POSSIBILITIES AND PROBLEMS OF PREVENTING OIL POLLUTION OF THE OCEANS

LAWSON A.W. HUNTER*

INTRODUCTION

Since the industrial revolution, pollution of the oceans has continued at an ever increasing rate. But, the size of the oceans means it is difficult to understand what effects pollution is having on nature's delicate balancing mechanisms. The result has been that parties advocating particular ocean management policies tend to issue emotional, rather than objective statements of views. This has been true with the problem of oil pollution of oceans. In this article we will attempt to present an alternate method of assessing a particular policy for controlling oil pollution. The policy or objective we will discuss is the prevention of oil pollution. Since we will concern ourselves only with prevention of oil pollution, there are necessary limitations on the scope of the discussion. For example, there will be no consideration of cleanup measures, their effectiveness or shortcomings. Similarly, the problem of liability for pollution will not be considered. In a more general sense, the distribution of the costs of pollution will also lie outside the scope of the discussion.

This article will deal only with the specific problem of oil pollution arising from the shipping industry. This encompasses spills from oil tankers normal ship operations, and harbour and dock handling of tankers and other vessels.

Cost Effectiveness

The costs of oil pollution fall into three main categories. First there are economic costs. Such costs would arise from the loss of a valuable commodity, i.e. petroleum products. There is the cost of the total loss or damage of tankers or ships due to collisions or strandings. There is also the cost of clean-up operations and the research and administrative work necessary for effective remedial action. Commercial fisheries and the resort or tourist industry may also suffer an economic loss. A second category is the ecological or biological cost. This may include harm to marine organisms with resultant effects on commercial fisheries that in the final analysis may adversely effect human life where the contamination works

* B.Sc. University of New Brunswick, Frederiction, N.B., (1967); LL.B. University of New Brunswick (1970); LL.M. Harvard Law School (1970). Presently a post-doctoral fellow in the Marine Policy Program, Woods Hole Oceanographic Institution.

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

upward through the food chain. The third category is the aesthetic cost made manifest in the loss of a pleasant environment due to unsightly beaches. [And, it should be added, there may be an economic loss to resort areas.]

The economic costs can be dealt with more easily than the ecological or aesthetic costs. Economic losses can be distributed throughout an entire enterprise over a period of time through such devices as insurance and compensation funds. Economic costs are easily analyzed by the use of cost effectiveness models and in that way can determine a proper course of action to combat oil pollution. If the costs of preventive measures within the same distributive and time parameters are less than the costs resulting from not taking such action, then rationality indicates that preventive measures are the least costly and most beneficial approach. This would be true regardless of the weight given in the analysis to the ecological and aesthetic costs of oil pollution.

The ecological and aesthetic costs are much harder to deal with because of their unquantifiable nature. These costs relate to the preservation of an enjoyable environment for man's existence and well-being. They may in the long run affect the very existence of man either collectively or individually. If their occurence is highly probable to a degree requiring action then such costs must be given very great weight. At some point these costs may outweigh the economic costs.

To attribute a cost to the ecological effects on marine life, water, food and possibly mankind is by far the most difficult task. Short term ecological effects are easier to deal with them long term effects because they are usually reflected in economic costs, for instance, loss of income to commercial fishermen or lost revenue in a resort area. But how do you attribute a cost to long term effects? The first step is the delineation of the possible long term hazards. This is where the scientists, marine biologists and chemists come into the picture. It is on the basis of their research and expertise that the decision as to the weight such hazards receive in the analysis must be made. The decision here is essentially political.

The foregoing discussion is a consideration of some of the inputs and variables that would go into an analysis of what course to follow in dealing with oil pollution of the oceans. It assumes that there are only two possible responses to the problem: (1) preventive action and (2) remedial action. This assumption eliminates the possibility of taking no action. It is submitted that this is reasonable in the present political setting where there is obvious concern over the problem of oil pollution. It is not assumed, however, that the course of action decided upon must be wholly preventive or wholly remedial. The two may interact. If remedial action is deemed to be the primary purpose, the remedial measures decided upon may be, in fact, preventive measures. This merely shows that remedial actions may have a preventive purpose or that the remedial purpose can utilize preventive measures. Also, if preventive action is determined to be the primary concern, remedial action will still be necessary for preventive measures have as their purpose the minimization of pollution. Total abatement is very unlikely. This factor may mean that the only important question to be answered is whether the costs of oil pollution of the oceans are high enough to necessitate a course of action whichis primarily preventive.

It is not possible presently to decide whether prevention should be the primary objective in dealing with oil pollution. But because of the importance of this question, the rest of the paper will emphasize the problems related to prevention of oil pollution. The costs of oil pollution of the oceans will be considered in more specific terms. This will be particularly true of the economic costs and the ecological, long term costs. Very little can be said about the aesthetic costs which would be beneficial. The result of this discussion will not be to decide whether prevention should be the primary objective, but only to clarify some of the factors to be considered. The economic costs will be essentially post-pollution costs. The ecological costs will deal with possible outcomes or results of continued oil pollution in the long term as determined by scientific research.

Economic Costs

It is possible that the results of a cost effectiveness analysis of the strictly economic, calculable costs of oil spills would show that preventive action resulted in a marginal benefit overall. In effect such an analysis would not take into account any costs attributable to aesthetic or ecological losses other than those directly resulting in an economic loss from a particular pollution incident. Examples of such losses would be drops in fishing revenues or decline in tourist trade. Such an analysis should take into account all of the economic costs of the particular system being analyzed. These costs fall in three categories.

(1) Government costs resulting from clean-up operations, rehabilitation, compensation shemes, research and administrative expenses. (2) The costs to ship owners and operators and cargo owners such as insurance premiums, ship repairs and replacement, cargo loss and liability to governments or private individuals. (3) The costs to private individuals such as fishermen, waterfront property owners and the owners of resort and commercial establishments.

At the present time the domestic legislation of most nations results in

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

the costs of oil spills falling, at least partially, into all three categories.[1] However, as international agreement is reached on the liability question[2] and as more nations adopt comprehensive and sophisticated legislation to handle the distribution of costs of oil pollution, the burden of these costs will probably shift toward the owners and operators to the virtual exclusion of private individuals and government costs.[3] How the costs of oil pollution are to be distributed is a complex political question. Regardless of the distribution scheme adopted, *all* the internal costs must be considered in an economic cost-benefit analysis and not just those absorbed by the owners and operators of ships and their cargoes.

Returning to the consideration of a purely economic cost effectiveness

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1. The Cost of the governments of France and England in cleaning up the "Torrey Canyon" spill have been estimated at $15 million. See letter from Russel E. Train, Under-Secretary of the Interior, in *Hearings on H.R. 4148, 91st Cong., Before the House Comm. on Public Works.* 316 (1969). This figure did not include losses to private individuals in the area of the spill which by some reports have reached the astronomical figure of $2 billion. J.O. Ludwigson, *Oil Pollution at Sea,* in *Oil Pollution: Problems and Policies,* 4 (Stanley E. Degler ed. 1969). Eventually the governments of England and France settled with the owners and insurers of the "Torrey Canyon" for $7.2 million, substantially less than the costs incurred. A. Stratton and W.E. Silver, *Operational Research and Cost Benefit Analysis on Navigation with Particular Reference to Marine Accidents,* 23 J. of Inst. of Navigation 325, 330 (1970).

2. See the *Final Act of the International Legal Conference on Marine Pollution Damage,* (1969) with the two conventions attached, 9 Int'l Legal Materials 1-64 (1970).

3. An example of this is the latest Canadian legislation in the area. Bill C-2, An Act to amend the Canada Shipping Act, Oct. 19, 1970 (first reading), Third Session, 28th Parl., 19 Eliz. II, (1970). Under this legislation the owner of the ship and the owner of the pollutant are jointly and severally liable (c) for the costs and expenses of and incidental to the taking of any action authorized by the Governor in Council to repair or remedy any condition that results from the discharge of a pollutant in waters to which this Part applies that is caused by or is otherwise attributable to that ship, or to reduce or mitigate any damage to or destruction of life or property that results from or may reasonably be expected to result from such discharge, to the extent that such costs and expenses can be established to have been reasonably incurred in the circumstances, See Appendix, page 73. (d) for all actual loss or damage incurred by Her Majesty in right of Canada or a province or any other person resulting from the discharge of a pollutant into waters to which this Part applies that is caused by or is otherwise attributable to that ship. See Appendix, page 73. The owner of the ship and its cargo are also liable for any action taken "to destroy or remove a ship or to destroy or remove the cargo or other material on board a ship . . . to the extent that such costs and expenses can be established to have been reasonably incurred in the circumstances . . ." Bill C-2, S. 743(2).

In addition the legislation establishes a fund to be used to compensate fishermen for loss of income due to the discharge of a pollutant. The fund can also be used to allow recovery of claims above the maximum amount directly recoverable from each separate incident. The income of the fund is basically a tax of up to 15¢ on every ton of oil imported to or exported from Canada. Bill C-2, S-757.

analysis, it should be noted that such an analysis can be categorized into different systems. Each system would be subjected to operational research techniques of its internal operation and the external costs of other systems would be excluded. For example an analysis of the costs of preventive measures whose aim was the elimination of operational pollution. Another possible model would separate the oil tanker trade from the rest of the shipping business for the purpose of analysis.

This is not to say that oil pollution of the oceans arising from tanker and ship operations cannot be viewed as a single system.[4] It can and for reasons cited below probably should be if a realistic picture is to be drawn.

For the moment let us assume that we are going to separate problems of accidents[5] from those of operation[6] for the purpose of cost-benefit analysis. It seems likely that the results of an analysis of an accidental problem would more likely show the marginal utility of implementing preventive measures to curtail such catastrophes than would an analysis of an operational problem. The direct expenses and costs of accidents are much greater than those associated with operational problems.[7] The legal mechanisms for making this type of polluter liable are also more sophisticated.[8] It is possible that preventive measures to control operational pollution would also show a marginal economic return. In fact this is the situation with the Load-on-Top technique of tank cleaning and ballasting where the oil companies have found that the value of the oil they recover and utilize through the use of this technique is greater than the cost

4. H. Raiffa, *Decision Analysis*, 295-297 (1968); also Stratton and Silver, supra note 1, at 327.

5. Accidental problems would result from collisions, strandings, groundings, explosions or any other case where extensive damage was done to a vessel with the result that a major oil spill occurred in a fairly localized area.

