# Towards environmental risk acceptance criteria

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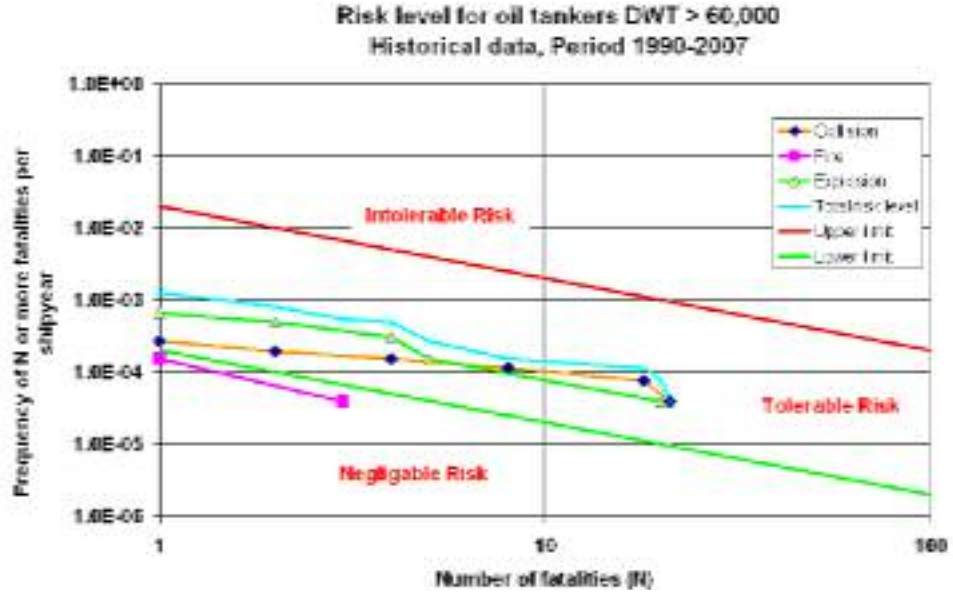
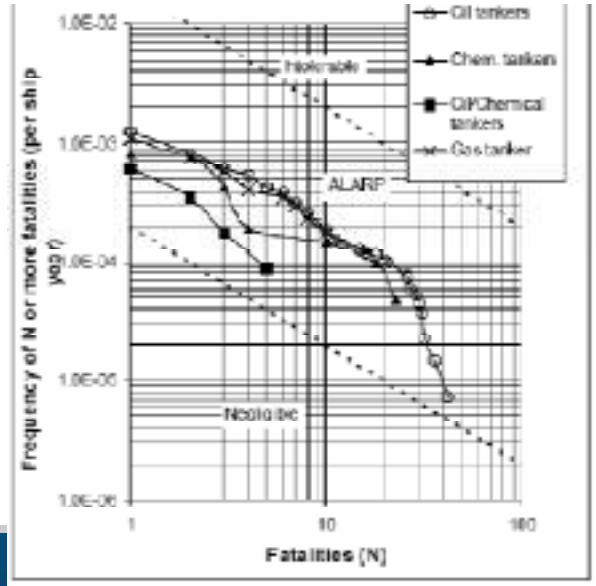
# Introduction to risk evaluation criteria[1]

- **Risk assessment requires criteria!**
- **Such criteria must be accepted by society.**
- **Example: risk evaluation criteria relat to human life ”individual risk” and “societal risk”**




- **FSA guidelines (MSC 83/INF.2) provides such criteria for the maritime regulatory framework.**
- **Basic philosophy of risk assessment:**
  - Risks between negligible and intolerable should be made As Low As Reasonably Practicable (ALARP).
  - Risk should be made ALARP by adopting cost-effective risk control measures.



# Introduction to risk evaluation criteria$_1$

- **Risk assessment requires criteria!**
- **Such criteria must be accepted by society.**
- **Example: risk evaluation criteria related to human life ”individual risk” and “societal risk”**

| | Max. tolerable | negligible |
|---|---|---|
| To crew member | $10^{-3}$ | $10^{-6}$ |
| To passenger | $10^{-4}$ | $10^{-6}$ |
| To third parties | $10^{-4}$ | $10^{-6}$ |

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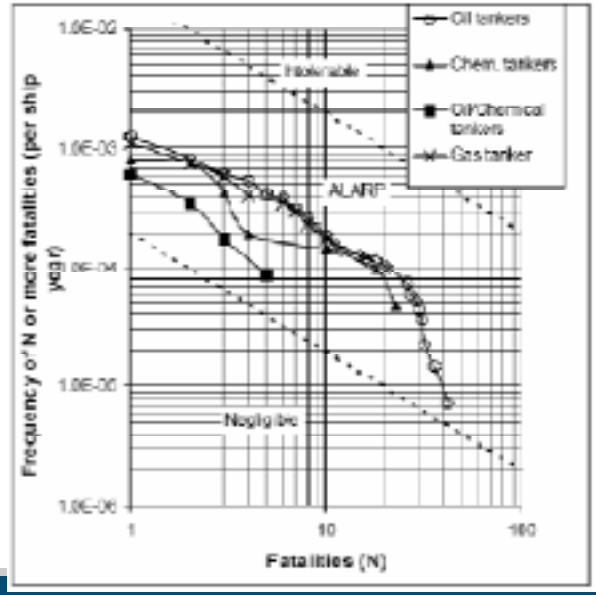


# Introduction to risk evaluation criteria$_2$

- **But how to evaluate environmental risk?**
- **Transfer of the safety philosophy requires:**
  - Definition of risk categories ("intolerable, tolerable, negligible)
  - Criterion for CEA
- **SAFEDOR suggested a new cost effectiveness criterion related to accidental <u>oil spills of tankers</u> in 2005:**

