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FORMAL SAFETY ASSESSMENT

Report of the Correspondence Group on Environmental Risk Evaluation Criteria

Submitted by Greece

SUMMARY	
Executive summary:	This document reports on the outcome of the work of the correspondence group on environmental risk evaluation criteria
Action to be taken:	Paragraph 39
Related documents:	MEPC 55/18, MEPC 56/18, MEPC 56/18/1, MSC 83/INF.2

Introduction

1 MEPC 56 noted that the one matter that needed consideration within the context of the Formal Safety Assessment Guidelines relevant to the work of the Committee was the draft Environmental Risk Evaluation Criteria.

2 The Committee recalled that MEPC 55 had considered the draft Criteria set out in annex 3 to document MEPC 55/18 and agreed that the draft criteria still needed in-depth consideration from the marine environment protection perspective. Subsequently, Members were invited to give their views on the draft Environmental Risk Evaluation Criteria for consideration by MEPC 56.

3 The Committee also recalled that MSC 82 considered whether this agenda item should be included in the agenda for MSC 83 and, recognizing that there may be an outcome of MEPC 56 regarding Environmental Risk Acceptance Criteria and other submissions at MSC 83, agreed to retain the item on the provisional agenda for MSC 83.

4 The Committee considered document MEPC 56/18/1 (Greece) which drew attention to some issues pertaining to the development of Environmental Risk Evaluation Criteria and emphasized that the need of the Organization (and other regulatory bodies) to assess environmental risk and formulate relevant policy necessitated the development of a risk matrix to assess effects on the environment. In the view of Greece, the use of risk matrices was crucial in Formal Safety Assessment and, only after gaining the needed experience, quantitative criteria to evaluate cost effectiveness could be discussed. In this regard, any environmental risk evaluation criterion should have a strong theoretical background and should be based on assumptions that could be justified.

5 All the delegations that spoke supported, in principle, the proposal put forward by Greece, to carry out a more in-depth analysis of the proposed environmental risk assessment criteria for the purpose of the Formal Safety Assessment (FSA) and for the inclusion of such criteria in the IMO FSA Guidelines (MSC/Circ.1023 − MEPC/Circ.392, as consolidated in MSC 83/INF.2).

6 The Committee recognized that environmental risk assessment criteria are still under development and there is limited experience on their practical application. In this connection, the Committee agreed that gaining practical experience with risk acceptance and cost benefit criteria is of importance to establish the criteria and threshold values for use in the decision-making process in the future.

7 The Committee, noting that further work, including more research, was needed on the subject, agreed to establish a correspondence group, under the co-ordination of Greece, with the following terms of reference:

.1 to review the draft Environmental Risk Acceptance Criteria as set out in annex 3 to document MEPC 55/18, taking into account document MEPC 56/18/1 (Greece) and the comments made in plenary with a view to finalize the Criteria; and

.2 to submit a written report to MEPC 57.

8 The following Member States, intergovernmental and non-governmental organizations participated in the work of the correspondence group:

Canada, Denmark, France, Ghana, Germany, Greece, Japan, Malaysia, Netherlands, Norway, United Kingdom and United States; the International Oil Pollution Compensation Funds (IOPC Funds); the International Association of Classification Societies (IACS), the International Association of Independent Tanker Owners (INTERTANKO), and the International Tanker Owners Pollution Federation Limited (ITOPF).

Method of work

9 It was first realized that the time for completing the work of the correspondence group on time for submission to MEPC 57, and as per the terms of reference, was rather short. To that effect, members of the correspondence group submitted input in two rounds of submissions. The first round mainly included reaction to documents MEPC 55/18 and MEPC 56/18/1. The second round also included feedback to and discussion of submissions of the first round. There has been no feedback to or discussion of submissions of the second round. A web site with submissions and supporting material was created and maintained.

10 First round submissions were received by Norway, the United States, INTERTANKO, Germany and ITOPF, in that order. Second round submissions were received by the United Kingdom, the United States, Greece, Denmark and again the United Kingdom, in that order. Members of the correspondence group were given an opportunity to comment on a draft version of this report, and some did. Some of these comments were taken on board in the final version of the report. All submissions are set out at annex to this document and are listed in the chronological order in which they were received.

Scope of work

11 Some words are necessary on the scope of this work. At its broadest interpretation, an analysis of environmental risk criteria in maritime transport certainly should not be confined to oil pollution, let alone pollution from oil tankers. In fact, the spectrum of the potential environmental consequences of a maritime accident is very broad, encompassing not only spills of cargo carried by oil tankers, but, among others, bunker spills from any ship, shipbuilding and ship recycling residues, ballast water, coatings, garbage, sewage, gas emissions, noise, radioactive and other hazardous materials, bio-fouling, chemicals, other dangerous cargoes, and others. The approach of the United Kingdom to environmental risk criteria (refer to the annex, round 2) is perhaps the most relevant here, addressing not only oil pollution, but a broader spectrum of environmental consequences.

12 The terms of reference of this correspondence group do not explicitly rule out a broad interpretation of the term "environmental risk acceptance criteria", or even of the term "oil pollution". However, the reference to annex 3 of MEPC 55/18 and to MEPC 56/18/1, which essentially deal only with oil pollution, implicitly limits the scope of the analysis by this correspondence group.

13 If one confines the analysis to oil pollution, the question is whether it should be confined only to 'cargo spills' from oil tankers, or include oil pollution from any ship. As ITOPF points out (refer to the annex, round 1), "the exclusion of bunker spills from the discussion misses one of the most important and obvious trends in recent years, namely that bunker spills have taken on greater-than-ever importance in relation to tanker spills of oil cargo." Based on this, confining the analysis only to cargo spills from oil tankers is probably too restrictive.

14 Thus, and although no explicit debate on this issue took place within the correspondence group, it is at least implicitly understood that the coverage of this analysis is limited to oil pollution from all ships, bunker spills included. In that respect, an analysis of other types of environmental consequences from the point of view of FSA is outside the terms of reference of this correspondence group and would come later.

15 The following paragraphs 16 to 38 highlight the main points made by members of the correspondence group, the main issues at stake, and the way ahead. For the full views of those who responded, one should refer to the annex.

MEPC 56/18/1

16 Document MEPC 56/18/1 (Greece) pointed out some weaknesses in the present proposals for environmental risk acceptance criteria, as discussed in annex 3 to document MEPC 55/18, and urged further proposals and discussion. Among others, it touched upon the following issues:

.1 it argued that an agreed Environmental Risk Index to be used in Step 1 of the FSA for hazard ranking should be developed before the development of Risk Acceptance Criteria (paragraph 10);

.2 it argued on the need to develop a Severity Index appropriate for measuring the effects on the environment (paragraph 12);

.3 it argued that the ALARP region limits (what is intolerable and what is negligible) and the slope of -1 need to be discussed and debated. A relevant question is "what is more important to prevent in society's view? A rare catastrophic event, or frequent events of smaller damage to the environment – such as bunker pollution?" (paragraphs 15 and 16);

.4 it argued at length why CATS (the cost to avert one tonne of spilled oil) is not an appropriate criterion (paragraphs 19 to 22); and

.5 the way CBA is performed and the associated use and value of the factor "F" should be discussed (paragraph 23).

Environmental Risk Index/Matrix

17 Referring to the first step of any FSA (Hazid), much of the discussion in the correspondence group focused on what might be a proper environmental risk index, or a proper environmental risk matrix. The development of such a risk index was actually decided upon as early as MSC 81 (refer to MEPC 55/18, paragraph 20). The FSA guidelines (as consolidated in MSC 83/INF.2) refer to a risk matrix in which the Risk Index (RI) is defined as the sum of the Frequency Index (FI) and Severity Index (SI). The definition of RI as the sum of FI+SI follows the definition of risk as the product of "frequency ∗ consequence" and the adoption of a logarithmic scale for both FI and SI. FI is defined in terms of frequency of accidents (number over ship-years) and SI is defined in terms of equivalent fatalities.

18 In order to extend this concept to cover for environmental consequences, it comes as no surprise that little or no changes in the definition of the Frequency Index (FI) should be necessary, and in fact none of the correspondence group members who contributed presented this is an issue. By contrast, much discussion took place regarding the appropriate definition of the Severity Index (SI). Some members pointed out that there may not be a single variable that can capture all environmental consequences. However, if one wants to define SI in terms of *one* variable, as is done in FSA, the question is, which one is the most appropriate?

19 Annex 3 of MEPC 55/18 does not refer to the Hazid step or to a risk index as such and therefore does not touch upon the issue of an environmental risk index explicitly. But it puts forward two concepts which touch upon it implicitly. First, the variable of **recovery time** is shown as a measure of damage (refer to MEPC 55/18, annex 3, Table 1 and Figure 3). This variable runs from less than a year ('minor' damage) to more than 10 years ('serious' damage).

20 Interestingly enough, the second concept that annex 3 of MEPC 55/18 puts forward leads to a different criterion. This is the "cost of averting a spill" criterion, which is very much linked to what project SAFEDOR termed CATS (cost to avert a tonne of spilled oil). According to this, the variable that should be chosen as representing the consequences of oil pollution is **oil spill volume**.

21 For the Hazid step, correspondence group members debated which of these two variables, i.e., recovery time, or oil spill volume, is more appropriate as a consequence criterion, although many of them pointed out that more than one variable is necessary to capture environmental consequences. The positions of Greece and the United States were more in favour of recovery time, while those of Germany and Norway were more in favour of spill volume. ITOPF argued that no right or wrong risk matrix exists, but argued at length on why spill volume is not an appropriate criterion (see also next section). The United Kingdom defined a severity index based

on the economic consequences of environmental damages. INTERTANKO did not touch upon the issue of the risk matrix directly, but argued at length on the deficiencies of spill volume as a criterion (see also next section).

22 Four types of severity indices were proposed as alternatives by correspondence group members. Already in MEPC 56/18/1, Greece had proposed that the NORSOK Standards Z-013 severity index be discussed and debated.

SI	**Severity**	**Effect on the environment (recovery time)**
1	Minor	Between 1 month and 1 year
2	Moderate	Between 1 and 3 years
3	Significant	Between 3 and 10 years
4	Serious	In excess of 10 years

With the possible addition of (refer to annex, round 2):

5	Disastrous	In excess of 100 years

23 Norway (refer to annex, round 1) proposed a severity index for accidental oil release which is based on oil spill volume, as follows.

SI	**Severity**	**Oil spill volume**
1	Minor	< 1 tonnes
2	Significant	1-10 tonnes
3	Severe	10-100 tonnes
4	Catastrophic	100-1,000 tonnes

With the possible addition of

5	Disastrous	>1,000 tonnes

24 The United Kingdom proposed a much more elaborate severity index, based on the economic consequences of environmental damage (refer to annex, round 2). Last but not least, Denmark proposed a composite severity index, which includes a combination of several variables, including oil spill volume and recovery time (refer to annex, round 2).

25 No final consensus on the issue of the environmental risk index or matrix was reached by the correspondence group. It may, however, be worthwhile to point out that expressing the environmental consequences in terms of recovery time has the advantage of being able to keep the same criterion whenever the scope of this analysis is extended to some environmental consequences other than oil pollution, which is not the case if oil spill volume is adopted as the consequence variable.

Cost based on spill volume – CATS

26 The issue on whether in the Cost-Benefit Assessment (Step 4 of the FSA) one should use spill volume as the key variable is very much related to the previous issue, as it is clear that there should be a close connection between the Severity Index of the Hazid step and any quantitative criterion used in the CBA.

27 A lengthy discussion among correspondence group members took place on this issue. The main thrust of Greece's position in MEPC 56/18/1, pointing out the deficiencies of basing cost calculations on spill volume, was by and large supported by various arguments by the United States, INTERTANKO, the United Kingdom, and to some extent ITOPF. INTERTANKO presented an elaborate analysis on the components of the cost of oil pollution,

and so did the United Kingdom. The United States stated that it had tried using a generic cost equivalent value for a barrel of oil or substance spilled, not spilled, or recovered, but no longer uses it due to regional differences and dependence on other attributes of casualty events. At the other side of the argument, Germany and Norway supported the CATS concept (cost to avert a tonne of spilled oil), proposed by project SAFEDOR, and already alluded to in MEPC 55/18. ITOPF argued on the deficiencies of CATS, but also indicated that an index similar to CATS in terms of simplicity should be devised, and an appropriate value should be decided.

