Environmental FSA for oil tankers

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Background (1)

1. IMO Rule making – FSA guideline

As an increase of society's concern of environmental protection, Environmental Risk Evaluation Criteria (EREC; Env. FSA guideline) is under development within the framework of Formal Safety Assessment at IMO/MEPC where target year is set to 2011 (by MEPC62).

2. EU Project SAFEDOR（2005～2009）

6 FSA studies has been submitted to IMO by Denmark.

(Crude oil tanker / LNG / Container / Cruise / Ropax / General Cargo)

A FSA study for crude oil tanker proposed that increases of double hull width/depth by 0.8-1.0m are judged as cost-effective.

Background (2)

It is important to protect maritime environmental from oil spill caused by ships (especially by oil tankers).

- Are Triple hull, Quadruple hull practical ?

A balance between Costs of risk reduction measures (RCO) and Benefits (risk reduction) is important.

Cost-Benefit Assessment (CBA) is necessary, and FSA was developed in IMO as a tool to evaluate new (future) regulations.

Safety FSA has been widely used for many years in IMO.

As an increase of society's concern of environmental protection, environmental FSA guideline is under development at IMO/MEPC.

Present study is carried out within the framework of establishment of environmental FSA guidelines in IMO

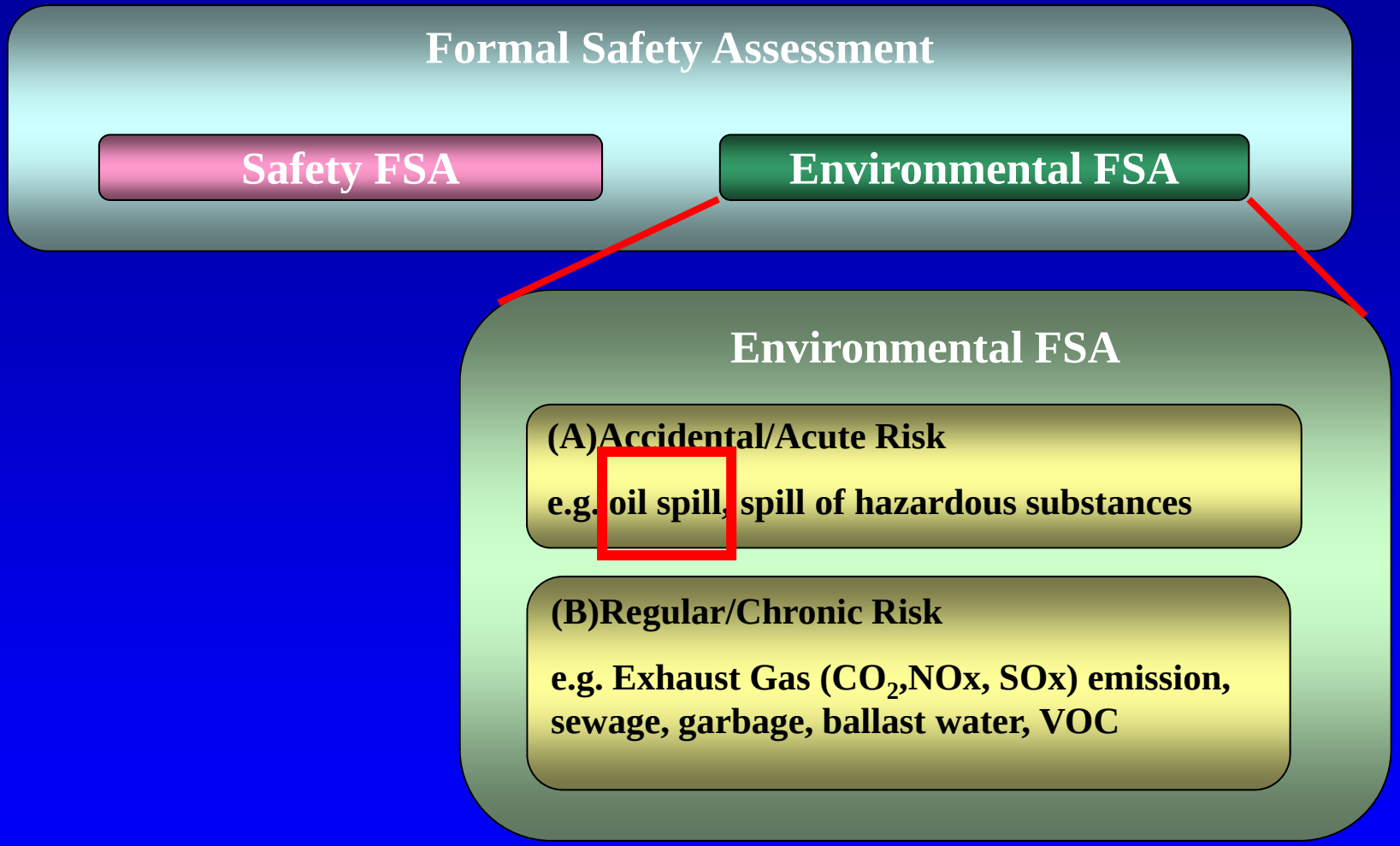
Main objectives of FSA is not an assessment of each accident, but CBA of new regulations.