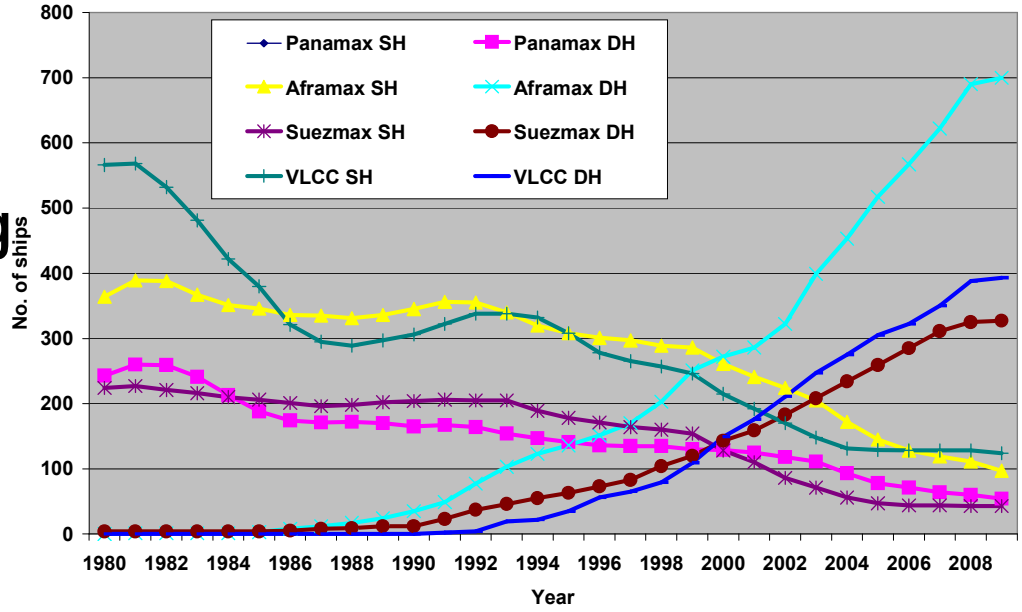
  Cost of Averting a Tonne of oil Spilt (CATS)
- **CATS is a cost-effectiveness criterion for ALARP process.**
- **The ALARP area for environmental risk not yet defined.**

# Introduction to risk evaluation criteria$_3$

- **$CATS_{(Thr)}$ (> $\Delta C/\Delta R$)**
  - Is a criterion independent of the oil type and the spill size.
  - For application in FSA investigation
  - Considers
    - cleaning costs (USD 16,000/tonne),
    - environmental costs (USD 24,000/tonne)
    - and an assurance factor (> 1, present proposal 1.5)

# Brief review of tanker operation[1]

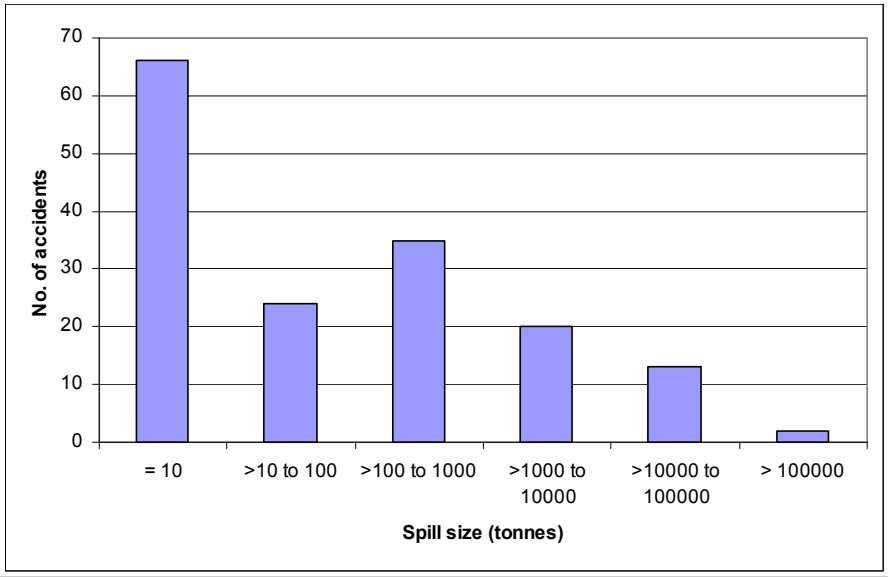
- **Data for major oil tanker segments (fleet at risk) and accidents was compiled using the LRFP-database:**
  - PANAMAX
  - AFRAMAX
  - SUEZMAX
  - VLCC & ULCC

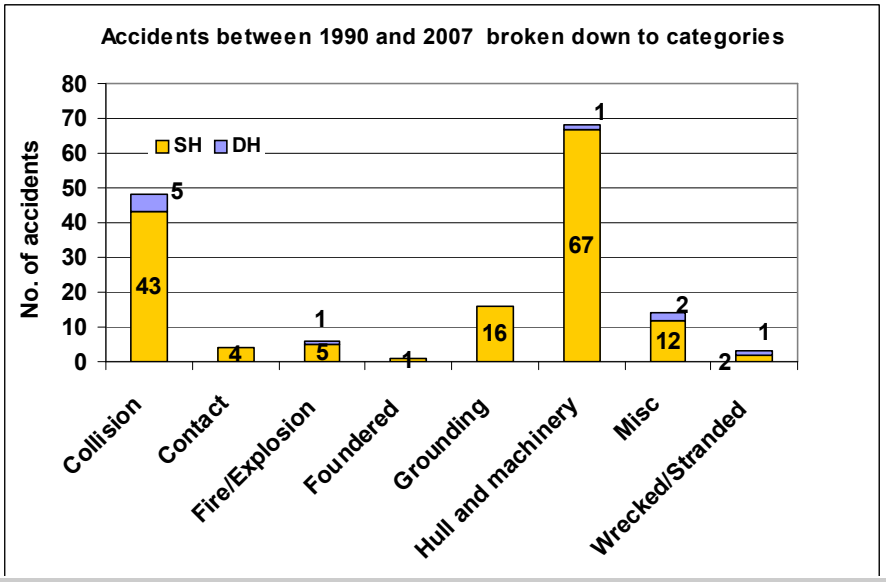



- **Data from the period 1990-2006 was used resulting in 25.780 ship years.**
- **Presently about 2000 tankers (> 60,000 DWT) are operating**