28 As regards the value of factor F used to determine the value of CATS (paragraph 23 of MEPC 56/18/1 and SAFEDOR report), Greece had argued in MEPC 56/18/1 that it should be the subject of discussion. Norway found Greece's position that F should not be inferred from previous legislative action as radical, as the Organization often uses this approach (principle of equivalency). Greece pointed out that the estimated value of F=2 in SAFEDOR (and in MEPC 55/18, annex 3) is not calculated from first principles, but inferred upon in reverse, so that previous legislative action, and specifically OPA 90, is on average compatible to a threshold of CATS = $60,000/tonne. The United States found no justification on the value of F being between 1 and 3.

29 Members of the correspondence group, not in favour of CATS, did not propose an immediate alternative for it, noting that this could be the subject for further research, discussion and debate. The United States supported the use of the consequence portion of the risk analysis equation as represented through recovery times because environmental damage is typically determined using the following criteria:

.1 type of material spilled;

.2 amount of material spilled;

.3 rate of spill;

.4 time of year that the spill occurs;

.5 location of spill;

.6 habitat impacted;

.7 clean up speed and effectiveness.

30 Greece suggested, as one idea, a non-linear function or even several non-linear functions which may or may not be linked. This does not mean that each ship type or each oil type will have to apply a different criterion. As a crude example only, it stated that (since location of spill is much more important than size) several regional criteria can be combined in one function using a "frequency of passage factor" based on the most frequent sea routes (for which data exists).

31 The United Kingdom presented a lengthy discussion of various techniques, including:

.1 cost-benefit analysis;

.2 cost-effectiveness analysis;

.3 cost-utility analysis.

Cost utility analysis is particularly useful where FSA studies are trying to evaluate effects on amenity and wildlife because “benefit” and “effectiveness” are difficult areas to apply economic evaluation criteria.

32 INTERTANKO proposed that sufficient time be devoted to developing environmental risk acceptance criteria that can meet the needs of MEPC and IMO to develop a *reliable yet simple* methodology, while not ignoring the most obvious factors that influence costs. Developing a methodology that incorporates the factors that influence both cleanup and environmental costs, particularly with regard to oil type and region, will provide a more accurate estimate of those costs while not setting up a system that will cause discord with regard to the applicability of those costs to individual situations or regions.

F-N diagrams and ALARP regions

33 Greece and the United States felt that F-N diagrams are very important, particularly for policy making. Among the issues that are currently open, is agreement on the boundaries of the ALARP regions in the F-N diagrams, and obviously the issue of what is the variable of the horizontal axis: spill volume, recovery time, or other. Germany stated that no diagram to evaluate societal acceptance of environmental risk for use at IMO was proposed in MEPC 55/18, annex 3. The slope of the ALARP border being -1 is also the subject of discussion, but the correspondence group could not resolve this issue. The United States agreed with Greece that there is no current basis for a slope of -1. Germany offered as starting point for a later discussion oil spill data which was plotted in a format similar to F-N-diagrams.

Summary

34 The following table attempts to summarize the main issues discussed by the correspondence group which are currently open and merit further discussion.

Issue	Comment
Decide on appropriate Severity Index (SI) in Hazid step.	No consensus was reached on what should be the consequence variable.
Decide on CATS versus alternative criteria.	No consensus was reached whether CATS or an alternative criterion would offer the needed decision-making quality.
Decide on boundaries of ALARP region, slope of F-N diagram and what is the variable of horizontal axis.	Slope of -1 questioned by two correspondence group members, but no consensus was reached on alternative proposals.

Final comments

35 Complementing what is included in the rest of this report, the following comments were requested for inclusion.

Norway

36 In Norway's opinion, using recovery time as a severity parameter is not possible. As stated during MEPC 56, we should strive at global parameters. We fully accept that recovery time is better than CATS, and it has been used in area specific studies also in Norway, however recovery time is not a common global parameter, it is a very area specific parameter. FSA is IMO's tool for decision-making in developing *global* regulations for ships, hence area specific parameters should be avoided. It should be noted that CATS has already been used in a few FSAs.

United Kingdom

37 The United Kingdom recognizes that both the criteria to be used, and their values, were unlikely to be agreed universally as applicable to every FSA study. The preferred approach was to give those involved in FSA studies a list of criteria to be considered for inclusion, and a range of values for them (with supporting evidence). During the FSA study scoping stage, the study team could review and select the criteria to be used.

Conclusion

38 In accordance with its terms of reference, the correspondence group has reviewed the Environmental Risk Acceptance Criteria, as set out in annex 3 to document MEPC 55/18, and document MEPC 56/18/1 (Greece), and discussed the relevant issues. Even though the scope has been limited to oil pollution, it is apparent that the relevant issues are of non-trivial complexity and solutions addressing all of them could not be obtained within the short time frame allocated to the correspondence group. This is particularly true given the divergence of views on some important facets of the problem. In view of this, the work of the correspondence group should not be considered as the end of the analysis of environmental risk criteria in FSA. In spite of the differences, the members of the correspondence group agree that progress has been made and additional work should be conducted without delay so as to advance the state of knowledge in this area, but more important, to enable use of realistic and more universally accepted criteria in future FSAs which may be forthcoming due to the urgent environmental focus of legislators and the public. Realistic and feasible suggestions to address environmental criteria, but no alternative for the cost-effectiveness criteria CATS, were put forth by members of the group, and there is hope that finalization of same could be achieved in the foreseeable future.

Action requested of the Committee

39 The Committee is invited to consider the report of the correspondence group and decide on further action on this topic as appropriate.

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ANNEX

SUBMISSIONS BY CORRESPONDENCE GROUP MEMBERS
(Listed by chronological order of receipt)

ROUND ONE OF SUBMISSIONS

NORWAY (*received: 31 August 2007*)

At MEPC 56, document MEPC 56/18/1 was only briefly discussed and the plenary at MEPC is not the place to go into detailed discussion on the document.

Norway do, however, have several comments to the content of this document as follows:

In paragraph 3 it is concluded that: Environmental risk assessment is about making estimations of harm to the ecosystem from shipping activities.

In our view this may be questioned in the context of FSA, as FSA is about IMO's options for reducing the risk (see paragraph 1), it is not always necessary to analyse all effects to all potentially affected ecosystems. The system boundary for an IMO FSA could be the ship, as the IMO regulations/RCOs relates to the ship. This is also the reason that CATS is a practical parameter.

In paragraph 10, the term risk index is used rather than risk acceptance criteria, and it is stated that a risk index should be agreed prior to agreeing the risk acceptance criteria. We disagree with this, and think there might be some misunderstandings here. The risk index is only used in a subjective ranking in FSA-Step 1: Hazid. The index is defined in log-log form (since risk = frequency x (severity of) consequence, hence RI=FI+SI). Therefore we only need one anchor point for SI for environment. The problem is therefore solved by agreeing on, e.g., CATS (for accidental oil releases).

It follows from the above that we disagree with the proposal in paragraph 13, quoted from NORSOK (which is for offshore). The proposed index (not proposed by [1]) can only be used for a ship that is located on one fixed location (like an offshore installation), where the environment at the location is known. Since a ship, when approved, can sail anywhere, we need an index that does not rely on such local details. We also strongly disagree that up to 1 year recovery time should be referred to as minor, or an excess of 10 years' recovery time is referred to as Serious. Norway would propose to use much stronger words, e.g., by changing serious to catastrophic or disastrous. For example in LMIS a serious accident is defined by referring to structural damage, unseaworthy, penetration of hull under water, etc. This is clearly much less serious than excess of 10 years recovery time.

We would rather equate to safety by saying that since SI=3 corresponds to one fatality, and is referred to as a severe accidents, severe (SI=3) should correspond to the accidental release of 50 tonnes (as 1 CAF=50 CATS), or 10-100 to indicate a range.

Based on this logic and keeping the agreed terminology we would arrive at

Severity Index for Accidental (oil) release		
SI		
1	Minor	< 1 tonnes
2	Significant	1-10 tonnes
3	Severe	10-100 tonnes
4	Catastrophic	100-1,000 tonnes

And maybe add

5	Disastrous	>1,000 tonnes

The statement in paragraph 14 that the proposal in MEPC 56/18/1 would not alter the IMO FSA Guidelines is incorrect. The terms used are those in the table above and not those proposed in MEPC 56/18/1 (minor, moderate, significant, serious).

In paragraphs 14 and 15, MEPC 56/18/1 is attacking its own proposal (made in paragraph 13, by picking a proposal from NORSOK). This information is only presented as background information on 'how others do it' in [1], and is not taken forward as a proposal for use. The figures are also plotting 'annual frequency', without indicating fleet year or ship year as would be required if the proposal was meant for ships.

In our view the FO (FO diagram, O for oil and not N for fatalities) risk acceptance diagram is not very important. Presumably the current fleet is in the ALARP area, and we are looking for RCOs based on cost-benefit. (As we have relevant information we may revert with a proposal for an RO later.)

Paragraph 18 is based on a misconception of what the CATS criteria is meant to be used for. CATS=$60,000 is proposed as the cut-off value for a marginal return of investing in risk reduction. In MEPC 56/18/1 this marginal return is used for the complete release, disregarding diminishing returns. For example, since ships have to float they are watertight, so there will not be a release of oil for an intact ship. The marginal return is zero. It takes an accident (of probability in the order of 10^{-2} per ship-year) to have a positive CATS.

When in the same paragraph, CATS and CAF are misused consistently, the order of magnitude seems correct, as the public outcry would be similar for a catastrophic accident with a large cruise ship (6,000 fatalities) as a catastrophic accident with a tanker.

We can in some way agree with the statements in paragraph 20. However, the point is more that in evaluating RCOs for ships sailing globally there are a lot of variations in where and how accidents could happen and evolve that IMO can not realistically consider in a regulation. For example, the design measures/RCOs/regulations are often the same irrespectively of cargo and the potential to pollute. In the FSA terminology this implies that the implicit CATS are the same. For example, tankers are sailing with the environmentally most unfriendly (dirty/heavy) oil when they get old (and less safe) because they are getting difficult to keep clean for transporting the lighter fuels. This just demonstrates that in current and probably all future IMO regulations there are variations that can not practically be accounted for, when the end result is a ticket to trade internationally. But certainly, there could be more discrimination on the potential pollution.

In our view we should first establish a CATS value, and thereafter establish a table of CATX/CATS (where X is other pollutants).

Paragraph 21: As indicated above, the risk acceptance criteria should be realistic, we should focus on what can be used in evaluation to RCOs, not on the numerous effects that can not be accounted for in a risk analysis of a generic ship, and we should be open to better proposals. In MEPC 56/18/1 there is no such proposal. The Norwegian data in Figure 20 in [1] indicates a strong correlation between cleanup cost and spill size, other data indicate a less clear correlation – and obviously for cleanup cost there is a mobilization cost. To focus on cleanup cost only is not correct, it is just an indication of a lower limit for investment in RCOs, as prevention is better than cure.

Paragraph 22: We agree, but is it realistic to have different ship design dependent on:

(a) type of oil;

(b) location of oil spill (e.g., implying different designs dependent on where the ships are sailing. Is the proposal by Greece to have many different classes of tankers dependent on where they can sail?);

(c) weather and sea condition (add ice here and Norway could agree);

(e) time of year;

(f) effectiveness of cleanup.

In general we are of the opinion that the Greek proposal seems very unrealistic.

Paragraph 23: This can obviously be discussed, but it is not likely that the difference in design (and regulations) will be strongly dependant on the exact CATS value (it is a cut-off for a marginal return!). It is also noted that the proposal in [1] is in agreement with the average value in OPA 90, and insurance factors can be read from the annual report of insurance companies.

In the last sentence it is stated that 'the value of F should not be inferred from previous legislative action'. If this is a principal view, it is certainly radical, as IMO often use this principle (principle of equivalency (example new FP/Reg 17) and harmonization (example: New damage stability).