6. Operational problems could be chronic pollution resulting from the normal operation of the ship eg. discharge of oily ballast water or bilge. They would also arise from spills resulting from onshore facilities for the handling and storage of oil and its transfer to and from ships. These two types of operational problems could be analyzed separately as well.

7. Costs resulting from catastrophes such as the "Torrey Canyon" fall into all three of the cost categories outlined above, i.e. governmental, owner-operator and private individuals.

8. Many of the legal problems confronted when trying to recover from those responsible for chronic operational pollution are not present when an accidental problem occurs. There is no difficulty in establishing or locating the parties responsible. Accidents are more likely to occur in national waters where domestic legislation can establish liability and the means of enforcement of judgments is more effective than in an international jurisdiction. Operational spills are likely to occur anywhere in the ocean. There is also the added problem of establishing the identity of the polluter. Tracing and tagging systems and techniques are being developed to overcome this problem.

involved in recovering it.[9]

The fact that a purely economic or internal cost benefit analysis would less likely show the desirability of preventive action to control operational pollution illustrates the weaknesses of such a narrow analysis. The total amount of oil pollution from chronic operational spills is much greater than that from accidental spills.[10] The long term effects of operational pollution may be much more serious than those from accidental spills also. The result may be that the main purpose of such systems analysis or cost-benefit analysis is to prove to the ship and cargo owners and operators that it would be better to prevent pollution from their own self-interest.

There is no doubt that if sufficient reliable data were available a cost effectiveness analysis could be used to determine whether on purely economic costs it would be worthwhile to implement preventive measures to control or eliminate oil pollution.[11] It could be used to test the utility of particular isolated preventive techniques such as improved navigational aids or new training programs. It can only be used, however, if there is accurate data. This necessity has led one group of experts to conclude that "this problem is not susceptible to precise cost-benefit analysis."[12]

Several types of data would be required. There would be the cost of implementation and regulation of preventive action that would include equipment and administrative costs. There also would be the costs related to spillage as damage to ships, insurance premiums, clean-up costs, and private liability actions. For proper data input one would have to know the effectiveness of the preventive measures and be able to generalize

9. K.G. Brummage, *The Consequence of Load-on-Top in Petroleum Refining*, in Proceedings of Int'l Conference of Oil Pollution of the Sea, Rome, 183 (1968); W.M. Kluss, *Prevention of Sea Pollution in Normal Tanker Operations*, presented at Summer meeting, Institute of Petroleum, Brighton, (1968).

10. M. Blumer, *Scientific Aspects of the Oil Spill Problem*, presented to the oil spills conference of the NATO Committee on the Challenges of Modern Society, Brussels, (1970).

11. Stratton and Silver, supra note 1, at 325; R.I. Price, *Anti-Pollution Measures—IMCO Subcommittee on Ship Design and Equipment*, 8 Marine Technology, 1, 7 (January, 1971).

12. Secretaries of Interior and Transportation, A Report to the President on Pollution of the Nation's Waters by Oil and Other Hazardous Substances (1968) [hereinafter cited as President's Report]; where the report says: It is reasonable to seek a comparison between the costs of preventive measures on the one hand and the costs associated with cleanup and damages on the other. If such a comparison were possible, it would permit us to distinguish on a quantitative economic basis between those preventive measures which warrant investment and those which do not. As with so many other pollution or safety problems whose occurrence is unpredictable, whose location cannot be pre-determined, and whose magnitude can vary markedly, the conclusion that must be reached is that this problem is not susceptible to precise cost-benefit analysis.

pollution costs over a given time period. This would involve not only arriving at a figure of how much it would cost to clean up spills of various sizes[13] but also estimating the number and size of spills likely to occur during the experimental time period. It would be necessary to estimate damage to ships, changes in insurance premiums, likely civil damage liability and many other cost factors. The uncertainty of this information would decrese the reliability of the outcome. But over a period of time if proper data banks were established, trends and stabilized norms should begin to appear which lessen the uncertainties. The United States Coast Guard is collecting much of the necessary information presently.[14] A cooperative effort should be made by all involved parties to insure that all the relevant information is available.

Even if sufficient reliable information is not available to ensure a reliable outcome to its application to the entire shipping and tanker business, the systematic collection of any information and its application to a realistic model would be a valuable addition to our knowledge and insights of the problem of oil pollution of the oceans.

Ecological Costs

One of the most difficult aspects of the oil pollution problem is the long term econological effects of continued pollution. Not only are the biological effects of oil pollution uncertain, but it is very difficult to quantify those possible effects in concrete economic terms. Yet these effects cannot be ignored.

> . . . the objective of heightened sensitivity in technology assessment should, whenever possible, be achieved by structuring the incentives of individual decision makers so that they are induced to alter their

13. There is already a dispute whether clean-up costs can be reduced to a unit cost/gallon or cost/ton figure. The U.S. Dept. of the Interior has stated that the cost of cleanup of oil spills is in the vicinity of $1.00/gallon of oil spilled. They recognize, however, that very small spills may have a disportionately high cleanup cost. *Hearings before the Subcomm. on Air and Water Pollution*, 91st Cong., Senate Public Works Comm., 1012 (1969).

In a letter to Senator Edmund S. Muskie dated May 19, 1969, the American Petroleum Institute stated: From the amounts of oil spilled and the clean-up costs reported, it is clear that the size of the spill is not the dominant factor in determining cleanup costs. More important are the location of the spill and the type of oil involved. If beaches and boats must be cleaned, the cost will be much higher than if oil can be quickly contained and removed from the water. Moreover lighter products, such as gasoline, are less costly to cleanup than crude oil or No. 6 fuel oil.

14. Price, supra note 11, at 7.

15. Private parties such as insurance companies, oil companies and tanker operators must all cooperate if realistic information is to be obtained.

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

cost-benefit calculations to encompass wider concerns than have heretofore been given consideration.[16]

The biological costs may result in:[17] (1) long term damage to coastal and inter-itdal zones where the great bulk of pollution occurs and (2) long term consequences to the marine environment and possible human life and health due to chronic pollution of the open ocean.

Coastal Pollution—Spillage near land in shallow water constitutes the bulk of pollution arising from accidental spills since these spills usually result from strandings or collisions. A considerable amount of coastal pollution also results from terminal handling spills during loading and unloading in port.[18]

Extensive research has been done on the biological consequences of pollution in this region. The results are anything but consistent. In some cases the effects have been disastrous, with immediate and persistent mortality of most animal and organic life.[19]

The best researched example of a spill causing such disastrous consequences is The West Falmouth spill in September, 1969.[20] The studies[21] of this spill have shown an almost complete mortality of all living organisms in the area. The oil also penetrated the sediment up to 40 feet below the surface and spread through the sediment from an initial area of 500 acres to over 5,000 acres. There was a resultant mortality of bottom life as the oil spread throughout the sediment. Studies have also shown that the oil picked up by oysters, scallops and clams was stored in the lipids areas of these organisms. This oil was not discharged from oysters up to nine months after they had been removed to clean water.[22] Mussels which

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16. Technology: Process of Assessment and Choice, Report of the National Academy of Sciences of the Comm. on Science and Astronautics. House of Rep., 55 (1969).

17. We will not discuss such costs as reductions in Commercial fishing revenue since such costs are part of the total economic costs of oil pollution.

18. Pollution in the coastal regions also arises from oil reaching the ocean but having originally been deposited on land or in watercourses.

19. For example, the wreck of the "Tampico" in Baja, California, Mexico in 1957 caused "a completely natural area [to be] almost totally destroyed suddenly on a large scale . . ." W.J. North, *"Tampico," a Study of Destruction and Restoration*, 13 Sea Frontiers, 212-217 (1967). Similar results were seen in a spill of 4,000 barrels of No. 2 fuel oil into Great Bay, N.H. in 1969. Thomas A. Murphy, *Environmental Effects of Oil Pollution*, presented to session on Oil Pollution Control, American Society of Civil Engineers, Boston, 13 (1970).

20. On September 16, 1969 a barge spilled 4,000 barrels of No. 2 fuel oil into Buzzards Bay, West Falmouth, Massachusetts.

21. See generally Murphy, supra note 19; Blumer, supra note 10; M. Blumer, J. Sass, G. Souza, H. Sanders, F. Grassle and G. Hampson, *The West Falmouth Oil Spill*, Woods Hole Oceanographic Institution, Ref. No. 70-44, (1970) [unpublished manuscript].

22. M. Blumer, G. Souza and J. Sass, *Hydrocarbon Pollution of Edible Shellfish by an Oil Spill*, Woods Hole Oceanorgarphic Institution, Ref. No. 70-1, (1970) [unpublished manuscript].

appeared unharmed by the spill failed to reproduce. The killing of plant life may have resulted in erosion and have caused the spreading of trapped oil.

These results are very disturbing both in the short run and the long run. The difficulty is, however, that not all coastal spills have shown the same results. The effects of the "Torrey Canyon" and "Arrow" catastrophes have not been nearly so pronounced.[23] How can this inconsistency be explained?

No two spills will ever occur under exactly the same set of circumstances. Until we have a body of knowledge about all the different factors that determine the consequences of a spill, it will be impossible to attach standard results to coastal spills.

Several factors determine the ecological effects of oil spills in coastal regions. First, the type of oil spilled is very important. At West Falmouth the oil was #2 fuel oil. This oil consisted of 41 percent aromatic fractions which are known to be very toxic.[24] Both the "Torrey Canyon" and "Arrow" spills involved crude oil.[25] This may explain the lower degree of mortality in these spills. An offsetting factor is that crude oil has a greater smothering effect than #2 fuel oil which tends to evaporate. The general point is that the type of oil spilled greatly determines the results.