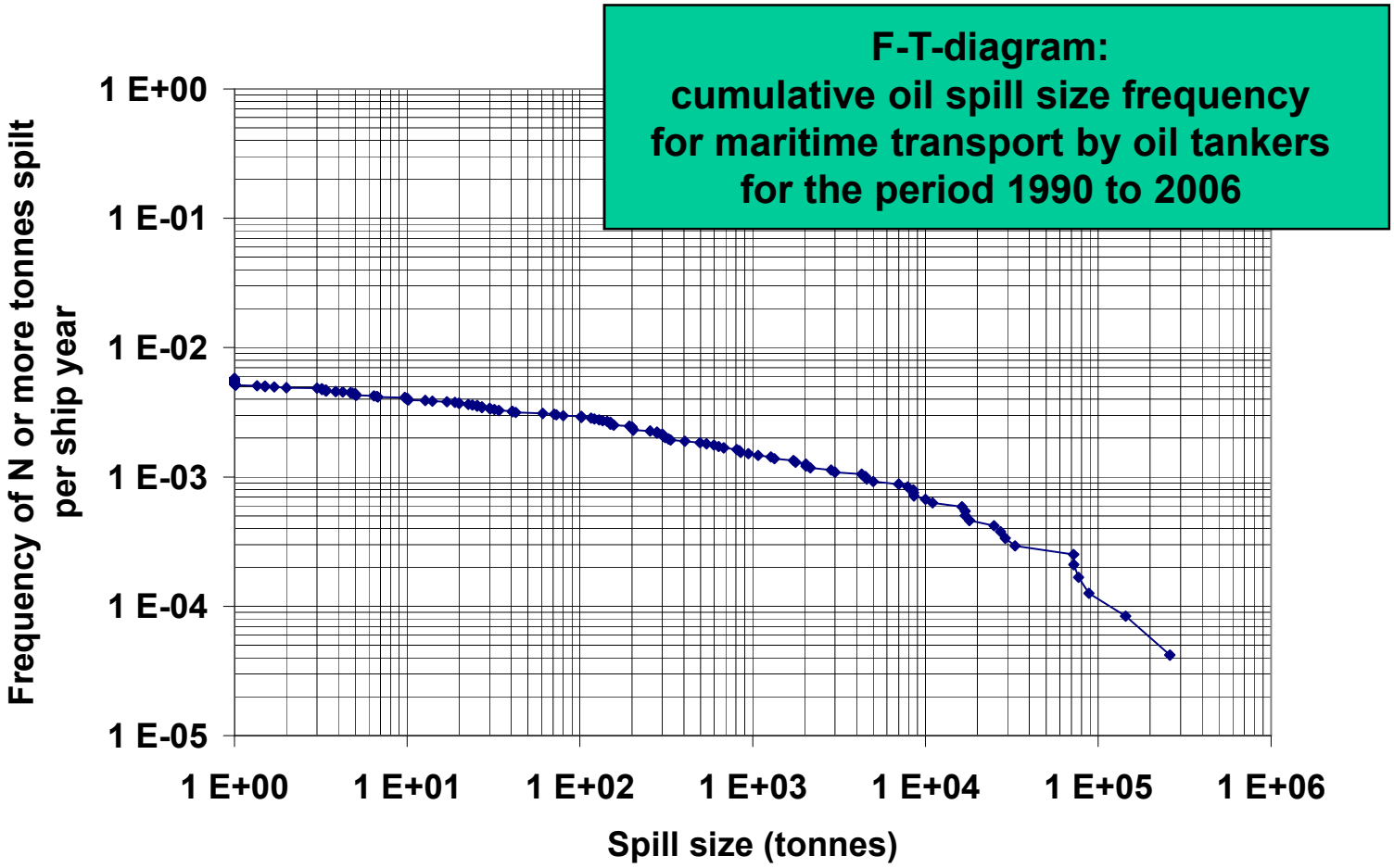
# Brief review of maritime oil spills[1]

- **160 accidents with oil spills ranging from 1kg to 260,000 t were analysed. (total: ~1 million tonnes)**
- **The number of accidents from double hull (DH) tankers is significantly smaller than for single hull (SH) tankers.**



# Brief review of maritime oil spills$_2$



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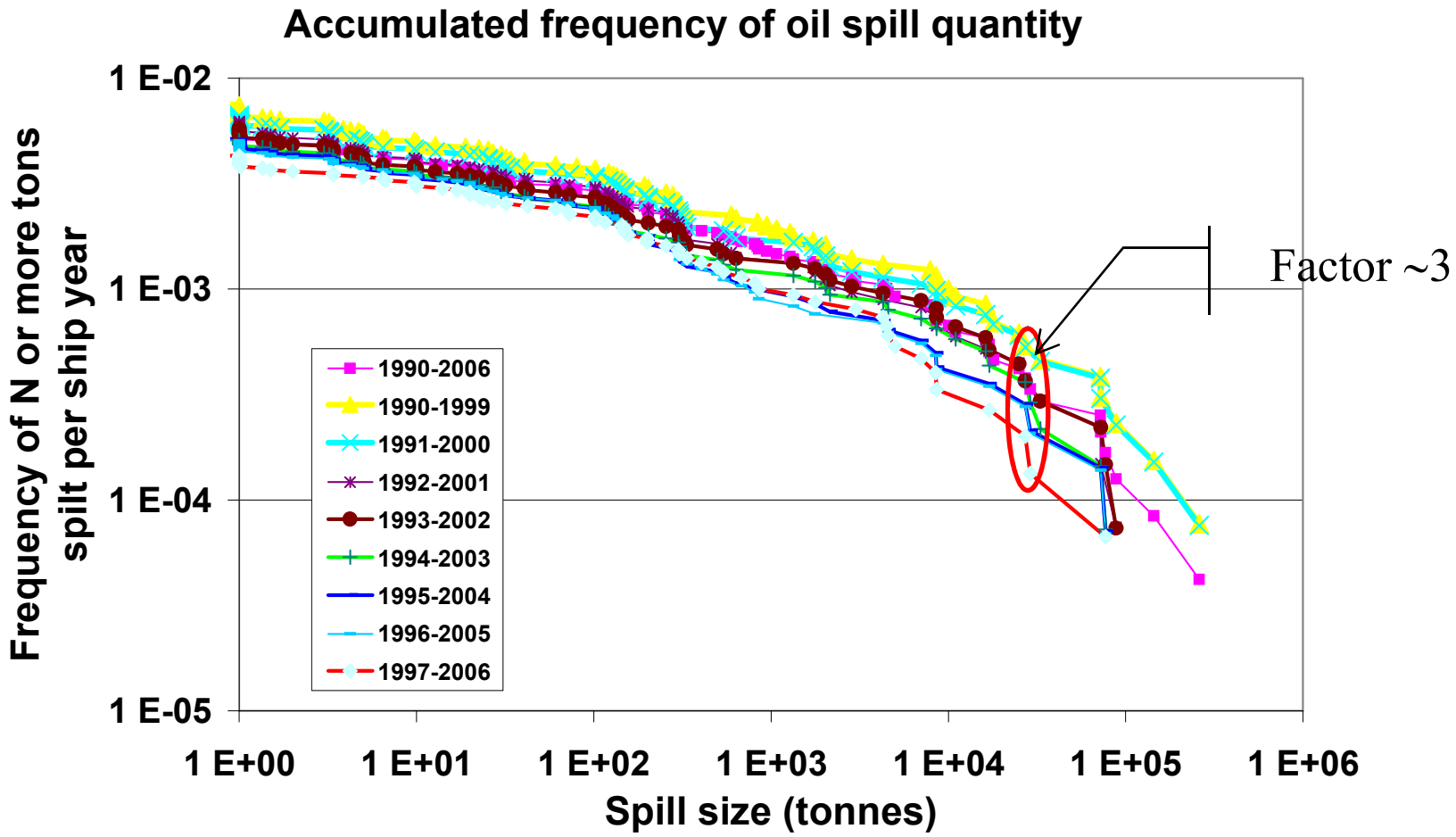
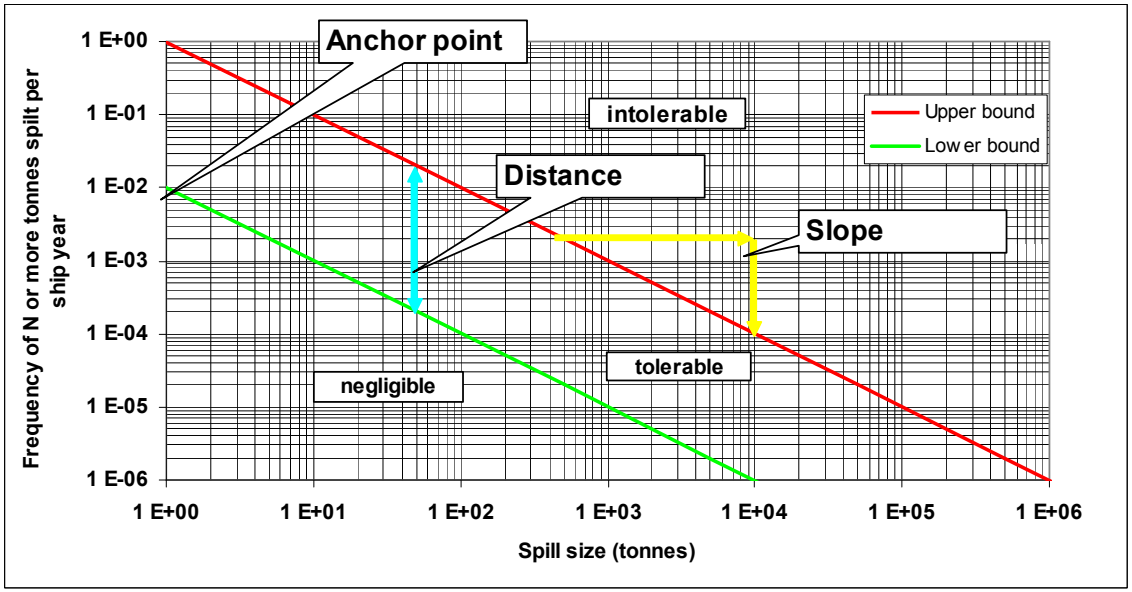


