FSA

BASIC CONCEPTS

DATA AND DATABASE ISSUES

NTUA WORKSHOP
ENVIRONMENTAL RISK EVALUATION CRITERIA
FEBRUARY 27TH, 2009

- PURPOSE
- BENEFITS
- WEAKNESSES
- LIMITATIONS

PRESENTATION TO
IMO MSC 85 , DEC. 2008

STEPS OF FSA

1. **IDENTIFICATION OF HAZARDS and ranking**
   (What might go wrong?)
2. **ASSESSMENT OF RISKS (RISK ANALYSIS)**
   (How bad and how likely?)
3. **RISK CONTROL OPTIONS (RCO)**
   (Can matters be improved?)
4. **COST BENEFIT ASSESSMENT**
   (What would it cost and how much better would it be?)
5. **RECOMMENDATIONS FOR DECISION-MAKING**
   (What actions should be taken?)

STEP 1: HAZID

Experts identify all possible hazards…and judge how frequent and how severe they are

Ranking of hazards

Likelihood (L)	Level	RISK INDEX (RI=L+C)			
Frequent	7	8	9	10	11
Probable	6	7	8	9	10
Reasonably probable	5	6	7	8	9
Seldom	4	5	6	7	8
Remote	3	4	5	6	7
Very remote	2	3	4	5	6
Extremely remote	1	2	3	4	5
Severity of Consequences (C)		1	2	3	4
		Minor	Significant	Severe	Catastrophic

STEP 2: RISK ANALYSIS

ASSESSMENT OF RISKS

The aim is to QUANTIFY the Risks of the hazards identified in step 1

RISK = Estimated frequency (probability) of the Event X Event's estimated Consequence

STEP 2: RISK ANALYSIS

For example:

How many times in the past, the examined casualty occurred	**x**	**The number of deaths involved**

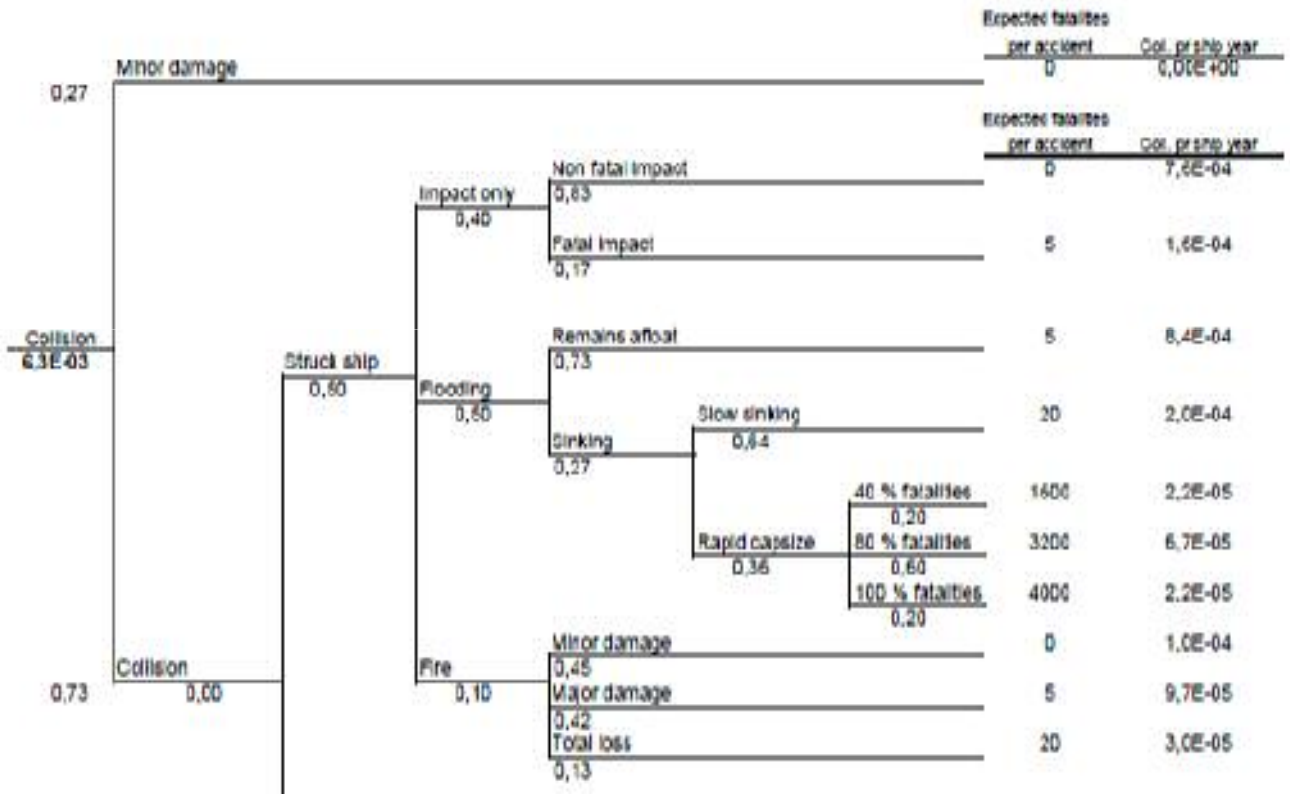
This also establishes the Current Risk Level (Before RCO)