Environmental and climatic conditions also affect the results. If the spill is in a closed area, the results will be more pronounced. The same is true in an open area if the wind is onshore preventing the slick from dispersing at sea.[26] Another factor is the roughness of the sea. High seas churn up the oil, emulsifying it and spreading it throughout the water column where it is retained for long periods of time.[27] The condition of the sea may also have a bearing on how much oil is deposited in the sediment. Another factor determining the degree of sedimentation of oil is the amount of silt, sand and other suspended particles in the water contaminated by the oil.[28] After oil is incorporated in the sediment its persistence will depend on the degree of biodedgradation which takes place.[29] Whether it will spread throughout the sediment depends on the

23. J. Smith, The Torrey Canyon Pollution and Marine Life Report, Plymouth Laboratory of the Marine Biological Association of the United Kingdom, (1970); Task Force-Operation Oil. Volume II, (Clean-up of the Arrow oil spill in Chedabucto Bay, Nova Scotia, Canada) (1970).

24. Blumer, Sass, Souza et al, supra note 21, 1.

25. Crude oil contains all the fraction which No. 2 fuel oil contains but in much lower concentrations per unit volume.

26. Murphy, supra note 19, 10.

27. Id., 10-11.

28. Id., 13.

29. Id., 15.

patterns of currents and sand movement in the particular area affected. Another very important factor is the water and air temperature at and immediately after the time of the spill. Oil, particularly crude oil becomes very viscous, almost solid at low temperatures.[30] It thus is not easily emulsified.[31] But it also may not be susceptible to biodegreadation which may be very important in extremely cold areas such as the Arctic or Antarctic.[32] Thus the entire behavior of oil, including its distribution in the water and bottom sediments may be greatly affected by air and water temperature.[33]

It is obvious that the biological results of coastal pollution depend largely on the particular circumstances of the spill. With more comprehensive research it will be possible to predict the results and have a sound basis for predicting the seriousness of this type of oil spill.

Open Ocean—Pollution in the open ocean is primarily the result of operational pollution such as tank cleaning or bilge pumping. It also results from the dispersion of oil from coastal pollution.[34]

To date very little research has been done on the consequences of chronic oil pollution in the open ocean. It is evident that the quantity of oil in the open ocean has reached the level where it is at least troublesome.[35] But is it possible that its effects may be much more profound and serious? The world's oceans cover seventy percent of the surface of our planet and consquently play a vital part in the ecological systems necessary for the maintenance of life on earth.[36] The massive introduction of foreign substances into the ocean may upset the delicate balance of nature's complicated systems. This is particularly true in the deeper parts of the ocean. These environments are relatively stress free. The disturbance of these environments may have grave, unpredictable consequences

30. This may account for the relatively minor biological damage in the aftermath of the "Arrow" case. In the month following the "arrow" grounding the daily minimum temperature ranged from 0-30°F. Task Force-Operation Oil, supra note 23, 5-6.

31. Id., 29.

32. Id., 80; see also Hugh Boyd, *Oil Poses Urgent Problems in Canada*, Marine Pollution Bulletin, 69 (May, 1970).

33. Temperature also effects the techniques available for clean-up. For example, mechanical collection by skimmers is by far the most efficient means of collecting semi-solidified oil; see gnerally, Task Force—Operation Oil, supra note 23.

34. In the "Arrow" case within a few days of the spill the oil contaminated the beaches of Sable Island which lies more than 100 miles southeast of Chedabucto Bay. Task Force—Operation Oil, supra note 23, 28.

35. Tar balls are present all across the Atlantic Ocean and throughout the Mediterranean. The beaches of Bermuda are so polluted that swimming is very unpleasant at best.

36. Well over one-half of all the oxygen in the earth's atmosphere is manufactured by oceanic phytoplankton. The resources of the potential sources of material for human society.

which could send shock waves along the entire hierarchical structure of the marine environment. Because these environments are relatively benign disturbances of minor proportions might be sufficient to set off a chain reaction. With the continued massive introduction of hydrocarbons into the open ocean it is inevitable that they will penetrate to the greatest depths of the ocean.

The serious effect oil can have in coastal regions has already been discussed. Yet coastal environments are by far the hardiest of all marine environments. The organisms that live in these regions have developed great tolerances to stress over the centuries. Granted, the concentrations of pollutant that have greatly affected coastal regions are much higher than could be expected to occur in the depths of the ocean. But this factor has to be discounted by the greater tolerance levels of the marine life in shallow water areas.

The ocean is a closed biological system; inputs of any kind, if great enough, will affect the whole system. It is very likely that the quantities of oil presently being pumped into the oceans is large enough to effect the system. Some possible effects have been discussed. For example, certain organic compounds marine organisms. "Such chemical attraction—and in a similar way repulsion—plays a role in the finding of food, the escape of predators, in homing of many commercially important species of fishes, in the swection of habitats and in sex attraction."[37] Concentrations below one part per billion may trigger a response.[38] Pollution may interfere with these processes by blocking the receptor or by triggering false responses.[39]

Another potential problem results from the known link between oil and cancer.[40] The higher boiling crude oil fractions contain carcinogenic inducing compounds. If marine organisms retain sublethal amounts of these compounds in their tissues, they may be passed up the food chain and eventually become part of the human diet.[41] Contaminated beaches pose an additional threat through skin exposure to the carcinogens.

37. Blumer, supra note 10, 6.
38. Id.
39. Id.
40. Id., 4-5.
41. The scientific community is in dispute over the possible dangers of cancer inducng hydrocarbons. One commentator feels that the levels of these compounds likely to end up in the human diet through the marine food chain is less than man is commonly exposed to in the atmosphere. However, this does not deny the fact that carcinogens in the environment should be kept at as low levels as possible. A.E. Martin, *Water Pollution by Oil—Some Health Considerations*, Presented at Avienmone Symposium on Oil Pollution, Institute of Petroleum, (May 1970).

Sublethal amounts of oil, if incorporated into organisms, can result in reduced resistance to infection and the eventual death of the organism.[42]

The lack of adequate research on the potential consequences of chronic oil pollution, particularly in the open ocean, makes it impossible to determine the seriousness of the problem. This in turn makes it very difficult to assign a weight to these consequences in a cost effectiveness analysis of the problem of oil pollution. This difficulty should not mean a discounting of these possible consequences, however.

> . . .[O]ne has only to consider how long DDT was in use before untoward consequences were observed, or how difficult it has been to establish with any degree of certainty a causal relationship between cigarette smoking and lung cancer, to realize that direct evidence of the public health hazards of marine pollution may not be forth coming for a very long time. It is all the more important in these circumstances that any suggestive evidence should be treated seriously so that it can be confirmed or dismissed. It would be the height of irresponsibility to ignore the whole problem simply because existing evidence is vague and inconclusive.[43]

There are two underlying assumptions of the discussion to this point: (1) The technology of oil pollution now makes it possible to reduce and control oil pollution caused by the shipping industry through the introduction of preventive measures. (2) It is politically realistic to speak of implementing effective preventive measures and enforcing their use.

Preventive Technology

As a starting point it is important to understand the scope and meaning of "technology" or "techniques" as words of art. The concept these words express is broader and more abstract than to mean simply machines or science and engineering. In a technological society technique has been defined as "the totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity."[44] This definition of technique encompasses not only scientific and engineering methods but also procedural and organizational methods. These two methodological approaches (scientific and procedural) may work complementary roles in a particular technology. Or they may be

42. Blumer, supra note 10, 12; see also Arthur Bourne, *The Sea Bird Wreck*, 44 New Scientist 292, (Nov. 1969).

43. *Public Health and Pollution*, Marine Pollution Bulletin, 97 (July, 1970).

44. Jacques Ellul, The Technological Society, XXV (1964).

separated at least in the sense that the difficulties in reaching "absolute efficiency" arise almost exclusively from one side. For example, engineering may have produced fool-proof navigational aids but until they are implemented through organizational techniques they remain virtually useless. So, in discussing the use of such navigational aids as part of preventive technology, the technique is completed only through organizational efforts.

It is important to clarify another matter at this point. The discussion of preventive technology in this section will deal only with the scientific and organizational aspects of preventive measures where each is viewed as a closed, independent subsystem. Thus, for example, it will deal only with the internal organizational aspects of establishing an effective navigation system. Such matters could be the coordination of ship-shore facilities, the hierarchy of authority and responsibility among personnel within the system or maintenance and inspection schemes to ensure maximum reliability of the equipment. It will not be concerned with the external political problems encountered in adopting the system, whether they arise privately within an oil company, nationally when a legislature contemplates regulatory legislation, or internationally through conventions on international safety or pollution.

Given the definition of "technique", the exclusion of external political problems does not seem warranted. Such problems obviously play a very important role in the broad development of preventive technology. Since they will be discussed in a later section of the paper, it was decided to exclude them at this point.

The impetus for research into preventive technology of oil pollution from maritime transportation arose primarily in the aftermath of the "Torrey Canyon" disaster[44] in 1967. For the first time many nations saw the consequences of an oil-based technology. National and international interests presented proposals for checking on pollution including feasibility studies.[45] Although research is still continuing, it is now possible to consider the results of some of the work done, on a theoretical and, in some cases, a practical basis.

45. The "Torrey Canyon" went aground off the southwest coast of England on March 18, 1967 releasing over 100,000 tons of Kuwait crude oil into the ocean. See generally Zulu Seawork Capabilities Reports, Oil Spill, D-1-D-17. (1968).

46. A Special Session of the Council of the Inter-Governmental Maritime Consultive Organization (IMCO) met at the request of the United Kingdom Government in London on May 4-5, 1967 to consider international action to be taken in light of the "Torrey Canyon" disaster. As a result of that meeting the IMCO Committee on Maritime Safety was directed to undertake studies of the preventive, curative and legal aspects of oil pollution.

