Statistical study of IOPCF data with relevance to establishing CATS criteria

Yasuhira Yamada
National Maritime Research Institute (Japan)

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- Oil spill from Tankers -

Sea bird with oil spilt

Background (1)

- Oil spill from Tankers -

Oil Spill from D/H Tanker

Baltic Carrier, Denmark, 2001

Nakhodka in Japan, 1997

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

Background (2)

Objective of environmental FSA (oil spill)

To reduce oil spill accidents from ships (tankers) in order to preserve maritime environment

- 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 (Step 4 in FSA)

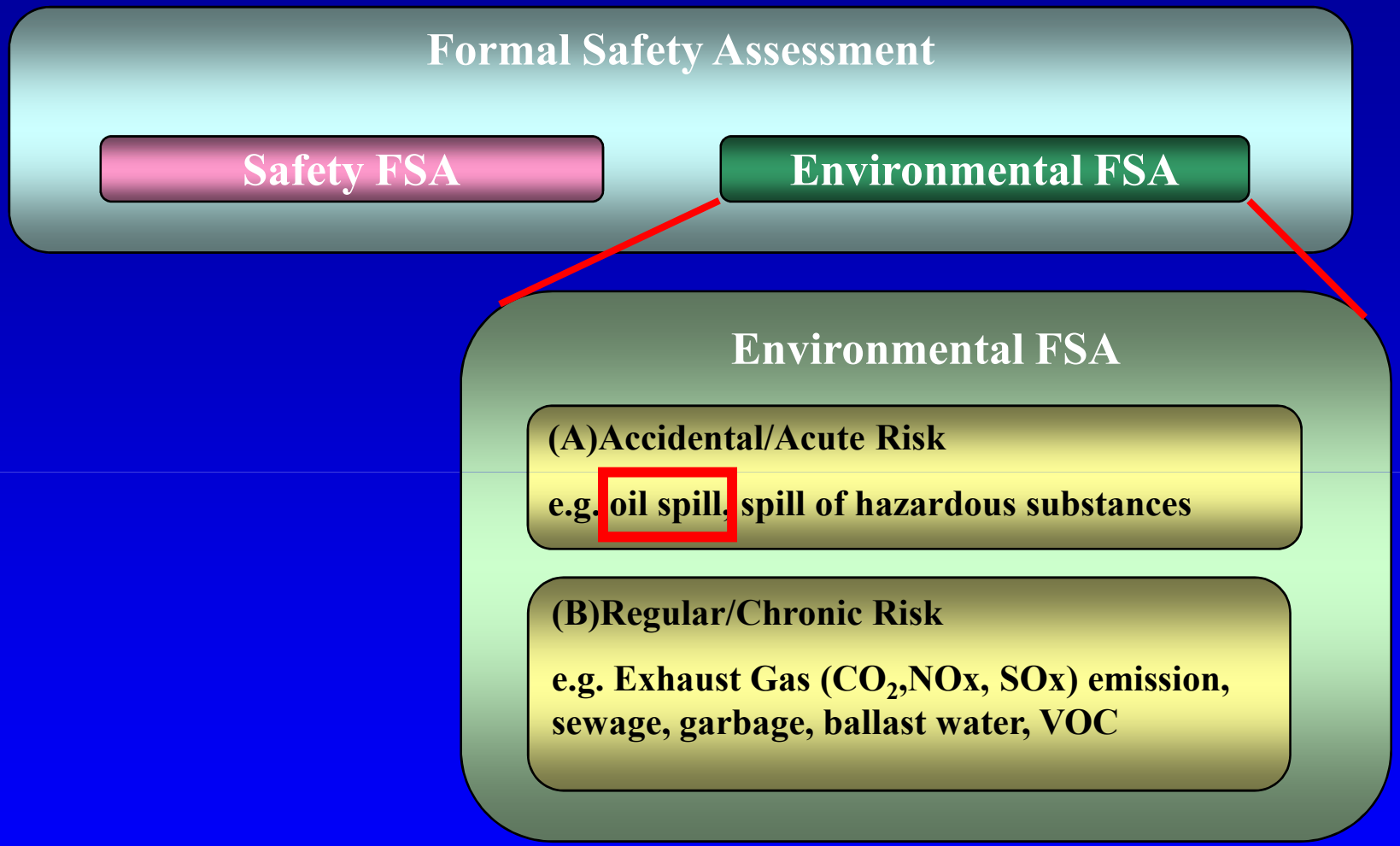
Phase 1: FSA study and its verification

Phase 2: Discussions in IMO start as one of agenda

Phase 3: Revision of standards/rules

Assessment of each accident is not objective of FSA

Background (3)



