MARINE ENVIRONMENT PROTECTION COMMITTEE
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Agenda item 17

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FORMAL SAFETY ASSESSMENT

Report of the Working Group on Environmental Risk Evaluation Criteria within the context of Formal Safety Assessment

Introduction

1 The Working Group on Environmental Risk Evaluation Criteria within the context of Formal Safety Assessment met from 22 to 24 March 2010, under the Chairmanship of Professor Harilaos N. Psaraftis (Greece).

2 The Group was attended by delegations from:

BAHAMAS
CHINA
DENMARK
FINLAND
GERMANY
GREECE
ITALY
JAPAN
MALTA
MARSHALL ISLANDS
NORWAY
POLAND
REPUBLIC OF KOREA
RUSSIAN FEDERATION
SAUDI ARABIA
SINGAPORE
SPAIN
SWEDEN
UNITED KINGDOM
UNITED STATES

and by observers from the following non-governmental organizations in consultative status:

INTERNATIONAL CHAMBER OF SHIPPING (ICS)
INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES (IACS)
OIL COMPANIES INTERNATIONAL MARINE FORUM (OCIMF)
INTERNATIONAL ASSOCIATION OF INDEPENDENT TANKER OWNERS (INTERTANKO)
INTERNATIONAL SHIP MANAGERS' ASSOCIATION (INTERMANAGER)
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS (RINA)
INTERFERRY
WORLD SHIPPING COUNCIL (WSC)

Terms of Reference

3 Using documents MEPC 60/17, MEPC 60/17/1, MEPC 60/17/2 and MEPC 60/17/3 as a basis, and any other relevant information, the working group was instructed to:

.1 recommend in Step 4 of the FSA an appropriate volume-dependent CATS global threshold scale or function for ascertaining if a specific Risk Control Option (RCO) is cost-effective, including its integration within the FSA methodology;

.2 recommend a way of combining environmental and safety criteria for those RCOs that affect both environmental and fatality risk;

.3 conclude on an appropriate risk matrix or index for environmental criteria;

.4 recommend an appropriate ALARP region and F-N diagram, including an appropriate value for the slope of the F-N curve;

.5 address the issue of collection and reporting of relevant data; and

.6 submit a written report to plenary on Thursday, 25 March 2010.

Working Definitions as a reference of this working group

Total spill costs components could be: clean-up costs, mitigating costs/preventing measures, property damage, economic losses (fisheries, tourism-related, etc.), environmental damage (reinstatement/restoration of the impaired environment, long-term environmental effects, reasonable legal costs).

CATS criterion: (cost to avert one tonne of oil spilled) is a function of: costs, assurance factor reflecting society's willingness to pay, and possibly other factors (for example, intangible environmental impacts, etc.).

CATS for an RCO is the cost of the RCO divided by the tonnes of oil spill averted by the RCO.

Recommend in Step 4 of the FSA an appropriate volume-dependent CATS global threshold scale or function for ascertaining if a specific Risk Control Option (RCO) is cost-effective, including its integration within the FSA methodology

4 The Group reiterated the previous views expressed by successive correspondence groups that environmental risk evaluation criteria should be expressed on a "cost per volume of spilled oil" basis. A majority of the delegations also reiterated the view that a volume-dependent scale or function should be used, as specified in the TOR.

5 The Group, in considering document MEPC 60/17/1 (Norway), noted that the document was being submitted as information to assist in the determination of the cost of averting an oil spill, as well as to provide Norway's views on the determination of the CATS criterion.

6 Norway, in introducing the document, underlined that CATS should include a societal willingness to pay for averting oil spills, and the use of compensation costs as a proxy for oil spill cost may not necessarily be appropriate, as it does not include either society's willingness to pay to avert serious environmental damage as well as the long term

socio-economic effects of an oil spill. In this connection, it pointed out that in its data set, only 38% of the costs were compensated for. It urged other flag States to look closely into the issue of using data from P & I Clubs and/or compensation funds with a view that more information can be available which will help determine a CATS value applicable globally. Based on its data, Norway reiterated its proposal to use the constant value of US$60,000 per tonne of oil spilled as a CATS threshold.

