A traffic separation scheme organized around the three primary approaches and centered at Ambrose Light has been established;33
4. It is preferred that tankers carry three more additional crew members than normal when operating in New York Harbor.

The advantages of an experienced pilot are fairly clear, and the first requirement seems self-explanatory. The use of double-sided ships can reduce the likelihood of oil spillage in the result of a collision. As such, the second requirement would be important in a heavily congested area

31 In Figure 4, Ambrose Light is off of Sandy Hook, NJ at the center of the dashed circle.
32 I am not making any claim that these are in fact correct assumptions, but rather they are only intended to serve as hypothetical examples. It may be the case that some are incorrect or unnecessary requirements.
33 This traffic scheme is not a hypothetical assumption, but has been recommended by the IMO.
such as New York Harbor where the risks of collision are much greater. As stated before, the use of traffic routing schemes has been found to greatly reduce the risk of a collision. The IMO recommends a traffic scheme for New York utilizing the three primary approaches to the harbor. Each approach is divided into two lanes of opposing traffic going to and from New York, with buoys separating the lanes. The scheme converges on Ambrose Light at the entrance to the harbor, which acts as a traffic terminal. The additional crew members are preferred in case of any emergencies that might arise due to the heavy traffic.

I have assumed that the OPA has redefined "gross negligence" as any ship not meeting established requirements when operating in the EEZ of the United States. In such a way, any ship not meeting the requirements for safe operation in New York Harbor faces unlimited liability in case of an accident. The third-party insurance companies, as an industry, see clear advantages in the use of a pilot familiar with local waters and conditions and agree that they will require this on any boat they insure as individual firms. They also recognize that traffic separation schemes reduce the risk of an accident occurring and as such, reduce their chances of having to make payments on a claim. The industry agrees to put an underwriting clause in all policies, which invalidates the policy when the insured ship, traveling to or from New York Harbor, is not acting in accordance with the established routing scheme. All insurers also see the advantages to double-hulls and more crew members, because they reduce the risk of an accident. They, naturally, decide to lower premiums for ships incorporating these advantages. It is over the required double-sides that the industry disagrees. I will assume the industry, for simplification sake, is composed of three firms. Since the industry is perfectly competitive, the three firms have identical premiums. 1 and 2 find that the risks of insuring a tanker in New York Harbor without double-sides, if faced with unlimited liability in the case of an accident, is too great. They incorporate sanctions into their policies on all tankers without double-sides operating around New York. Insurer 3, on the other hand, decides to continue insuring tankers without double-sides but adjusts his premium upward accordingly to reflect the greater risk of a large claim when faced with unlimited liability.
So far, I have looked at the hypothetical reactions of legislation and insurers when faced with this scenario. To complete the analysis, let us look at the reaction of the insured. The insured faces the greatest liability for pollution damages, and their principal concern is pollution liability insurance. Pollution liability insurance is often obtained through P&I clubs. Since these Clubs often spread their risks and reinsure with third-party insurers, they must necessarily enforce the requirements outlined by third-party insurers when offering pollution liability insurance.

For simplification purposes, I am dealing with a sample population of two ships, A and B. Tanker A is a large conglomerate that has enough assets to self-insure if it chooses and is registered in Great Britain. However, A under most conditions will not self-insure and prefers to spread the risks. Weighing the risk of facing unlimited liability of its own assets versus the cost of an experienced New York Harbor pilot, tanker A decides to stick with its policy and meet the pilot requirements. When deciding whether to put double-sides on the ship, A has three different options to consider. The first is self insuring and in the case of an accident, again facing unlimited liability and risking its assets. The second possibility is to construct double-sides and use an independent insurer. The shipowner is indifferent between insurers, in this case, because their premiums are equal. The final possibility for A is to insure with Agent 3 and operate without double-sides. The shipowner finds that independent insurance is an advantage in either case. He also determines that the decrease in premium for having double-sides is greater per year than the cost to build the double-sides. Tanker A also realizes that the additional cost of building a double-hull is less than the reduction in his premium that he will receive for having the second hull. As such, the owner of Tanker A chooses to update his ship with a double-hull. He also finds it cost effective to obey all routing schemes, based on the same argument for having an experienced pilot. Finally, the shipowner determines that the cost of three crew members, under British Shipping Law, is much greater than the reduction he would receive in his premium and chooses not to hire the additional crew.
Tanker B is Liberian registered and has limited assets. The shipowner must use independent insurance to meet financial responsibility requirements in the U.S. Since insurers require a harbor pilot, he is forced to bear the cost of an experienced pilot familiar with New York waters. The shipowner also finds that it is better to build the double-sides than use the insurer that does not require their use. However, since tanker B does not frequently enter New York Harbor, his premium reduction is less than the cost of building a double-hull and chooses not to do so. The threat of unlimited liability and no insurance places far too great a risk on Tanker B's assets, and it is, economically, in his best interest to obey the routing schemes. The cost of hiring three additional crew members under Liberian regulation is less than the reduction the shipowner would receive in his premium, and he chooses to hire the additional manpower.