As a first step of Env. FSA oil spills are considered

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)

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IOPCF Data (1)

International Oil Pollution Compensation Fund (IOPCF)

98 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 2007 (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)

IOPCF Data (2)

MEPC58/17/1 based on IOPCF-2005.

Present based on IOPCF-2007 (Slightly updated)

Database includes 135 oil spill accidents in member States

Weight (W) known: 113 accidents

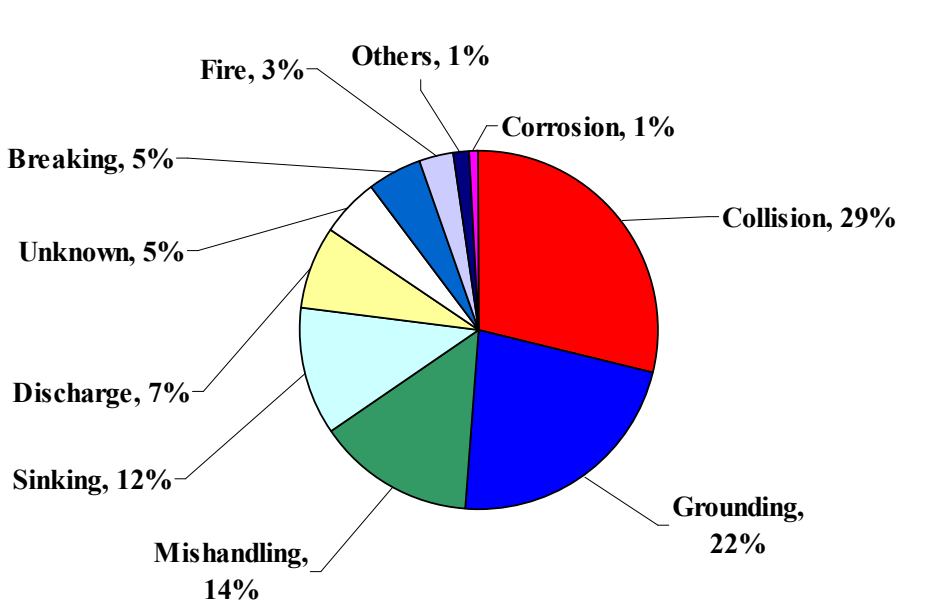
Cost (C) known: 129 accidents

W&C available for 99 accidents

Regression analysis was carried out using 99 accidents data

Exchange rate: Average rate (2002-2007) in IOPCF report is used.

Causes (Lower Level) of Oil Spill from Tankers



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

Collision is the most probable cause (lower level) of oil spill from tankers

More than 50% of causes (lower level) consist of Collision & Grounding

Higher level causes of collision & grounding might be machinery failure or lack of watch keeping

RCOs to prevent higher level causes should be also taken into account in risk analysis (Step 2 in FSA) and in considering RCOs (Step 3 in FSA)

Ranking of Oil Spill Accidents (IOPCF 2007)

Rank	Ship name	Year	Cost [million US$]
1	Prestige	2002	$1,101
2	Osung N3	1997	$301
3	Nakhodkha	1997	$231
4	Erika	1999	$168
5	Nissos Amorgos	1997	$115
6	Aegean Sea	1992	$108
7	Braer	1993	$95
8	Sea Empress	1996	$70
9	Haven	1991	$56
10	Sea Prince	1995	$55

Cost of Oil Spill

Rank	Ship name	Year	Oil spill weight [ton]
1	Haven	1991	144,000
2	Braer	1993	84,000
3	Aegean Sea	1992	73,500
4	Sea Empress	1996	72,360
5	Prestige	2002	63,272
6	Evoikos	1997	29,000
7	Globe	1981	16,001
8	Seki	1994	16,000
9	Erika	1999	14,000
10	Tanio	1980	13,500

Oil Spill Weight

Ranks of oil spills in terms of cost do not correspond to those in terms of oil spill weight.