Safe Sea Routes and Traffic Separation

It is inevitable that a rapidly increasing volume of petroleum products moving over the oceans in increasing numbers of ships and tankers[47] travelling via unassigned and less-than-safe routes will result in more collisions,[48] strandings and, it follows, overall oil pollution.[49] This is especially so in waterways where traffic is congested.[50] Areas where collisions are likely to occur have been labeled accident "black spots."[51] As part of its general program of research initiated after the "Torrey Canyon" IMCO studied the possibilities of assigning routes to ships and tankers and separating traffic in congested areas. The conclusion they reached was that ". . . generally speaking separation of traffic is the best way to reduce the risk of hull damage to tankers and therefore of pollution."[52]

The first such routes were approved and recommended by IMCO in June of 1967. Since that time more routes have been approved covering many of the more congested world traffic patterns. National government

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47. The volume of petroleum products moving via the oceans increased by 75% between 1958 and 1967. J.H. Kirby, *The Clean Seas Code—A Practical Cure of Operational Pollution* reprinted in Zulu Seawork Capabilities Report D-45, D-48 (1968).

48. S.E. Calvert, O.B.E., *Human Factors and the Collision Problem*, 22 J. of Inst. of Nav. 48 (1969), states that ". . . the number of vessels involved in collision every year [is] . . . 7 percent of the world fleet." In a Danish study the question what would happen to collision risk in a narrow fairway such as the Danish Sound if traffic density for both crossing and passing traffic doubled was posed. Two important facts emerged:

> "(1) Generally speaking, Masters of ships appeared to be able to cope efficiently with the two-ship collision situation but could become confused when they were confronted with a triangular three-ship situation.
>
> . . .
>
> (2) If traffic across and through the fairway doubled, the occurrence of the dangerous triangular three-ship collision situation increased by the factor of 8." A. Wepster, *The Future of Merchant Marine Navigation*, 22J. of Inst. of Navigation 92, 98. (1969).

49. In 1968, the year after the "Torrey Canyon" ". . . at least seven tankers . . . lost a total of 16 million gallons of crude and fuel oils to the oceans . . . [T]his combined loss represented about one-half the cargo carried by the Torrey Canyon." K.E. Biglane, *A History of Major Oil Spills Incidents*, Proceedings of Joint Conference on Prevention and Control of Oil Spills, sponsored by the A.P.I. and F.W.P.C.A., New York, 5, 6 (1969). [hereinafter cited as New York Conf.]

50. One such waterway is the Dover Strait between England and mainland Europe. It is said that ". . . half the collisions in the world took place in an area between the English Channel and the Elbe . . ." Captain T. Dilling, *Separation of Traffic at Sea*, 191, 194, Report of Proceedings, Int'l Conf. on Oil Pollution of the Sea [hereinafter cited as Rome Conference] (1968).

51. Id., 195.

52. Id., 197.

authorities in several countries, particularly Great Britain, the U.S.S.R. and the United States have become active in the field.[53]

There is one important characteristic of the IMCO routes: they are suggestive only, not compulsory.[54] Part of the reason for this is that IMCO as an international organization has no authority to impose regulations;[55] it can only make recommendations. Another reason is the long standing concept of freedom of the seas and the right of the Master of a vessel to choose his own course.[56] In addition some commentators have noted that safe sea routes might become more costly by lengthening the voyage of the ship.[57] Owners and operators of the world's maritime fleet also have undoubtedly recognized this problem. It is questionable whether the routes can remain voluntary and in addition achieve the most effective results. In a study of the first two years of routing in the Dover Strait between England and the Continent the author found that in comparing the five years before routing with the two yers after, ". . . collisions per fog day have . . . been reduced by 60 percent . . ."[58] Spot checks of the same route have shown that the routes have not been followed in a significant number of cases.[59] If the collisions resulting from voluntary routing are too frequent to be acceptable, then routing may have to be compulsory.[60] The involvement of several national government agencies in promoting domestic routing schemes, often for different purposes than the international routes,[61] invites conflict which will not be easily resolved.

There is no doubt that routing schemes can be very effective in reducing collisions and other potential pollution hazards. But the practice of voluntary compliance may be a serious drawback to their potential effectiveness. If so, compulsory schemes may be necessary to ensure compliance.

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53. Wepster, supra note 48.

54. Colin Good, Sec.-Gen. of IMCO, *Int'l Action on Oil Pollution Since the Loss of the "Torrey Canyon,"* Rome Conv. (1968) 271.

55. H. Meyers, The Nationality of Ships, 228, 229 (1967).

56. Dilling, supra note 50, 193 where he says, "No one would suggest that a Master must be bound at all times to follow a pre-set navigational pattern, come what may."

57. President's Report, supra note 12, 88.

58. J.H. Beattie, *Two Years of Routing in the Dover Strait*; 22 J. of Inst. of Nav. 442, 446 (1969).

59. Id., 443-446.

60. On January 18, 1971, two tankers collided in San Francisco harbor with serious oil pollution resulting even though there are routing schemes in force in San Francisco harbor.

61. In addition to avoiding collisions, schemes are now being developed for routing deep-draught vessels, for routing to prevent coastal pollution and routing around off-shore drilling rigs. Wepster, supra note 48, 100.

Navigational Aids

The "Torrey Canyon," "Ocean Eagle"[62] and "Arrow"[63] catastrophes were all the result of navigation errors. These often are human errors, which might have been avoided had satisfactory navigational equipment been available and in working order. Today it seems inconceivable that sophisticated navigational aids are not available, and mandatory. The scientific technology exists, but the equipment is not installed or used in many vessels. There are minimum international safety standards which are far below what modern technology could provide.[64] It is argued that sophisticated equipment is expensive and no doubt that is true. But it is certainly cheaper than the costs of an accident. Their use might also result in insurance rate[65] and other cost reductions.

Another problem is that often even the navigation equipment that is installed is not operating or serviceable when needed.[66] In the case of the "Arrow" apparently the equipment was not properly maintained,[67] nor were there qualified crew members capable of using or maintaining it during voyage.[68]

The conclusion seems to be that the scientific technology of navigation is more than adequate. It is the human and regulatory aspects of navigation that are the major technological problem to be overcome.

Crew and Officer Training

"The obvious and not too surprising conclusion . . . is that human error is the principal villain in pollution."[69] There may be navigational error such as in the case of the "Torrey Canyon," "Ocean Eagle" or

62. Ludwigson, supra note 1, 12.

63. Judgment, Royal Commission of Pollution of Canadian Waters by Oil and Formal Investigation Into Grounding of the Steam Tanker *"Arrow"* (1970) 41.

64. *Keeping Coasts Clear*, 37 New Scientist, 196 (Jan. 25, 1968).

65. Ludwigson, supra note 1, 13.

66. Report of the Task Force-Operation Oil (clean-up of the "Arrow" Oil Spill in Chedabucto Bay) volume I, 28 (1970); see also Judgment, Royal Commission supra note 63, 19-34.

67. In the case of the "Arrow" she had been in for repairs and was issued a certificate on Jan. 29, 1970 by the American Bureau of Shipping classifying her as Al (e) oil carrier; the highest rating given to tankers by the American Bureau of Shipping. On February 4, 1970, less than a week later, she went aground off the coast of Nova Scotia, Canada; supra note 63, 8.

68. Task Force-Operation Oil, supra note 66, 28.

69. Commander Albert G. Stirling, ***Prevention of Pollution by Oil and Hazardous Materials in Marine Operations***, New York Conf., 48 (1969).

"Arrow."[70] Confusion, in dangerous situations due to lack of sea-going experience and proper education, can result in faulty judgments and accidents.[71] Such errors become more likely as traffic increases, particularly in heavily travelled routes. One commentator, after studying the statistics of collisions at sea and talking to seamen, has come to the conclusion that presently "the problems of a mariner faced with a risk of collision are not very different from those of a player in a game of chance."[72]

Human errors also result in oil pollution during the loading and unloading period when a valve may be left open or a tank allowed to overflow or a coupling not carefully checked.[73] Most human errors can be traced to lack of experience and education.[74] The problem is how to overcome these deficiencies. Ship owners and operators strive to keep their operating expenses at a minimum which may lead their vessels to be understaffed or staffed by an inferior crew. The standards of training and education necessary to obtain a certificate of standing as an officer are the perogative and responsibility of the flag state of the vessel. Efforts at standardization of crew qualifications on a multinational basis have been unsuccessful.[75]

Another problem relating to the staffing of ships is the determination of the minimum acceptable composition of the crew in terms of numbers[76] and skills.[77]

The problem of human error is undoubtedly the most difficult of all causes of pollution to control and regulate, particularly because of the

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70. Ludwigson, supra note 1; see also supra note 63.

71. Wepster, supra note 48, 98-99.

72. Calvert, supra note 48, 48 where he says ". . . the official enquiries held after a collision have a close family resemblance to the 'post-mortems' after a game of bridge, with this difference that the unlucky, or the less skillful guessers, face legal penalties, and sometimes professional ruin."

73. These types of operational errors are truly human errors. The major cause of operational pollution, (tank cleaning, ballast discharge, bilge pumping, etc.) is not accidental but clearly intentional.

74. Complacency can also be a major cause of pollution and a serious human weakness. Pollution resulting from a complacent attitude on the part of the screw is not the result of a faulty judgment because often there is no judgment at all.

75. The International Labor Organization and the IMCO established a joint committee to consider the problem of training and qualifications of officers and crew but "the initial work has elucidated that international standardization of certificates for masters or officers would raise considerable difficulties." Good, supra note 54, 271.

76. Highly computerized systems on new supertankers has resulted in a reduced complement of crew on these behemoths.

77. As noted above; Task Force—Operation Oil, supra note 66, much of the navigation equipment on the "Arrow" was inoperable at the time of her grounding and there were no crew members capable of repairing it en route.

independent standards established by each flag state and the ability of ship owners and operators to serve only their own purpose in hiring crews.

