ASSESSING ENVIRONMENTAL RISK: IS A SINGLE FIGURE REALISTIC AS AN ESTIMATE FOR THE COST OF AVERTING ONE TONNE OF SPILLED OIL?

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Abstract

We hereby comment on document D-4.5.2-2005-10-21-DNV (entitled "Risk Evaluation Criteria" and produced in the context of the SAFEDOR project[3]). The above document develops a methodology to determine risk evaluation criteria for oil pollution, and comes up with a figure of $60,000 as the cost of averting one tonne of spilled oil. Much additional analysis is reported, but the above figure stands out, and may have important policy ramifications, particularly if adopted by the IMO or other regulatory bodies. In fact, as recently as 7 Feb. 2006, the SAFEDOR deliverable was discussed within a correspondence group of the IMO (MSC 81/18). In the following, we provide some very brief notes on Assessing Environmental Risk for use in IMO's Formal Safety Assessment (FSA) or risk-based design and operation.

INTRODUCTION

As is known, Formal Safety Assessment (FSA) *"is a structured and systematic methodology, aimed at enhancing maritime safety, including protection of life, health, the marine environment and property, by using risk analysis and cost benefit assessment".* (MSC. Circ 1023). At IMO there has been, so far, no application of FSA for environmental consequences. Currently, all applications assess only individual and societal risk to people.

As decided during MSC 80 (May 2005), an intersessional group (MSC and MEPC) is tasked to *"consider the development of a **risk index** relevant to the protection of the marine environment".* Environmental risk assessment is about making estimations of harm to the ecosystem from shipping activities. Shipping causes regular and accidental releases to the marine environment. Regular releases such as CO_2, NO_x and garbage releases are regulated by the IMO.

An FSA application could be used to assess these risks, however, the present discussion is focused to accidental releases since FSA is the tool that will be

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[3] See Skjong et al (2005). This document can be downloaded from the SAFEDOR web site (www.safedor.org) . SAFEDOR is a research project of the European Commission (6th Framework Programme).

used to evaluate the cost and benefits of the options that will be proposed by the IMO to reduce the risks coming of these unwanted releases. Unwanted releases are divided into two main categories. The first one, and most important, is **oil** and the second is **non-oil** and include e.g. chemicals, sewage water, and radioactive materials. The major reasons for these releases are operation procedures and accidents. Operations include loading, discharging of cargo and bunkering and accidents include collisions, groundings, hull failures etc.

SAFEDOR's deliverable focuses on **oil spill pollution**. There is no doubt that oil spills represent an important type of marine environmental damage. **Focusing on oil spills** will essentially narrow the assessment of marine environmental risk basically to the design and operation of tankers**,** whereas other risks such as hazardous substances or land-based pollution may be just as important, or even more so. But this is not the main problem, in our opinion.

RISK INDEX RELEVANT TO MARINE POLLUTION

The first step in assessing environmental risk is to construct a risk index similar to the one that is currently used to assess effects on human safety and ships. Actually, there is just the need to modify the Severity Index (SI) since the Frequency Index as described in the Guidelines could be used unmodified.

Frequency Index			
FI	FREQUENCY	DEFINITION	F (per ship year)
7	Frequent	Likely to occur once per month on one ship	10
5	Reasonably probable	Likely to occur once per year in a fleet of 10 ships, i.e. likely to occur a few times during the ship's life	0.1
3	Remote	Likely to occur once per year in a fleet of 1000 ships, i.e. likely to occur in the total life of several similar ships	10^{-3}
1	Extremely remote	Likely to occur once in the lifetime (20 years) of a world fleet of 5000 ships.	10^{-5}

Table 1 Frequency Index [MSC Circ. 1023]

Severity Index				
SI	SEVERITY	EFFECTS ON HUMAN SAFETY	EFFECTS ON SHIP	S (Equivalent fatalities)
1	Minor	Single or minor injuries	Local equipment damage	0.01
2	Significant	Multiple or severe injuries	Non-severe ship damage	0.1
3	Severe	Single fatality or multiple severe injuries	Severe damage	1
4	Catastrophic	Multiple fatalities	Total loss	10

Table 2 Severity Index [MSC Circ. 1023]

The use or Risk Index to assess effects on the environment is essential to

- Evaluate and rank hazards
- Focus on risk areas that need control and
- The qualitative evaluation of the effectiveness or Risk Control Measures.