What is FSA (Formal Safety Assessment) ?

- Proactively improve safety and environmental protection.
- A tool to quantitatively evaluate cost-effectiveness of new regulations (exclude political aspect and evaluate as scientifically as possible)
- Any FSA studies submitted to IMO need to be reviewed by Group of Experts (GoE) in IMO.
- New/revised regulation proposed as a result of FSA studies is going to be discussed at the Committee after review process

Environmental FSA

Background (3)



As a first step of Env. FSA oil spill is considered in IMO

Formal Safety Assessment (MSC 83/INF.2)

5 Steps in FSA

Step 1 Identification of Hazard (IH)

Step 2 Risk Analysis (RA)

Step 3 Risk Control Options (RCO)

Step 4 Cost Benefit Assessment (CBA)

Step 5 Recommendation for Decision Making (RDM)

Present study would contribute to discussions with regard to Cost-Benefit Assessment (Step 4)

CATS

Cost-effectiveness criteria in Environmental FSA

CATS : Cost of Averting a Ton of oil Spilt

FSA
Step 1
Step 2
Step 3
Step 4
Step 5

Risk analysis (using event tree / Bayesian)

Criteria to judge cost-effectiveness

$$\frac{\Delta C_i}{\Delta R_i} = CATS_i < CATS_{thr}$$

ΔC_i : Cost for Introducing a RCO_i [US$]

ΔR_i : Risk Reduction (oil spill weight) by Introducing a RCO_i [Ton]

$CATS_{thr}$ is a threshold value to judge cost effectiveness of arbitrary RCO_i.

According to SAFEDOR project $CATS_{thr}$=60,000 was proposed.

Reasonable and appropriate value of $CATS_{thr}$ is under discussion in MEPC and is one of most important issue.

FSA for crude oil tanker (SAFEDOR)

MEPC 58/17/2, MEPC58/INF.2 (Denmark)

Assuming $CATS_{thr}$=60,000[US$/ton] , following RCOs are judged as cost-effective