Tanker Construction

The world tanker fleet is growing at an unprecedented rate and mammoth ships of over 200,000 d.w.t. are becoming the major element of the fleet.[79] The Japanese Transport Ministry has approved the construction of a 477,000 d.w.t. tanker, more than 100,000 tons larger than the previous record-holder.[80] The growth of the tanker fleet both in numbers and size presents serious problems in terms of pollution probabilities. The potential damage from the loss of a 477,000 d.w.t. tanker, four times the size of the "Torrey Canyon" is staggering.

Pollution of catastrophic dimensions results primarily from danger situations such as collisions or strandings. In danger situations, ship construction plays a large part in avoiding and evading disaster. At least five factors are involved in characterizing a ship's response capabilities. They are (1) maneuverability, (2) stopping and backing powers, (3) prime mover, multiple units or multiple screws, (4) controllable—pitch propellers and (5) anchors, remote release, stern anchors, etc.[81] Serious doubts have been raised about the stopping power and maneuverability of the new mammoth tankers.[82] The size of tankers has increased tenfold in the past twenty years but their power plants have only increased threefold.[83] In addition, ". . . the responses of a mammoth tanker to rudder signal or other disturbances are so slow that a human being cannot perceive them

78. The discussion of Tanker Construction will only consider the aspects of anker construction technology relating to accidental pollution problems such as collisions or strandings. There are aspects of the technology dealing with operational pollution but they will be discussed in a later section of the paper.

79. "The world tanker fleet grew by another 8.2 million deadweight tons during the first half of 1970, bringing its capacity up to a total of 140.3 million d.w.t. Mammoths of over 200,000 d.w.t. continue to dominate, with 90 in service at the end of June and another 215 on order." *The Booming Tanker Business*, Petroleum Press Service, October (1970) 362. The same article noted that as of June 30, 1970 there were orders for 63 million d.w.t. of new tonnage, almost one-half the then existing capacity of the fleet. Of this tonnage on order over 80 percent is for vessels in the 200,000 d.w.t. range and larger.

80. Id., 363.

81. Price, supra note 11,2.

82. ". . . [T]ank sizes have grown at a far greater rate than the installed power. Hence, the stopping ability has been reduced significantly, with the bvious reduction in ship maneuverability." *Oil Spillage Study; Literature Search and Critical to Control and Prevent Damage*, Battelle Memorial Institute, 7-6 (1967).

83. Philip Mandell, *Mammoth Tankers*, Technology Review, February (1971).

early enough to take corrective measures."[84] Another danger is the increased likelihood of strandings due to the greater draught of mammoth tankers. The 477,000 d.w.t. tanker on order in Japan has a draught of 92 feet.[85] At the end of the second World War few ships had a draught of greater than 36 feet.[86] The danger exists "because of the limits in the accuracy with which the depth of the sea in areas remote from the land can be measured."[87] The problem is particularly acute in areas such as the southern North Sea where there is heavy traffic in water levels rarely over 20 fathoms. The international shipping community has recognized the problem and a special subcommittee of IMCO was directed to study the possibilities. The results have not been at all satisfactory. The subcommittee concluded:

> . . . at the present stage of technological development there appeared to be few practical means for improvement in the design, construction and equipment of ships compared with the current practice which would significantly reduce the degree of risk of collision or stranding. The Subcommittee agreed to continue its study and to collect data on certain matters which might lead to improvements in manoeuvrability of ships, such as high power lateral thrusters, auxiliary braking devices, multiple screws and rudders, controllable pitch propellers, optimum manoeuvring operations, steering gear power systems and special instrumentation, including low velocity measuring devices.
>
> The Subcommittee felt that more effective results would be achieved by improving navigation rules, and members were invited to collect data on manoeuvring characteristics of large ships which would be useful for the improvement of navigation rules."[88]

Apart from the ability of a tanker to avoid or evade a danger situation, the construction of the vessel might be such that pollution would be prevented or minimized once a danger situation was unavoidable. The construction techniques which would achieve such a result deal with the structural strength of the vessel, or its tank alignment more so than with

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84. *The Booming Tanker Business*, supra note 79, 363.

85. Tony Loftas, *Tanker Peril in Shallow Seas*, New Scientist, 264 November (1970).

86. Id. He also states that the danger is aggravated "by the fluctuations known to occur in predicted tidal levels as well as changes in the level of the sea-bed itself which might be caused by the migration of sand waves over it."

87. Price, supra note 11, 5.

88. Id., 7; W.H. Swift, C.J. Touhill, W.L. Templeton, D.P. Roseman, *Oil Spillage Prevention, Control and Restoration—State of the Art and Research Needs*, in Oil Pollution: Problems and Policies, (Stanley E. Degler, ed.) 31, 52 (1969).

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

the ship's response capabilities. For example double hulls reduce the probability of pollution from damage sustained in stranding. A protection against pollution in a collision situation would include structural barriers at the side of the vessel in the form of ballast tanks.[89] This solution reduces cargo space but at the same time eliminates the need for carrying ballast in cargo tanks which is a major cause of pollution.[90] A method of reducing the potential amount of pollution from a grounding or collision is to establish a maximum size of cargo tanks with reinforced bulkheads between tanks. In this regard IMCO has recommended a "freeze" on the size of tanks in oil tankers.[91]

It would seem that there are technological and engineering means of reducing the threat of pollution. However, no real international action in the form of standards has been taken. The IMCO subcommittee studying ship design felt they could not recommend measures until they knew what quantity of oil pollution society was willing to accept as the consequence of a single accident.[92] This is a strange position in which to be left. They also felt that the public clamor over oil pollution would lead governments to become involved in the question of tanker and tank size as a social problem. Therefore, they felt "(a) solution based solely on considerations of naval architecture could . . . prove to be unacceptable."[93]

The lack of political consensus and economic analysis has again resulted in postponement of positive action.

Operational Pollution

The total volume of oil and oil products lost to the oceans each year from operational pollution is far greater than that lost through collisions and strandings.[94] Of the oil lost through operations the largest amount results from discharging ballast, tank cleanings and bilge pumping into the open sea. After a tanker discharges her cargo she must take on ballast during the return voyage for reasons of safety and stability. Sea water is pumped into her emtpy cargo or fuel tanks. It is usually necessary for a tanker to fill one-third to one-half of her tanks with sea water on the

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89. Swift, Touhill, Templeton, Roseman, supra note 89, 51.

90. Price, supra note 11, 7; The recommended size of tanks is 30,000 cubic metres for wing spaces and 50,000 cubic metres for centre tanks.

91. Id.

92. Id.

93. Blumer, supra note 10, 1.

94. Keeping Coasts Clean, supra note 64, 196; J.E. Moss, *Character and Control of Sea Pollution by Oil*, Petroleum Institute, (1963).

ballast voyage.[95] This sea water is contaminated with the residue of oil left clinging to the walls of the cargo tanks after discharge of the cargo. This residue is estimated to be 0.4% of the total cargo of the tanker.[96] If the ballast is discharged without cleaning the tanks, about 15 percent of the residue left clinging to the tanks is discharged with it.[97] If the tanks are cleaned, as they must be periodically, then the potential pollution is the entire 0.4 percent of the residue. At the ocean oil transport load of 1970 this would have amounted to 6 million tons.[98]

What possibilities are there for controlling this enormous potential pollution? The potential exists only because oil is transported over the ocean. At the present time, however, it is not feasible to suggest an alternate mode of transportation. The resource and sources of petroleum are not distributed evenly over the earth so that transportation from one place to another becomes less necessary. The consumers of oil and petroleum products are similarly not evenly distributed over the globe and the principal consumers areas presently have limited regional sources, requiring transportation by the seas.

It is perhaps rational to discuss the type of oil products being transported over the oceans. In 1967 over three-quarters of the petroleum travelling the oceans was crude.[99] This is a sharp reversal from pre-1945 practice when refineries were normally built near the source of oil rather than near the consumer.[100] It is generally assumed that crude oil and persistent oils[101] are much more dangerous to the environment than non-persistent refined products.[102] If this is true,[103] one possible method of

95. Kirby, supra note 47, D-50; This amount is reduced in modern tankers which have expensive inner epoxy coatings on their tanks.

96. Moss, supra note 95, 49; Frederick Zachairiasen, *Oil Pollution In the Sea: Problems for Future Work*, Institute for Defense Analyses 4, (1968).

97. Blumer, supra note 10, 1.

98. Kirby, supra note 47, D-48; This figure does not include the trade within territorial waters, for example along the east coast of the United States where the percentage of refined products may be much higher.

100. Kluss, supra note 9, 2.

101. Persistent oils are crude oil, diesel fuel and heating oil, the heavier fractions of crude generally speaking. Non-persistent oils are the refined lighter fractions that are more volatile and tend to evaporate more quickly.

102. Sweeney, *Oil Pollution of the Oceans*, 37 Fordham L. R. 155 (1968-69); The classification of persistent and non-persistent oils is established by the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, [1961] 3 U.S.T. 2989, T.I.A.S. No. 4900, 327 U.N.T.S.3. At the London conference in 1962 to amend the 1954 Convention, a resolution was passed stating that "[t]he only entirely effective method known of preventing oil pollution is the complete avoidance of the discharge of *persistent* oils into the sea . . ." [emphasis added], Proceedings and Resolutions of 1962 International Conference on Prevention of Pollution of the Sea by Oil, London, 40 (1962).

103. Although persistent oils cause greater problems than do non-persistents, some non-persistents have a very high toxicity; Blumer, supra note 10.

reducing oil pollution would be a change of the *situs* of refineries, reversing the post-1945 trend. In this way the petroleum products travelling the oceans would be primarily of the nonpersistent, less harmful variety. Of course, it is very unlikely such a change would ever take place.[104] The location of refineries in the consumer area was not done for economic reasons, alone but as protection against instability in producing countries and national security.

What can be done in the face of this tremendous potential of operational pollution? The solution that has been advanced, particularly by the oil companies,[105] is the adoption of the Load-on-Top (LOT) technique of ballasting and bulk cleaning.[106] This technique was made compulsory by 1969 amendments to the 1954 Oil Prevention Convention.[107] These amendments have not as yet come into force.