# Introduction to ALARP

- **It defines that risks should be reduced to as low as reasonable practical and cost-effectiveness is used to assess risk control options.**

- **An ALARP area can be defined by two lines in the double-logarithmic F-N diagram.**
- **A slope of -1 is typically used to express risk aversion.**
- **In FSA the anchor point is set using economic considerations.**



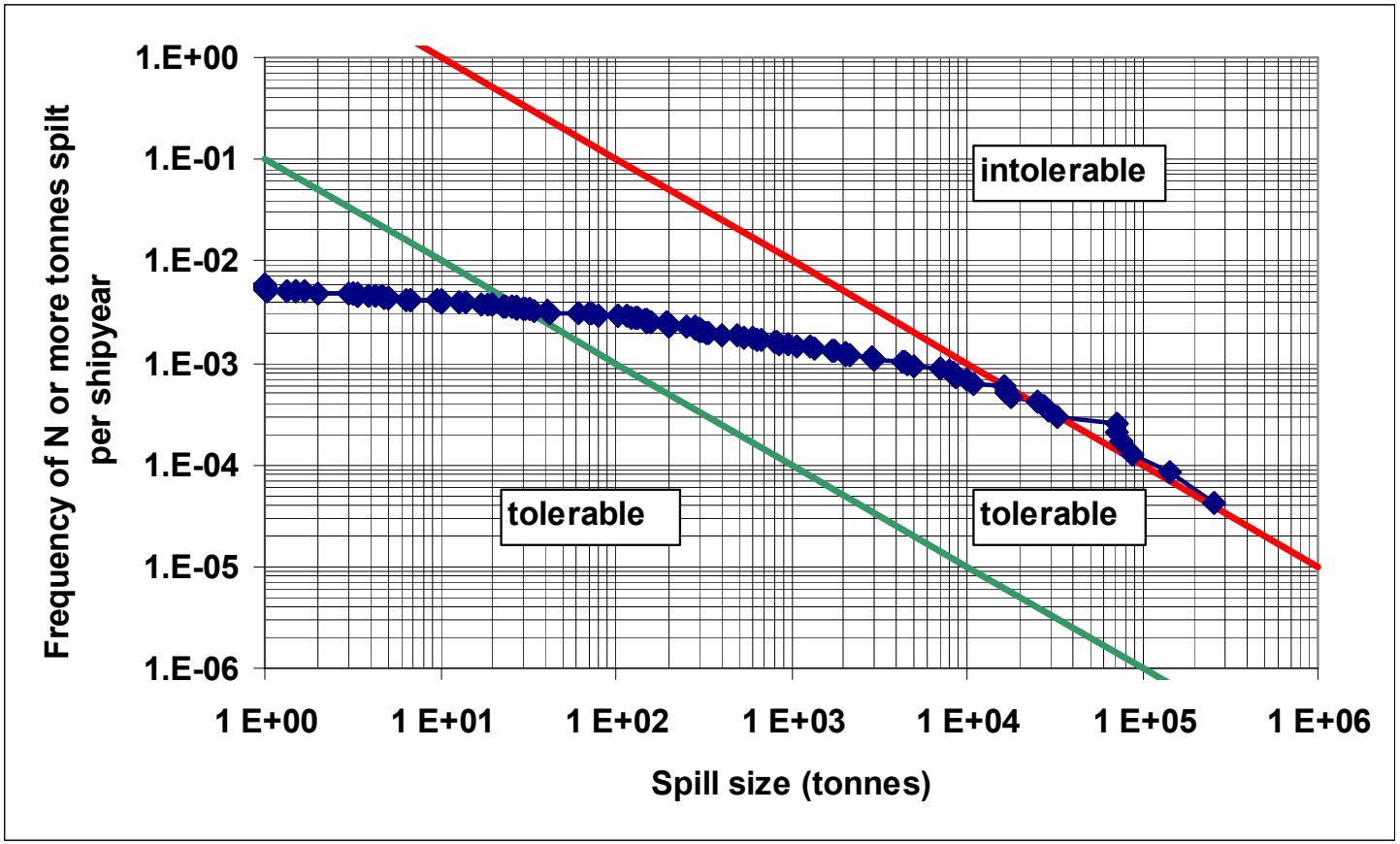
# Setting an ALARP area

- **Approach 1: It is accepted as means of transport, and associated risks are also considered acceptable.**
- **Approach 2: Societal acceptance of oil spills is based on the same economic value considerations as the societal acceptance of loss of life.**
- **Approach 2b: Approach 2 + non constant CATS**
- **Approach 3: Transfer from oil transport by pipeline.**

# Setting an ALARP area – approach 1

- It is accepted as means of transport, and associated risks are also considered acceptable.
- Therefore, current maritime oil transport by tankers – defined by 1990-2006 data - is JUST acceptable and cost-effective risk control options should be implemented. SH and DH tankers are considered.
- Boundary to intolerable risk defined by tangent of F-T diagram.
- Slope of -1
- The width of the ALARP area is taken as two orders of magnitude.