7 While the Group expressed appreciation for the valuable information, a concern was expressed by some delegations that the spill cost data presented by Norway referred to a limited sample of 17 spills and thus is not representative of worldwide spill cost data, being likely on the high side *vis-à-vis* world figures. An objection was also raised that the constant CATS threshold is not compatible with the volume-based dependant already specified in the TOR. Other delegations observed that a linear function of a volume is also volume dependent.

8 Some delegations supported the view of Norway that society's willingness to pay should be ascertained, whereas some other delegations voiced concern that this difficult subject may take a long time to be finalized. The Chairman noted that progress on the specific TOR was necessary within a very short time frame, given the deadline set by the Committee to complete this work (2010) and, before one could handle the issues of willingness to pay, risk aversion, or assurance factor, agreement on which spill cost function can be used should first be sought.

9 As regards the issue which among a cost scale or cost function should be pursued, the Group expressed the view that a cost function has several advantages over a scale and would thus be preferable as a tool.

10 The Group noted that research work independently conducted by Japan (MEPC 59/17/1), Norway (MEPC 59/INF.21) and Greece (MEPC 60/17, annex 2) led to very similar non-linear functions of total spill cost versus spill weight, obtained by regression, as shown in Tables 1 and 2 and Figure 1 below:

Table 1: Non-linear functions of total spill costs (obtained by regression)

Reference	Total spill cost function V: spill weight (tonnes)	Data source
Japan: Yamada 2009 (MEPC 59/17/1)	$38{,}735V^{0.66}$	IOPCF[1]
Norway: Psarros *et al.* 2009 (MEPC 59/INF.21)	$60{,}515V^{0.647}$	IOPCF, Safeco project
Greece: Kontovas *et al*. 2009 (MEPC 60/17, annex 2)	$51{,}432V^{0.728}$	IOPCF

1 For more information on the IOPCF, see www.iopcfund.org.

Table 2: Total Unit Spill Cost (Total Spill Cost/Spill Weight) US$/tonne – see also Figure 1[2]

V- tonnes	Log(V)	Japan	Norway	Greece	Constant Unit Cost
1	0	38,735	60,515	51,432	40,000
10	1	17,705	26,845	27,494	40,000
100	2	8,093	11,909	14,697	40,000
1,000	3	3,699	5,283	7,857	40,000
10,000	4	1,691	2,343	4,200	40,000
100,000	5	773	1,040	2,245	40,000

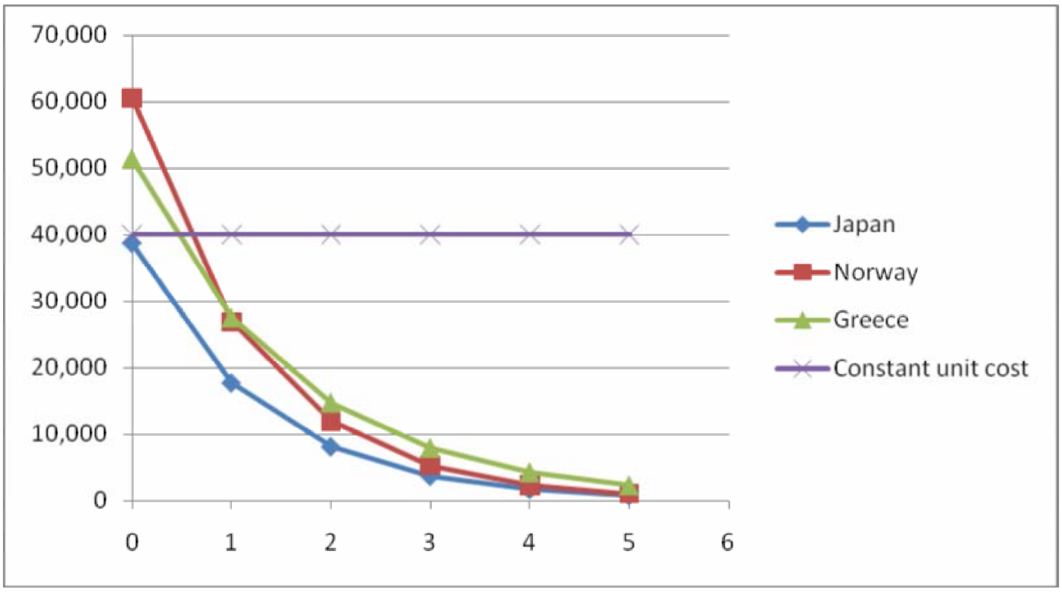

Figure 1 – Total Unit Spill Cost (US$/tonne) *vs* log(V) for V≥1 tonne

11 The Group also noted information on oil spill history in United States waters presented by the delegation of the United States. The results of the preliminary research indicate estimates between US$25,488 and US$116,187,257 per tonne of oil spilled. The delegation of Greece also circulated information on oil spill costs in Greece, showing a non-linear trend of costs versus spill size.

