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# FORMAL SAFETY ASSESSMENT

## Comments on the Correspondence Group report on Environmental Risk Evaluation Criteria

**Submitted by Japan**


| SUMMARY | |
|---|---|
| ***Executive summary:*** | This document provides comments on the report of the correspondence group (MEPC 60/17) with regard to the ALARP region and F-T diagram |
| ***Strategic direction:*** | 12.1 |
| ***High-level action:*** | 12.1.1 |
| ***Planned output:*** | 12.1.1.1 |
| ***Action to be taken:*** | Paragraph 4 |
| ***Related documents:*** | MEPC 60/17, MEPC 59/17, MEPC 59/17/1, MEPC 59/17/2, MEPC 59/INF.21, MEPC 59/24, MSC 83/INF.2 and MSC 72/16 |


## Introduction

1 This document is submitted in accordance with paragraph 4.10.5 of the Guidelines on the organization and method of work of the Committees and their subsidiary bodies (MSC-MEPC.1/Circ.2), and provides comments on document MEPC 60/17.

## Comments

2 Having recalled that the Correspondence Group was instructed by MEPC 59 to recommend an appropriate ALARP region and F-N diagram, including an appropriate value for the slope of the F-N diagram, Japan has prepared a method for setting the ALARP region on Frequency-Ton (F-T) diagrams, following the method for the safety FSA (MSC 72/16), in order to facilitate the discussion in the Committee. The proposed method is set out in the annex to this document.

3 Before starting any detailed discussion on the matter, Japan would like to remind the Committee that there is a conceptual difference between the ALARP region and CATS. ALARP region is a criterion expressed in the form of risk, and is a basis for deciding whether or not the risk is acceptable for the maritime society. A threshold value of CATS is a cost-effectiveness criterion expressed in the form of cost of averting a unit risk, and used to assess to what extent risk control options are cost-effective when the Committee considers measures.

**Action requested of the Committee**

4 The Committee is invited to consider the comments in paragraphs 2 and 3 above, including the annex, and to decide as appropriate.

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## ANNEX

## A METHOD FOR SETTING BORDERS OF THE ALARP REGION ON F-T DIAGRAMS BY ECONOMIC SCALE*

1 For the Safety FSA, the method for setting borders of ALARP region on F-N diagrams is explained in document MSC 72/16. Following the method used in the safety FSA, a method for setting borders of ALARP region on F-T diagrams regarding the environmental FSA can be described as below.

2 Firstly, a comparison of factors relating to setting ALARP borders should be made. In case of a fatal accident, the shipowner needs to compensate for the loss of lives. As for an oil spill accident, the shipowner and the oil company need to compensate not only for the loss of oil but also for the environmental damage. In this regard, charter rates for tankers and cargo value should be taken into account in the case of an oil spill accident. The comparisons are summarized in Table 1 below.

**Table 1: Factors relating to setting ALARP borders with respect to a fatal accident and an oil spill accident**

| | **Lost object** | **Side effect** | **Responsible persons** | **Economic loss** |
|---|---|---|---|---|
| Fatal accident (Safety FSA) | Human lives | nil | Shipowner | Charter rate |
| Oil spill accident (Environmental FSA) | Oil | Environmental damage | Shipowner and oil company | Charter rate and cargo value |

3 The following values are used in this method:

$GDP_W$: World annual GDP (US$/year)
$WO_W$: World annual oil spill quantity (ton/year)
$W_{max}$: The largest quantity of spilled oil (ton)
$W_{min}$: The smallest quantity of spilled oil (ton)
$EV_{tanker}$: Annual income earned by chartering a tanker (US$/ship*year)
$PLO_A$: Average Potential Loss of Oil (ton/ship*year)
F(w): Frequency corresponding to the oil spill quantity, w.