# Setting an ALARP area – approach 1




**Note: presently, all spills smaller than 20 tons are rendered negligible.**

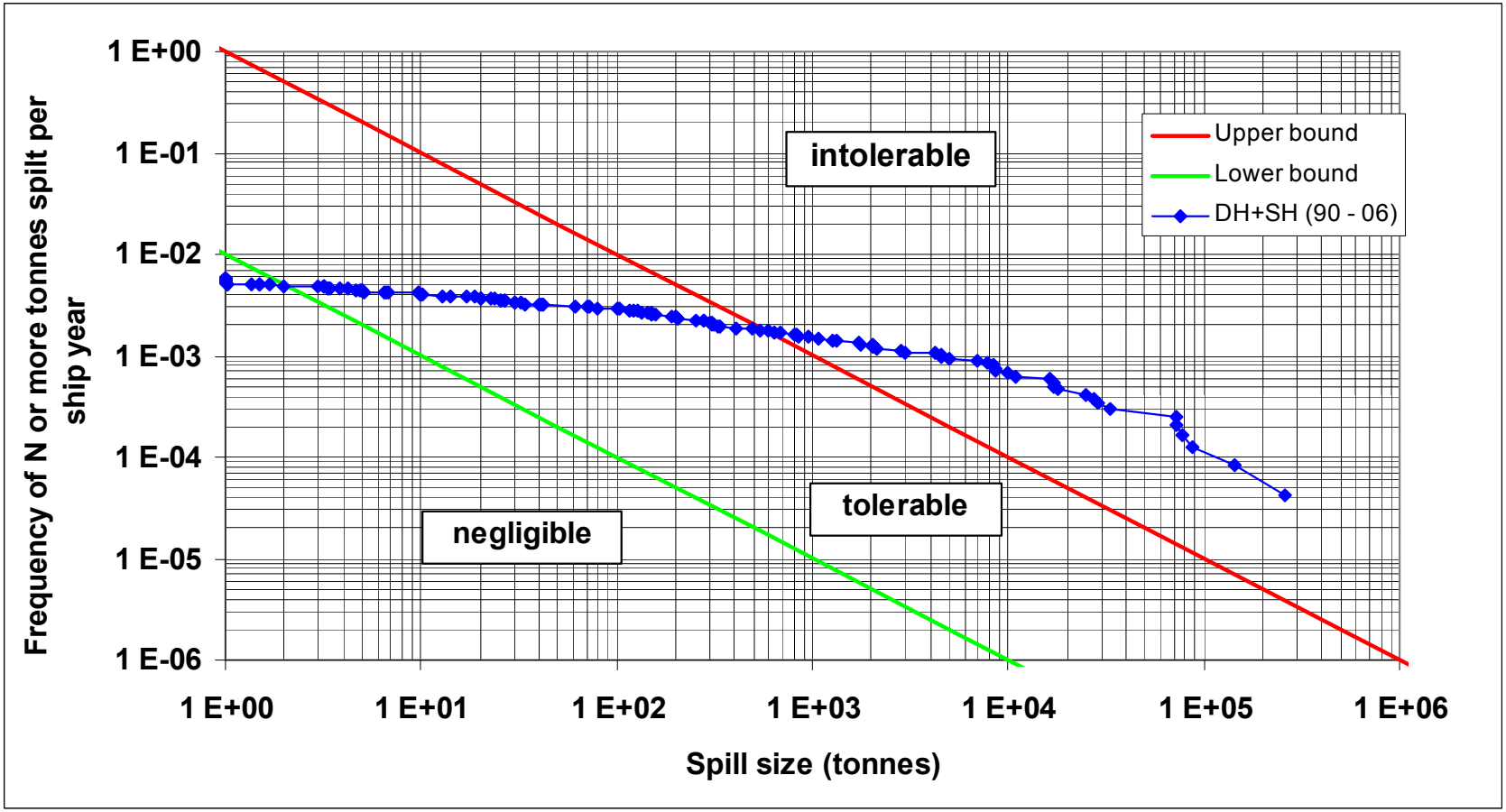
# Setting an ALARP area – approach 2

- **It is assumed that the societal acceptance of oil spills is based on the same economic value considerations as the societal acceptance of loss of life.**
- **This implies that a translation of the value of life to the value of environment is possible.**

# Setting an ALARP area – approach 2

- The ratio of cost-effectiveness criteria CAF and CATS is used to scale existing ALARP boundaries.
- $CATS_{Thr}$ = 60,000 USD
- CAF = 3 million USD
- Anchor point for tolerable - intolerable boundary for tanker crew safety: N = 1; F = $2 \cdot 10^{-2}$.
- The anchor (T= 50; F1= 0.02)
- Slope of -1
- The width of the ALARP area is taken as two orders of magnitude.