12 With regard to the IOPCF data used in the above three regressions, the Group were informed by the observer of the IOPCF on the fundamental features of the Compensation Conventions (1992 CLC and 1992 Fund Conventions), in particular, on the scope of the compensation regimes and the admissible claims under these Conventions. The Group was informed that claims in respect of pollution damage fall under one of the following broad categories:

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2 For comparison purposes, in Table 2 (last column) and in Figure 1 (Constant unit cost), the total spill cost per tonne of US$40,000/tonne corresponding to a constant CATS value of US$60,000/tonne is also shown (assuming an assurance factor of 1.5; refer to paragraph 21.2).

.1 mitigating/preventive measures (including clean-up);

.2 damage to third party property due to oiling;

.3 economic loss including fishery and tourism-related losses; and

.4 reinstatement/restoration of the impaired environment.

13 The IOPCF representative explained that in rare cases (such as the **Prestige** spill) the upper limit set by the Fund had been reached, and that for some categories of spill costs, such as environmental damages, the scope of the Conventions was limited. In addition, in some cases, the shipowner would pay directly some of the costs. In all such cases, the funds disbursed by IOPCF are below actual total spill costs.

14 With regard to the reinstatement/restoration of the impaired environment, the Group noted that claims other than loss of profit from the impairment of the environment are accepted only where reasonable measures of reinstatement are undertaken and that IOPCF will only pay for related studies where such studies pertain to establishing the need for reinstatement measures. Compensation is not paid in respect of claims for environmental damage based on abstract quantification calculated with theoretical models.

15 The Group also noted that the IOPCF compensation scheme only addresses spills of oil carried as cargo or bunkers from oil tankers or any type of seagoing vessel constructed or adapted for the carriage for carrying persistent oils including crude oil, heavy fuel oil and lubricating oils. Some delegations expressed concern that this data may not be representative for the entire fleet of ships. The Group noted that the value of the limits are expressed in Special Drawing Rights (SDR) so that the value in another currency will vary according to the exchange rate at the particular time.

16 Following extensive discussion on which components of the spill cost should be included in the total spill cost function, the Group agreed that this function should cover those elements as defined in "total spill costs components" (used as a working definition as a reference for the working group), to the extent that all of these costs are due to the spill. Long-term ecological damage can be addressed by the environmental factor as proposed by Japan (refer to paragraph 21.2). Reasonable legal costs can also be included. However, whereas the value of lost oil and damage to the vessel are included in the assessment undertaken by the United States, the Group agreed that such damage costs cannot be ascribed to the spill itself and thus cannot be part of the spill cost function. These costs should be included independently and explicitly in monetary terms in the FSA.

17 Following extensive discussion as to what type of total spill cost function should be used, a majority of the members of the Group agreed that a non-linear function is more justifiable by the available data, with some other Group members supporting a constant total spill cost per tonne and some other members not being able to take a position on this issue.

18 Notwithstanding the fact that the IOPCF data underestimates to a degree total spill costs (see paragraphs 13 to 15) above, it was considered useful as a start to establish a basis, noting that 103 countries have ratified the CLC and Fund Conventions. Among the three non-linear regressions performed, the one proposed by Greece was considered most conservative (resulting in larger cost figures per tonne of oil spilled – except for spills less than 4 tonnes). Thus, this regression formula was proposed as a basis.

19 Some Group members expressed concerns that if the cost values of the above regression formula are misinterpreted for being the CATS values, the values are too low for large spills, and may lead to removal of regulations already enforced. Furthermore, the analysis may not be representative when used in the context of FSA. However, other members felt that too high a CATS value, not supported by the data, may lead to unrealistic regulations which may have an adverse impact on the environment.