4 Eq. (1) is defined following the equation (1) in document MSC 72/16 and Eq. (2) is defined as below. Eq. (2) means that average F-T diagrams is assumed as a line, the slope of which is -1 and which passes through the point of $(W_{min},F(W_{min}))$ in a double logarithmic graph.

$$PLO_A = \frac{WO_W}{GDP_W} \cdot EV_{\text{tanker}}$$
$$= \int_{W_{\min}}^{W_{\max}} F(w)dw + F(W_{\min})W_{\min} \qquad (1)$$

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$$F(w) = \frac{F(W_{\min})}{w} W_{\min} \tag{2}$$

5 Eq. (3) is derived from Eq. (1) and Eq. (2), and Eq. (4) is derived from Eq. (1), Eq. (2) and Eq. (3). Then, Eq. (4) can be transformed to Eq. (5) in case that $W_{min} = 1$.

$$\begin{aligned} PLO_A &= F(W_{\min}) W_{\min} \int_{W_{\min}}^{W_{\max}} w^{-1} dw + F(W_{\min}) W_{\min} \\ &= F(W_{\min}) W_{\min} \left( Ln(W_{\max}) - Ln(W_{\min}) \right) + F(W_{\min}) W_{\min} \end{aligned} \tag{3}$$

$$F(W_{\min}) = \frac{\frac{WO_W}{GDP_W} \cdot EV_{\tan ker}}{\left( Ln(W_{\max}) - Ln(W_{\min}) + 1 \right) W_{\min}} \tag{4}$$

$$F(1) = \frac{\frac{WO_W}{GDP_W} \cdot EV_{\tan ker}}{Ln(W_{\max}) + 1} \tag{5}$$

The upper border can be defined as a line which passes through the point of ($Log(W_{min})$, $Log(10*F(W_{min}))$) with the slope of -1 in double logarithmic graph. The lower border can be defined as a line which passes through the point of ($Log(W_{min})$, $Log(F(W_{min})/10)$) with the slope of -1 in double logarithmic graph.

**Application example of this method for Aframax Tanker**

6 World GDPs from 2001 to 2008 are obtained from the database of IMF, titled "World Economic Outlook database: October, 2009". Annual quantities of spilled oil from 2001 to 2008 are obtained from the statistics of ITOPF (The International Tanker Owners Pollution Federation Ltd.). These figures are listed in Table1 below. In addition, income earned by crude oil transport for 25 years using an Aframax tanker can be estimated at $8.32 \times 10^9$ US$[1)]. The data relating to the income are listed in Table 3.

**Table 2: World GDPs from 2001 to 2008 (IMF: World Economic Outlook database: October, 2009) and world annual oil spill quantities (ITOPF: TANKER SPILL STATISTICS: 2008)**

| Year | GDP (billion US$) | Oil Spilt (ton) | Year | GDP (billion US$) | Oil Spilt (ton) |
|---|---|---|---|---|---|
| 2001 | 31,892 | 8,000 | 2005 | 45,385 | 17,000 |
| 2002 | 33,187 | 67,000 | 2006 | 49,115 | 13,000 |
| 2003 | 37,301 | 42,000 | 2007 | 55,270 | 18,000 |
| 2004 | 41,947 | 15,000 | 2008 | 60,917 | 2,000 |
| Total | 355,014 | 182,000 | **Average** | **44,377** | **22,750** |

**Table 3: Income earned by transport of crude oil using an Aframax Tanker**[1)]

| | |
|---|---|
| Loading weight [ton] | 81,000 |
| Cargo loading rate [%] | 98 |
| Amount of conveyed oil per navigation [tons] | 79,380 |
| Crude oil price (2005) [US$/ton] | 472 |
| Income per navigation [US$/nav] | $3.75\times10^{7}$ |
| Navigation per lifetime | 222 |
| Total income per lifetime [US$/ship*25years] | $8.32\times10^{9}$ |
| **Average annual income [billion US$/ship*year]** | **0.333** |

7 Taking 16 million US$ as an average charter rate of an Aframax tanker, while it is an average of all sizes of tankers, $PLO_A$ is calculated by Eq. (6). Also, F(1) is calculated by Eq. (7) assuming that $W_{max}$ = 300,000 ton and $W_{min}$ = 1 ton.

$$PLO_A=22{,}750 \times ((0.333+0.016) / 44{,}377) = 1.79\times10^{-1} \text{ (ton)} \quad (6)$$

$$F(1)=\frac{1.71E-1}{(Ln(W_{\max})-Ln(W_{\min})+1)}=\frac{1.71E-1}{13.6}=1.31\times10^{-2} \quad (7)$$

8 From Eq. (7), it becomes clear that the upper border of ALARP region on F-T diagrams is a line which passes through the point of (Log(1), Log($1.31\times10^{-1}$)) with a slope of -1 in double logarithmic graph. Similarly it also becomes clear that the lower border of ALARP region on F-T diagrams is a line which pass through (Log(1), Log($1.31\times10^{-3}$)) with the slope of -1 in double logarithmic graph.