Usual Measures are Annual Frequency , $F = \frac{\text{No of Casualties}}{\text{Shipyears}}$

Annual Fatality Rate, $PLL = \frac{\text{No of Fatalities}}{\text{Shipyears}}$

STEP 2: RISK ANALYSIS

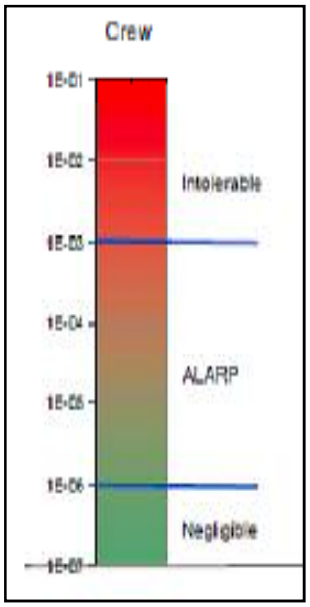
Fault trees , Event trees, can be used to model the Hazard Scenarios



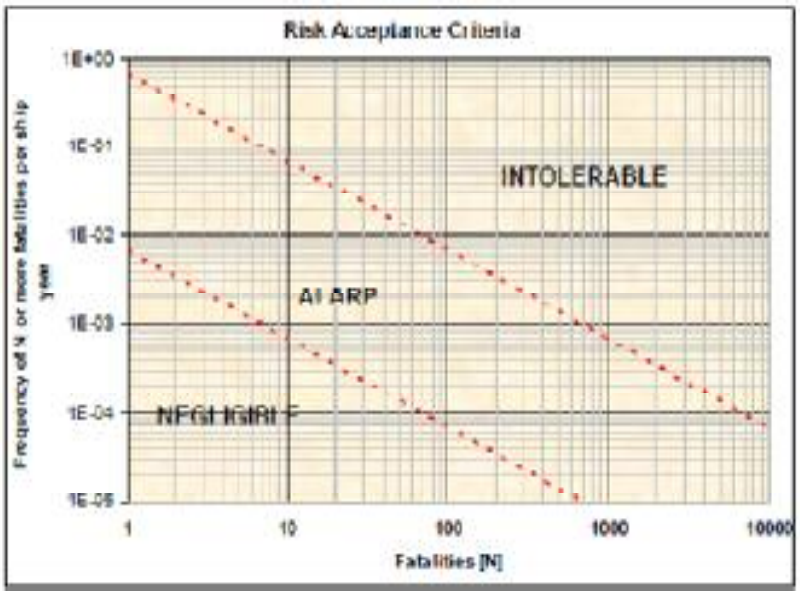
STEP 2: RISK ANALYSIS

Once the Current Risk Level (of the hazard scenario under examination) is established, It is compared with "Acceptable" Risk levels