20 Other members expressed a concern that going with constant costs' values cannot be supported by the data. Some delegations expressed concern that a constant CATS is much larger in a large oil spill area than by curves obtained by regression of oil spill data.

21 Noting that the regression formula proposed by Greece would serve as a basis for deriving the total cost of an oil spill, the Group further proposed that in order to arrive at the recommended CATS criterion, the following should be considered:

.1 Member Governments or interested organizations having their own additional data, attempt to verify, and adjust as necessary, the said regression formula by incorporating their additional (chosen) data in the analysis. In this connection, the Group agreed to request the Committee to invite the interested stakeholders to submit their data for each cost component (see working definitions) and the results of their analysis for consideration;

.2 Following a more reliable establishment of the cost curve, a proposed CATS formula, to be used in the cost effectiveness step of FSA, can be established by introducing a margin or factor value (so called assurance factor) still to be agreed, representing society's willingness to prevent an accident rather than simply neutralize its consequences.

With regard to paragraph 21.2 above, some delegations supported the view that the "assurance factor" may have to be volume-dependent since this may be influenced by non technical decisions. The Japanese delegation expressed the view (refer to document MEPC 60/17/2) that an assurance factor of 1.5 and environmental factor of 2.5 were proposed by the Safedor projects[3], and these values could be used as a starting point for discussion of these factors. The Group agreed that more information was required on which to base such a proposal.

22 Norway, supported by the United States, stated that CATS is a societal willingness to pay for preventing oil spills and that an alternative method for calculating the CATS criterion values can therefore also be identified by cost-effective analysis of existing regulations. It urged Member Governments and intergovernmental organizations to submit cost-effectiveness analysis of such regulations.

23 As regards the integration of a non-linear cost function within the FSA methodology, some delegations noted that although this may be conceptually straightforward, it will also be more computationally complex than if a linear function were used. This would involve the estimation of total spill costs calculated by the non-linear function for each probable spill size in the event tree of the risk analysis step, and for the RCOs that are contemplated. Some members expressed the concern that the review process may be more complicated and less transparent. The Group agreed to request the Committee to invite Member Governments and interested organizations to use the non-linear cost function in FSA studies with a view to

[3] For more information on Safedor projects, see www.safedor.org.

gaining experience with its application and provide information to the Organization, which may help to improve the proposed functions.

24 The discussion was not concluded as to how to address the gap between actual spill costs and the CATS value that takes into account society's willingness to pay.

Recommend a way of combining environmental and safety criteria for those RCOs that affect both environmental and fatality risk

25 The Group considered how environmental and safety criteria for those RCOs that affect both environmental and fatality risk could be combined. The Group considered a variety of options that can be applied. These include the following:

.1 the first option is based on criteria already in use in the FSA methodology and which had been used in existing FSA studies;

.2 the second option is a variant of the first, proposed by the United States, which is set out at annex 1; and

.3 the third option is what was proposed by the Chairman, as set out in document MEPC 58/17 (included in annex 2 for ease of reference).

26 The Group agreed to finalize this issue when the CATS function is resolved.

Conclude on an appropriate risk matrix or index for environmental criteria

27 For the Frequency Matrix, the Group agreed to use the one already established for FSA methodology (MSC 83/INF.2) and agreed to propose this for the Committee's consideration:

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 1,000 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 5,000 ships	10^{-5}

28 The Group recalled that the severity index (SI) used in a Hazard Identification (Hazid) session for ranking identified environmental hazards, had been discussed by successive correspondence groups and that, among the various options discussed, an SI based on oil spill weight/volume should be recommended. As regards the rationale, the Group noted that one should consider who will eventually be the end-user of the SI. If naval architects would use the SI in Hazid step, connected to new or alternative (oil) tanker designs or associated rule development, an SI based on oil spill weight/volume would be easier to apply consistently. Furthermore, an SI based on spilled oil weight would be preferred because the criterion of spilled oil can be dealt with more uniformly than environmental damage cost.