9 These border lines of ALARP region and F-T diagrams of Aframax tankers (tankers of 60,000 DWT and above) are shown in Figure 1. Quantities of oil spill accidents and tanker populations are obtained from the casualty and ship characteristics database of LRFP (Lloyd's Register Fairplay) from 1990 to 2007. The upper border of ALARP region by the above method categorizes oil spill accidents of single hull tanker over 30 tons of oil spilt as intolerable. On the other hand, the upper border indicates that oil spill accidents of double hull tankers are inside ALARP region.

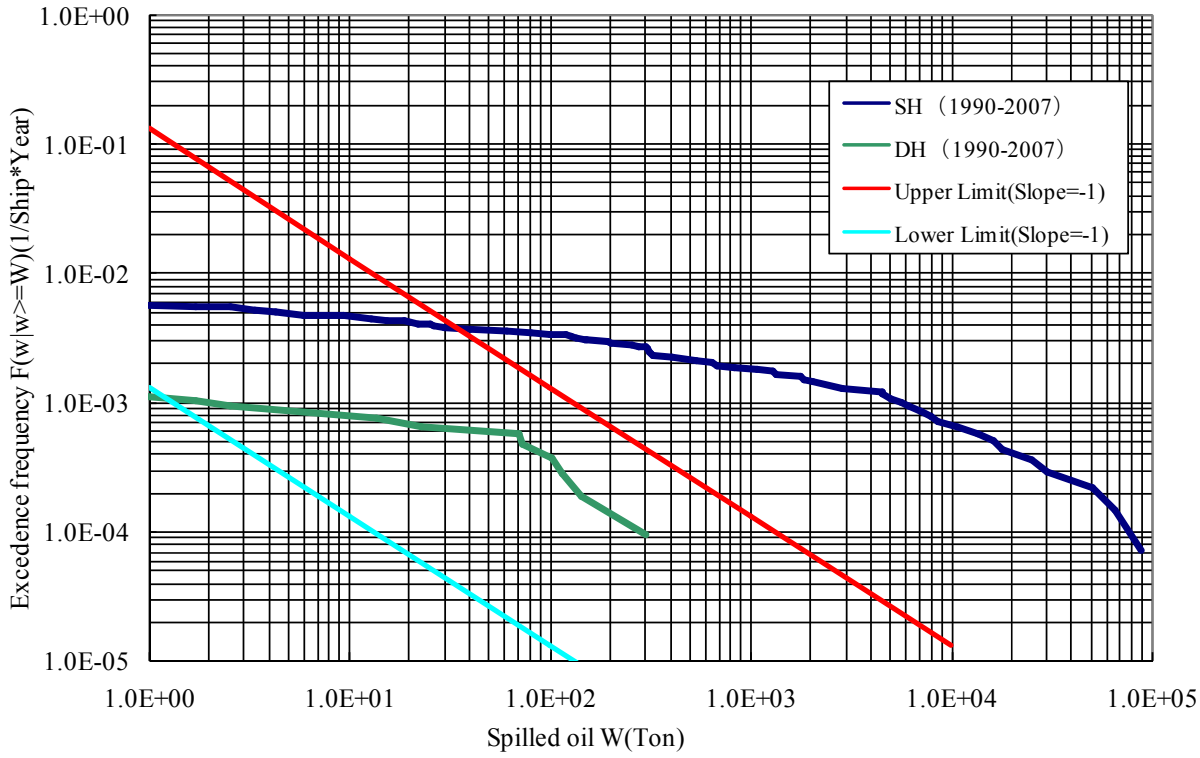


**Figure 1: F-T diagrams of Aframax tankers with the ALARP region**

10 MARPOL Annex I requires phase-out of single hull tankers, including Aframax size single hull tankers, and Figure 1 shows that this ALARP region justifies the requirement. In the future, further study on various sizes of tankers, such as VLCC and Panamax, are needed to assure the validity of this method.

**Reference:**

1) T. Yuzui, M. Arai and F. Kaneko: “Inclusive Environmental Impact Assessment of Oil Tankers”, Proceedings of TEAM2009.