Once again, I am not advocating these particular precautions or attempting to predict a shipowner's reactions to a particular situation. But rather, this application of the principles outlined in this thesis offers a theoretical scenario. It shows that insurance can be an effective means of regulation, in that the precautions taken by the insured and required by the insurer are undertaken out of their own economic best interest. Furthermore, their implementation does indeed improve safety standards. Finally, because all parties are acting in their best interest, insurance is a self-enforcing and cost-effective monitoring system.

**Conclusion**

The question originally posed in the introduction must be asked again. What role can marine insurance play in controlling pollution from marine oil spills? As an environmentalist, my temptation is to suggest that every precaution be taken to prevent marine oil pollution. As an economist however, I recognize this to be a potentially inefficient solution. Numerous safety measures that benefit society may not be cost-effective. These standards, which cannot be justified by the resulting magnitude of the reduction in claims, are not the domain of marine

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34 A shipowner's costs and benefits are influenced by numerous factors. To attempt to predict shipowners' reactions to implementing higher standards requires an analysis of great extent and is a thesis topic in itself.
insurance. Once again, I make no attempt to suggest the proper precautions or safety measures.

In many cases, this depends on each individual situation. Regardless though, a study of general cost-effective means would most certainly require another thesis of equal size. My attempt is to suggest a process by which the most knowledgeable parties have an incentive to institute all cost-justified precautions.

Insurance's means of control is through the use of underwriting clauses and risk-based premiums that promote cost-effective safety measures. These are the most efficient means of control, because insurers and tanker owners alike are acting in their own economic best-interest. In such a way, the precautions taken by shipowners will be highly effective in reducing pollution, because a tanker will only undertake measures that bring a reduction in premiums that outweigh their costs. Likewise, insurers will only find it beneficial to reduce premiums if the precaution significantly reduces their risk of pollution claims. These controls should be applied to improving safety in the areas of crew training, hull and equipment design and maintenance, and IMO routing schemes and areas to be avoided.

The role of insurance is clear, but where does it fit into the existing framework? There are three conditions where insurance can play a constructive role. The first is when it acts in conjunction with existing legislation. In this situation, insurance does not establish the standards but acts as an enforcement agent. Underwriting sanctions, which enforce safer conditions, are most effective when working in conjunction with Federal legislation. Routing schemes and areas to be avoided are excellent examples of how this method of control can be applied to reduce oil spills. When a national government requires compliance with a precaution, their greatest difficulty lies in enforcing those standards. By placing unlimited liability on tankers in these situations, the insurer who has underwritten a $700 million pollution liability policy faces far greater risks than under normal limited liability conditions. When a tanker is not in compliance with established regulations, an insurance company's costs rise. In such a way, they act as the enforcement. A tanker faced with unlimited liability and no insurance has the incentive to follow
established regulations even at an additional cost, as long as the risk reduction outweighs the costs. For example, let’s assume the government has established the channel between two islands off limits to tanker traffic because of a fragile ecosystem. The tanker ignores the regulations, because going around the island increases the costs of the journey by several thousand dollars. Furthermore, the Coast Guard presence is understated due to their limited resources. If the government regulation also says that the tanker faces unlimited liability, the insurer is forced to rethink the risk of paying out a large claim. They void coverage on all tanker traffic in this channel. With possible pollution damages amounting to billions of dollars, the tanker now finds it in his best interest to avoid the short-cut and circumvent the island.