significant influence to ship structural design

3 Active Steering Gear Redundancy

4 Installation of ECDIS

6 Installation of Navigational Sonar

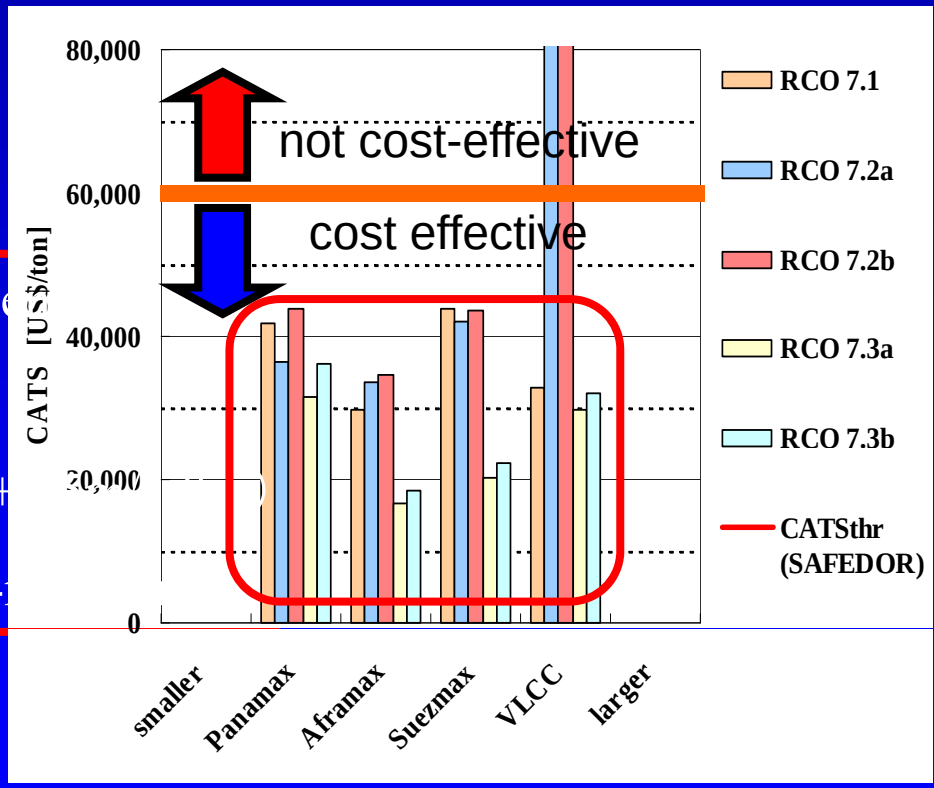
7.1 Change of Cargo Oil Tank Arrangeme

（Increase Number of Cargo Oil Tanks）

7.2 Increase of Double Bottom Height（+

7.3 Increase of Double Side Width（+0.4

8 Hot Works Procedure Training



CATS value (Tanker type / RCO7.1-7.3)

IOPCF

IOPCF Data (1)

International Oil Pollution Compensation Fund (IOPCF)

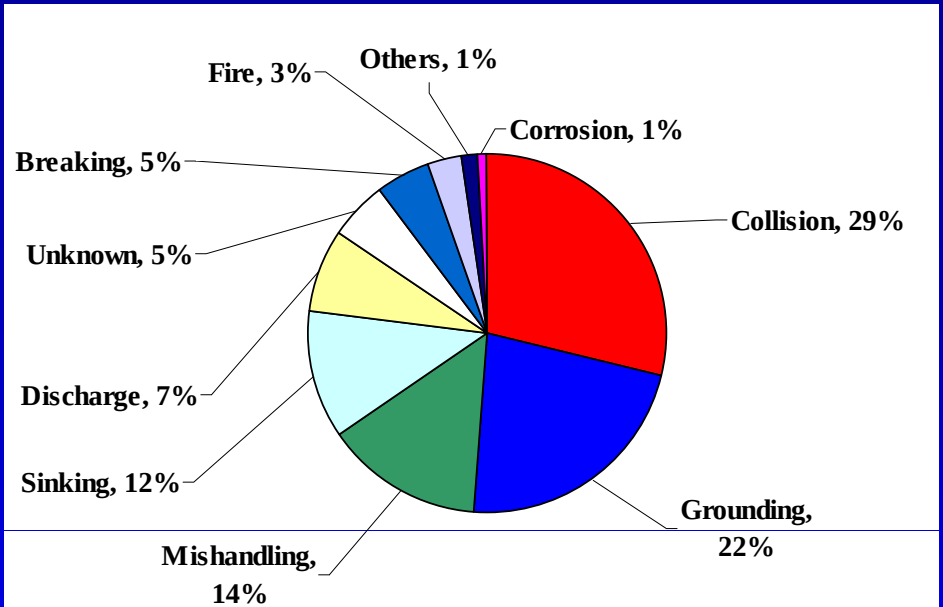
102 States are the members of 1992 Conventions (by 2007).

IOPCF compensates to "spills of persistent oil from oil tankers that cause pollution damage in the territory (including EEZ) of a State Party to the respective Convention"

Data used in the present study include accidents from 1970 to 2009 (under 1972, 1992 Conventions).