Components of Costs in IOPCF data

Item	Number of incidents
Clean-up	115
Indemnification	59
Fishery-related	57
Property Damage	18
Tourism-related	14
Loss of income	11
Preventive Studies	10
Others	10
Environmental Damage	2

Indemnification: Paying somebody an amount of money because of the damage or loss.

Details of indemnification are not described in the report

In addition to clean-up costs, compensation for fishery, tourism, loss of income are also included.

Environmental damage is included in 2 cases. Adjustment might be necessary to take into account environmental cost.

Important! Not to double-count costs of compensation, if combining with another database.

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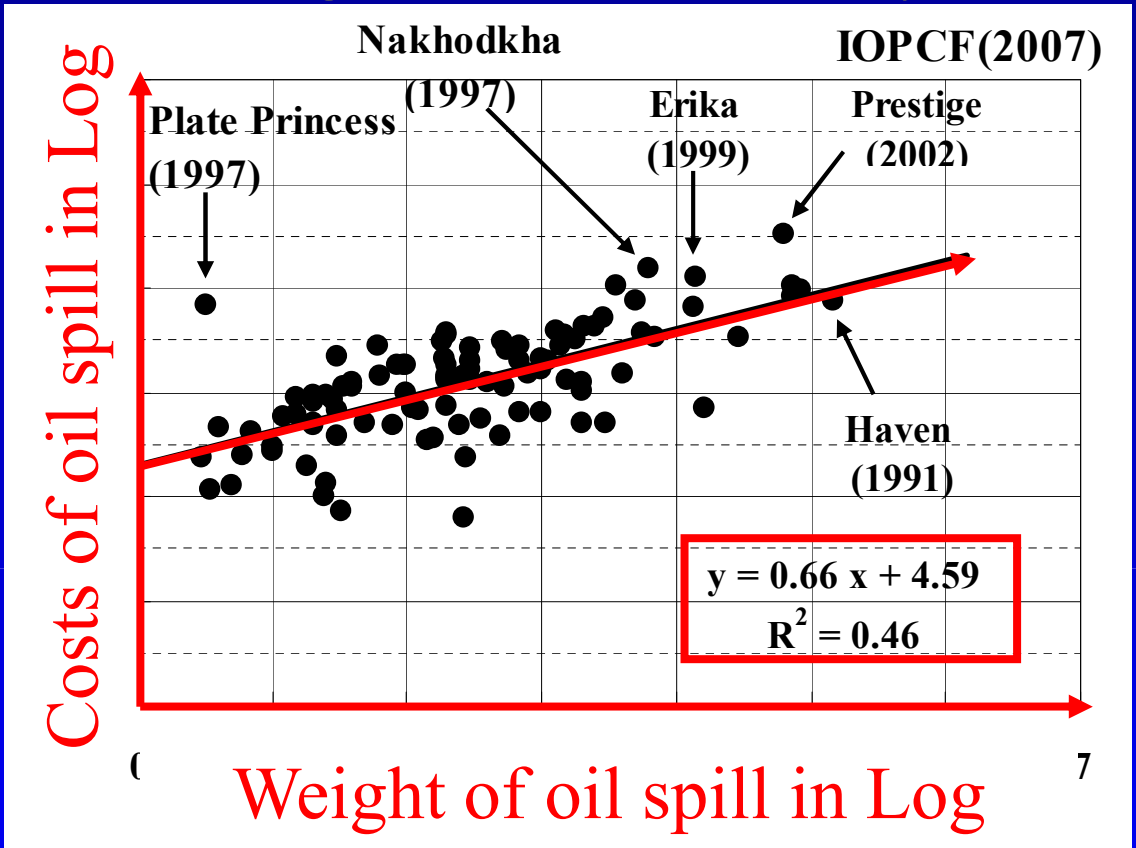
Regression Analysis