There is no doubt that LOT substantially reduces operational pollution.[108] But its overall effectiveness must be tested before it can be accepted as the final solution. There are shortcomings in the LOT system. First is the fact that only about 80 percent of the world's tankers presently use the technique.[109] The amount of salt water contamination may be so great that refineries cannot accept the residue.[110] Some refineries are unwilling to accept the residue in any event.[111] Because LOT is based on a separation principle, if the voyage is not long enough, it is ineffective.[112] The most toxic components of oil are soluble in water, thus the so-called clean water which is discharged after separation is not completely harmless.[113] The technique cannot be used if the cargo being carried by the tanker changes

104. In recent months, however, producing countries have begun to realize the power of their position and there has been talk from Middle East governments that they will soon insist on refined products be exported from their countries instead of crude oil.

105. Kluss, supra note 9, 7; Kirby, supra note 47, D-56.

106. For a description of the mechanics of the technique and its effects, see Kluss, supra note 9; also Oil Pollution of the Sea, 10 Harv. Int'l L.J. 316, 351 (1969); and Kirby, supra note 47.

107. 1969 Brussels Convention, 9 Int'l Legal Materials 1-64 (1970). See Also G. Boos, *Critical View of 1969 Amendments*, Marine Pollution Bulletin, 169, (Nov. 1970).

108. Boos, supra note 107, 170.

109. Id., 169; see also Man's Impact on the Global Environment, Report of the Study of Critical Environmental Problems, 241 (1970). Those who do not use LOT are primarily independent tanker operators and not oil companies; Kluss, supra note 9, 7.

110. Brummage, supra note 9, 188.

111. Boos, supra note 107, 170.

112. Blumer, supra note 107, 170.

113. Id. It should be pointed out, however, that the water soluble components are the most volatile components also. Thus they tend to go off into the atmosphere if they are near the water-atmosphere interface.

from heavier, persistent oils to lighter non-persistent oils.[114] Separation while the tanker is en route is never as successful as when done on land due to the constant rolling and pitching of the ship.[115] A major problem is that tanks are not always cleaned. If the vessel is carrying the same type of product on successive voyages there is no need to clean the tanks on the ballast voyage. In fact it has been estimated that tanks are cleaned on only 20 percent of the trips.[116] What this means is that on ballast voyages where tanks are not cleaned, the discharged ballast is contaminated with about 15% of the oil left clinging to the tanks after discharge of the cargo.[117] This is obviously a major source of pollution. A final limitation of the LOT technique is that the receiving facilities on shore may be inadequate or, in many cases, non-existent.[118] This is particularly true at repair yards.[119]

It seems obvious that the LOT system has serious technical and regulatory drawbacks. The provision for adequate shore reception facilities would eliminate a considerable portion of the problem.[120] But it would still not be a closed system where all flushing of tanks at sea was prohibited.[121]

Operational pollution has not been eliminated as of now. But it is technically possible to do so as many nations are beginning to realize.

Implementation

In the preceding section we discussed the technology of preventive measures for the control of oil pollution of the oceans from ships and tankers. From a purely technological perspective, effective preventive possibilities do exist. But their mere existence does not mean that they can be implemented in the real world where non-technical matters weigh in the decision

114. Brummage, supra note 9, 185.

115. Moss, supra note 95, 21.

116. Zachariasen, supra note 97, 4; Moss, supra note 95, 49, estimates that tanks in the crude oil trade are cleaned about two times a year.

117. Zachariasen, supra note 97, 4.

118. Receiving facilities are usually available at the refineries of major oil companies, but this is not always the case at other refineries. Also, oil companies have not always accepted the residues of tankers which they do not own or which are not under charter to them; Moss, supra note 95, 31, 70.

119. It has been estimated that .4 percent of all oil pollution resulting from the operation of tankers is chargeable to cleaning tanks in preparation for repairs at shipyards, Moss, supra note 95, 73.

120. A combined LOT system and shore reception facilities program called the Clean Seas Code has been proposed by the oil companies; Kirby, supra note 47.

121. The United States proposed a closed system at the oil spills conference of the NATO Committee on the Challenges of Modern Society held in Brussels in November, 1970. New York Times, (November 7, 1970). 46.

making process.

Action to control oil pollution can be taken on three different institutional levels. First international action may be the result of multinational agreements.[122] Secondly action may be taken by nations, unilaterally, to control pollution in their territorial and inland waters.[123] Thirdly, private individuals or groups involved in or affected by oil pollution may take action of their own, apart from any governmental involvement.[124] Each of these centres of activity must be involved in any scheme to control and prevent oil pollution of the oceans. Each of the three levels of activity also have very different situations and problems complicating consensual agreement on a plan of action. These problems must be solved if an effective global scheme for the prevention of oil pollution is to be a reality.

The difficulties of international action are greater than those encountered on the national or private level of activity if merely because of the complexity of the political process in an international forum. Reaching international accord means agreement by many political bodies, with often diverse interests. It seems only reasonable that an international consensus will be harder to reach and will likely be a compromise in any event, possibly jeopardizing the effectiveness of the solution agreed upon. International agreement must take into consideration the dichotomy between maritime and non-maritime nations[125] as well as the interests of developed and underdeveloped nations.[126] In addition to national and private interests, international action will also have to accommodate the interests of other multinational interest groups.[127] The equitable distribu-

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122. For example, the International Convention for the Prevention of Pollution of the Sea by Oil, 1954, [1961]. 3 U.S.T. 2989, T.I.A.S. No. 4900, 327 U.N.T.S.3. amended by Conference of Contracting Governments at London, April 11, 1962, [1966] 2 U.S.T. 1523, T.I.A.S. No. 6109. NATO's Committee on the Challenges of Modern Society is also considering action.

123. This control may be legally extended to include the contiguous zone; see Robert H. Neuman, *Oil On Troubled Waters: The International Control of Marine Pollution*, 2 Journal of Maritime Law and Commerce, 349, 357 (1971).

124. Neuman, supra note 123, 349.

125. Developed nations create the bulk of the pollution and it is they who are most concerned now. But when they seek to establish international regulation the result deprives underdeveloped nations of the freedom of action they would otherwise have. Such regulation may also result in a direct economic cost which underdeveloped nations cannot afford.

126. Many groups are now concerned with oil pollution, e.g. NATO's Committee on the Challenges of Modern Society, the Intergovernmental Oceanographic Commission (IOC) UNESCO, FAO and the United Nation generally.

127. For example, to adopt a closed LOT system would require shore-based tank and separator facilities along all shipping routes. The distribution of the cost of such facilities need bear little relation to the volume of traffic through a particular port or by a particular coast.

tion of costs of adopted preventive action may be a difficult problem.[128] Finally, the compulsion for action may be less at an international conference than in a domestic setting because of the unaccountability of the participants and the convenient rationalizations for inaction. All of these problems are potential stumbling blocks to international action.

The political process involved in national legislation is probably less complex than the international processes. One result of this may be that national action to control oil pollution turns out to be too extensive and restrictive.[129] There is certainly a role and need for domestic action to control oil pollution in territorial waters and ports, but its scope may overlap with potential international jurisdiction. National legislation should complement international action to present a united front against a common problem. Impatience with slow international political action can lead to over-reaction on the part of a concerned nation which may result in further delays of international concensus.

A controversial area which affects international, nation and private interests is the use of flags of convenience by much of the world's tanker fleet. Rather than discuss the specific implementation problems of international, national and private decision making bodies, the circumstances surrounding the use of flags of convenience serve as a good model to illustrate the conflicting interests and problems raised by the three-tiered decision-making apparatus involved in oil pollution of the oceans. Through a partly descriptive and partly analytic discussion of flags of convenience hopefully these problems will come to light.[130]

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128. Neuman, supra note 123, 349.

129. The discussion will center on the advisability of the use of flags of convenience and their role in a scheme for the preventionof oil pollution. However, it is submitted that the problems faced in making this decision are similar to those encountered when dealing with oil pollution on an international, national or private level only more aggravated in the sfse that they all come to focus on a single problem in the case of flags of convenience. In any event the three interests, international, national and private, are very much involved in the use of flags of convenience.

130. One definition of a flag of convenience is:

". . . the flag of any country allowing the registration of foreign-owned and foreign-controlled vessels under conditions which, for whatever the reasons, are convenient and opportune for the persons who are registering the vessels." B. Boczek, Flags of Convenience 2 (1962). See also D. Bowett, The Law of the Sea 55-59 (1967).

Flags of Convenience countries are often called the Panlibhon countries, a contraction of Panama, Liberia and Honduras, which have traditionally been the most popular flags.

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

Flags of Convenience[131]

"Freedom of the Seas" is one of the fundamental principles of the law of the sea. However, only ships that have a "nationality" can exercise the rights of navigation implicit in the freedom.[132] The Panlibhon countries argue that the granting of nationality to a ship is the unrestricted prerogative of all sovereign nations.[133] Other nations feel that the right to grant nationality must be exercised in the "interests of all,"[134] taking into account generally accepted international rules.[135] This dispute culminated with the passage of the following provision at the Geneva Convention on the Law of the Sea in 1958:

> Each State shall fix the conditions for the grant of nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships shall have the nationality of the State whose flag they are entitled to fly. There must exist a *genuine link* between the State and the ship; in particular, the State must effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag.[136]

The requirement of a "genuine link" between the vessel and the state granting nationality was first used by the International Court of Justice in the *Nottebohm Case*.[137] The vagueness[138] and ambiguity[139] of the test has turned the seeming victory of the nations favoring restrictions on the granting of nationality into a rather empty one. Certainly it has not halted the flow of registrations under flags of convenience.[140]

The growth of tanker fleets under Panlibhon flags in recent years has been phenomenal. This is especially true of the Liberian fleet. In 1939 there were no merchant ships of over 1000 gross tons plying the world's oceans under the Liberian flag.[141] As of June 30, 1970 Liberia had a tank ship fleet of 34,461,000 dead weight tons ranking first and accounting for

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131. Boczek, supra note 131, 2; also Comment, *Oil Pollution of the Sea*, 10 Harv. Int'l L.J. 316, 330 (1969).