29 Following discussion on an appropriate SI, the Group agreed that whilst it was not in a position to detail the SI until such time that there was agreement on the CATS, the Group noted the importance to use an appropriate SI which reflects actual risk levels in order that hazards that are deemed important are neither ranked low nor discarded. To that effect, (a) the SI should be based on volume-dependent criteria since this should mirror the approach already decided; (b) the SI should not be different for different oil types; (c) a logarithmic scale should be applied; and (d) whilst regional perspectives or specific FSA scenarios might necessitate to use a customized SI, it is important to agree on the general principles for what the SI might be, as it is important to keep in mind that the ultimate purpose of the methodology to be developed in the future was to recommend RCOs for IMO rule-making which are applicable worldwide.

30 In presenting document MEPC 60/17/2, Japan noted that an RI (risk index) value, which corresponds to a disastrous oil spill (SI=4, catastrophic) and whose frequency is extremely remote (FI=1), is equivalent to 5 (RI=5). On the other hand, the RI value, which corresponds to a small oil spill (SI=1, minor) and whose frequency is frequent (FI=7), is equivalent to 8 (RI=8). This indicates that the RI of catastrophic but extremely remote (once in a hundred thousand ship years) oil spills may be ranked lower than that of a small oil spill. The difference of 3 in the RI, which is expressed in logarithm, means that the actual risk level is 1,000 times larger. To alleviate this problem, Japan proposed that SI can be as high as 7.

31 Following an exchange of views the Group agreed that the severity index needs to be consistent with the CATS function, but until such time that the CATS function is resolved, the exact detail of the severity index could not be finalized.

An appropriate ALARP region and F-N diagram, including an appropriate value for the slope of the F-N curve

32 The Group noted that the boundaries of the ALARP region, the slope of F-N diagram and what is the variable of the horizontal axis, remain to be resolved. The Group recalled the approach suggested by Germany (MEPC 59/17), and noted the submission by Japan (MEPC 60/17/3) on the same subject.

33 In considering the information in document MEPC 60/17/3, the Group noted that factors related to setting ALARP borders in this document were based on the Aframax tankers and that such a study needed to be expanded to other sizes of oil tankers, such as VLCC and Panamax, to ensure the validity of the boundaries. Still, the fact that the slope was set equal to -1 and that the boundary between tolerable and intolerable risk was a factor of 100 (or 2 on the log scale) is subject to debate, and the Group was not able to arrive at a concrete recommendation on these points.

34 One Group member noted that in Germany's prior study, one 17,000 tonne spill could put the entire double hull fleet outside the ALARP region, and suggested changing the slope of the ALARP borders so as to avoid such a possibility. Another delegate suggested omitting the F-N diagram altogether, on the ground of not providing useful information. However, some members said that an attempt to retain these diagrams within the environmental FSA should be made.

35 The Group concluded that it might be premature to take this issue forward until such time the CATS function is resolved.

Collection and reporting of relevant data

36 The Group recognized the importance of providing data in order to test and apply any agreed methodology. In this regard, the Group noted that the information provided in the GISIS, in particular, the module on reported casualty incidents, may contribute to this end, at the same time also noting that data through GISIS may still be insufficient due to the lack of reporting by Member States, or that it did not include some of the underlying causes of incidents (root causes). Some Group members voiced their concern that spill clean-up, damage or cost data may not be readily available in GISIS or other databases, making any cost benefit analysis very difficult or impossible.

37 In this context, the Group supported the recommendations put forward by the MSC FSA Expert Group (MSC 87/18) with regard to historical data, comprehensiveness and availability of data, including improving the GISIS casualty data and, if relevant, complementing it with other available data. One delegation, supported by others, noted that the GISIS has limitations with regard to producing outputs in a format that can be used in FSA studies. In addition, some delegations also noted that the GISIS does not contain specific oil pollution damage quantification which is needed for completing the CATS discussion. In referring to resolution A.1029(26) on GISIS, the Group urged Member States to continue providing as complete information as possible in GISIS module dealing with reported casualty incidents.

Other relevant issues and consideration on how to complete the work

38 The Group agreed to request the Committee that a working group be reconvened at MEPC 62, since it was felt that the time interval between MEPC 60 and MEPC 61 is too short to allow Member Governments and other interested organizations to attempt to collect relevant data, verify and adjust as necessary, the regression formula proposed by Greece. In this connection, the Group requested the Committee to consider extending the deadline for completing the work to 2011. Therefore, the Group agreed to request the Committee to retain this item on the agenda for MEPC 61.