Individual

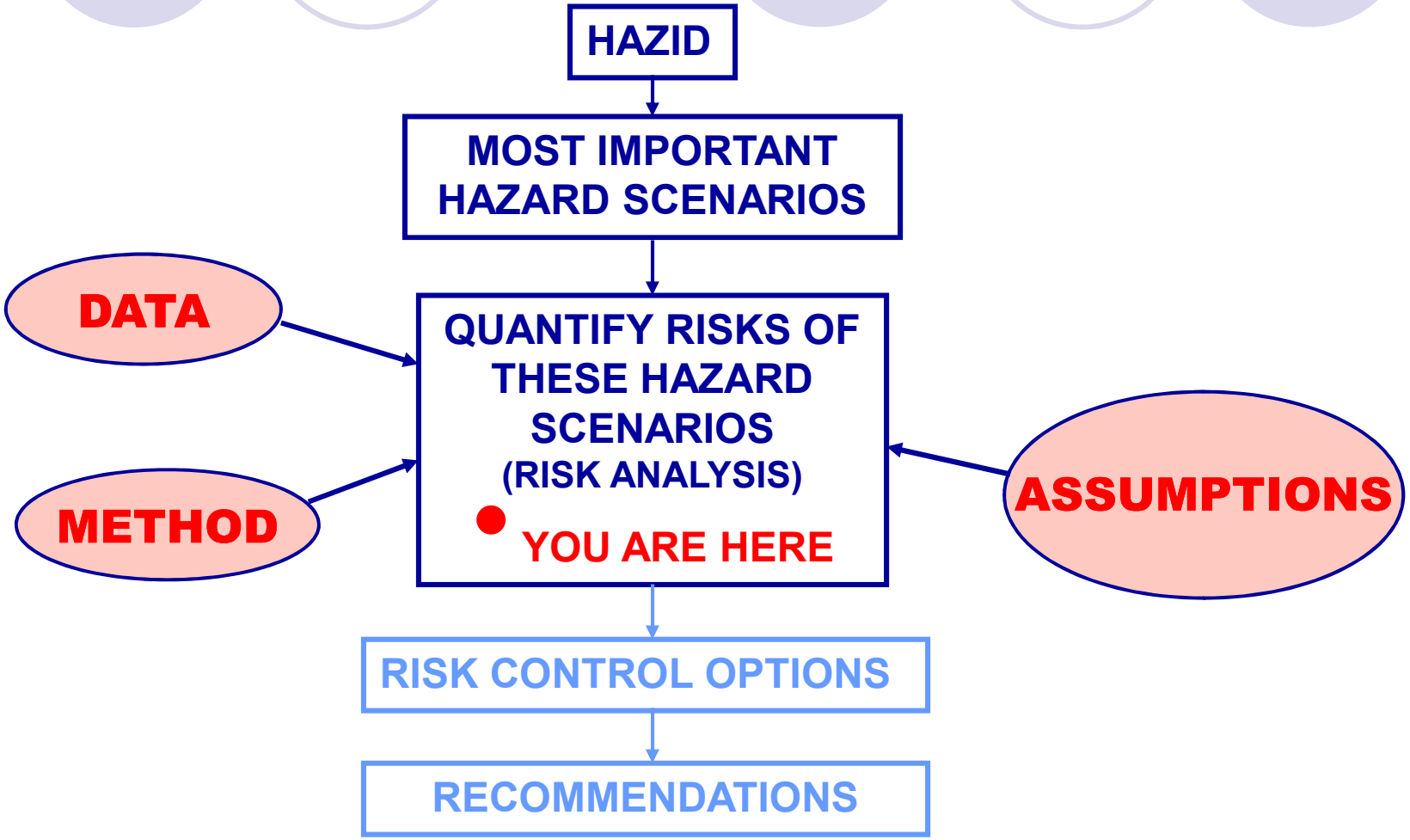


Societal



If Current Risk is IN or over The ALARP region, Risk Control Options are examined in order to reduce the Risk