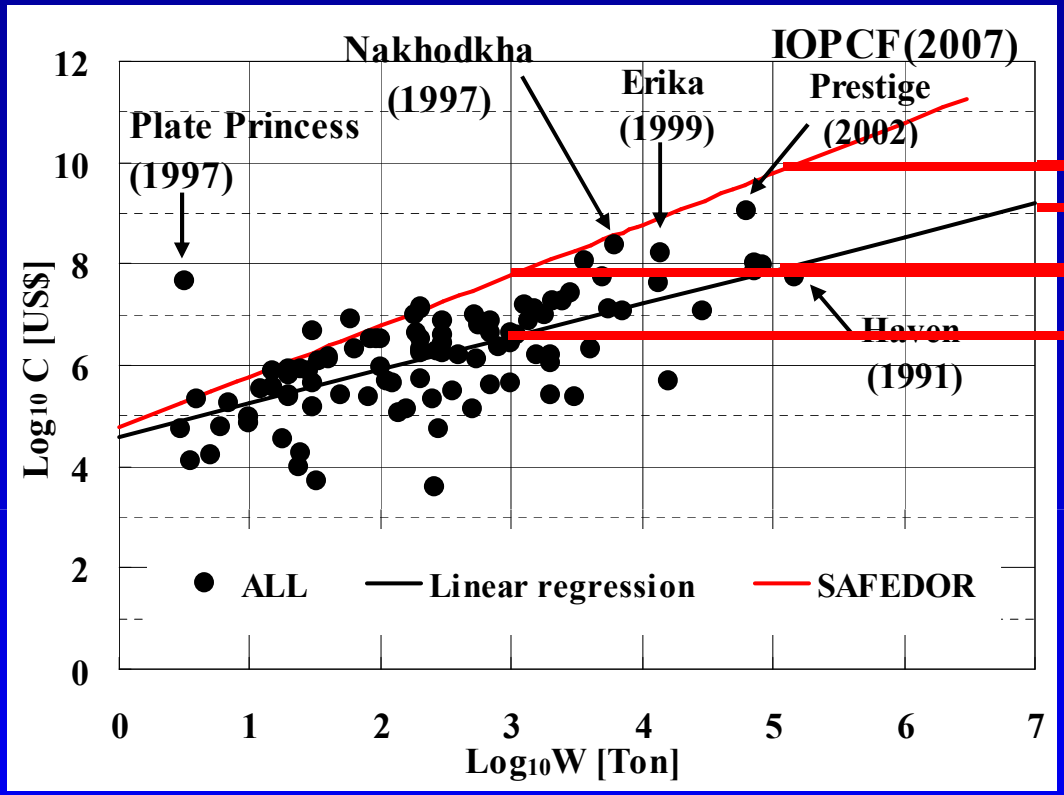


Positive correlation between LogC and LogW can be seen although deviation is relatively large (Friis-Hansen & Ditlevsen, 2001)

Regression formula is obtained (least square method)

Regression Analysis

- Comparison with existing (60,000) -



1 scale: difference 10 times

In case of Haven, 60,000 overestimates about 100 times larger costs more than 10 times differences.

Environmental costs are assumed to be 1.5 times of cleaning up costs (SAFEDOR)