Paragraph 28: We disagree. The risk matrix (used in Hazid) follows from the criteria (not vice versa), see comment above.

REFERENCES

[1] SAFEDOR D4.5.2 at www.safedor.org

UNITED STATES (*received: 13 September 2007*)

Response to MEPC 55/18, annex 3:

Environmental risk evaluation criteria will be used within the Formal Safety Assessment (FSA) process to evaluate and prioritize risks, and risk management options. As such, these criteria will have a major influence on any work undertaken by IMO. Given the impact of this work, the development of environmental risk evaluation criteria should be technically sound, and should involve all stakeholders.

Specific comments:

- Lacks background information

The proposed criteria in MEPC 55/18, annex 3 provides a good starting point for discussions, however, it does not provide enough background information for the risk criteria and limits. The paper needs more rigor and supporting data to provide a basis for the proposed assumptions, criteria and methodology.

For example, the basis for the policy insurance parameter is unclear. On page 6 of MEPC 55/18, annex 3, F (property) is set equal to zero to isolate prevented spillage. Perhaps F (fatalities) should be stated as equal to zero as well.

- Narrow focus

The focus of MEPC 55/18, annex 3 is too narrow since it primarily discusses accidental oil spills from tankers. This may be appropriate if the transport of oil in bulk will be the only consideration. However, there is the occurrence of "regular releases" from non-tank vessels, i.e., the release of ballast water, and dry cargo sweeping.

- Assumptions

The assumption that costs are independent of oil type and independent of spill size and geography seems inappropriate. The fact that 1) heavy oil sinks, light oil floats, and gases evaporate, and that 2) the per ton cleanup cost is also decreasing as tons spilled increases leads one to believe otherwise. Furthermore, the Oil Spill Intelligence Report notes that the most important factors in determining cost per ton are location, oil type, and amount of oil spilled.

- Our experience

The United States uses a cost effectiveness calculation to monetize and compare competing regulatory alternatives for prevention or mitigation of spills. For regulatory analysis, this calculation usually uses the cost (of the rulemaking) divided by the number of barrels not spilled (based on historical casualty spill data). The lower the costs and the greater the barrels not spilled or recovered, the more cost effective the measure.

The United States no longer uses a generic cost equivalent value for a barrel of oil or substance spilled, not spilled, or recovered. In the past, this generic cost equivalent value had been applied. However, this practice has since stopped based on the premise that the cost of an oil spill is not the same nationally, and in most cases regionally, and depends on the attributes of casualty events (i.e., oil spill in the Houston shipping channel vs. an at-risk New England fishery). Due to this, it will be difficult to determine a universal value for "Cost of Averting one Tonne of Oil Spilled."

- Scope

Environmental risk evaluation criteria, if adopted, should have a disclaimer that its use is limited and does not replace government guidance for the use of risk in regulatory development, including regulatory impact analysis. Language that specifies the scope and purpose that MEPC 55/18, annex 3 can have (i.e., for non-regulatory risk and emergency preparedness analysis) should be included.

- Cost

The economic costs associated with oil spills, the unknowns about costs, and the concept of the willingness to pay to prevent or keep a barrel of oil out of water – these issues are crucial to the discussion of environmental risk. As such, these issues should be addressed up front.

For example, important factors to consider in determining cleanup costs of oil spills are: spill size, oil type, location, response methodology, and on-water response effectiveness.

Response to MEPC 56/18/1:

In line with Greece's position, the United States does not support the environmental risk evaluation criteria presented in MEPC 55/18, annex 3.

It is inappropriate to use a single criterion (in this case, "Cost of Averting one Tonne of Oil Spilled") to represent effects on the environment. As safety is multifaceted, so too is environmental consequence estimation. The CATS criterion addresses oil spill cleanup costs, but is likely to exclude environmental effects on birds, marine life, recreation, and perhaps even commercial shipping.

There will be difficult international differences to reconcile, such as the cost of labour and technology used around the world for spill response. In addition, different habitats and ecosystems have different potential costs for rehabilitation. Thus, perhaps an ecosystem type approach would be appropriate.

Specific comments:

- Paragraph 14

It is not necessarily the case that if the aforementioned four-category Severity Index is used, that the resulting risk matrix is the same as the one currently in use (MSC/Circ.1023 – MEPC/Circ.392). Consequence categories must first be determined to be equivalent through some economic analysis that ensures they are equivalent. Obstacles to this will be:

1) agreeing to the statistical value of a human life;

2) estimating and monetizing environmental impacts like loss of recreation, or species extinction.

- Paragraph 15

The United States agrees that there is no current basis for a slope of -1.

- Paragraph 26

A regression analysis may be a worthwhile project. Other important variables might likely be location of spill, type of oil, availability of response assets, etc. It will be complex to factor in total costs, especially those difficult to quantify like species impacts, recreational impacts, scenic impacts, etc.

INTERTANKO (*received: 17 September 2007*)

Herewith please find our preliminary comments on the proposed MEPC Environmental Risk Acceptance Criteria (MEPC 56/18/1).

Cleanup costs of oil spills

The most important factors in determining per-tonne oil spill cleanup[1] costs are: spill size, oil type, location, response methodology, and on-water response effectiveness[2]. These factors are interrelated with regard to their influence of cleanup costs:

- **Spill size** is not linearly related to per-tonne cost. Smaller spills of a minimum threshold size will often require much of the same initial mobilization and management costs are larger spills. When the total costs are averaged over the entire spill volume, the costs are lower with larger spills.

- **Oil type** determines the behaviour and impacts of oil, particularly with regard to the degree of evaporative loss, persistence, and propensity for becoming submerged. These factors can significantly affect cleanup costs[3]. The cost of cleaning up a smaller heavier fuel spill may be significantly higher than the cost of a much larger diesel or light crude spill, for example.

- **Location** is one of the most important factors in determining cleanup costs for a number of reasons. The proximity to the shoreline and sensitive environmental and socioeconomic features determines the degree to which shoreline cleanup will be necessary. This phase of cleanup operations is often the most expensive due to the labour requirements. The location in relation to the shoreline also determines whether dispersant chemical application will be possible with regard to local or national regulations and

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1 Clean-up is defined as removing the oil from the environment and preventing and managing the spread of oil. Costs associated with oil spill clean-up include the costs of labour and equipment, dispersant chemicals, management, logistics, source control (preventing further leakage from the spill source), and oil disposal. Specifically excluded are costs to rehabilitate the environment.

2 Etkin, D.S. 1998. *Financial Costs of Oil Spills in the US*, Cutter Info. Corp., Arlington, MA, 346 pp.; Etkin, D.S. 1999. Estimating clean-up costs for oil spills. *Proceedings of 1999 International Oil Spill Conference:* 35-39.;
Etkin, D.S. 2000. Worldwide analysis of oil spill cleanup cost factors. *Proceedings of 23rd Arctic and Marine Oilspill Program Technical Seminar*: 161-174.;
Etkin, D.S. 2004. Modeling oil spill response and damage costs. *Proceedings of 5th Biennial Freshwater Spills Symposium.*
Etkin, D.S., D. French McCay, and J. Rowe. 2006. Modeling to evaluate effectiveness of variations in spill response strategy. *Proceedings of 29th Arctic and Marine Oilspill Program Technical Seminar:* 879-892.
Etkin, D.S. 2005. Development of an oil spill response cost-effectiveness analytical tool. *Proceedings of 28th Arctic and Marine Oilspill Program Technical Seminar:* 889-922.

3 Oil type also has a significant effect on the degree of environmental impact with regard to toxicity (lighter fuels are more toxic than heavier fuels, e.g.) and persistence (heavier oils can remain in sensitive habitats for longer time periods as well as coat bird feathers more readily than lighter oils).

potential effectiveness[4]. The location also determines the degree to which logistics (getting response equipment and personnel on site, reaching the impacted shoreline areas, providing support for personnel, and disposing of oily waste) will affect costs. Local and national regulations also determine the degree of vessel owner liability, which can also affect costs. While in most nations, the levels of liability and potential damage compensation are determined by the CLC and IOPC Fund, there is *unlimited* liability in a number of US coastal states and in all states under certain circumstances as allowed by OPA 90[5]. In addition, local and national standards with regard to "how clean is clean" can have a large impact on cleanup costs. The "how clean is clean" criteria will also be determined by the degree to which sensitive sites are impacted. A spill in a heavily industrialized area that is already considerably polluted will usually require less of a cleanup response on shoreline areas than a spill that is in a relatively pristine location or near a sensitive aquaculture facility or drinking water source. The nature of the shoreline will also determine the type of response that is feasible and advisable. A sensitive location such as a wetland will require intense labour and careful work in comparison to a sandy shore where bulldozers may be employed. Location also determines the cost of local labour which is employed for shoreline response as well as for other response activities. A labourer working on the coast of West Africa or in Asia will generally be paid less than a shoreline response contractor on the United States or United Kingdom coasts.

- **Response methodology and strategy** can have a large impact on costs[6]. Overall, a response strategy that relies on dispersant application as the primary response will reduce costs over a mechanical containment and recovery-focused strategy. Not only is the mechanical approach more expensive and labour intensive, but it also is considerably less effective than dispersants in removing oil offshore to reduce shoreline impact. Mechanical recovery generally results in a 10 – 25% recovery rate under good conditions while dispersants[7] can remove 70 – 90% of the oil when applied properly. In some cases, one or the other method is not technically or practically feasible.

- **The effectiveness of the on-water recovery/removal** operations is essential to determining the degree of shoreline impact and the costs of the ensuing shoreline operations. In addition to response methodology, rapidity of response, technical and strategic skill of responders, and the degree to which weather and other uncontrollable factors allow for a reasonable response will affect the effectiveness of on-water operations.

While it is understandable that for simplicity in developing global criteria certain assumptions and generalizations must be made, ignoring the impact of these aforementioned criteria on oil spill cleanup costs will result in average cost values that can be several orders of magnitude different from actual costs for many areas and situations. The degree to which the spills in one location or of one type are weighted in the calculation of the average per-tonne cleanup cost will affect the final outcome.

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4 Water depth and degree of mixing, as well as proximity to potential sensitive sites, such as aquaculture, will determine whether dispersant applications will be advisable.

5 Oil Pollution Act of 1990.

6 Etkin, D.S. 1998. Factors in the dispersant use decision-making process: An historical overview and look to the future. *Proceedings of 21st Arctic and Marine Oilspill Program Technical Seminar*: 281-304.

7 Technically, dispersants dilute, breakdown, and physically disperse the oil into small droplets in the water column rather than "remove" the oil.

The calculated cost of US$60,000 per tonne that was proposed by one delegation is the equivalent of 56% of the per-unit cost of *cleanup* for the **Exxon Valdez** spill (about US$107,000 per tonne in 2007 US dollars).This does not include the environmental or socioeconomic damages or settlements in that case, which amounted to at least twice as much as the cleanup costs[8]. The **Exxon Valdez** spill was the most expensive spill worldwide to date and represents an extreme case of total costs, though it is important to note that this spill was only the 35th largest tanker spill and not a worst-case discharge with a 37,000-tonne release. The per-unit *cleanup* cost of the **T/V Exxon Valdez** spill is not particularly high for the US, because, although the spill was the most expensive in world history, when the per-unit cost is divided over the total amount spilled, the cost is lower than many smaller spills, particularly those of heavy oils. Responses to heavy oil spills can cost US$160,000 per tonne or more depending on location and other circumstances. Oil spills outside of the US can also be very expensive. For example, the 4.4-tonne **T/V Sambo** No.11 spill in South Korea netted cleanup costs of US$114,000 per tonne. In this case, the persistent nature of the heavy oil and the proximity of the spill to aquaculture sites added to the higher cleanup costs. In addition, the relatively small size of the spill meant that the high costs associated with the response crew, dispersant application, and booms and other equipment were averaged over a smaller amount of spillage to drive up the per-unit cost.