The second condition is when insurance does not enforce federal standards of port states, but acts as catalyst to speed up the transition to the improved precautions. National legislation provides sufficient time for the transitions to occur. For example, the OPA allows some ships until the year 2015 to refit with double hulls. While I am not indicating that double-hulls are cost-effective, if they are insurance can quicken the process by offering premium incentives to ships with double-hulls. This encourages owners with single-hull ships to refit sooner. Finally, insurance can act in lieu of effective federal legislation and international agreements and as a transitionary measure until all port states pass adequate national legislation. In this role, insurance must act to establish and enforce the standards. Fortunately, many of the international agreements have outlined sufficient standards, but governments are simply failing to enforce them. The insurance industry can act as this international enforcement agency.

Does the current system approximate the ideal? If not, where is the system defective? Clearly we have not achieved the ideal situation. The most effective solution is for port states to establish undisputed standards for ships operating in their EEZ and leave insurance to the role of enforcing these standards. The U.S. has made significant gains toward achieving this Utopia and has come further than any other nation with the Oil Pollution Act of 1990. But we are not there yet. For insurance to be effective, “gross negligence” and “willful misconduct” must be clearly
defined to correspond with the provisions of insurance underwriting clauses. The insurance industry, acting in accordance with U.S. law, can threaten non-cooperating firms with unlimited liability and no insurance. For example, the U.S. government must agree upon routing schemes and areas to be avoided in U.S. waters. “Gross negligence” and “willful misconduct” should be defined to include any ship not in accordance with the outlined conditions. The insurance industry can now effectively use underwriting clauses to enforce compliance. Finally, the U.S. needs to incorporate all oil pollution legislation under one federal law that limits liability under most situations. States should not have their own rights to establish liability limits, as they do now. If tankers are always forced to face multiple jurisdictions and unlimited liability, the costs of operating in the United States will become too high, especially in terms of insurance premiums. The shipowners will simply refuse to transport oil to the U.S., which as we have seen has already begun to occur. This is not a viable option, since the U.S. is dependent on foreign imports of oil.

Foreign governments must take the first step by establishing comprehensive oil pollution legislation similar to the OPA. In the aftermath of the Braer disaster, Great Britain has come under fire for lacking this sort of legislation. This brings the thesis back to the question, I originally started with: Could the Braer spill have been prevented? And, if so, why wasn’t it?

The inquiry into the Braer accident is still far from over, and a definite cause has not been determined. Perhaps, in this case it was an accident that could not have been prevented. But one thing is definite, the Braer was a high risk ship that failed to meet many international standards, and many of the areas in which it was sub-standard could have been influenced by the marine insurance industry. For starters, the Braer was an old ship that sailed under a flag of convenience, both high risk categories. Furthermore, the crew did not share a common language; they were a mix of Polish, Filipino and Greek (Prynn 1993, p. 2). The International Transport Workers’ Federation did not issue the ship a “blue certificate”, because it did not meet minimum standards for crew conditions (Clancy 1993, p. 1). It is also believed that proper maintenance of
the fuel tank ventilators should have been sufficient to prevent seawater from entering the engine (“Wreck...” 1993, p. 15). An auxiliary generator to lower the anchor could have possibly prevented the ship from drifting into the rocks. Finally, many advocates feel tanker traffic should be restricted from this shipping lane South of the Shetland Islands because of the environmental sensitivity of the area and the severity of the winter storms. In conclusion, improved crew, equipment and maintenance standards would have improved the safety of the *Braer*, and enforced routing schemes would have prevented the *Braer* from traveling through this stormy channel. Marine insurance could provide a self-enforcing means of implementing these higher levels of precaution.

Long strides have been made toward eliminating marine oil pollution, but the remaining journey is still a long one. Fortunately, nature has an incredible healing power. The same storm that caused the *Braer* spill also ultimately helped clean it up. The oil was effectively dispersed, and it evaporated into the atmosphere. Even the following day, after the *Braer* broke apart, brown oily seas were replaced with a crystal blue ocean, and the air lost the tinge of oil. The Shetland Islands were fortunate and lucky, but the problem is not yet solved. Should we mistakenly think so, just ask the people of Valdez, Alaska. They will tell you otherwise.
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