2.5 times < 100 times

Nonlinear regression formula

$Log_{10}C = aLog_{10}W + b$ a=0.66, b=4.59

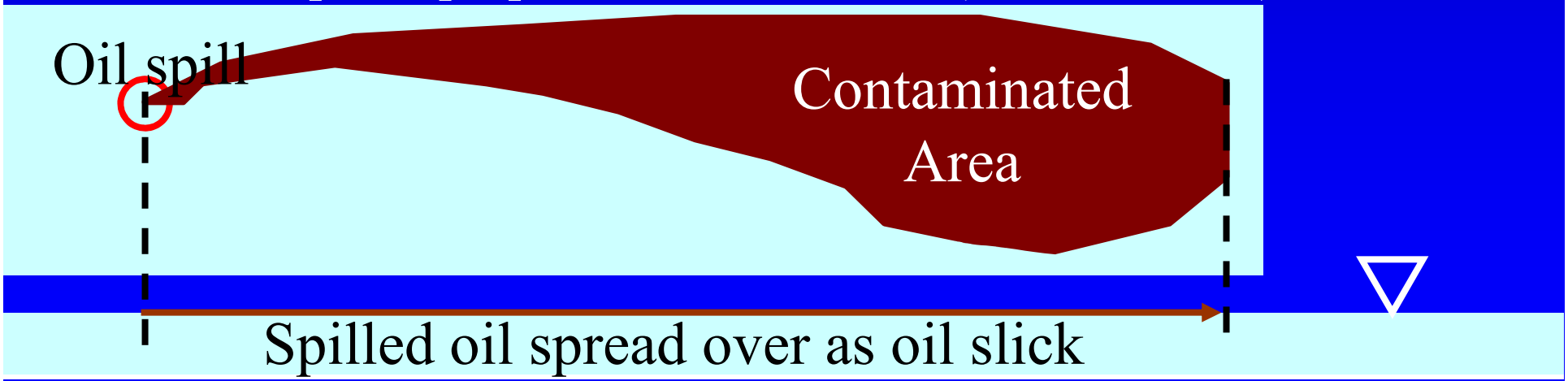
$$Log_{10}C = aLog_{10}W + b \quad \Leftrightarrow \quad C = W^{a} \cdot 10^{b}$$

$$C = W^{0.66} \cdot 10^{4.59} = 38735 \cdot W^{0.66} = C_0 \cdot W^{a}$$

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

Dimension [m^2] Area

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



CATS

CATS: Cost to Avert a Ton of oil Spilt

Japan basically support the concept of CATS and CATScr proposed by SAFEDOR (Consistent with Safety FSA)

RCO is judged as cost-effective if following formula is satisfied

$$CATS < CATS_{cr}$$

Risk analysis/Cost estimation

$$CATS = \frac{\Delta C}{\Delta R}$$

Cost Increase for RCO [US$]

Oil Spill Risk Reduction RCO [Ton]

CATScr is a threshold value to judge cost-effectiveness of RCO

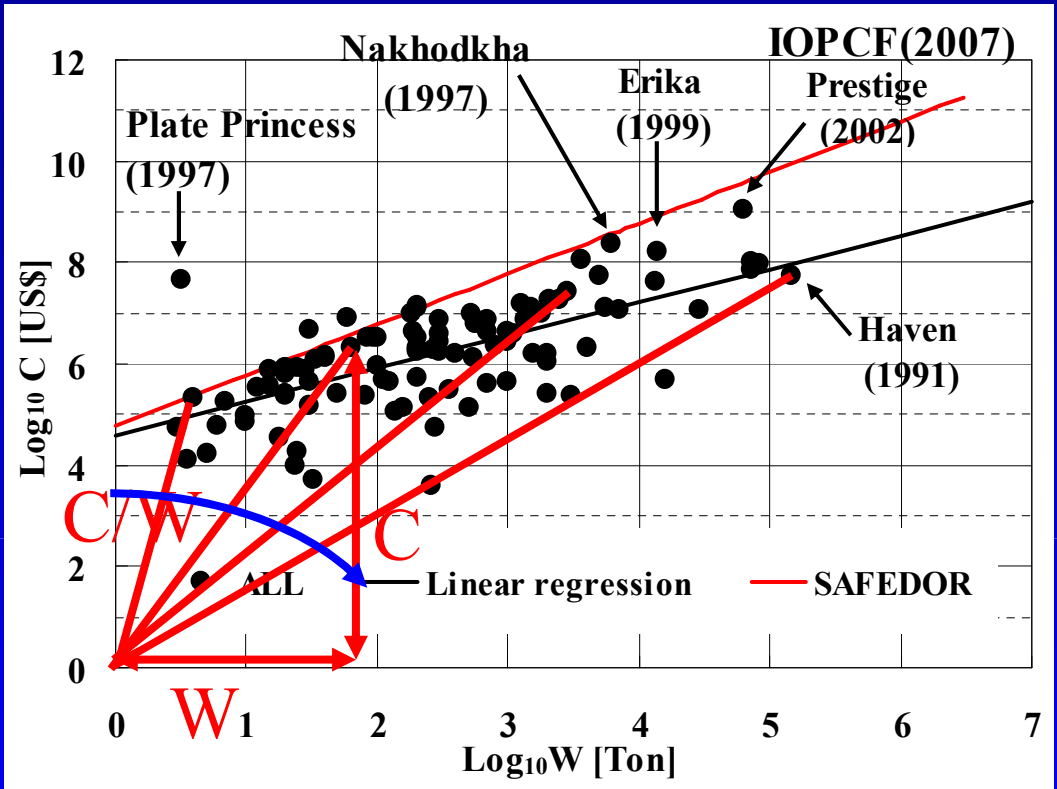
It is important to distinguish CATS and CATScr