While these examples represent the extreme of costs there are other spills that have considerably lower costs, particularly if the oil spill occurred far offshore, burned, involved a light oil, or was naturally or chemically dispersed. For example, the 17,000-tonne **T/V Mega Borg** spill in the US Gulf of Mexico cost about US$385 per tonne. In this case, the light crude largely burned in the offshore spill. There was little shoreline impact. The factors of oil type, location, and response type[9] dictated the lower costs in this case. Another example of a very low-cost spill is the 85,000-tonne **T/V Braer** spill, which came to about US$6 per tonne for cleanup. Here the use the dispersants and the wave action of a severe storm dispersed the oil to dramatically reduce shoreline impact.

Overall, on a per-unit basis, cleanup costs for tanker and non-tank vessel spills have been shown to range from as little as US$4 per tonne to as much as US$138,000 per tonne. The factors of oil type, location, spill size, and response determine the per-tonne costs. The problem with having a *universal* value, such as the proposed US$60,000 per tonne, is that when it is applied to specific situations (e.g., **Prestige** or **Erika** spills), there are bound to be seemingly preposterous hypothetical costs that may be calculated compared to the actual known costs. The costs may be exceedingly high or exceedingly low, depending on the circumstances of the spill. The simple reason for this is that the factors that determined the actual costs (i.e., spill size, location, oil type, response) were not taken into account in the average per-tonne cost applied.

Environmental Costs

The concept of placing a value of the environment when it is impacted raises many complex and contentious issues. In the United States, a spiller is responsible for compensating the costs of environmental or natural resource damages, as per OPA 90. While it is a relatively simple process to determine certain types of socioeconomic impacts, such loss of tourism income or impacts on commercial fishing, the environment does not come with a price tag. The manner in which the environmental damage costs are calculated has been the matter of debate, discourse, research, and legislation over the last two decades in the United States both at the federal and

[8] The addition of these costs would bring the total costs to about US$300,000 per tonne.
[9] The combustion of the oil can be considered a form on *in situ* burning.

state levels. The most commonly applied methodology now for larger spills uses the concept of habitat equivalency analysis (HEA). HEA basically determines the actual or estimated impact of the spill (through field studies and/or modelling to count numbers of wildlife and acres of habitat impacted) and then calculates the cost of restoring the environment in that location or by establishing other equivalent habitats in other locations. The theory and practice are that replanting an oiled wetland, e.g., will create a habitat where the species of birds and other wildlife that have been oiled can repopulate over a period of time.

While creating matrices of environmental risk with regard to degree and length of impact, as proposed, are an important part of determining environmental risk criteria, ultimately, there will be a need to place a specific cost figure into the cost-benefit formula. This will require an examination of the way in which these types of costs could be applied either in a global way or on a regional basis. Given the way in which costs overall vary from one region to another and the way in which different habitats and ecosystems have different potential costs for rehabilitation, a regional or ecosystem type approach would be the most accurate.

Overall Conclusion

Risk is defined as the probability of occurrence multiplied by the cost of the consequence of the occurrence:

Risk = probability x consequences

The probability of a pollution event (such as the release of oil or chemicals from a ship) occurring is relatively easily calculated based on past historical data and certain types of modelling. The risk will vary by vessel type and by location. The consequences of the events include the cost involve the cost of the spill cleanup, environmental damages, and socioeconomic damages.

In conducting cost-benefit analyses of pollution prevention measures on ships, it is necessary to develop a way to estimate the cost of the impacts of pollution so that the potential realized benefit of preventing those pollution incidents can be measured against the cost of retrofitting or redesigning ships as well as the potential costs to crew and passenger safety[10]. Ultimately, it is necessary to factor in the probability of the spill event occurring. Essentially, the risk needs to be balanced against the cost of implementing the prevention measure.

In the case of spills, it is necessary to come up with a way to measure the cost of a spill of a certain type. If a spill prevention measure (e.g., double hull) is likely to result in a reduced number of spills or a reduction in the volume of spillage, there needs to be a way to measure the cost of that "averted spillage". Some prevention measures may hypothetically reduce some kinds of spills (e.g., large releases from drift groundings) while increasing the likelihood of other types of spillage (e.g., smaller spills during refuelling). There needs to be a reliable way to measure the value of spills of certain sizes and types, to analyse, for example, the impact of many small fuel spills or fewer large spills of oil cargo.

[10] For shipowners, there is also the cost of loss of the assets of the ships in the event of an accident. That cost is not considered here.

Because the criteria described herein so significantly influence costs, we would propose that sufficient time[11] be devoted to developing environmental risk acceptance criteria that can meet the needs of MEPC and IMO to develop a *reliable yet simple* methodology, while not ignoring the most obvious factors that influence costs. Developing a methodology that incorporates the factors that influence both cleanup and environmental costs, particularly with regard to oil type and region, will provide a more accurate estimate of those costs while not setting up a system that will cause discord with regard to the applicability of those costs to individual situations or regions. Variations of models we have already developed could assist in accomplishing this task. In addition, data on marine vessel spill costs do exist for further analysis.

The cleanup cost component of the environmental risk acceptance criteria that takes into account some of these factors can be accomplished without unnecessarily adding complexity to the process. Incorporating an environmental cost component that takes into account location and oil type differences can also be accomplished. What would likely result is an algorithm that takes into account the types and amounts of crude oil and products that are being transported and the locations through which they are being transported when considering the potential costs of releases.

GERMANY (*received: 24 September 2007*)

Assessing future rules and regulations requires consideration of environmental protection in addition to human safety. Therefore, the discussion on environmental risk acceptance criteria is due and Germany supports the establishment of justified risk acceptance and risk evaluation criteria also for environmental protection.

Although the discussion appeared to have started with the publication of the cost-effectiveness criterion CATS (see SAFEDOR report D452 on www.safedor.org), the discussion has now widened and includes establishing a severity index for ranking of hazards as well as a – still unnamed – diagram to present oil spills and their cumulative frequency of occurrence and the associated societal acceptance criteria to span an ALARP area. It is important to understand that these three items are separate issues and – in the opinion of Germany – should be addressed separately.

Therefore, Germany suggests the following comments:

1. establishing a severity index for ranking of hazards
   Although the SAFEDOR report did not propose such a severity index and the use of CATS is not dependent on a severity index, such severity index is useful for ranking identified hazards in the qualitative phase (step 1 of an FSA). A new severity index should only address oil spill volume and not recovery time because recovery is dependent on oil spill location. As anchor point, SI=3 (severe) could be set using the ratio CAF/CATS as proposed by Norway.

2. societal acceptance of oil spill volumes
   Although the SAFEDOR report did not propose a societal acceptance criterion and the use of CATS is not dependent on it, a societal acceptance criterion is useful for interpretation of computed risks in the quantitative phase (step 2 of an FSA).

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[11] A time frame of three or four months would probably *not* be sufficient to accomplish this task given the many viewpoints that need to be considered in addition to the large volume of data and analysis that may need to be processed.

The most logical step to start is the review of historical oil spill data. In the course of the SAFEDOR project, GL asked ITOPF to provide data on major oil spills (Data on 178 large oil spills, kindly received in 2007 on special request from International Tanker Owners Pollution Federation Limited). Combining the data on spill volume and date of spill with estimates on the oil tanker fleet population, a so-called FT-diagram can be derived and it is shown below. To display the variation over time, three data sets have been plotted separately: entire data set (231.276 ship years) with casualties from 1967 to 2005, reduced data set (109.115 ship years) with casualties from 1990 to 2005, and a second reduced data set (77.406 ship years) with casualties from 1995 to 2007. It can be seen that the risk profile is lower if only recent casualties are accounted for.

The presented data could serve as starting point for establishing a societal acceptance criterion and the associated ALARP area.

3. <u>cost-effectiveness criterion CATS</u>

To start, one has to understand that the cost-effectiveness criterion CATS was not developed to be used in estimating the cost of oil spills, as is suggested in MEPC 56/18/1, paragraph 18. Instead, CATS is proposed to assess proposals for new rules and regulations (and may be used for assessing design changes of individual ships). As such, it is most similar to CAF which is already in use at IMO.

If this use of CATS is considered, one may readily deduce that CATS is valid for world wide service and cannot be dependent on the location of an oil spill because the location of future oil spills are not known at the moment of rule making!

However, a possible dependence of CATS on the spill size may be discussed if based on a proper study documenting that cost of oil spills which happened world-wide clearly depend on spill size. Such a study should be commissioned to provide a better decision basis.

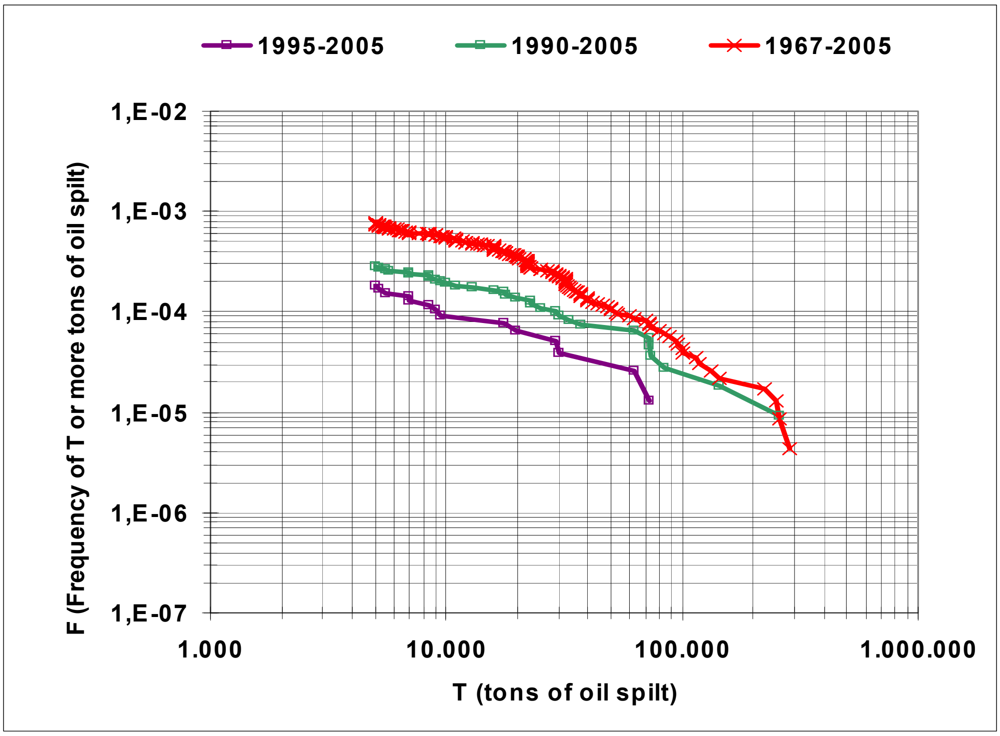

Figure: Historic oil spill cumulative frequency vs. spill size. Data from ITOPF (2007)

ITOPF (*received: 26 September 2007*)

(with specific paragraph reference to MEPC 56/18/1 and general reference to SAFEDOR D452, MEPC 55/18, annex 3)

The need for Cost-Benefit Analysis (paragraph 1)
The purpose of FSA as stated in the various IMO FSA Guidance documents is to enhance maritime safety, including the protection of life, health, the marine environment and property. It is suggested that this can be done by using risk analysis and cost-benefit analysis (CBA). While the aim is outside question and the means seem reasonable in theory, it is important to keep in mind that the reference to CBA should not be taken as an open invitation to literally base safety decisions on business-like cost and benefit considerations. In fact, the current FSA-debate on the risk/severity index and the 'proper' location and slope for the "negligible" and "intolerable" risk curves that define the ALARP region ("as low as reasonably practical"), serve to set boundaries just where and where not CBA-type considerations are acceptable. While advice on pre-incident preventive measures generally fall outside the realm of ITOPF expertise, we have long understood that the difficulties in defining and collecting quantitative information on the actual benefits of oil spill response generally preclude the use of CBA for setting optimal levels of preparedness and response. The same must be true for prevention. Instead, we continue to hold that vessel safety is best dealt with through expertise-based, IMO-negotiated standards for construction and operating practices. Further, we note that as formulated so far, the improvements in vessel design based on the paramount issue of crew and passenger safety also benefit the environment by reducing risk of vessel failure.