[An important parenthesis: Using a logarithmic scale, the Risk Index is defined as the arithmetic sum of FI+SI=RI. There may be an inherent problem with such a definition, which collapses the two main determinants of risk (frequency and consequences) into a single number. For instance, suppose that once a month (FI=7) there is a risk that leads to a single injury (SI=1). This means that RI=8. Suppose also there is another risk where once a year (FI=5) a death occurs (SI=3). Here RI=8 as well. Is it reasonable that these two scenarios are equivalent in terms of risk? One would assume that the latter would be more serious. Also, if within a year in a 1,000 –ship fleet an accident occurs that produces more than 10 deaths, FI=3, SI=4, and RI=7. Why is that scenario less serious than the previous ones?][4]

The SAFEDOR deliverable extends this methodology to environmental (oil spill pollution) damage. Even if the above reservations are not valid, we think that some trial FSA applications have to be carried out in order to gain the necessary experience before any kind of effort is applied to reach commonly-accepted risk evaluation criteria that will be used in the last steps of the FSA application and more specific in evaluating the cost-effectiveness of the Risk Control Measures.

RISK EVALUATION CRITERIA - CATS

The SAFEDOR report discusses risk evaluation criteria in general; however, most chapters rely on past work. The major topic in this report and the one that is discussed in detail is the one that contains the risk evaluation criteria for accidental releases to the environment and the so-called **CATS** (Cost of Averting one Tonne of Oil Spilled).

It has to be noticed that the CAF value (Cost of Averting a Fatality) is based on statistical analysis of the LQI (Life Quality Index) for OECD countries.

Life Quality Index (LQI) is intended as a social indicator that reflects the expected length of "Good Life", in particular the enhancement of the quality of life by good health and wealth. The original LQI definition is given by Nathwani, Lind and Pandey (1997). A way of expressing it is somehow like this : $LQI = g^{w} \cdot e^{1-w}$

The ICAF value is determined by assuming that an option is accepted as long as the change in LQI owing to the implementation of the option (=RCO) is positive. This means that

$$ICAF = \frac{g \cdot e}{4} \cdot \frac{1-w}{w} \qquad (8\text{-}1)$$

[4] For more on this point see Kontovas, C.A. (2005) and Psaraftis and Kontovas (2006).

where
g is the Gross Domestic Product per capita
e is life expectancy at birth
w is the proportion of life spent in economic activity.

ICAF depends on LQI whick means it depends on location (country or region of interest).

On the other hand, CATS is not based in an index like this one and, thus, it depends on statistical data of costs of oil spills.

In page 55, the following assumptions are made (for simplicity):

a. Per tonne cleanup costs assumed constant with spill size
b. Per tonne cleanup costs assumed independent of oil type, ie, a generic oil type is assumed
c. Per tonne cleanup costs assumed constant within certain locations
d. Per tonne cleanup costs assumed independent of all other factors.

It is very hard for us to justify these rather drastic assumptions, particularly given there is ample reference in the literature (see for instance the work of Etkin, among others), that the cost of oil spills on a dollar per tonne basis depends on a variety of parameters and has a broad variance.

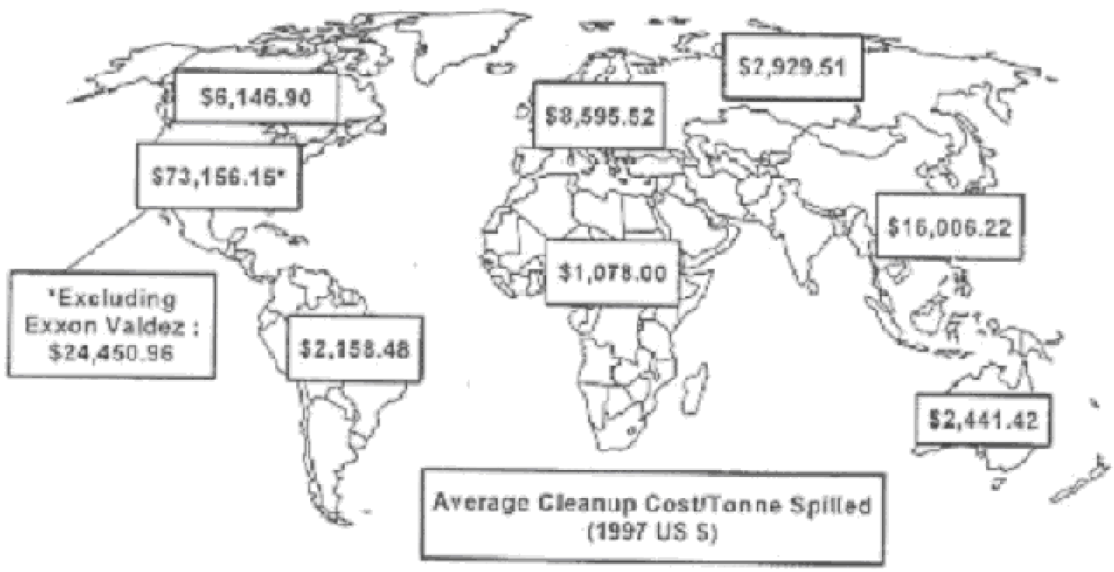
According to ITOPF (see White and Molloy,2005), factors that determine the clean-up cost of spills include:

- Type of oil
- Amount of oil spilled and rate of spillage
- Physical, biological and economic characteristics of spill location
- Wheather and sea conditions
- Time of the year
- Effectiveness of clean-up

In general, costs involved in oil spill incidents include

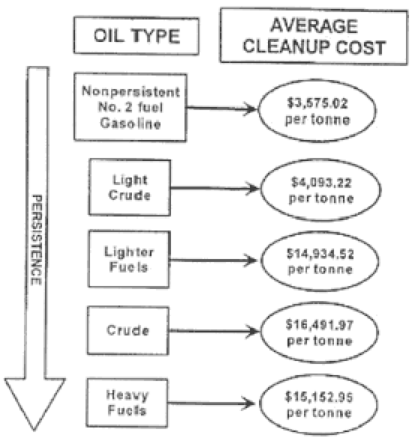
- Clean-up costs
- Indemnification of the owner and
- Compensation costs to third-parties

The CATS value of $60,000 per tonne given in the SAFEDOR report is based probably on statistical data but it is not absolutely clear where this exact value is based on. As recently as 7 February 2006, MSC 81/18 cites this SAFEDOR report and claims that the latter concludes with a $19,000 per tonne value. In fact, in page 60 of the SAFEDOR report, a $63,000 per tonne value is given, based on US spill scenarios. In page 59, formula (4.5) gives F*30,000, implying that F=2 (not clear why). Arguing how the 30,000 and 63,000 figures were arrived at and why F=2 may be a difficult proposition. The same is true for the assertion that 1<F<3. Last but not least, there is no justification or evidence that condensing such a broad range of values into one single number makes sense, much less into the $60,000 per tonne figure (or the $19,000 one for that matter).



The above figure illustrates the average cleanup cost per tonne spilled (in 1997 U.S. dollars), based on analysis of oil spill cost data in the OSIR International Oil Spill Database. It testifies to the broad variation of values on a per tonne basis.

This leads us to believe that the only way to justify this CATS value is probably that it is based on the OPA 90 overall cost effectiveness for the period (1996-2025) -- which is an estimation that includes the next 10 years and therefore its highly over-estimated. According to that assessment, the overall effectiveness corresponds to 63.000 $/tn. But even in the case that this value was correctly estimated (for which we have serious reservations), we feel that such a high value cannot be used as a risk evaluation criterion for the whole planet, let alone for policy purposes.



Average cleanup cost depending on oil type and persistence (in 1997 U.S. $), based on analysis of oil spill cost data in the OSIR International Oil Spill Database (Etkin,1999)

It has to be noticed that in the literature average values are between 8.000 – 14.000 $ per tonne. Extreme values are encountered in oil spills less than 7 tonnes and in estimations of US authorities (USCG, US Environmental Protection Agency etc.)

For some additional considerations on how much one would be willing to pay to avert oil pollution damage, see Psaraftis, et al (1986) (a pollution response perspective).

CONCLUSIONS

The need of IMO (and other regulatory bodies) to assess environmental risk and formulate relevant policy necessitates the development of a risk matrix to assess effects on the environment. The use of risk matrices is crucial in Formal Safety Assessment and can be, also, used in qualitative risk assessments. After gaining the needed experience, quantitative criteria to evaluate cost effectiveness could be discussed. In any case, any criterion like the CATS should have a strong theoretical background and should be based on assumptions that can be justified. The SAFEDOR deliverable may be a useful contribution towards such an objective, but in our opinion we still have a rather long way to go.

Therefore our main conclusion is that although the SAFEDOR report is very interesting, it includes a wide spectrum of assumptions (in both data and methodology) that would make the adoption of such a figure (or any other single one, for that matter) very questionable. A fortiori, we feel that it would be rather premature if this (or any other) single figure is adopted for environmental policy formulation by IMO or other bodies, without further analysis.

References

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