Present study is carried out mainly for establishing CATScr

Smaller spills - Larger spills

C: Costs

W: Weight



Slopes to points represent C/W

Tendency: slopes decrease as W increases according to IOPCF data

Smaller spills have larger C/W, larger spills have smaller C/W

Comparison of C/W

Formulation

SAFEDOR $C = 60000 \cdot W$

$$CATS_{cr} = \frac{dC}{dW} = \frac{d}{dW}\left(60000 \cdot W\right) = 60000$$

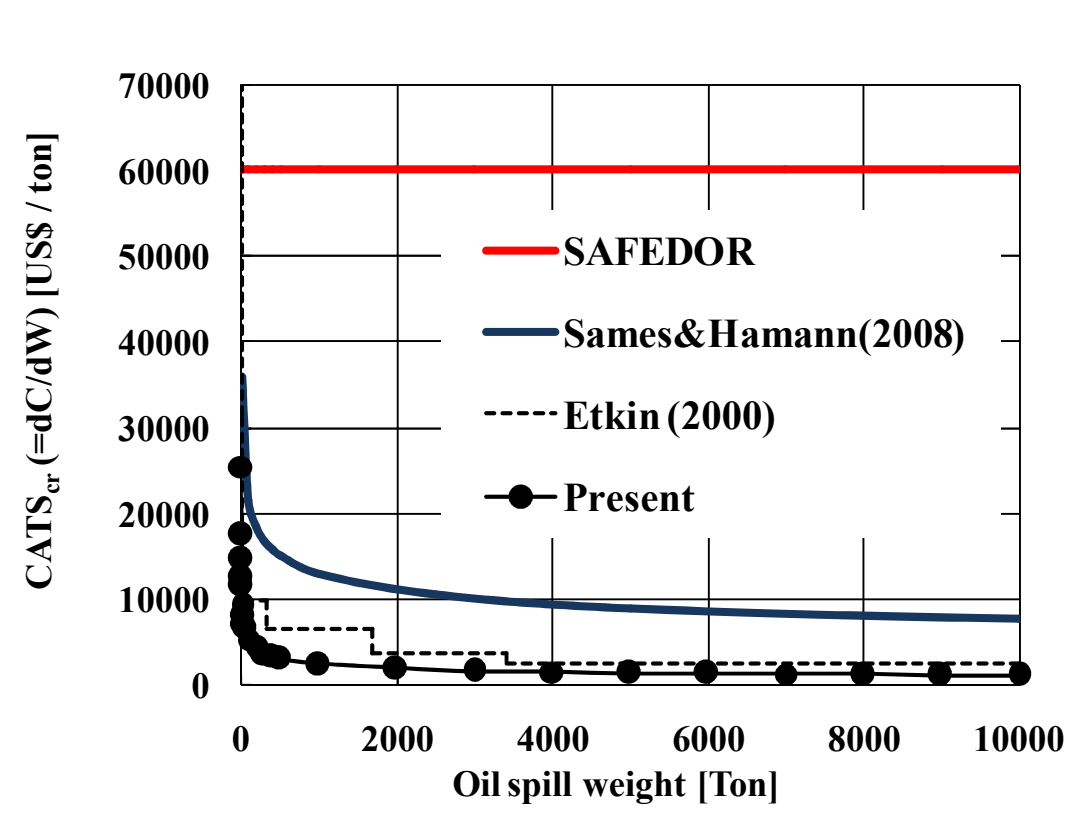
Constant

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

$$CATS_{cr} = \frac{dC}{dW} = \frac{d}{dW}\left(38735 \cdot W^{0.66}\right) = 25441 \cdot W^{-0.34}$$