Having said this, we recognize that there may be cases where IMO decision makers are faced with incremental improvement decisions where the inclusion of some cost-benefit methodology, even if artificial, will be of great help.

Focus on reducing harm (paragraph 3)
We agree that the focus of FSA is and should be "reducing risk" rather than "studying harm". While there are parties who undertake global studies of various measures of harm (e.g., GESAMP), the idea here is to identify potentially rectifiable areas of risk, then focus on the optimal level of improvement such that all related areas of risk are brought into as near as possible a state of equivalency. As pointed out by others, while CATS is entirely inappropriate for estimating overall impact (because it is not an average value), it could be valid in the restricted arena of incremental decision making. See below for more detail.

SAFEDOR and the focus on cargo spills from tankers (paragraphs 3 and 4)
It is not entirely clear why the recent discussion (as appears to have originated in the SAFEDOR report) of expanding FSA to include issues over and above crew and passenger safety/fatality have narrowed in entirely on cargo carried by oil tankers. The SAFEDOR report does run through various statistics on global movement of cargo, which do show the importance of the oil trade in terms of quantity. However, by assuming that environmental impact is a direct function of the quantity spilled which in turn is assumed to be a direct function of the cargo weight and distance covered by vessels, an overly simplistic result is attained, namely that non-oil, non-tanker and bunker spills can be disregarded. In particular the exclusion of bunker spills from the discussion misses one of the most important and obvious trends in recent years, namely that bunker spills have taken on greater-than-ever importance in relation to tanker spills of oil cargo. Indeed, as a general indicator of the trend, please note that ITOPF now regularly attends more bunker than cargo spills each year. In addition, these spills are not only becoming more important

in terms of number, they are proving to be more likely to cause damage and require extensive cleanup operations. This is the result of larger-than-ever vessels carrying heavier-than-ever grades of fuel oil, as well as greater financial liabilities and heightened public sensitivity to oil spillage.

Risk/Severity Index (paragraphs 10 to 16)
ITOPF recognizes that there is no "right" or "wrong" matrix for describing environmental risk. The severity labels, recovery times and curve slopes are not a matter to be strictly determined by objective scientific and economic study. They are a matter of subjective opinion and are properly dealt with in the forum of inter-governmental debate in the IMO.

CATS definition (paragraph 17)
The Greek submission describes CATS, the "cost of averting a spill" as the "'per tonne of spilled oil' environmental criterion equivalent to CAF, the Cost to Avert a Fatality". Whether or not one agrees with the proposed use of CATS, the comparison to CAF is accurate in so far as both are theoretical constructs, neither of which attempts to actually measure the true value of the environment or life. This is worth thinking about. In reference to the latter, few people would probably agree that a life is 'worth', say $3m. Some might think that figure is high, some will say it is low and still others will contend that it depends on who the person is, how old, how the death occurred, etc. Yet, in spite of this disagreement, in the safety sector there appears to be agreement that using an artificial value is justified in order that equivalency can be achieved within and across all modes of transport. Further research and work will show if this is the case for environmental considerations or not.

CATS and factors influencing response cost (paragraphs 18 to 22)
ITOPF has long stressed that there are no meaningful 'average' costs for oil spills. As often quoted, there is a long list of factors that influence the impact of a spill, the cost of response and the level of residual damage that is best left for natural recovery. Some suggestions for dealing with this situation and coming to a workable cost concept (e.g., CATS – Cost of Averting One Tonne of oil Spilled) have been: to use regression analysis to take the many variables into account, to fit a non-linear function to the data to take spill size into consideration, to use different equations for different vessel and oil types, or to use region-specific CATS values. Unfortunately, none of these options, would appear feasible.

- While sophisticated statistical methods are available for problems much more complex than that at hand, the simple fact is that there are not enough data points to even begin a reasonable statistical study. It is often pointed out by those who research the question of oil spill response costs that data on costs for past incidents is difficult to gather for reasons of confidentiality in insurance markets. This is true, but we would point out, however, that even if the pay-out data were published, there would be serious questions of validity and comparability to sort out. Most importantly, even if this were accomplished, the sample size would be far too small for the number of variables involved. Luckily, oil spills are too rare to provide for statistically robust studies!

- The suggestion of using a non-linear curve to take into consideration that there are often economies of scale in spill response costs is, in theory, a step in the right direction, but it is not enough to offer a workable solution. The principal idea here is that the greater the spill volume the less significant the per unit share of the initial mobilization costs. Also, there are often significant economies of scale to be realized as responders learn how to operate more efficiently over the duration of a single incident or bulk rates for materials or disposal are negotiated. It is, however, well-known amongst field responders, 1) that it is not the quantity of oil that matters so much as the sensitivity of the location and the geographic spread of shoreline stranding and 2) that costs do not fall smoothly as volumes increase because there are 'lumps' in mobilization and other costs. From a practical point of view, it is often insignificant if a particular beach has a 10 or a 20 cm thick layer of oil across it. The increase in resources and cost arising from a 10 km or 20 km length of affected beach, however, are truly significant. So, while 'larger' spills often cost more than smaller ones, it is more a question of where the oil goes than how much goes there.

- The suggestion has been made to use different cost figures for different oils and/or for different vessel types. One obvious problem with this approach is that it reduces the data set size even more, thus leading to CATS estimates with even greater variability and lower statistical reliability. Another is that many of the safety-improving measures that would be analysed using FSA might reach across a number of different vessels types. The main practical difference is that tank vessels carry a great variety of oil types throughout their lifespan, often ranging from very heavy to very light.
- The trouble with region-specific values is that shipping is very much a global industry; a significant portion of the world fleet transits regularly through multiple regions. Because it cannot be predicted just *when* a failure will become critical and lead to an incident, it cannot be predicted *where* this will occur and therefore which of the estimated cleanup cost parameters should be used to define cost. In fact, experience has shown that for regions, or even individual countries, it is not possible to develop a single meaningful cost parameter because of differences in local costs.

<u>Average vs. Marginal Costs</u> (paragraph 18)
The CATS (Cost of Averting One Tonne of oil Spilled) concept is clearly not an easy one to grasp or explain. Several, among other, factors which are easily misinterpreted include the following:

- CATS is a 'threshold' or 'marginal' value. When considering the degree to which a generic vessel should be optimally improved to avoid failure and thereby oil spill impacts, for instance, the 'marginal value' characteristic of CATS can be used to determine just how expensive that last increment of oil spill impact will be in order to justify that last increment of improvement. While the notion of marginal value in oil spill response is hardly ever labelled as such, experience in the field and thorough reporting in the industry literature should dispel any doubt that it exists. We all know that costs differ according to the size of the incident and the particular point of time in the response. CATS describes this in a mathematical way.
- CATS is not an average value. The concept of 'average' costs may seem convenient, but it is also only a theoretical construct. To mix the two concepts of 'average' and 'marginal' creates only confusion. In other words, it is nonsensical to multiply a CATS value by a spill volume. CATS is simply a maximum level in a whole series of such levels of per tonne costs that can be used when comparing incremental changes in expected benefits and costs.
- CATS is not an estimate of real-world oil spill response cost. In its proper form it should be a politically negotiated agreed construct used to aid research into the specific question of regulatory impact. It has no real-world meaning outside this arena.
- CATS does not provide "the answer". It is an aid to the political process and is best used along with other sources of information including expert opinion, data reviews, stakeholder discussions, etc. In the end, decisions made in the IMO forum are political agreements formed on the basis of consensus, rather than formulaic output. While there

is nothing new about this, it should be kept in mind when debating the FSA-CATS approach.

- CATS is not a "willingness-to-pay" (WTP) value in the sense of recent literature on economic valuation (e.g., contingent valuation). The WTP concept in that literature refers to the stated preferences of individual members of the public in relation to, for example, the protection of an environmental resource or provision of a recreation amenity. These survey-solicited values are "aggregated up" from the level of individuals to a study population using sophisticated statistical sampling methods. The literature is as extensive as it is controversial. CATS, on the other hand, is the highest incremental value that regulatory decision-makers will use in their calculations as to the costs and benefits related to proposed safety improvements. While both concepts can involve incremental changes to an environmental good (or human health or recreation, etc.), the key difference is that one is an attempt to be a mirror public opinion while the other sets out to be a working value used in the political/regulatory process. The focus of the two are therefore different.

<u>Focus on Response Costs</u>
As pointed out by others, the focus of CATS on response costs alone is not to deny that there are no other potential categories of impact. There are many. However, the quantification of many of these can be particularly controversial. As described in the Norwegian comments on MEPC 56/18/1, the use of cleanup costs alone "is just an indication of a lower limit for investment…". While the answer is an empirical one, it would seem probable that in many cases it would be sufficient to justify increased investment in those areas most needed improvement.

<u>Conclusions</u>
In light of the confusion surrounding the terminology and thinking ahead to possible misuse of IMO-published figures, it might be prudent to rename "CATS", possibly incorporating in the name the terms (or equivalents) 'marginal', 'response', "avoided"/"averting", "value", "index", or "threshold". While it is unlikely that such an easy and convenient acronym as CATS will be found, we believe that there is potential to reduce confusion. We note that the use of the term 'marginal' makes it unnecessary to mention "1 tonne" and that there might be less confusion if the term "cost" is not used.

Most importantly, there would be a need to establish a politically-agreeable, working value for the "CATS" parameter, however it is named. The discussion should be aided by research on marginal and average oil spill response costs for particular countries and regions for particular years, but there should be no expectation that it is anything other than an artificial value.

- Given the global nature of shipping and the IMO remit to unite disparate regions of the world under wide-reaching standards, there could be some merit in choosing a CATS value that represents the higher end of the cost scale. In other words, the reasonable worst-case scenario would be assumed that the failure occurs in the most expensive region. Such an approach would offer increased simplicity as well as equity.

- The value might be updated with regular inflation adjustments, but, in line with its nature as an artificial, regulatory construct, there should be no attempt to adjust it following particular oil spill incidents.

ROUND TWO OF SUBMISSION

UNITED KINGDOM (*received: 22 October 2007)*

The United Kingdom views environmental risks as inclusive of life cycle considerations. Thus, shipbuilding activity (but not the extraction of raw materials and their refining into products used in shipbuilding), coatings, ballast water, bio-diversity, bio-fouling, particulate and gas emissions, noise emissions, radiation emissions, the results of fire and explosion, dangerous goods, bulk goods and liquid cargoes (and bunkers), garbage and sewage, economic loss, amenity loss, recycling impacts are, in the United Kingdom part of the environmental impact associated with ship operations. Environmental risk from potentially polluting wrecks might also be considered, although in the United Kingdom this work is proceeding separately and the results will not be available in time for our group.

Several of your submissions to date have alluded to these issues, but most of the data and numeric criteria have applied to liquid pollutants - the United Kingdom view is that we need to widen these assessment criteria.

More generally, the criteria should include, in our view, measures to assess those aspects of harm that are more difficult to quantify than in the case of safety (to humans) risk. These would include the generation of criteria for the following aspects of environmental harm:

a. the “flash to bang” time – i.e., the time it takes to notice that harm is occurring and whether the effects can be noticed or measured at all;

b. whether the harm is acute or chronic (and whether it accumulates over time);

c. the degree of persistence of the harm;

d. the degree to which the harm is reversible (currently and with future technology);

e. a measure of the variety of the environment affected;

f. a measure of the variety of the pollutants;

g. a measure for cumulative effects or effects which operate in combination.

The hazards themselves and the frequency and severity they represent will be widely agreed by the group we suspect. We think our work might also try to focus on which of the above criteria should be considered, and how a metric might be generated for them. This is not to ignore the point made by several submissions so far, that if we assume that ships operate globally it will be extremely difficult to generate a single “global harm” index or cost since the environment varies so widely. Nevertheless, a “patterns of trade” analysis would show where certain types of harm are more likely. The point made by ITOPF, that safety interventions also benefit the environment in that the consequences of a ship accident very frequently include injury, environmental damage and economic loss to ships, equipment and cargo, is well made.