ISSUES WITH STEP 2: RISK ANALYSIS



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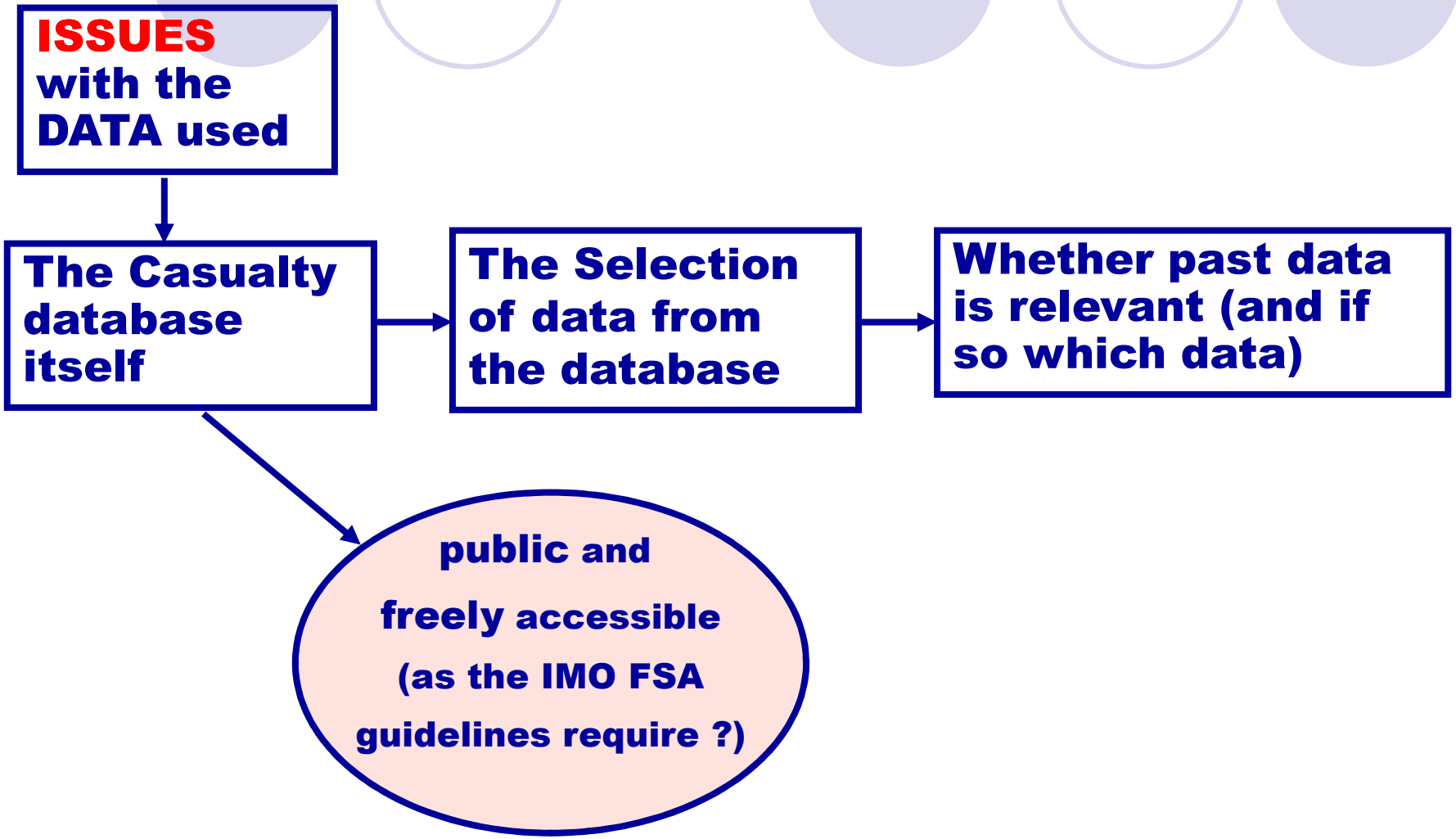
STEP 2: RISK ANALYSIS



ISSUES WITH THE DATABASE itself

- **The Database used is not structured for FSA use, and the casualty categorization is not best.**
- **They provide CONSEQUENCES, not CAUSES.**
  (e.g. Collision, Grounding, Fire, Explosion, etc.)
- **These consequences are wrongly treated as "Initiating Events"**

ISSUES WITH THE DATABASE itself

Results:

- ***The FSA focuses on mitigation of <u>consequences</u> instead of prevention of causes.***
- ***(more important) So does regulatory focus!***

E.g. make ships collision-proof !

ISSUES WITH THE DATABASE itself

"Neat" Categorizations of Casualties

Example 1:

The Nassia casualty, Bosporus, 42 killed, 1994 (Reported as a Collision)

Actual Sequence was Collision-fire-grounding.

Is the Nassia a collision, a fire, or a grounding?

ISSUES WITH THE DATABASE itself

Is the Nassia a collision, a fire, or a grounding?

- **The correct answer is "all of the above".**
- **And the correct answer for CAUSE is**

"none of the above".