Most of major oil spill accidents in Member states are included such as Braer(1993), Nakhodka(1997), Erika (1999), Prestige(2001) and Baltic Carrier (2001)

Causes of Oil Spill from Tankers



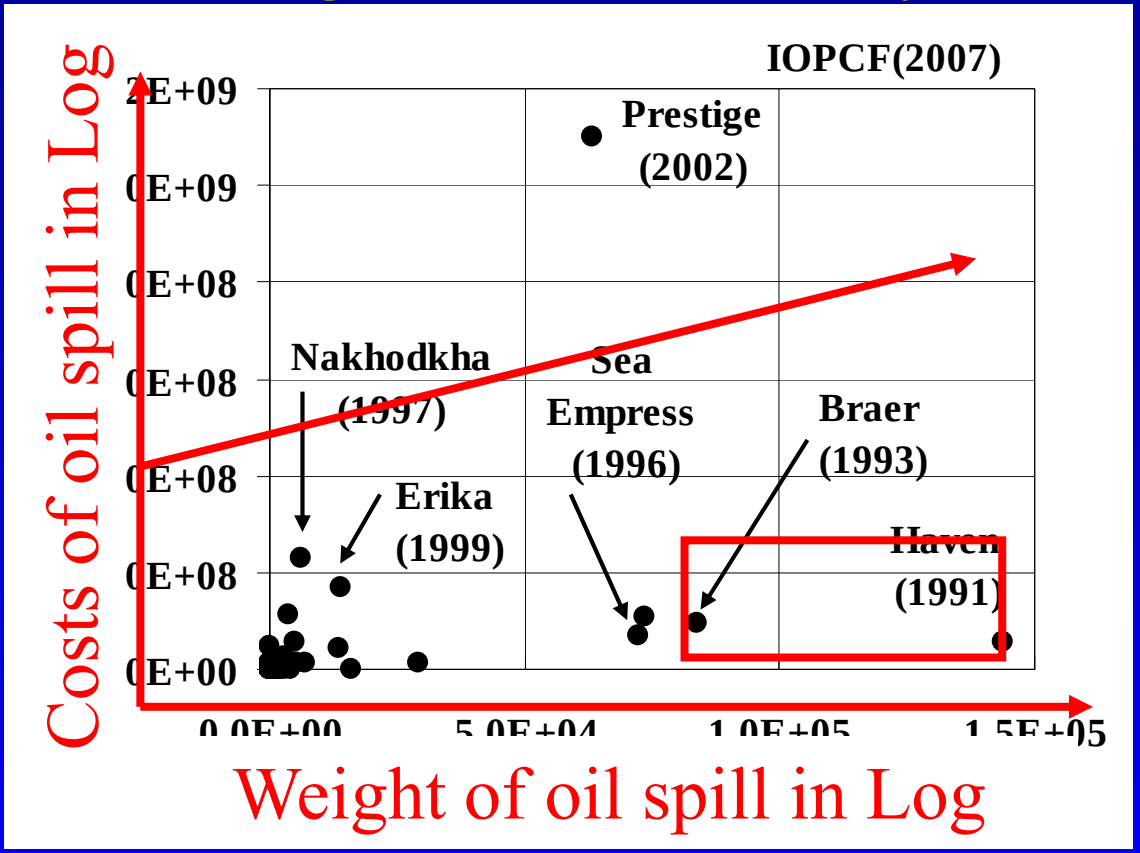
Cause of oil spills from tankers in 1970-2007
IOPCF (2007)

Collision is the most probable cause of oil spill from tankers

More than 50% of causes consist of Collision & Grounding

It is important to prevent collision and grounding of tankers in order to reduce risk of oil spill.