UNITED STATES (*received: 2 November 2007*)

In response to Norway's submission:

- Comments on the severity indexes provided in annex 3 and by Norway: it is noted that any factor used to determine a severity index is subjective and arbitrary. Severity indexes cannot be determined solely by amount of oil released, or by the environment's recovery time. The index provided in annex 3 is simple, straightforward and communicable, yet, may not be any more precise than the severity index recommended by Norway. Annex 3's severity index timeframe can change due to the complexities involved with the effects of a spill on the environment: i.e., the metabolic recovery rate of the affected species and environment, and the type and volume of substance spilled. However, we understand the attempt to develop a severity index. Given the two options, the United States recommends use of recovery time versus tons of oil spilled as recommended by Norway.

- In contrast to Norway's position, the United States believes the F-N diagram is important. A "correct" diagram (once adequate justification and background for the risk criteria and limits has been developed; the current version in annex 3 lacks the basis for the proposed assumptions, criteria and methodology) will be imperative to determine the cost of averting a (minor, moderate, significant, or serious) spill at a certain frequency level.

In response to Germany's submission:

- As stated above, the United States recommends that the severity index should address recovery time vice oil spill volume.
- As stated above, determination of a cost concept (i.e., CATS value) is dependent on a properly developed and justified F-N diagram. However with regards to the F-N diagram proposed in annex 3, it is unclear how F was determined, what is the justification that F is between 1 and 3, and if a linear function is appropriate, vice a curved line, or a parabola.
- The United States agrees with Germany's comments regarding societal acceptance of oil spills which pointed out that societal acceptance of oil spills changes in spatial and temporal scales. However, the United States disagrees with Germany's assertion that the severity index should only address oil spill volumes. As stated above, the United States recommends use of recovery time vice tons of oil spilled.

In response to ITOPF's submission:

- The United States agrees that it is extremely difficult to normalize oil spill costs.
- The United States agrees with ITOPF's comments regarding basing all of the risk analysis on tank ships oversimplifies the risk. Especially in light of bunker related spills. The United States agrees that non-oil, non-tanker and bunker spills should not be disregarded. As stated by ITOPF the heavy grades of fuel oil on bulk carriers elevate risks. The consequence of a spill from these heavy bunkers and increased probability denote risk associated with this fleet.
- The United States agrees that there are not enough data points to reach a statistically significant conclusion with regards to determining a cost concept value. The United States understands the need to determine such a value and recommends

referring to a politically agreed upon/logically sound F-N diagram to determine this value.

- The United States agrees that although spill volume is important in determining the costs of a spill, it is less important than the spill's location, the time of year it occurs, and the type of oil spilled.
- The United States agrees the cost concept value (i.e., CATS) is an artificial value developed as a politically negotiated agreed construct.

In response to INTERTANKO's submission:

- The United States agrees with Intertanko's comments regarding the factors influencing the costs of oil spills. The factors that influence the cost of an oil spill are implicit in the original MEPC 55/18, annex 3 risk analysis diagram which has the consequence factor as recovery time.

General comments from the United States:

The United States supports the use of the consequence portion of the risk analysis equation as represented through recovery times because environmental damage is typically determined using the following criteria:

- Type of material spilled;
- Amount of material spilled;
- Rate of spill;
- Time of year that the spill occurs;
- Location of spill;
- Habitat impacted;
- Clean up speed and effectiveness.

All of these criteria will influence the speed of habitat recovery. What is more difficult to quantify are the definitions of Minor to Serious. MEPC 55/18, annex 3 does not provide enough detail on how these limits were established.

The United States agrees that the probability portion of the equation can be generated by annual spill frequency much like FEMA's (Federal Emergency Management Agency's) flooding frequency (i.e., 100-year flood or 1% chance of the flood flows occurring in any year in a 100-year period). FEMA bases the height of levees on this system. Again what is more difficult to quantify is the annual probability limit.

Although it is important to categorize risk in terms of Negligible (low risk), Intolerable risk (high risk) and ALARP; again it is difficult to draw the lines. MEPC 55/18, annex 3 provides little insight into how these lines were generated.

The United States agrees with Greece's comments in that defining severity, drawing risk boundaries and defining F all require discussion and should have a rational basis. The United States also agrees with Greece's comments regarding CATS in that using cost of averting a spill on a per tonne basis may be inappropriate. The United States recommends referring back to the original MEPC 55/18, annex 3 risk matrix where the cost is based on averting a serious spill every 100 years, for example.

The United States supports non-economic remediation of the environment. There are things beyond economic loss when an area is affected by an oil spill. Regardless of a lack of proven economic value in an environment, the United States supports that the shoreline be returned to its original state prior to damage from an oil spill.

GREECE (*received: 6 November 2007*)

We would like to thank all contributors for their thoughtful and substantial contributions and we apologize for being a little late in our reply.

Greek submission MEPC 56/18/1 pointed out some weaknesses in the present proposals for environmental acceptance criteria and urged further proposals and discussion. Indeed it seems we have made a good start with several proposals and ideas being put forth to improve the criteria.

We would like to summarize Greece's topics of concern and offer some comments on the received contributions. Very briefly MEPC 56/18/1 touched upon the following issues (among others):

1) It argued that an agreed Environmental Risk Index to be used in Step 1 of FSA for hazard ranking should be developed before the development of Risk Acceptance Criteria (MEPC 56/18/1, paragraph 10).

2) It argued that we need to develop a Severity Index appropriate for measuring the effects on the environment (paragraph 12)

3) It argued that the ALARP region limits (what is intolerable and what is negligible) and the slope of -1 need to be discussed and debated. One relevant question which lawmakers need to consider is "what is more important to prevent in society's view? A rare catastrophic event, or frequent events of smaller damage to the environment – such as bunker pollution?" (paragraphs 15 and 16).

4) It argued at length why CATS is not an appropriate criterion (paragraphs 19 to 22).

5) The way CBA is performed and the associated use and value of the factor "F" should be discussed (paragraph 23) .

Greece did not make concrete proposals as to what to use instead of CATS, primarily because we feel such proposal should follow from discussion and debate. We did however suggest, as one idea, a non-linear function or even several non-linear functions which may or may not be linked. This does not mean that each ship type or each oil type will have to apply a different criterion.

As a crude example only, we can state that (since location of spill is much more important than size) several regional criteria can be combined in one function using a "frequency of passage factor" based on the most frequent sea routes (for which data exists). The point is that we feel improvements to CATS are possible and quite feasible and we are encouraged that several contributors seem to agree.

In general we are of the view that the more the criterion chosen and developed approximates reality, the better.

As with the larger topic of "Risk Analysis, Risk Based Construction rules" etc., Greece's position has always been that a complicated problem should be no excuse for oversimplifications. Oversimplifications will result in wrong regulations which are worse than no regulation.

We now make some additional brief comments, based on the input submitted by other correspondence group members:

Norway seems to disagree with most with the points above, as well as with most of MEPC 56/18/1 itself, but proceeded to offer some suggestions for a Severity Index (SI) based solely on spill volume, which is in line with the suggested use of the CATS criterion. For the reasons stated in MEPC 56/18/1, we do not concur with this since we feel that volume alone does not really reflect the impact (severity) to the environment.

In reply to Norway's comment on the NORSOK index, we should clarify that Greece did not "propose" the NORSOK index as is, which was indeed taken from the SAFEDOR report, in which this "approach to environmental risk acceptance criteria is nevertheless believed to still be relevant" (page 43). Greece simply proposed that this index should be "analysed and debated" (as clearly is stated in paragraph 13 of MEPC 56/18/1).

In that respect, we are surprised with Norway's rationale of excluding this index on the ground that since it is being used in the Norwegian offshore sector, it may refer only to risk from fixed installations and not from a ship, which can move anywhere. The NORSOK severity labels 'minor' (SI=1), 'moderate' (SI=2), 'significant' (SI=3) and 'serious' (SI=4) denote consequences to the environment, irrespective of the source of pollution, whether that is fixed or moving. We have no objection to adding SI=5 ('disastrous'), as Norway proposes, but we do not agree to measure severity in terms only of volume of oil released, again as proposed by Norway, for the reasons already stated. Recovery time seems a much better criterion (again, as proposed in the original MEPC 55/18, annex 3, in NORSOK, and also supported by some members of the correspondence group). If SI=5 is used, recovery time might be 100 years.

Greece cannot see how in paragraphs 14 and 15 of MEPC 56/18/1 we attack our own "proposal" on NORSOK, as these refer to the F-N diagrams and not to NORSOK. We do not agree that the F-N diagrams (or F-O as Norway renames them) are not that important. On the contrary, we believe that they are very important and should be politically agreed upon (as the United States in its 2nd round input also stresses). We also cannot agree with Norway's position that risk acceptance criteria (Step 5 of the FSA) must be agreed upon before Step 1 (Hazid) is agreed upon. We believe that quite the reverse should be the case.

As finally regards the value of factor F (paragraph 23 and SAFEDOR report), Norway finds Greece's position that F should not be inferred from previous legislative action as radical, as IMO often use this approach (principle of equivalency). In fact, the estimated value of F=2 in SAFEDOR (and in MEPC 55/18, annex 3) is not calculated from first principles, but inferred upon in reverse, so that previous legislative action, and specifically OPA 90, is on the average compatible to a threshold of CATS = $60,000/MT.

Germany's proposal (paragraph 2) in using the ITOPF-GL supplied data for the ALARP area is welcomed and we feel we should examine this avenue. This could be a starting point for establishing a societal acceptance criterion and the associated ALARP area. On the Severity Index however, we do not understand why it should address only volume of spill (Germany's paragraph 1).

Greece understands that CATS tries to be the equivalent to CAF, the Cost of Averting a Fatality − which in turn is related to the Life Quality Index(LQI). Although CAF is based on a sound methodological approach and is a concept that is devoid of non-linearities (two fatalities are twice as bad as one), in CATS we cannot find a similarly sound methodology and one sees significant non-linearities in volume.

ITOPF makes many points with many of which we would agree, particularly the view that there are no meaningful average costs for oil spills. The fact that CATS is a marginal cost value (as Norway also stated) is understood. However this does not mitigate our concerns as to both the value being assigned to it and whether CATS itself should be the only criterion in the Cost Benefit Analysis of the FSA.

We thank **INTERTANKO** for providing definitions/explanations of common terms. It is important that we all speak the same language. We are also thankful for the clear insight provided, as regards the factors that are important in determining oil spill cost. We wish to note that as per the provided data, clean up costs have run from as low as $4/MT to $138,000/MT (with M/T Braer being only at $6/MT !).

We agree with INTERTANKO (and the United States) that a regional type approach is more accurate and we totally agree with the statement "Sufficient time to be devoted to developing environmental risk acceptance criteria… reliable yet simple…. while not ignoring the most obvious factors that influence costs".

We also agree with the **United States** on all counts and we kept the remark that in effect a "CATS" was tried in the USA and later aborted since costs are not same even nationally. We would not want a similar IMO "trial", only to discover CATS is not so appropriate.

With regard to the input provided by the **United Kingdom** all points made would be supported by Greece. Especially the notion of life cycle consideration. These are non-trivial issues which must be examined, and we look forward to seeing the work that the United Kingdom is engaged into in this area. However we believe the TOR of this group are quite specific for now. But we should try to take onboard and at least try to consider criteria (metrics) for the United Kingdom's suggested points a to g.

DENMARK (*received: 6 November 2007*)

As a member of the SAFEDOR project we have gained some experience with the monetary losses and damage to environment, which we believe is relevant to the correspondence group. In the SAFEDOR project we found it was necessary to **extend** the IMO Frequency Indices (Table 1 in the attached document) and furthermore to **extend** the Severity Indices to cover monetary losses and damage to the environment (Table 2 in the attachment).

Please note, that the same approach as described in "Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process" MSC/Circ.1023, MEPC/Circ.392 has been used:

$$\text{Risk} = \text{Frequency} \times \text{Consequence}$$

Therefore

$$\text{Log (Risk)} = \text{Log (Frequency)} + \text{Log (Consequence)}$$

And therefore (with the indices defined in the attached document):

$$RI = FI + SI$$

The two tables have already been published at the RINA conference, where some of the outcome of SAFEDOR were presented. The paper is named “HAZARD IDENTIFICATION – SOME EXPERIENCE”.