132. Boczek, supra note 131, 39.

133. Id., 2.

134. Meyers, supra note 55, 2.

135. Convention on the High Seas, done at Geneva April 29, 1958, [1962] 2 U.S.T. 2312, T.I.A.S. No. 5200, 450 U.N.T.S. 82, art. 5(1).

136. [1955] I.C.J.4.

137. Boczek, supra note 131, 3.

138. M. McDougal and W. Burke, The Public Order of the Oceans 1122 (1962).

140. The growth of flags of convenience fleets is discussed below.

141. Boczek, supra note 131, 14.

one quarter of the entire world fleet.[142] In addition, as of December 31, 1968 there were tank ships under construction or on order with intended Liberian registration totalling 16,617,000 d.w.t.[143] This total accounts for approximately 30 percent of new tanker construction.[144] Growth of other flags of convenience fleets have been less spectacular, but the group has been joined by new members who have relaxed their registration requirements. Most notable of this group is Greece. The Greek fleet doubled in the two years between 1968-70 after registration requirements were relaxed. The Greek fleet is now the sixth largest in the world.[145] It is obvious that the efforts of the 1958 Convention were fruitless.

But what are the attractive features of Panlibhon registration? Economic reasons are cited by tanker owners are the primary reason for the development and continued use of flags of convenience.[146] Flags of convenience countries are for the most part under-developed nations for whom taxes collected from their fleet is an easy revenue source.[147] Even so, the fees charged by these countries are substantially lower than those charged by other maritime nations.[148] There are other reasons, also why these flags are convenient for operators.[149] The ships can be owned by foreigners. They can be manned with foreign crews, free from trade union intervention. They can be repaired in foreign shipyards. In essence the operators has "a great measure of freedom to arrange his affairs as he thinks fit."[150] The dangers of lack of regulation have been pointed out with regard to crew and officer training and in times of slackening freight demand.[151] There may be similar dangers with regard to oil pollution. The effective

142. DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics 97 (1970).

143. *The Booming Tanker Business*, supra note 79, 362, 364.

144. Id.

145. Id.

146. The Role of Flags of Necessity, American Comm. for Flags of Necessity 27-35 (1962). American shipowners use the term "flags of necessity" as an alternative to flags of convenience implying the economic necessity of registration under such flags. Liberia calls them "flags of attraction."

147. Boczek, supra note 131, 58. The Liberian government receives one-seventh of its total revenue from registration fees and taxation of its registration fleet.

148. Boczek, supra note 131, 56-57; Meyers, supra note 55, 57, n.1.

149. Meyers, supra note 55, 57, n.1.

150. Id.

151. Study on the Expansion of the Flags of Convenience Fleets and on Various Aspects Therof, Maritime Transport Comm., Organization for European Economic Cooperation, 9 (1958) [mimeographed], official Records of the Conference, Geneva Conference on the Law of the Sea (1958) vol. II (Al Conf. 13140) 34-5, where Professor Francois stated:

> ". . . a system under which any state can grant its flag to all ships applying for it is in fact the acme of freedom. That conception of freedom is, however, incompatible with the interests of the international community . . ."

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

control and prevention of oil pollution requires proper regulations and their strict supervision. If the claims made against the Panlibhon are justified, then flags of convenience do present a stumbling block to the control of oil pollution of the oceans. We shall now attempt to investigate the behavior of these nations in regard to oil pollution control.

The question of whether the Panlibhon countries effectively regulate their fleets according to recognized International norms has been discussed many times.[152] The prevailing opinion seems to be that they do live up to their obligations. Such small states do face added difficulties in trying to regulate a large fleet, however. Since their fleets do not make regular stops at ports of their home country, regulation and inspection must be carried out abroad through consular offices and appointed agents. The administrative costs of maintaining inspection services around the world may be relatively high.[153] Although academic opinion seems to believe that Panlibhon countries are no worse than other maritime nations[154] in the regulation of their fleets, a study has never been done to prove or disprove this assertion. It would be very helpful if some empirical work were done in this area.

If it is not possible to state definitely what standards are maintained by the Panlibhon countries, we can look at specific examples of their efficiency.

In three major strandings in three different countries from 1967-1970 all the tankers were of Liberian registration.[155] All three cases were the first major oil pollution incidents to occur in these countries. The conclusion reached by the government commission established to study the "Arrow" case in Canada was:

> We are well aware of the fact that no form of transportation can be 100 percent safe but from the record available to us the standard of operation of the world's tanker fleets, particularly those under flags of convenience, is so appalling and so far from the kind of safety which science, engineering and technology can bring to those who care, that the people of the world should demand immediate action.[156]

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152. Boczek, supra note 131, 264-272; Bowett, supra note 131, 55-59; Meyer, supra note 55.

153. The Liberians do maintain such a system of consultate offices.

154. A comparison to standards set by other maritime nations may not be very useful, for that comparison does not question what the standards should be.

155. The "Torrey Canyon," in England "Ocean Eagle" in Puerto Rico and "Arrow" in Canada.

156. Task Force—Operation Oil, supra note 66, 3.

This conclusion was partially based, no doubt, on the evidence given at the official inquiry into the stranding of the "Arrow." At the hearing it was established that even though the "Arrow" had been inspected less than a week before the stranding and given the highest rating for oil tankers, almost none of her navigation equipment was functioning at the time of the stranding.[157] In addition she was not equipped with the relatively inexpensive Decca radio equipment which could have prevented the collision. Such equipment is most valuable and effective close to land where the "Arrow" made most of her voyages. The conclusion seems to be that not only was the "Arrow" not equipped with satisfactory navigational aids but the relatively unsophisticated aids she did have were not effective.[158]

The above case deals with equipment standards and the efficiency of the inspection of that equipment by Panlibhon countries. Another area we might investigate is the compliance of Panlibhon tankers to voluntary international agreements. In June, 1967 IMCO established safe sea routes for selected congested shipping lanes. One such route was established in the south North Sea and Dover Strait. Compliance to the suggested routes was voluntary since IMCO has no power to prescribe rules.[159] In a study of the first two years of operation of the scheme Liberian vessels were involved in the largest number of collisions.[160] Of the eleven tankers observed not complying with recommendations, nine were of Liberian registry.[161] Although these statistics are incomplete and hence inconclusive, they do indicate that a problem may exist. Further study should be undertaken.

Another area of international concern is the action taken by flag states after one of their vessels has been involved in a major catastrophe. Little publicity is given to such hearing, presumably since news of the clean-up and damages are deemed more newsworthy. Although one can question the usefulness of such hearings, they are one means of establishing standards of conduct of officers and crews. They also can establish standards of safety and navigational equipment necessary on ships.[162]

Liberia held a hearing into the "Torrey Canyon" incident. The results

157. Id., 28; see also Judgment, Royal Commission, supra note 63, 19-34.

158. The "Torrey Canyon" presents a similar but less striking example regarding navigational aids. See House of Commons, Rep. from the Select Comm. on Science and Technology, Sess. 1967-68: Coastal Pollution (1968).

159. See section above on separation of Traffic and Safe Sea Routes.

160. Beattie, supra note 58, 443. One Liberian vessel hit the South Goodwin light vessel.

161. Id., 446.

162. Commandant L. Oudet, *The Black Flood: Lessons of the Torrey Canyon*, 21 J. Of Inst. of Navigation 41, (1968).

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

of the hearing have been severely criticized. One question the "Torrey Canyon" hearing raises is the relationship between the owners and operators of the Panlibhon fleet and governments of the flag state. It has been suggested that the Board of Inquiry in the "Torrey Canyon" case was established to relieve the owners of responsibility, using the master, who was found responsible, as the scapegoat.[163] The heavy dependence of Liberia on the American controlled portion of their fleet[164] and the fact that the board was composed entirely of Americans[165] suggests that the Liberian government may have instigated the hearing at the behest of the American owners rather than from a sense of international responsibility. In any event the fact that the board was entirely American does not speak well for the competence, responsibility and freedom of action of the Liberian government.

The whole relationship between flag states and owners has become more complex than originally envisaged when flags of convenience developed after World War II. At that time the primary concern of the owners was economic. This is still largely so. But over the years international concerns have demanded greater regulation of safety and pollution standards. This had added an entirely new facet to the relationship between flag states and owners.

To protect their right to use flags of convenience the owners must ensure that the flag states maintain the minimum acceptable international standards without seriously interfering with the profits and benefits they extract from the use of those flags.[166] These two purposes are to a large degree inconsistent. To ensure that minimum standards are maintained, the owners have several avenues open to them. They can pressure the flag states to take action to maintain an air of responsibility.[167] The flag states will also want to maintain at least minimum standards for fear of losing their fleet to another state. But the standard to be maintained is always the lowest common denominator. The owners can also take matters into their own hands, either individually or as a group. They would most ikely take this step in areas where they had little faith in the administrative ability of the flag state and in areas where they could be self-supervising and self-regulating. Examples of this type of action on the part of the

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163. Id., 53.

164. Meyer, supra note 55, 57, n.1. Nearly 50 percent of the Liberian fleet is American owned.

165. Oudet, supra note 162.

166. Id., 41.

167. The "Torrey Canyon" hearing may be an example of this.

oil companies are the introduction of LOT[168] and the establishment of TOVALOP.[169]

The major oil companies who own a large percentage of the tanker fleet have been very active at antipollution conferences and seminars. It would be unfair to condemn their effort as useless or ill-intended. But because of their vested interests in the petroleum industry, their motives must be questioned. It is questionable whether they should be expected to take the public interest into consideration when formulating their policies and attitudes. Without further empirical study it is not possible to condemn the owners and operators for acting from self-serving motives only. But in any case, and particularly because of the increasing covergence between owners and flags of convenience, it will not be sufficient to allow them to be self-regulating. Their interests are basically economic in nature and need not jive with objective decisions concerning oil pollution policies. An impartial third party serving a broad spectrum of social concerns would seem essential to generate the necessary effective regulation of pollution and safety standards.