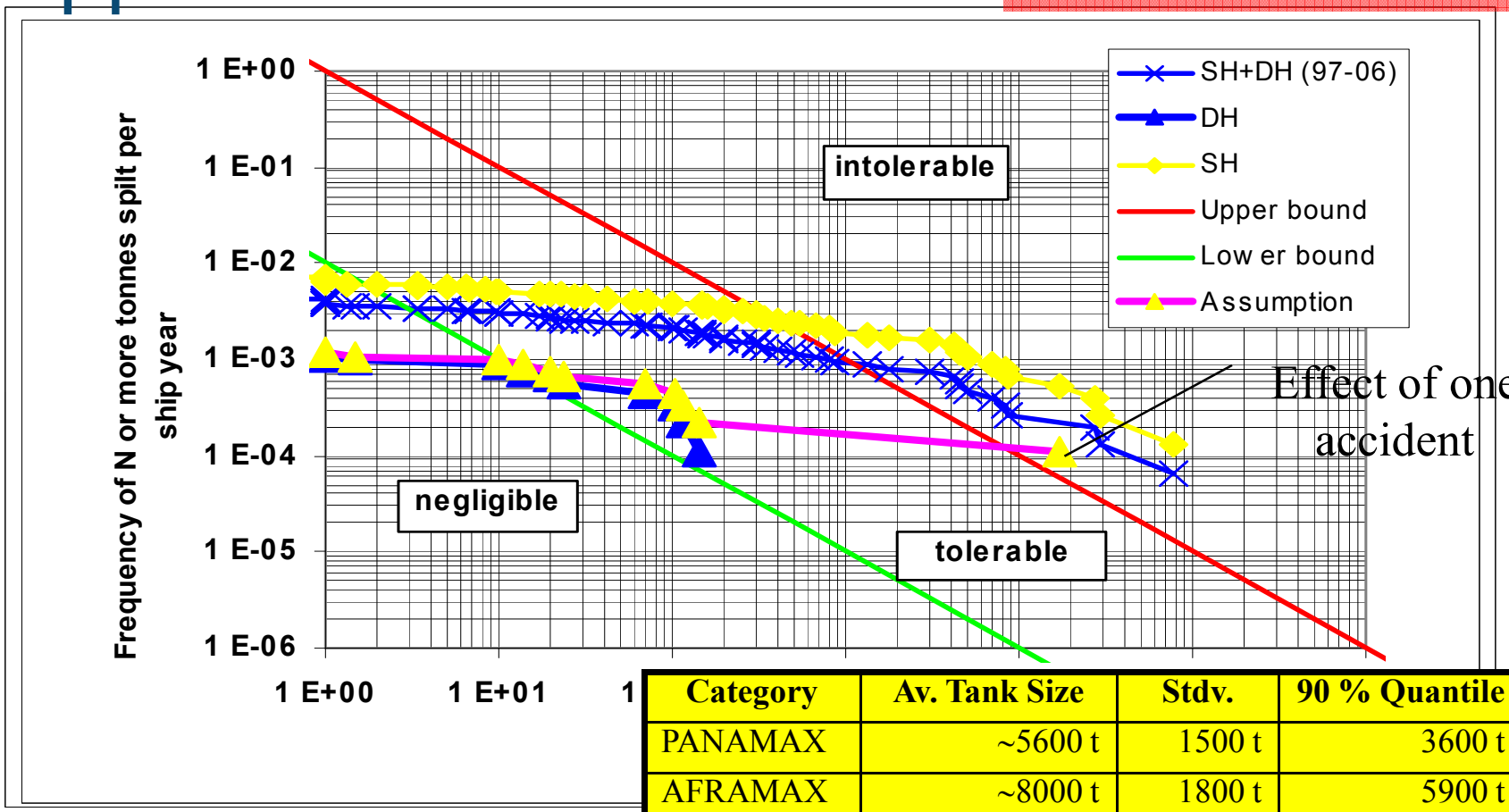
# Setting an ALARP area – approach 2




**Note: presently, all spills larger than 700 tons are rendered intolerable.**

# Setting an ALARP area – approach 2

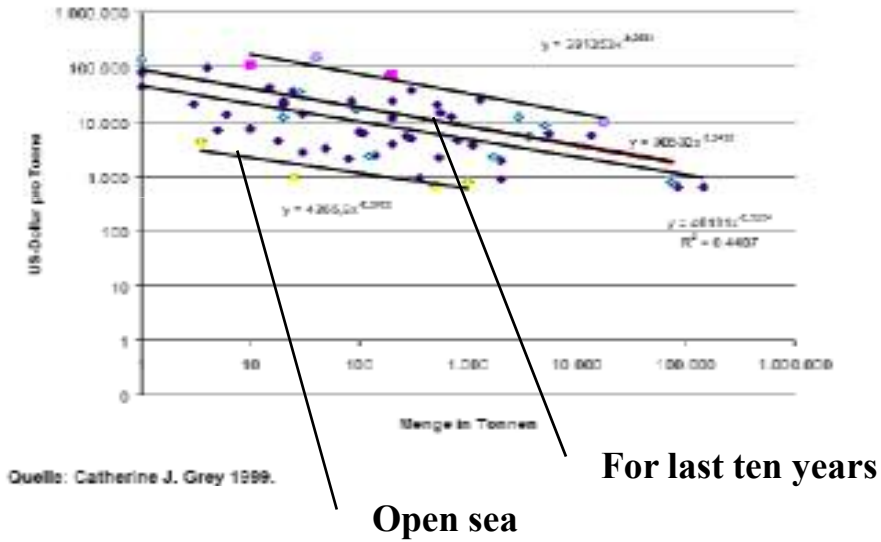
Effect of one accident with a spill of 17000 tonnes?




| Category | Av. Tank Size | Stdv. | 90 % Quantile |
|---|---|---|---|
| PANAMAX | ~5600 t | 1500 t | 3600 t |
| AFRAMAX | ~8000 t | 1800 t | 5900 t |
| SUEZMAX | ~11300 t | 2300 t | 8300 t |
| VLCC | ~18500 t | 2800 t | 15000 t |
| ULCC | ~19000 t | 3000 t | 15000 t |

# Cost of oil spills

- **Cost of oil spills vary with spill location, spill size, oil type, etc.**
- **Larger oil spills typically cost less per unit oil spilt.**
- **Examples:**
  - OSIR data: small ≈ 10,000 USD/tonne
    large ≈ 1,000 USD/tonne
  - Grey data: small ≈ 100,000 USD/tonne
    large ≈ 1,000 USD/tonne
- **A spill-size dependent CATS was created and tested to define the ALARP area using CAF/CATS.**

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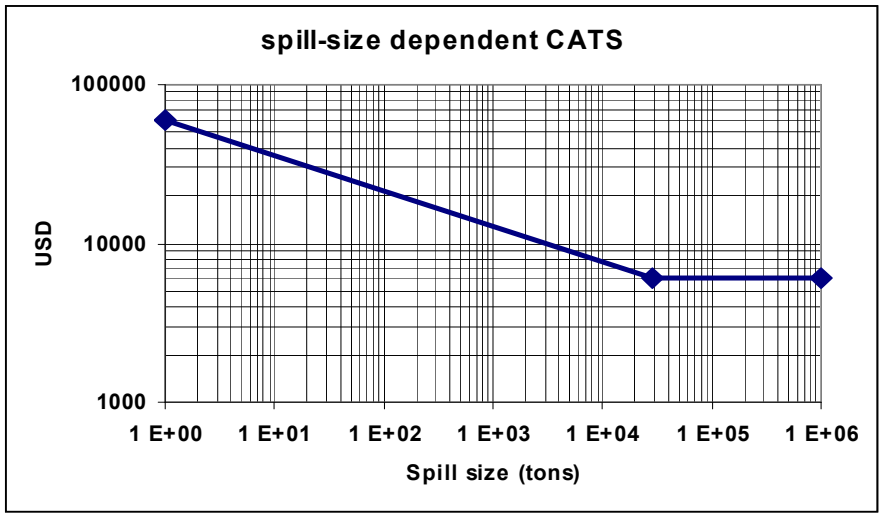