Table 1: Severity Indices, including monetary losses and damages to the environment

		Human safety		Property Related				Environment related
SI	**Severity**	**Human Safety**	**Equivalent fatalities**	**Effect on ship**	***Cargo***	***3rd Party assets***	***Other Monetary Losses***	
5	*Disastrous*	*Large number of fatalities*	*100*	total loss *(of, e.g. a large merchant ship)*	*US$ 300 million*	*major public interest*	*US$ 300 million*	*uncontrolled pollution long-term effect on recipients long-term disruption of the ecosystem*
4	Catastrophic	Multiple fatalities	10	total loss *(of, e.g. a medium size merchant ship)*	*US$ 30 million*	*extensive damage*	*US$ 30 million*	*severe pollution medium-term effect on recipients medium-term disruption of the ecosystem*
3	Severe	Single fatality or multiple severe injuries	1	Severe damage *(yard repair required, downtime < 1 week)*	*US$ 3 million*	*severe damage in vicinity of ship*	*US$ 3 million*	*major release effects on recipients short term disruption of the ecosystem*
2	Significant	Multiple or severe injuries	0.1	non-severe ship damage *(port stay required, downtime 1 day)*	*US$ 300.000*	*significant damage*	*US$ 300.000*	*minor release minimal acute environmental or public health impact small, but detectable environmental consequences*
1	Minor	Single or minor injuries	0.01	Local equipment damage *(repair on board possible, downtime negligible)*	*US$ 30.000*	*minor damage*	*US$ 30.000*	*negligible release negligible pollution no acute environmental or public health impact*

Table 2: Risk Indices resulting from the extended frequency and severity indices

		Risk (RI)				
		SEVERITY (SI)				
		1	*2*	*3*	*4*	*5*
FI	**FREQUENCY**	***Minor***	***Significant***	***Severe***	***Catastrophic***	***Disastrous***
8	*Very frequent*	9	10	11	12	13
7	Frequent	8	9	10	11	12
6	*Probable*	7	8	9	10	11
5	Reasonably probable	6	7	8	9	10
4	*Unlikely*	5	6	7	8	9
3	Remote	4	5	6	7	8
2	*Very remote*	3	4	5	6	7
1	Extremely remote	2	3	4	5	6

UNITED KINGDOM (*received: 21 November 2007*)

These short remarks will illustrate how the United Kingdom is thinking about ERC. ERC are necessary to ensure that the results of FSA studies include environmental impacts and that these can be treated in an equivalent way to safety impacts. This paper will not define hard and fast empirical criteria, but rather provide tools for those involved in scoping and designing and conducting FSA studies to help them decide which environmental criteria should be used within the study, and how values might be established for the criteria for the purposes of an individual study. The suggestions here provide a starting point for those discussions, selections, and evaluations.

The proposals here are also designed to be used in FSA studies which might have one of 2 foci:

- An FSA study about environmental aspects of shipping per se
- An FSA study of another aspect of shipping safety which might have environmental consequences

Environmental Risk Criteria are different to Safety Criteria in many ways including:

- Environmental risks are both chronic (in that they happen as part of the day-to-day running of ships) and acute (in that they are the results of accidents), while safety risks tend to be acute;

- Environmental risks cover a wider range of issues including multiple species harm, persistence, reversibility, escalation/concentration by the food chain, location, time of day/year, variety of pollutants, cumulative and in-combination effects, detection times and the balance between benefits and harm.

The required scope of Environmental Risk Criteria is significantly different to Safety Risk Criteria. Environmental Criteria have to include a much wider range of issues.
In assessing probability these issues include:

- Acute vs. Chronic Risks;
- Accidental vs. Deliberate Acts;
- Legal vs. Illegal Acts.

In assessing impact these issues include:

- Multiple Species harm;
- Persistence;
- Reversibility;
- Escalation/Concentration in the Food Chain;
- Location and time of year/day;
- Variety of pollutants;
- Cumulative and in-combination effects;
- Detection time;
- Environmental Benefits v Environmental Harm.

These issues can be discussed in detail later (Required Scope of Environmental Risk Criteria for Marine Operations and Examples of Environmental Aspects of Marine Operations).

There are existing Environmental Risk Criteria used by a variety of organizations including some defined in international standards. These range from simple "Risk Matrix" criteria for operational decision-making to detailed "Quantified Risk Assessment" based techniques for analysing the transit of nuclear material.

The paper outlines a method for assigning a Risk Index value to an environmental aspect of shipping operations in a similar way as a Risk Index value is assigned to a hazardous (safety) aspect of design/operations. This process is a single step process for global effects, and a development of the Formal Safety Assessment model's current "severity x frequency = risk" process for acute risks. The United Kingdom thinks that these should be examined in detail to ensure that FSA ERC are compatible with existing standards where possible, especially international standards.

These risk index values have been selected so that an environmental aspect and a safety hazard with the same risk index value are broadly equivalent for ranking purposes.

FSA vs. Environmental Terminology

In FSA a "Hazard" is described as "A potential to threaten human life, health, property or the environment". The term Hazard is not used in environmental studies, the term Environmental Aspect (from ISO 14000) is more broadly used. Figure 1 demonstrates suggested 5 step Environmental Methodology.

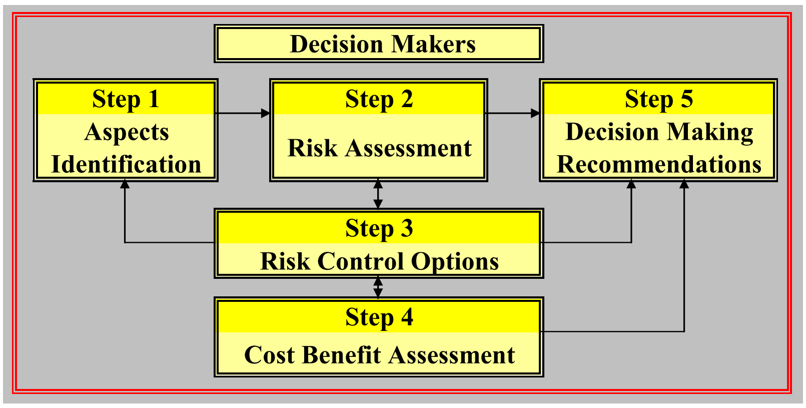

Figure 1: Suggested 5 Step Environmental Methodology

In FSA a "Consequence" is described as "The outcome of an accident". Although consequence is also used in environmental definitions the term "Environmental Impact" is more broadly used.

In FSA, risk control options (and measures) are developed by considering a causal chain.

causal factors → failure → circumstance → accident → consequences

Figure 2: Causal Chain

The environmental equivalent is the Environmental Impact Chain.

source → pathway → receptor

Figure 3: Environmental Impact Chain

Environmental Ranking

Environmental ranking is different to safety ranking in that it has to address both Chronic and Acute Risks. The result of this is that some risks:

- Have to be based on a direct assessment of the risk to the environment from shipping at the global level (e.g., CO_2 emissions);
- While others can be based on the risk to the environment on a statistical per ship basis (e.g., Fuel spill from a collision).

This is shown in the following flow diagram.

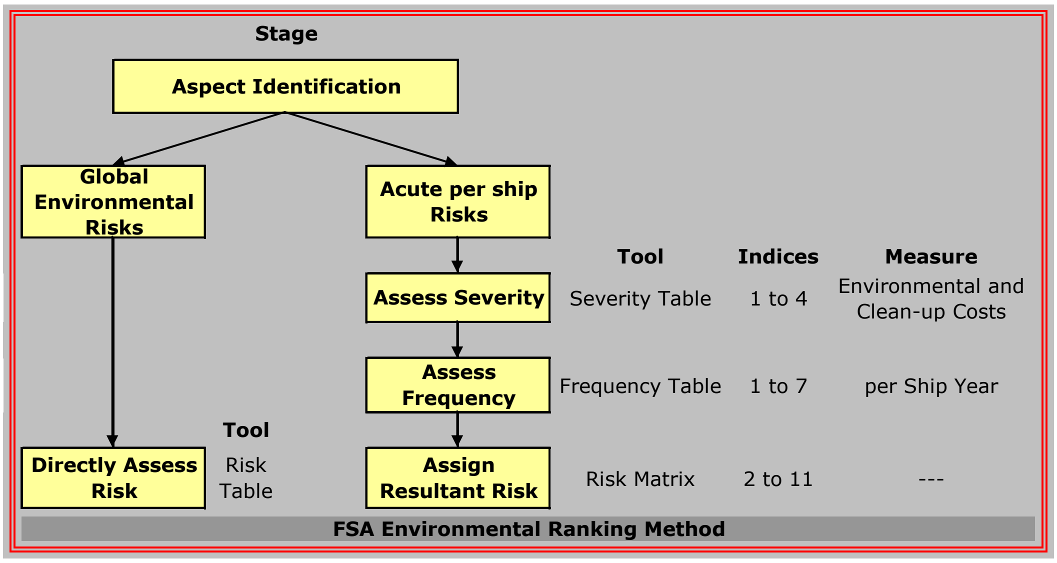

Figure 4 Proposed Environmental Ranking Method

Equivalence between the Environmental Risk Index and the Safety Risk Index

The Risk Indices used have been chosen so that there is a broad equivalence between safety and environmental risks with the same risk index allowing for ranking of risks on a combined safety and environmental basis.

The basis of this equivalence is financial. For a given value of risk index the safety harm (based on A value of preventing a fatality of $3,000,000) is the same as the environmental harm (comprising environmental cost and clean up cost).

Global effects do not require a three-stage process (as they are largely chronic effects and are therefore going to occur) and the risk index can be assigned from a Risk Index Table such as the one shown below.

This Table is based on the effect of global shipping on the environment.

The relationship between the severity and its definition and the value of the risk index is selected to be broadly comparable to both:

The Environmental Risk Index for Acute Risks;

The Safety Risk Index currently in the FSA Guidelines.

Risk Table

A proposed Risk Table is shown below.

<table>
<tr><th colspan="3">Risk Table for Global Environmental Risks</th></tr>
<tr><th>Description</th><th>Direction of change</th><th>Risk Index</th></tr>
<tr><td rowspan="3">Indicative environmental and clean-up costs to the world environment of the order of $1,500M per year
Impact: Regional/federal scale impacts or impacts over extensive sea areas or coasts encompassing groups of nations. Direct and indirect impacts are generally very large scale and long-term. May be cumulative. Acute events may represent a national threat, or may have substantial trans-boundary implications.
Examples: Use of non-renewable fossil fuels by ships worldwide contributing to cumulative resource depletion and climate change processes (chronic); introduction of invasive, non-native Zebra mussel into Canadian Great Lakes (acute) with persistent, massive indirect environmental and economic consequences.
Stakeholders: Strong negative international responses. Investigation and mitigation involves international resources/co-operation and large environmental trade-offs.</td><td>Deteriorating situation</td><td>7↑</td></tr>
<tr><td>Status quo</td><td>7</td></tr>
<tr><td>Improving situation</td><td>7↓</td></tr>
<tr><td rowspan="5">Indicative environmental and clean-up costs to the world environment of the order of $150M per year
Impact: Regional/federal scale impacts or impacts over extensive sea areas or coasts, where chronic impacts arise from very high numbers of low level chronic processes (e.g. CO_2 or VOC emissions). Acute direct and indirect impacts may be large-scale, long-term, environmentally, socially and economically damaging or resource depleting. Unlikely to represent a national threat but may have trans-boundary implications.
Examples: Energy loss from ships through inefficient recapture of waste heat (chronic), disproportionate transfer of environmental burden (pollution and wastes) from developed to transitional or developing states during certain ship decommissioning operations (acute); internationally significant Tier 1 spills in highly environmentally sensitive or commercially important environments (acute).
Stakeholders: Negative national responses. Investigation or mitigation may involve national and/or international resources and environmental trade-offs.</td><td>Deteriorating situation</td><td>6↑</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Status quo</td><td>6</td></tr>
<tr><td>Improving situation</td><td>6↓</td></tr>
</table>