Power function of W

Comparison of C/W



Small spill: High C/W

Large spill: Low C/W

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 (Etkin, 2000; Sames & Hamann, 2008).

Possible main factors for the difference

(1) The effect of oil amount on the costs.

(2) Environmental costs

(3) Assurance costs (Skjong et al, 2005)

$$CATS_{cr} = 60000$$

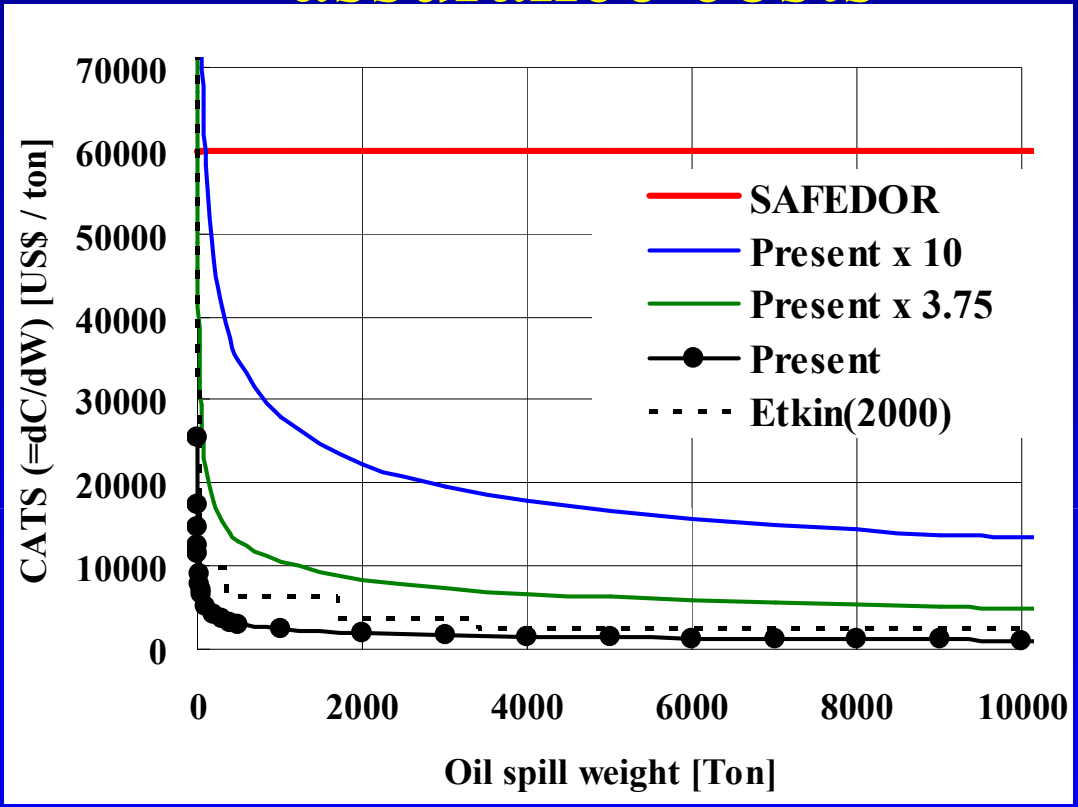
$$CATS_{cr} = C_{clean} + C_{env} + C_{assurance}$$

$$CATS_{cr} = (C_{clean} \cdot F_e) \cdot F_a$$

$$CATS_{cr} = (16{,}000 \cdot 2.5) \cdot 1.5$$
$$= 16{,}000 \cdot 3.75$$
$$= 60{,}000$$