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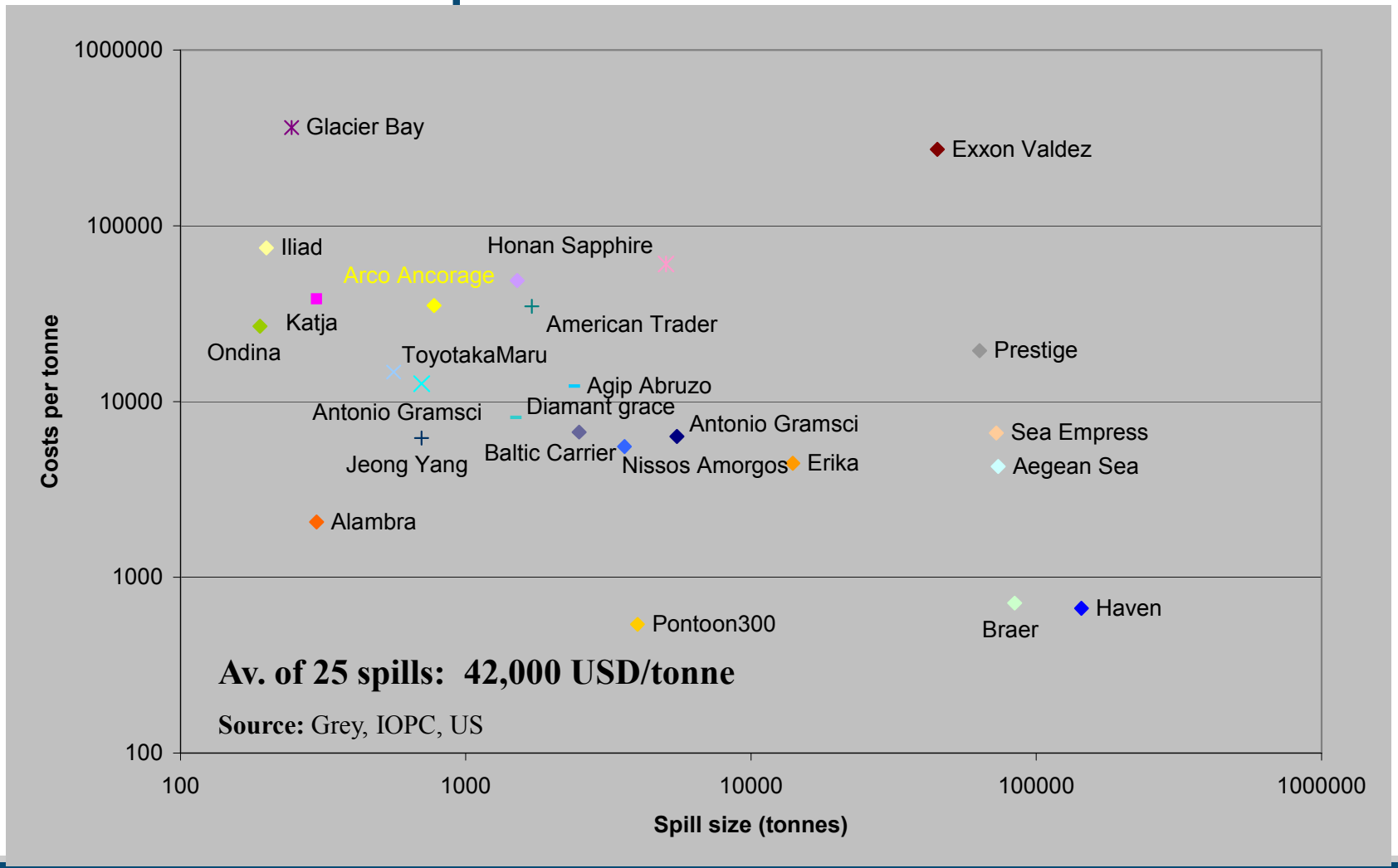
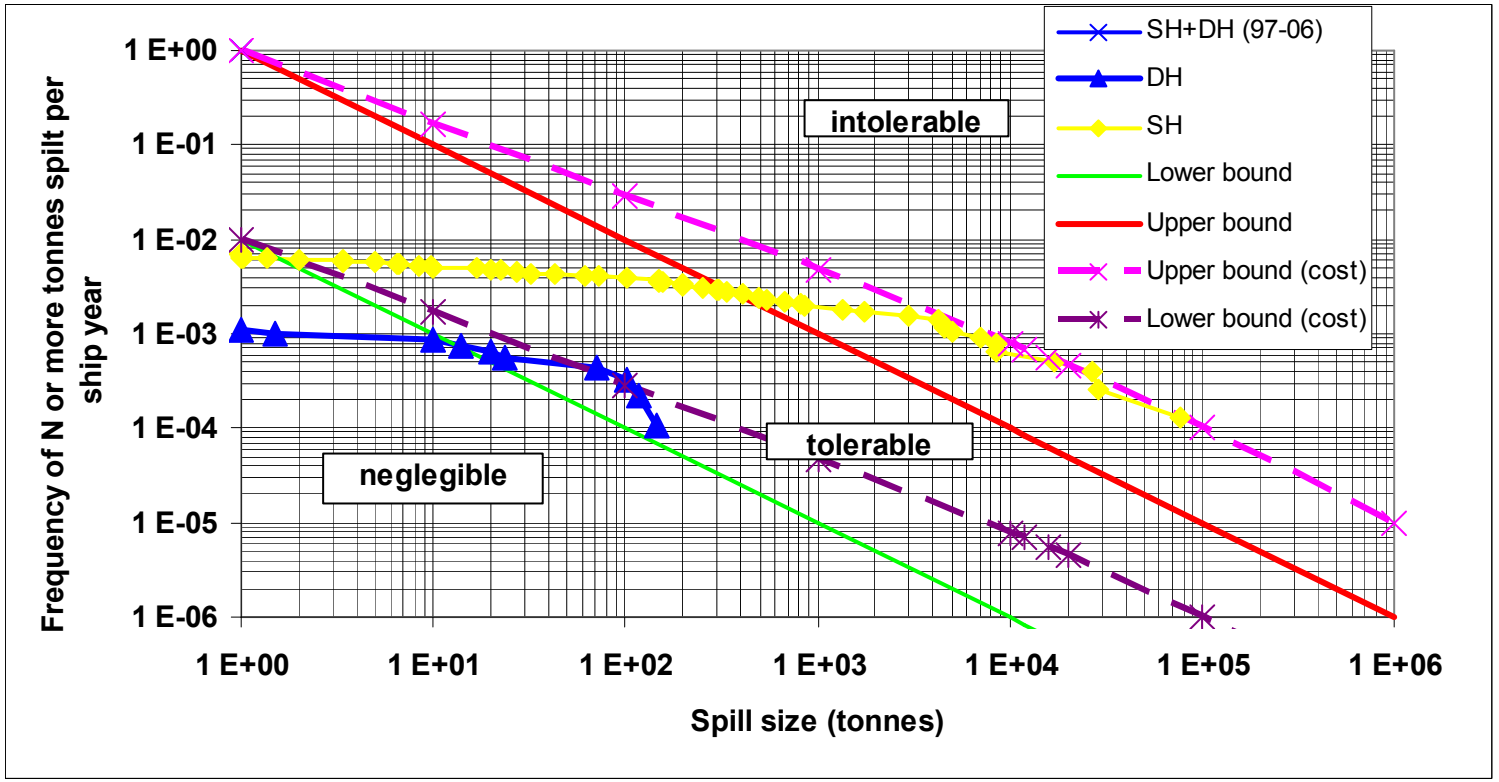