Regression Analysis



Positive correlation between LogC and LogW can be seen although deviation is relatively large (Friis-Hansen & Ditlevsen, 2001)

Regression formula is obtained (least square method)

Nonlinear regression formula

$$Log_{10}C = 0.66 \cdot Log_{10}W + 4.59$$

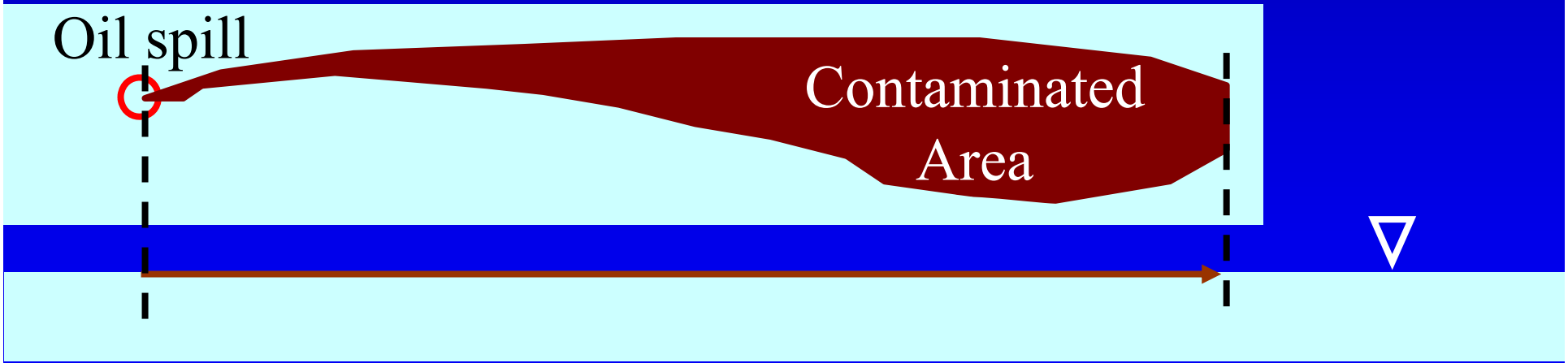
$$C = 38735 \cdot W^{0.66}$$

Nonlinear formula

$$C = C_0 \cdot W^{0.66} \approx C_0 \cdot W^{2/3} = C_0 \cdot \rho^{2/3} \cdot V^{2/3}$$

Dimension [m^2] Area

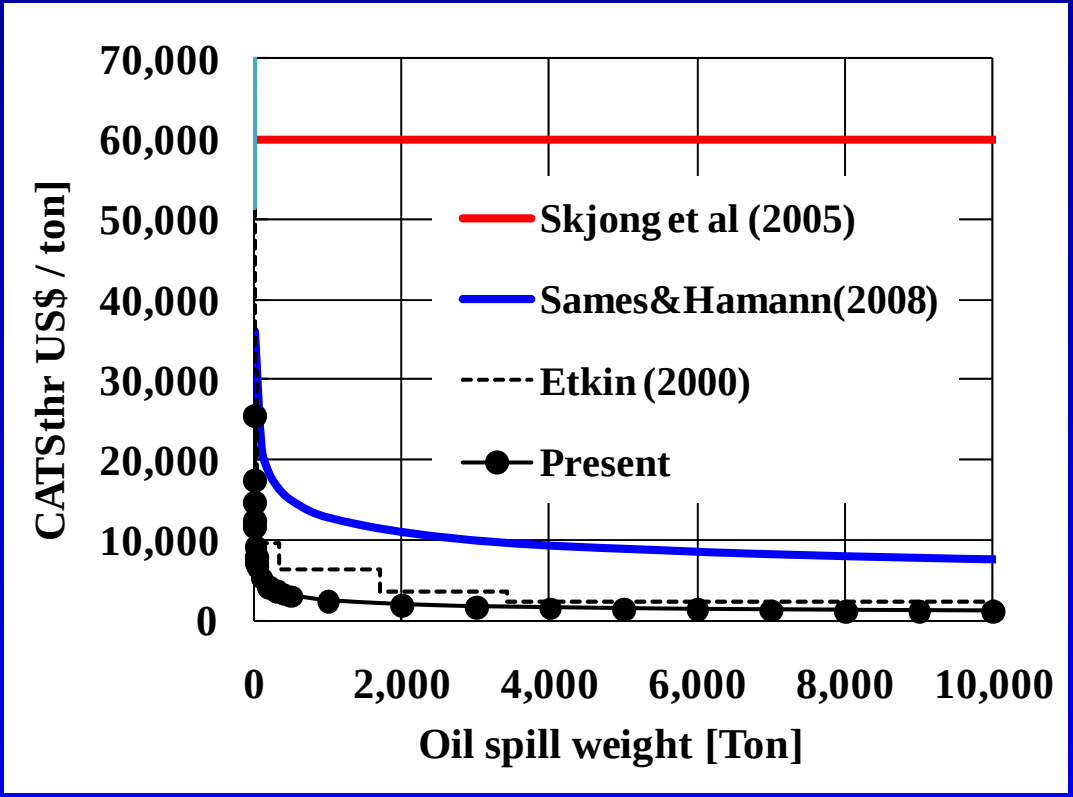
Cost of oil spill is proportional to the Area (contaminated)