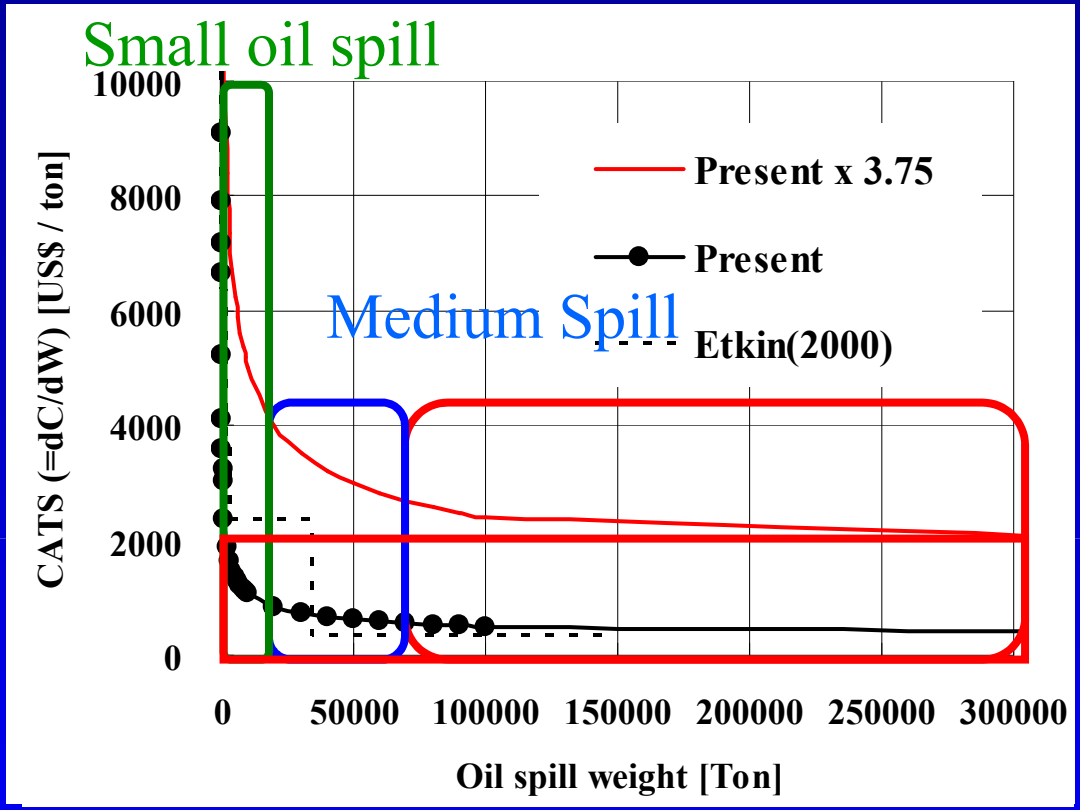
SAFEDOR

The effect of environmental costs and assurance costs



Even considering the effect of environmental costs and assurance costs (facor=3.75- 10), 60,000 [US$/ton] is higher than present results especially in larger oil spills.

Possible Grouping of CATScr



It is not reasonable to use “large CATScr for small spillage” in estimating costs of large oil spill.

CATScr should be defined depending on amount of oil spill risk

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Conclusion (1)

A nonlinear formula to estimate oil spill costs from weights of oil spill is derived based on regression analysis of IOPCF data.

The formula provides larger C/W for smaller spill, and provides smaller C/W for large spill mainly due to the effects of initial costs of cleaning process. These tendencies corresponds well to the previous studies (Etkin, 2000, Sames & Hamann, 2008)

In carrying out cost-effective analysis, it is reasonable to estimate costs of oil spill depending on the corresponding weight of oil spilt.

Discussion

In order to take into account costs of environmental damage "environmental damage factor (Fe)" can be used in combination with the regression curve although further study to quantify reasonable value of "Fe" is highly required.

As for the assurance factor (Fa), this factor might be explicitly put outside CATScr since this factor is a kind of factor decided by decision makers as pointed out by Skjong et al (2005).

$$CATS < CATS_{cr} \cdot F_a$$

Thank you for your attention