ISSUES WITH THE DATABASE itself

Nassia real cause

- The cause was a black out on another ship, the BC Shipbroker which, without electrical power, had no steering, and turned into the Nassia.

- Cause = Machinery failure of BC Shipbroker

ISSUES WITH THE DATABASE itself

US CGMIX database (which includes pilot reports) includes 100 times more machinery failures than LMIU

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ISSUES WITH THE DATABASE itself

"Neat" Categorizations of Casualties

Example 2:
Nagasaki Spirit - Ocean Blessing collision (51 killed) 1992

The CAUSE for the casualty was "PIRACY"

(The cause was Piracy on the Ocean Blessing which, not being under control, collided with the Nagasaki Spirit)

ISSUES WITH THE DATABASE itself

- **Few major events dominate (there are few collisions, few major spills etc.)**
- **Their "Statistical Significance" is minor (the sample is very small)**

e.g.

One future rather small oil spill may reverse the results of any prior analysis.

RISK ANALYSIS OF LARGE TANKERS, SAFEDOR WORKSHOP, GLASGOW, MAY 2008

Eliopoulou, Papanikolaou, Hamman

DIAGRAM FROM FSA SUBMITTED TO IMO

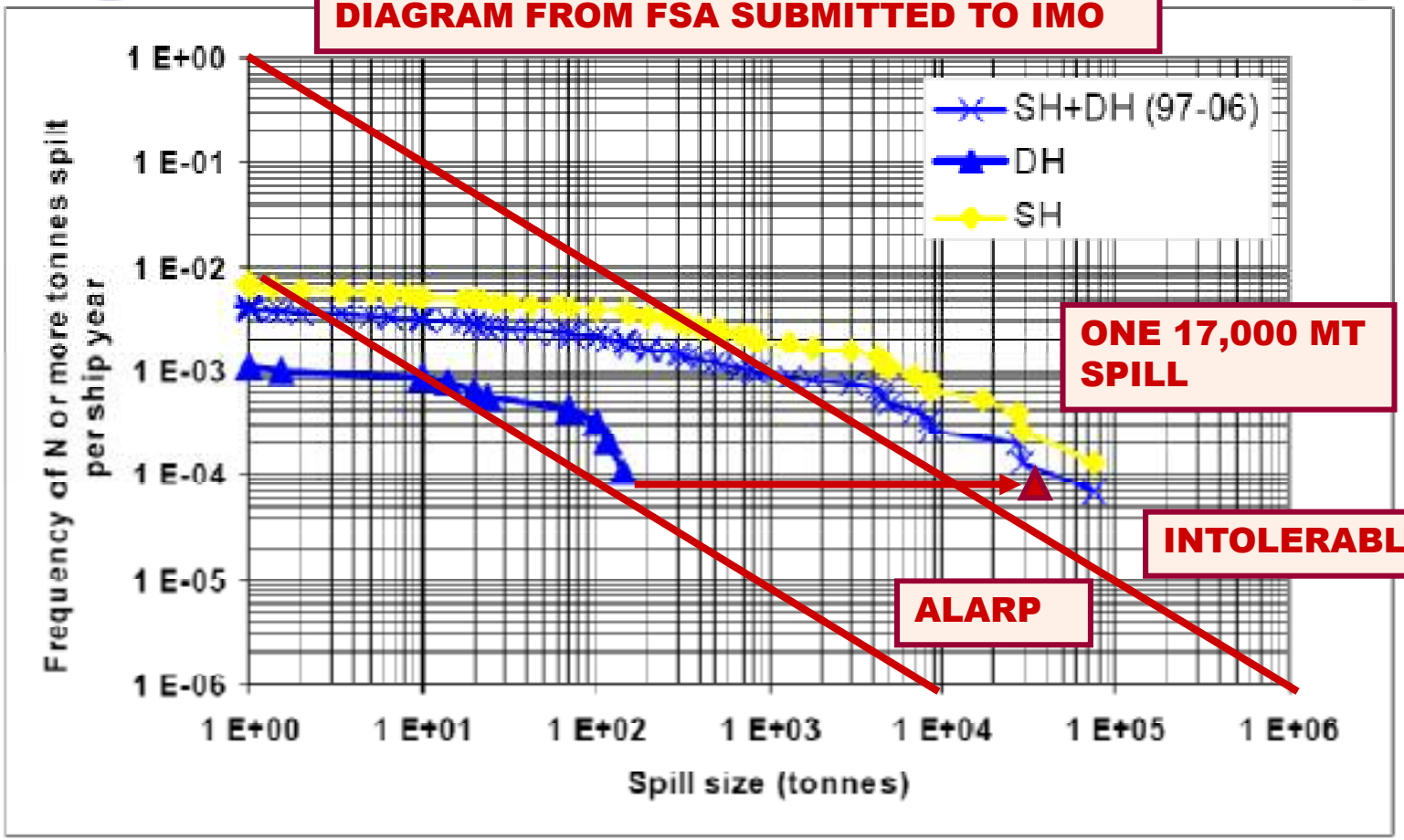

Figure 26: Estimated Potential Loss of Cargo, per tanker size [36]

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A 17,000 MT spill is

- **2 tanks of a SUEZMAX Tanker**

OR

- **1 Tank of a VLCC**

- ***AND WHAT IF THE 75,000 MT SPILL OF M/V AEGEAN SEA (OBO) WAS INCLUDED IN THE DH DATA ?***

ISSUES WITH THE DATA within the database

FURTHER ISSUES WITH DATA IN CURRENT DATABASES

- CENSORED (Owners, Class, Flag)
- UNAUDITABLE (pay fee, don't disclose, no background of each accident)
- SUBJECTIVE (need to assign casualty to a neat categorization)

- LMIU/SAFEDOR : Structural failure not an important cause
- CTX: By far the most important cause

ISSUES WITH THE SELECTION OF DATA

Not always the proper data for the examined hazard is selected

e.g. DOUBLE HULL BULK CARRIERS:
(hazard examined being side shell structural failure)
Some FSAs included fatalities from