Risk Table for Global Environmental Risks		
Description	**Direction of change**	**Risk Index**
Indicative environmental and clean-up costs to the world environment of the order of $15M per year ***Impact:*** Mainly negative, larger-scale operational impacts that industry aims to control or maintain within prescribed limits or requirements. These are recorded/reported at a national level but generally occur in the vicinity of individual vessels at sea, in areas where vessels are concentrated (ports/shipping lanes), at ship yards, waste treatment or disposal sites, ship breakers yards, or in the supply chain. Chronic impacts involve localized nuisance, interference, pollution, environmental and social disruption, resource usage and low level inputs to cumulative processes. Also encompasses acute impacts arising from incidents such as maritime spills, collisions and overboard losses of cargo. May represent a local threat. **Examples:** Routine discharge of treated oily bilge water (chronic); leaching of copper from antifouling coatings (chronic); collision of vessel with offshore wind turbine (acute); Tier 1 or Tier 2 spills in areas that are not particularly sensitive or vulnerable (acute) ***Stakeholders:*** Ranges from no response to negative local or national responses (depending on the issue). Mitigation may involve local or national resources (at worst).	***Deteriorating situation***	5↑
	Status quo	5
	Improving situation	5↓
Indicative environmental and clean-up costs to the world environment of the order of $1.5M per year ***Impact:*** Mainly negative, smaller-scale operational impacts that industry generally maintains within prescribed limits or requirements. Acute impacts are generally highly localized and short-term. Also encompasses smaller-scale chronic impacts. **Examples:** Routine discharge comminuted sewage in non-sensitive areas (chronic); Tier 3 spills in non-sensitive areas (acute). ***Stakeholders:*** Strongly negative local responses (depending on the issue). Most issues will not evoke a response. Mitigation involves well established techniques.	***Deteriorating situation***	4↑
	Status quo	4
	Improving situation	4↓
Indicative environmental and clean-up costs to the world environment of the order of $150,000 per year ***Impact:*** Encompasses small localized negative impacts from very small scale acute and chronic events. ***Examples:*** Rust from ships falling into the marine environment (chronic); overboard loss of small quantities of lubricants washed off decks by rain or sea spray (chronic) or impacts of anchors on sea beds in locations that the not environmentally sensitive (acute). ***Stakeholders***: Generally not concerned. Mitigation often not required.	Not applicable	3
Positive ***Impact:*** *Beneficial change (improvement or enhancement) to environmental or social conditions.* ***Example:*** reinstatement of a previously polluted area of shoreline. ***Stakeholders:*** Approval or support. Level of confidence in solutions and outcomes depends in approach (some are experimental).	Not applicable	Positive

Acute risks require the same three-stage process as safety. The severity index is based on the severity of an acute event from a single ship.

A proposed severity Table is shown below.

Severity Table for Acute Environmental Risks on a per ship basis	
Severity Index	**Description of the effect on the environment**
6	**Indicative environmental and clean-up costs per ship of the order of $3,000M** Environmental Costs Internationally significant degradation, damage or loss of ecologically, commercially or culturally important habitats, species or biodiversity. Generally: impacts extensive; long-term with poor potential for recovery. Includes trans-boundary impacts. Internationally significant pollution of the atmosphere, marine environment, coast or land (including very damaging Tier 1 incidents in ecologically sensitive or commercially important environments). Massive usage, depletion or wastage of scarce or non-renewable resources; usage of toxic or noxious materials; transfer of hazardous wastes, pollution or other environmental problems to inappropriate locations or media with international implications; or constraints relating to the management of these impacts. Internationally significant effects on human health or well being. Internationally significant losses of income, public finances, amenity, cultural heritage or resources. Long-term or widespread social disruption (including other infrastructure, supply chain, users of the coast, seas, ports). Strong negative response from international or national stakeholders. Clean-up Costs Clean-up, remediation or abatement generally requires massive international resources.
5	**Indicative environmental and clean-up costs per ship of the order of $300M** Environmental Costs Nationally significant degradation, damage or loss of ecologically, commercially or culturally important habitats, species or biodiversity. Generally: Impacts extensive; can be long-term with poor potential for recovery. Potential for trans-boundary impacts. Nationally significant pollution of the atmosphere, marine environment, coast or land (including Tier 1 incidents). Large-scale usage, depletion or wastage of scarce or non-renewable resources; usage of toxic or noxious materials; transfer of wastes, pollution or other environmental problems to inappropriate locations or media with national implications; or constraints relating to the management of these impacts. Nationally significant or serious locally significant effects (affecting communities) on human health or well being. Nationally significant or serious locally significant losses of income, public finances, amenity, cultural heritage or resources. Nationally significant or serious locally significant social disruption (including other infrastructure, supply chain, users of the coast, seas, ports). Strong negative response from national stakeholders (may escalate to international level). Clean-up Costs Clean-up, remediation or abatement requires national resources (may escalate to international resources).
4	**Indicative environmental and clean-up costs per ship of the order of $30M** Environmental Costs Locally significant degradation, damage or loss of ecologically, commercially or culturally important habitats, species or biodiversity. Impacts may be extensive or localized; may be long-term with poor potential for recovery. Locally significant pollution of the atmosphere, marine environment, coast or land (including Tier 2 and 3 incidents). Locally significant usage, depletion or wastage of scarce or non-renewable resources; usage of toxic or noxious materials; transfer of wastes, pollution or other environmental problems to inappropriate locations or media with local or national implications; or constraints relating to the management of these impacts. Temporary effects on human health involving individuals or longer-term effects on human well being involving communities. Locally significant temporary loss of income, public finances, amenity, cultural heritage or resources. Locally significant social disruption. Strong negative response by local stakeholders (may escalate to national level). Clean-up Costs Clean-up, remediation or abatement requires local resources (may escalate to national resources).

Severity Table for Acute Environmental Risks on a per ship basis	
Severity Index	**Description of the effect on the environment**
3	**Indicative environmental and clean-up costs per ship of the order of $3M** Environmental Costs Locally significant degradation, damage or loss of ecologically, commercially or culturally important habitats, species or biodiversity. Impacts generally localized with good potential for recovery. Locally significant pollution of the atmosphere, marine environment, coast or land (including Tier 3 incidents). Small-scale usage, depletion or wastage of scarce or non-renewable resources. Usage of toxic or noxious materials; transfer of wastes, pollution or other environmental problems generally not an issue. Temporary effects on well being individuals and not communities. Short-term nuisance or local temporary loss of amenity, resources and income to individuals rather than communities, with no risk public finances or cultural heritage. Social disruption generally not an issue. Negative response by local stakeholders. Clean-up Costs Clean-up, remediation or abatement dealt with by company resources.
2	**Indicative environmental and clean-up costs per ship of the order of $300,000** Environmental Costs Localized, transient ecological disruption, close to the source of the effect, generally with prospects of with rapid recovery. Localized deterioration in water quality, or shoreline/ground contamination . Small Tier 3 oil spill affecting a single shoreline area Transient nuisance. Local concern by stakeholders. Clean-up Costs Ship-borne and external response costs.
1	**Indicative environmental and clean-up costs per ship of the order of $30,000** Environmental Costs Very small tier 3 event. Clean-up Costs Ship-borne and external response costs
Positive	**Positive** Environmental or social improvement or enhancement.

Frequency Table

The proposed frequency Table is unchanged.

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 Table – Acute Environmental Risks

Risk Matrix

The resulting Risk Matrix is an extended version of the safety risk matrix to accommodate severity indices 5 and 6.

Risk Index (RI)							
		SEVERITY (SI)					
FI	FREQUENCY	1	2	3	4	5	6
7	Frequent	8	9	10	11		
6		7	8	9	10	11	
5	Reasonably probable	6	7	8	9	10	11
4		5	6	7	8	9	10
3	Remote	4	5	6	7	8	9
2		3	4	5	6	7	8
1	Extremely Remote	2	3	4	5	6	7

Table 2: Risk Matrix – Acute Environmental Risks

Environmental Measures and Tolerability

Environmental risk does not make the split between individual and societal risk in the same way. Environmental risks are holistic in nature and are therefore more like societal risks.

The basic criterion for Environmental risks is similar to Safety but tends to use slightly different terminology. This is:

Intolerable;

Acceptable (negligible in safety);

Tolerable for the region in between where the activity can continue if the trade-off between societal benefits and environmental/social penalties can be justified;

Beneficial which will or could potentially deliver benefits or improvements.

The criteria for tolerability can be based on ALARP (as with safety) or other techniques such as:

BPEO (Best Practicable Environmental Option);

BATNEEC (Best Availability Techniques Not Entailing Excessive Cost);

BAT (Best Available Technique).

Environmental Calculations

The basis of the environmental calculations should be the same, namely cost of averting "environmental harm". However there is not a "unit of environmental harm" as there is with safety where the "unit of safety harm" is a fatality (or fatality per year).

The "environmental harm" has to be calculated based on cost and is made up of:

The **Clean-up Cost;** and
the **Environmental Cost**.

The equivalent calculation is then Gross Cost for Averting Pollution (Gross CAP) and Net Cost for Averting Pollution (Net CAP):

$$\text{Gross CAP} = \Delta C/\Delta E$$
$$\text{Net CAP} = \Delta C\text{-}\Delta B/\Delta E$$

ΔE is the environmental improvement per ship in terms of the reduction in clean-up costs and in the environmental cost, implied by the risk control option.

Clean-up Costs

The Clean-up Cost is the tangible cost associated with the clean-up and compensation for loss of business and amenity during the clean-up. An example of Clean-up Costs for oil spills is $60,000 per tonne (SAFEDOR in 2005).

Environmental Costs

The Environmental Cost is the intangible value set on the damage to the environment from an activity and the loss of amenity to humans. These costs, sometimes referred to as appraisal values, are not universally agreed and the FSA submission will need to propose and justify the values used.

Some examples of possible values of Environmental Costs are shown in Table 3. However as these numbers are not agreed, until agreed numbers emerge it will be necessary for each FSA to propose and justify the values used.

Environmental Aspect	Abatement Technology with an associated Cost to a Ship	Indirect Environmental Cost with an associated cost to Society	Appraisal Values for the Environmental Cost
CO_2 emissions from fuel combustion	Development and implementation of lean burn engines.	Cost and implementation of development of carbon capture technology.	£15.09 per tonne (under the EU Emission trading scheme). £25 per tonne (the UK shadow price).[12]
Waste generated from vessels	Development of recycling receiving facilities in ports around the world, construction of more recycling facilities.	Energy costs associated with recycling.	£24 per tonne (in the UK as of 1st April 2007 for landfill).
Oil in produced water	Improvement in separation equipment on vessels. Development of legislation to reduce oil in water content discharged.	Energy costs associated with increased oil in water treatment mechanisms.	£140,000 per tonne (under the BERR Produced Water Trading Scheme).
SO_2 emissions from fuel combustion	Conversion of existing fleet to adapt to USLD.	Energy and emissions costs associated with removal of sulphur from fuel.	$860 per tonne (2006).
Ballast Water (Australia)	Avoidance of damage to tourism, public health and aquaculture.	Damage to tourism, public health and aquaculture.	$2 per tonne of ballast discharged.

Table 3 Examples of Appraisal Values for Environmental Costs

12 This is an example of how there are not agreed values of environmental costs.

There is a trend in national legislation for intangible environmental costs to be transferred to being tangible costs through taxation. Some of the examples above are based on taxation values.

If such taxation (or other cost measure) is introduced into international shipping then care must be taken to make sure the environmental cost is not double counted in both the environmental harm calculations and the business cost calculations.

The United Kingdom would like to add that all three cost-improvement techniques can be applied to environmental risk cost appraisal. These include:

- Cost-benefit analysis;
- Cost-effectiveness analysis;
- Cost-utility analysis.

Cost utility analysis is particularly useful where FSA studies are trying to evaluate effects on amenity and wildlife because "benefit" and "effectiveness" are difficult areas to apply economic evaluation criteria.

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