# Setting an ALARP area – approach 2b



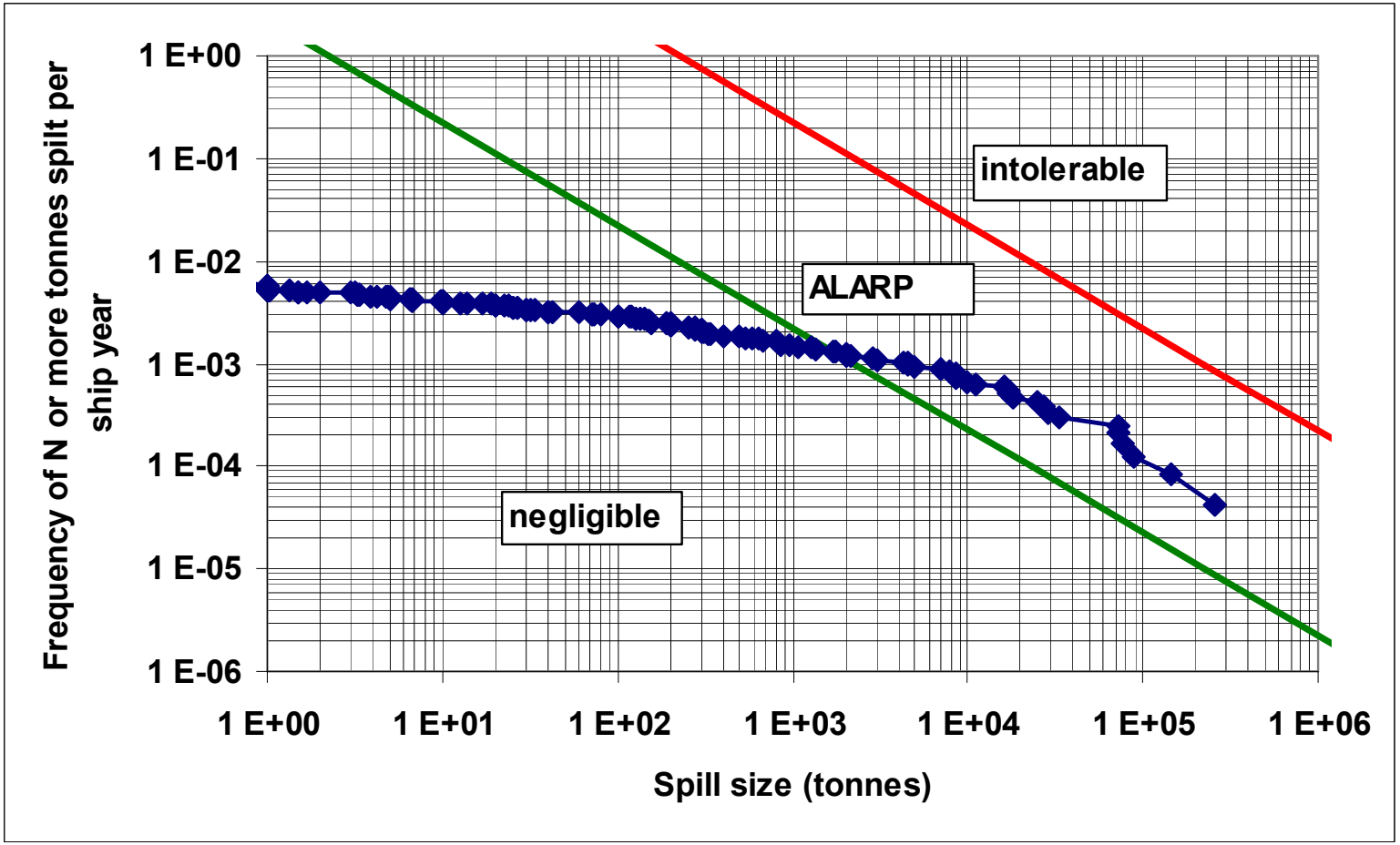

**Note: spill-size dependent CATS shifted boundaries to higher frequencies.**

# Setting an ALARP area – approach 3 Pipeline as reference ?

- Crude oil is transported also by pipeline. About 200.000 miles of pipelines span the US.
- The contribution to GDP from the pipeline industry averages to 10.5 billion USD per year (2002-2006).
- At the same time, the volume of oil spilt in pipeline accidents averages to 14.670 t per year (2002-2006).
- This results in 1.41 t oil spilt per million USD contribution to GDP.
- Source: www.bts.gov

- The four major oil tanker classes were considered separately and their current charter rate (per day for 1-year time charter) was used to determine annual revenues.
- The average annual revenue from oil transport by tanker is 16 million USD.
- Combining the pipeline data with the shipping data yields a target value for PLO of 22.6 t oil spilt / per ship year.
- This can be used to construct the acceptance criteria in the FT-diagram.

# Setting an ALARP area – approach 3




**Note: using pipeline data shifted boundaries to higher frequencies.**

# Conclusions and outlook$_1$

- **Risk assessment requires criteria!**
- **Risk acceptance criteria are not based on natural law.**
- **Safety and environmental criteria must be accepted by society.**
- **ALARP principle in combination with cost-effectiveness analysis to determine acceptable risk.**
- **Presupposition: definition of intolerable and negligible risk.**
- **Different approaches for a definition of “tolerable area” are presented.**

# Conclusions and outlook$_2$

- **Cost-benefit analysis within FSA process requires a threshold.**
- **Such a threshold may either be constant of spill size dependent.**
- **The definition of such a threshold should consider**
  - The societal need of environmental protection.
  - The application in IMO process (improvement of regulations)
  - That most of the tanker operate worldwide and transport different oil grades.
- **CATS was proposed by SAFEDOR ($CATS_{Thr}$ = 60,000 USD)**


GL
GERMANISCHER LLOYD
1867
OPERATING 24/7