- **Very small bulk carriers < 9,000 t or 90m**
- **Collisions**
- **Casualties due to hatch cover water influx**

While not accounting for recent regulatory improvements (ESP, Solas XII) which were measurable from the data

LIMITATIONS IN LOOKING AT HISTORICAL DATA (RELEVANCY)

IACS submission MSC 78/19/1

- Historical data cannot be used for new designs
- Historical data may not match the data needed in the FSA risk model (and this usually goes unnoticed)
- The effects of newly implemented RCO's (e.n. new regulations) cannot be observed by historical data
- Looking at historical data is <u>not</u> proactive and is <u>not</u> creative. <u>Analytical modeling</u> has to be used to evaluate rare events

LIMITATIONS continued

- 5 FSAs submitted recently to IMO (LNG, TEU, Tanker, Cruise, ROPAX).
- Not surprisingly their biggest risks were found to be
  1. Collision 2. Contact 3. Grounding 4. Fire
- Does the ship type matter ?
  Or is the database categorization the driving factor ?
- For spills the data is more chaotic. If the sample is wrong, one cannot hope for proper CATS.

STEP 5: (our) RECOMMENDATIONS

1. *Stick closely to IMO FSA guidelines (esp. HAZID follow-up)*
2. *Develop RCOs to address HAZID (not to address the historical data)*
3. *Develop a better database going to causes of accidents*
4. *The database must be accessible to all reviewing the FSA.*
5. *Any assumptions made which seriously influence outcome, should be clearly highlighted by authors (with sensitivity)*
6. *Use Analytical modeling / first principles / experiments to avoid assumptions and expert judgement in the deduction of probabilities or risk reduction (esp. for rare events or novel issues/designs)*
7. *Use Gross CAF*

FSA *SOME REFERENCES*

A PUBLIC / FREE DATABASE: www.c4tx.org/ctx/job/cdb/prod/search.html

1. Zachariadis P.,H.N.Psaraftis, and C.A. Kontovas "Risk Based Rulemaking & Design - Proceed with Caution," RINA conference on Developments in Classification and International Regulations, London, UK, January 2007.