Action requested of the Committee

39 The Committee is invited to approve the report in general and, in particular, to:

.1 note the progress made in determining a CATS criterion (paragraphs 4 to 24);

.2 urge Member Governments/organizations to verify and adjust as necessary the proposed regression formula and to submit the data for each cost component and the results of the analysis for consideration by the Committee (paragraph 21.1);

.3 invite Member Governments and interested organizations to use the non-linear cost function in FSA studies with a view to gain experience with its application and provide information to the Organization which may help to improve the proposed functions (paragraph 23);

.4 note the options proposed for environmental and safety criteria for those RCOs that affect both environmental and safety risk (paragraph 25 and annexes 1 and 2);

.5 endorse the Group's view on using the Frequency Matrix already in use for the safety FSA methodology (paragraph 27);

.6 note the progress made in determining the appropriate severity and risk indices as well as an ALARP region and F-N diagram (paragraphs 28 to 35);

.7 endorse the Group's view that the severity index needs to be consistent with the CATS function (paragraph 31);

.8 endorse the Group's views on the collection and reporting of relevant data for environmental FSAs (paragraphs 36 and 37); and

.9 endorse the Group's request regarding the proposed arrangements in order to complete the methodology, including the establishment of a working group at MEPC 62 (paragraph 38).

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ANNEX 1

UNITED STATES PROPOSAL ON COMBINING ENVIRONMENTAL AND SAFETY CRITERIA

COST		BENEFIT
Full Life Cycle A: Design B: Construction C: Operation D: Maintenance E: Decommissioning Total COST (C_T)= A+B+C+D+E Adjust for inflation		Monetized (B_M) • Cargo • Vessel Damage • Other Lives (B_L) • Death • Injuries • Use CAF value for dollar amount Environmental (B_E) • MT Not Spilled

1. Calculate C_T

2. Subtract monetized benefit and monetized lives from C_T

   $C_T – B_M – B_L$

3. Calculate B_E

4. Calculate Environmental Cost Effectiveness (ECE)

   $$ECE = \frac{C_T - B_M - B_L}{B_E}$$

5. Compare ECE to environmental risk evaluation criteria.

   IF ECE < lower bound (e.g., $25,000/MT not spilled), then implement

   IF ECE > upper bound (e.g., $116,000,000/MT not spilled), then reject

   Otherwise, CONSIDER

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ANNEX 2

CHAIRMAN'S PROPOSAL ON COMBINING ENVIRONMENTAL AND SAFETY CRITERIA

Reference: document MEPC 58/17, annex, page 6 (section 4)

The safety criterion for a specified RCO uses the concept of GCAF (Gross Cost to Avert a Fatality):

- If GCAF = $\Delta C/\Delta R$ < VHL, then RCO is cost-effective, otherwise not.
- Among alternatives that pass this test, choose the one with the minimum GCAF.

In the above formula, ΔC is the expected cost of the RCO, ΔR is the expected reduction of fatalities due to the RCO, and VHL is an estimate of the value of human life (the value currently used in FSA studies is 3 million dollars per person).

Both ΔC and ΔR are assumed to be expressed on an annual basis.

If now the RCO in question also reduces environmental risk, let **ΔTSC be the expected total spill cost averted due to the application of the RCO.**

ΔTSC can be calculated from the assumed total spill cost function.

ΔTSC = (Expected total spill cost BEFORE RCO) – (Expected total spill cost AFTER RCO)

Then the combined criterion is the following:

RCO cost effective if $\Delta C < F^*\Delta TSC + VHL^*\Delta R$

ΔTSC: expected environmental benefit (volume of spill averted)
VHL*ΔR: expected safety benefit (fatalities averted)
F: Assurance factor (≥ 1).

It is then possible to combine fatality and environmental criteria as follows:

- The specific RCO under consideration is cost-effective globally if its cost $\Delta C < F^*\Delta TSC + VHL^*\Delta R$, otherwise it is not.
- Among alternative RCOs that pass this criterion, the one that achieves the highest positive **difference** ($\Delta TSC + VHL^*\Delta R - \Delta C$) is preferable.

In case NCAF (Net Cost to Avert a Fatality) is used instead of GCAF, ΔC is replaced by (ΔC-ΔB), where ΔB accounts for expected benefits due to the RCO (other than lives saved or environmental).

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