Spilled oil spread over as thin oil slick.

The formula seems to be reasonable.

Comparison of $CATS_{thr}$



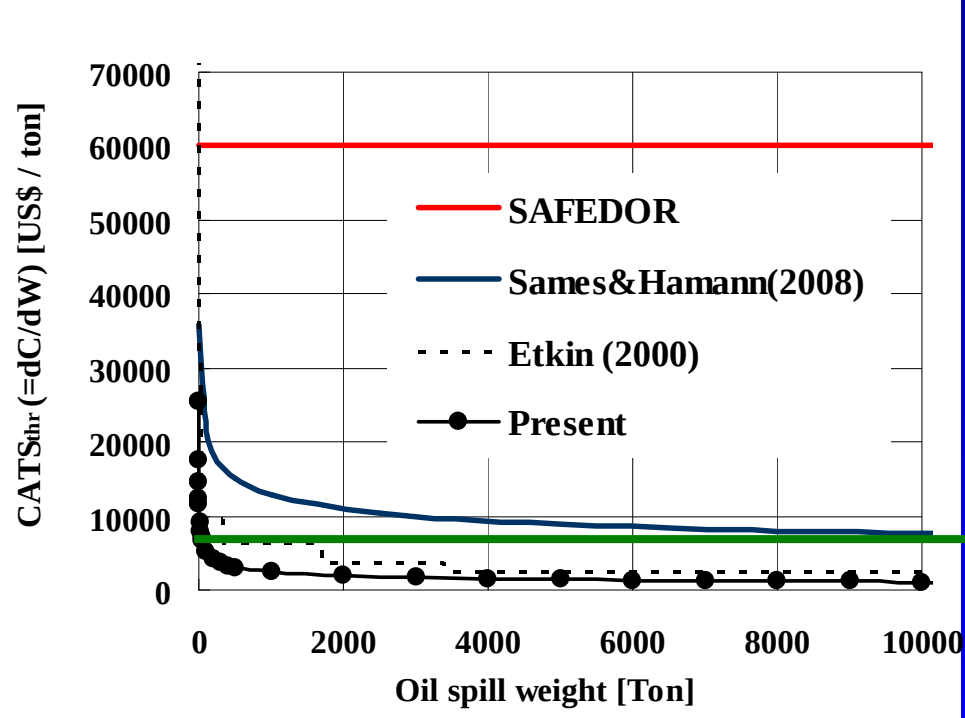
Cost per unit ton decrease considerably as W increase.