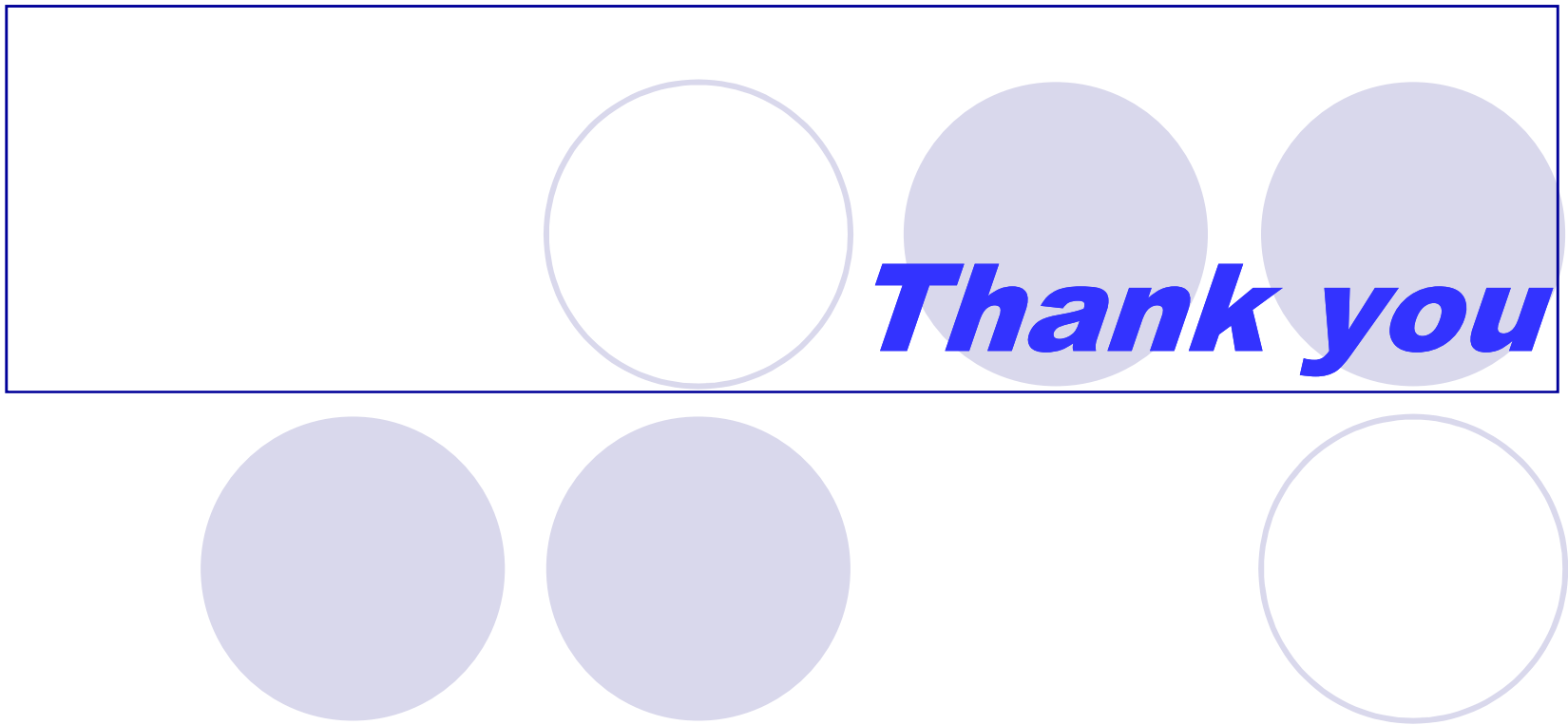
2. Kontovas, C. A., H.N. Psaraftis, and P. Zachariadis, "The Two C's of the Risk Based Approach to Goal-Based Standards: Challenges and Caveats," International Symposium on Maritime Safety, Security and Environmental Protection (SSE07), Athens, Greece, September 2007.

3. Kontovas, C. A., H.N. Psaraftis, and P. Zachariadis, "Improvements in FSA Necessary for Risk-Based GBS," PRADS 2007 Conference, Houston, USA, October 2007.

4. Psaraftis, H. N., "Environmental Risk Evaluation Criteria," WMU Journal of Maritime Affairs, Vol. 7, No. 2, 411-430, 2008.

5. Kontovas, C.A., H.N. Psaraftis, "Formal Safety Assessment: A Critical Review," Marine Technology, in press, 2009.

IMO DOCs BY GREECE:
MSC 82/INF.3, MSC 81/6/15, MSC 81/6/16, MEPC 56/18/1, MEPC 57/17, MEPC 58/17


Thank you