Conclusion

The analysis developed in this paper has dealt essentially with prevention of oil pollution. Possible inputs to a cost effectiveness approach to the problem, have been considered. We have also dealt with the technology of prevention and the problems of implementation in a political sense. Is it possible to come to conclusion as a result of this analysis?[170] Because of the gaps in information and understanding it is not possible to present a cohesive operational model as a solution. Instead an attempt will be made to come to some conclusions about the generalities of the political problems likely to be encountered in implementing an effective solution.

It is easiest to discuss these problems by dealing with the three levels of political involvement separately. These three levels are international, national and private.

Private[171]

The position of oil companies and tanker operators already has been

168. Kirby, supra note 47.
169. Supra note 124.
170. The conclusions will assume that prevention is the chosen approach.
171. In the "private" category we shall consider only oil companies and associated tanker owners and operators.

discussed.[172] There is no doubt these parties can and should play an essential role in the solution to the problem of oil pollution. However, their intense involvement in the industry should keep decision makers wary of possible prejudices. It can be argued that oil companies to date have not always viewed the pollution situation objectively. A complication is that, quite often, because it is their business, they are the only ones who can make an objective appraisal of a problem since they have the facts, figures and research.[173]

There are cases of clear conflict of interest, however. A notorious example is the use of detergents after the "Torrey Canyon" disaster. The detergents used were more poisonous than the oil spilled. It just so happened that the detergents available were manufactured by the major oil companies themselves.[174] Two points can be postulated from this example. Firstly, it is inconceivable that the oil companies did not know that their detergents were toxic.[175] It would be interesting to know what else their research has revealed about oil pollution and prevention. Secondly, the use of detergents has always been advocated as an important clean-up method by the oil companies. This would seem to indicate that their primary concern is getting the oil out of sight so there will be no adverse public reaction. Yet the great scientific dangers of this approach are well documented.[176]

Another indication of their lack of concern for prevention of pollution is their interest in liability. Oil companies have been very active both domestically and internationally at conferences dealing with liability. Their most startling unilateral move was the establishment of a voluntary international indemnification scheme known as TOVALOP.[177] On the surface, the establishment of the fund appears the action of a conscien-

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172. See section on Flags of Convenience.

173. Most major oil companies have giant laboratories and spend millions of dollars of sophisticated research. Yet the results of this research are classified, not available to the public sector. Very often the results of this research might be beneficial to prevent pollution, yet it cannot be used. The conclusion is not necessarily that their research should be public, but that public agencies will have to become more intensely involved in research and rely less heavily on oil companies for their data.

174. This is still largely the case today.

175. It did not take long after the "Torrey Canyon" for the oil companies to manufacture new less toxic detergents once there was a public and official outcry against the results of the "Torrey Canyon." Even if they were unaware of the toxicity of the detergenets that surely shows the lack of concern they have for the ecological aspects of oil pollution and its clean-up.

176. Blumer, supra note 10, 8, 9.

177. TOVALOP stands for "Tankers Owners Voluntary Agreement Concerning Liability for Oil Pollutin."

tious industry legitimately concerned with the by-products of their enterprise. But there may be another side to the coin. Firstly, why could the tanker industry not insure through the ordinary insurance industry or why did they not wish to do so? It can be argued that they felt by establishing a self-insurance scheme they could make a financial saving. This could be done in one of two ways: (1) The premiums insurance companies charge reflect their attitude toward the danger of losses. Thus, after suffering monumental losses in cases like the "Torrey Canyon," insurance companies are likely to be wary of the tanker industry. They could tie their rates to safety standards on board the tanker, crew standards, etc. The tanker owners may feel either that the insurance companies have overestimated the risks of accidents or that it would be cheaper for them in any event not to install extra equipment and run a self-insurance scheme. The results of such an approach would be to suffer insurance losses rather than install preventive equipment. (2) The tanker owners might have felt they would have more control over the amount of damages allowed through TOVALOP than they would if they insured with independent insurance companies. This could also result in a financial gain for the industry.

It would be untrue to say that oil companies show no concern about pollution. But their concern is chiefly the result of their reliance on the consumer's good will. Their approach seems to be, as pointed out above, that as long as the oil is out of sight there is no problem. Granted they have done research and implemented changes that may reduce pollution. But these changes always have a financial flavor to them. The only improvement voluntarily adopted by the tanker operators to reduce operational pollution is the LOT technique and it was not adopted until it was determined to be financially advantageous.[178] Their efforts to reduce accidental spills, of course, have a saving to them if successful.

Since tanker owners only use the transportation facet of the world's oceans, it is perhaps understandable that their concerns would not extend beyond paring costs or maintaining good public relations. But it is precisely this one-sided approach, this lack of genuine concern for long term ecological costs to all of mankind which must be overcome. The participation of tanker owners is essential to the eventual reduction of oil pollution of the oceans, but their advice and concern must be appraised objectively and independently.

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178. LOT was known as a possible technique long before it was adopted by the major oil companies in 1963.

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

National

National governments can take action in two ways to control and prevent oil pollution. They can strictly supervise and regulate the ships flying their flag. The rules they apply to their fleets, though they may be promulgated unilaterally, are more likely to reflect international standards. Secondly, they can adopt laws to protect their sovereign territory from pollution. Such rules might be an extension of sovereignity for pollution purposes over portions of the ocean as Canada did in the Arctic.[179] Domestic laws might also prescribe rules for ships entering territorial waters.[180] But in this area the influence of international rules will also be evident. A small country adopting strict anti-pollution laws is unlikely to induce compliance by the entire world tanker fleet. The unilateral insistence on such rules might also have detrimental economic effects on the adopting country through higher shipping rates or higher costs for petroleum products.

Domestic legislation is important in the international anti-pollution effort, but it must go hand-in-hand with international developments to have any serious impact.

International

The international control of oil pollution is an extremely complex problem. International efforts to date have achieved a measure of success. But neither international, national, or private efforts have stopped or reversed the ecological deterioration of the oceans. Part of the difficulty has been a lack of direction; a failure to determine objectives. Surely the first step must be a clearer definition of the desired goal. To date there has been a kind of schizophrenic split between all-out prevention and improved clean-up techniques. One is reminded of the proverbial horseman jumping on his horse and riding off in all directions at once. Defining objectives, however, is not an easy or quick process, particularly in an international setting. How should it be approached? It has been suggested earlier in this paper that systems analysis and cost effectiveness are tools which should be applied to the oil pollution situation.[181] Assuming such analysis is undertaken, how is it transformed into the real world? This is the crucial question and it would be presumptuous to project a fixed answer.

179. Neuman, supra note 123.

180. For example, see the bill C-2 supra note 3.

181. Implicit in such an analysis are certain cost allocations which will be basically political decisions.

However, certain comments can be made about the problem. It seems obvious that those concerned with the ocean oil pollution in all countries should be confronted with the facts and the analysis. The United Nations is convening a world wide conference on environmental problems in Stockholm in 1972.[182] The conference could be very beneficial, but it must tie in all the concerned groups such as IMCO, ILO, FAO and WHO. General statements of principle or objectives can be useful if they are utilized by appropriate groups as the foundation for concrete action.

A problem of major concern is the proper sort of organizational structure to deal with oil pollution of an international scale.[183] At present, IMCO is the primary international agency studying the oil pollution area.[184] But IMCO has organizational and political drawbacks. It has no real regulatory powers; it can only make recommendations to its members. It seems likely that effective regulation is the most important aspect in the effort to control pollution. IMCO also is very limited financially[185] and, as a result, cannot undertake ambitious research and planning projects. IMCO is certainly not independent of the shipping industry in general and relies heavily on research done by private and public organizations. It is questionable whether such an organization could ever be effective in controlling pollution regardless of the expressed position of the international community of states. Thus, a new organization or a reconstituted IMCO may be required. A model for such an organization could be the International Civil Aviation Organization (ICAO) established by the Convention on International Civil Aviation.[186] ICAO is much more independent than IMCO and has strong regulatory powers.[187] One of its aims is the international standardization of safety and technical matters.[188] ICAO has also played an active role in crew training and accredita-

182. A preparatory conference may be held in the United States before the Stockholm Conference with the hope of reaching some common conception of the problem before Stockholm and in that way facilitating the work of the conference.

183. It is not assumed that such an organization would deal solely with oil pollution of the oceans. It would very likely have a much broader jurisdiction covering several aspects of maritime trade, transport and safety.

184. More recently NATO has become concerned with environmental problems.

185. IMCO has the smallest budget of any of the specialized agencies of the United Nations, only $1 million per year.

186. Convention on International Civil Aviation, T.I.A.A. 1591, 15 U.N.T.S. 295, signed at Chicago, Dec. 7, 1944.

187. ICAO has no authority over the territory of a signatory, but its standards and procedures are obligatory in the air space over the oceans between members. A. Spooner, *The Role of ICAO in the Technical Development of International Civil Aviation*, Proceedings of Symposium on Civil Aeration Safety, Stockholm, (1966) 9.

188. Id., 8.

Transportation Law Journal, Vol. 4 [1972], Iss. 1, Art. 4

tion.[189] ICAO has the authority to adopt international standards and recommend practices which are binding on members.[190]

General speaking ICAO seems like a much more effective organization than IMCO. Granted, there may be logical reasons for their different structures. Historically speaking, the shipping industry has enjoyed great freedom and lack of regulation, probably as a result of the freedom of the seas concept. The aviation business was embryonic in 1944 when the Civil Aviation Convention was signed. The entire aircraft business was subject to safety problems at that time. Also, because the safety of airplanes was uncertain, and the loss of human life was possible in accidents, international regulation and control might have been easier to accept. Whether such arguments can be sustained today as reasons for not controlling the international shipping industry is dubious.

If international consensus could be reached on the establishment of such an independent, watchdog organization to control pollution of the oceans, many of the policy and organizational problems would be overcome.

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189. Id., 15.
190. Supra note 17, article 37.