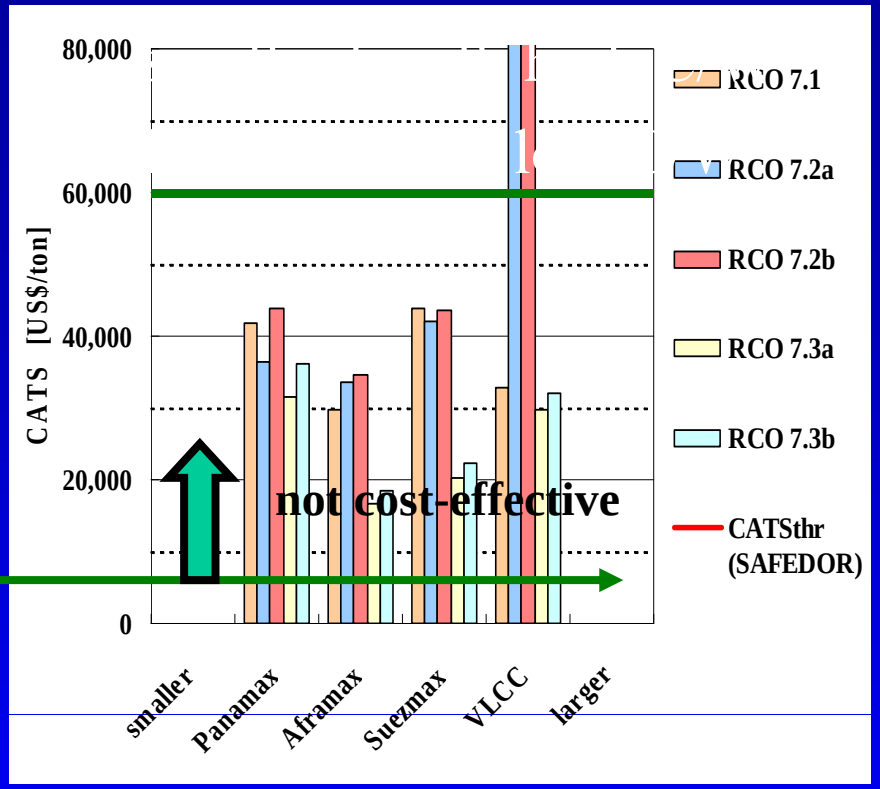
Mainly due to initial cost of launching cleaning up ship and setting up oil fence/boom (Etkin, 2000)

Present tendencies corresponds well to the previous studies.

A majority of delegations support a weight-dependent $CATS_{thr}$ (IMO MEPC 60/WP.11)

Comparison of C/W





Tendency of present regression analysis corresponds well to previous research and seems to be reasonable.

There is a relatively high possibility that results of judgment of cost-effectiveness of RCO in FSA study for crude oil tanker might change.

Current Discussion in IMO

EREC has been discussed since MEPC55, and extensive discussion has been carried out mainly thorough CG (55, 56, 57, 58, 59, 60).

It is described in the report of FSA-CG (MEPC60/17, paragraph 25.2) that

"25.2 after much discussion, the correspondence group agreed that a volume-dependent non-linear scale or function of a global CATS threshold is preferable to a single CATS threshold. This, in and of itself, may be the most important point of convergence within the correspondence group since its inception."

Current Discussion in IMO

Extensive discussion has been made with regards to oil spill cost function at the FSA-WG of MEPC60.

According to the report of FSA-WG(MEPC60/WP.11, paragraph 17), it is described that

"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"

This result was in line with that obtained in FSA-CG, and this report was approved by the MEPC60.

Conclusion

Based on IOPCF data, a non-linear formula to estimate cost of oil spill from weight of oil spill is newly derived.

According to the regression formula, it can be derived that C/W for large oil spills becomes much smaller than that for small oil spills. This is mainly due to the effect of initial cost such as launching cleaning up ship and oil fence/boom decreases as the oil spill amount increases.

It is reasonable to use weight dependent CATSthr within the framework of environmental FSA (for oil).

Cost-effectiveness of RCO submitted by Denmark might change by using a nonlinear weight dependent CATS（depending on safety factors）

Future discussion

- MEPC61 urged member governments to finalize EREC by MEPC62（2011, July）, where FSA-WG is supposed to be held at this session.

- In addition to $CATS_{thr}$, other items such as ALARP and SI index should be solved in order to finalize EREC.

- Review of Tanker FSA study might be judged again at MEPC62 considering achievement of finalization of EREC at FSA-WG at this session.

- How to merge Safety FSA and Environmental FSA might be going to be discussed after EREC is established.

Reference
FSA Guideline (MSC.83/INF.2)

1.1.1 Formal Safety Assessment (FSA) is a structured and systematic methodology, aimed at enhancing maritime safety, including protection of life, health, the marine environment and property, by using risk analysis and cost benefit assessment.

1.1.2 FSA can be used as a tool to help in the evaluation of new regulations for maritime safety and protection of the marine environment or in making a comparison between existing and possibly improved regulations, with a view to achieving a balance between the various technical and operational issues, including the human element, and between maritime safety or protection of the marine environment and costs.

Thank you for your attention