

Goal Based Regulations by Rolf Skjong, DNV

**Open Workshop on Risk-Based
 Approaches in the Maritime Industry**

**22nd and 23rd May 2007, National
 Maritime Research Institute (NMRI),
 Tokyo, Japan**



Pick a regulatory ideology

- *Goal Based Regulation (e.g. UK MoD)*
- *goal Oriented Regulation (e.g. Canadian NEB),*
- *industrial self regulation regime (Norwegian offshore),*
- *safety Case Regime (UK HSE),*
- *risk informed, performance based (US NRC),*
- *performance based regulation,*
- *science based regulation (US Food and Drug Administration),*
- *result based regulation (Canada/BC deregulation office), etc.*



A large activity in regulatory reform

Some studies on efficiency of regulations (OECD, XX Institutes of regulatory reform)

It is worth looking into experiences from other industry

NEB comparing Regulatory Styles



Comparison of Regulatory Styles ¹¹¹			
Regulatory style	Defines	Risk approach	Compliance
Prescriptive	means	deterministic	check list
Goal-oriented	goals	risk-informed	professional judgement and acceptance criteria
Performance-based	measures	risk-based	objective criteria
Self regulation	outcomes	company determined	self audit

Why Goal Based Regulation?



Standard arguments/literature:

Transparency: Is the regulation justified from

- **Safety**
- **Environmental**
- **Standardisation (practical, inter-modal, interoperability)**

Opens for free competition and innovation

Accommodate different standards:

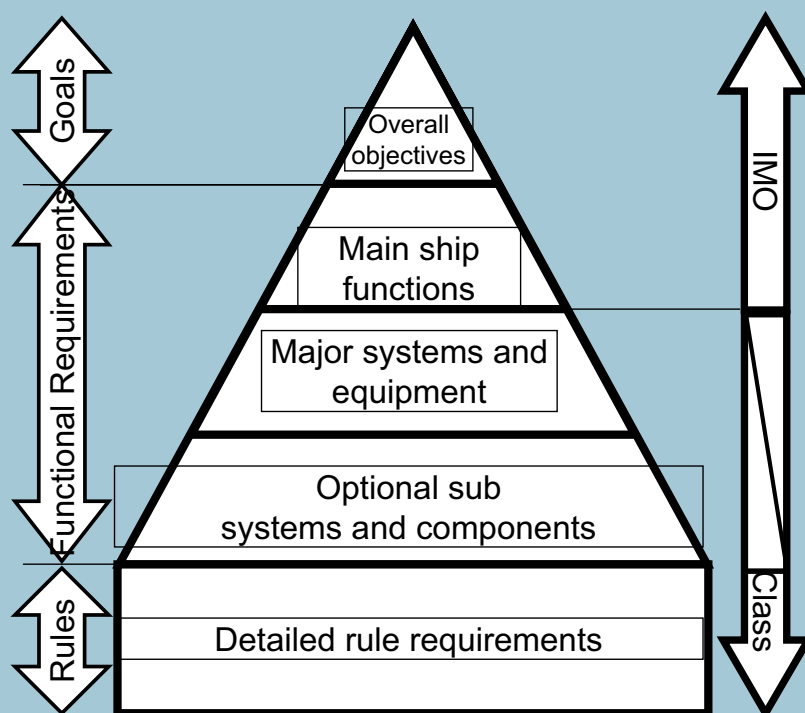
- 🌐 **Goal Based Regulation:**
- 🌐 **Goal Based Standards not Standard!**

Why Goal Based Regulation?

- Result of need for transparency and justification for regulations.
- Reaction to prescriptive regulations which:
 - i. ...tend to put the responsibility on the regulator if a solution proves insufficient to prevent an accident. The service provider only follows prescription and is thereby feeling relieved of responsibility
 - ii. ...are distilled from past experience. When technology are developing faster than experience can be gained the regulation may become a direct threat to safety.
 - iii. ...encourage mediocrity and are destructive for innovation.
 - iv. ...are used as trade barriers and may be viewed as illegal in the context of free trade agreements (e.g WTO, EU)

From 'Danish +' submission at MSC79/6/15

Relationship between safety goals and functional requirements



Goal Based Regulation



- *Wishes and perceptions (IMO submissions)*
 - *State what shall be achieved*
 - *No method on how to achieve*
 - *Open for innovation*
 - *Ensure against sub-standard*
 - *Clear*
 - *Demonstrable*
 - *Long standing*
 - *Adaptable*

Risk Based Regulation - FSA



- *Wishes and perceptions (UK/1997)*
 - *Structured*
 - *Systematic*
 - *Comprehensive*
 - *Objective*
 - *Rational*
 - *Auditable*
 - *Repeatable*
 - *Well documented*
 - *Defensible*
 - *Reliable*
 - *Robust*

Example Goal Based Regulation?



'People shall be prevented from falling over board'

Example of Prescriptive Regulation 'Ships shall have a 1 meter high railing surrounding each deck and open space where people could otherwise fall over board'

IMO, after accident where a crew member is washed overboard though the railing 'Ships shall have a 1 meter high railing, with a maximum distance between horizontal rails of 10 cm, surrounding each deck and open space where people could otherwise fall over board'

Etc. New accident – more detailed prescription

IMO, after accident where the captain's 4 years old son climb the railing 'Ships shall have a 1 meter high railing, with a maximum distance between vertical rails of 10 cm, surrounding each deck and open space where people could otherwise fall over board'

Challenge with Goal Based Regulation?



High Level Goals are more abstract (e.g. 10^{-4} probability/ship year) than prescriptive regulation (1 meter high)

Goal Based Regulations require higher level of training, in order to result in same practice

Verification will be on abstract level: What is a credible argument for safety?

Goal Based Regulations must deter from presenting untenable arguments

Goal Based Regulations relating to safety and environmental regulations are also risk based

Goal in Goal Based Regulation?



Example of high level goal in use (safety):

Risk should be 'tolerable and ALARP'

Goal based regulations can be applied at any level, from top-level systems (the ship) downwards

Need a method to break down high level goals to tenable sub-goals:

This method is QRA/PSA/FSA – no other method has been presented anywhere

Goal – High Level Goal?



Proposed:

- design life,***
- environmental condition,***
- structural safety,***
- structural accessibility,***
- quality of construction***

Of these: Only one high level goal

In submissions a number of other goals is mentioned.

Most are on the level already in e.g. SOLAS

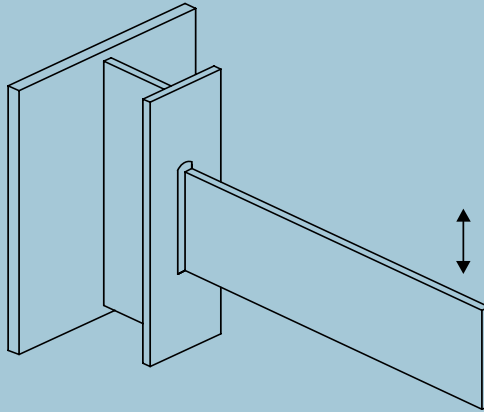
Evacuation in 30 minutes, 60 minutes fire protection, 40 meter fires zones etc.

On this level of abstraction the number of goals are countless

This is clearly not the intention!

Fatigue – Risk Based

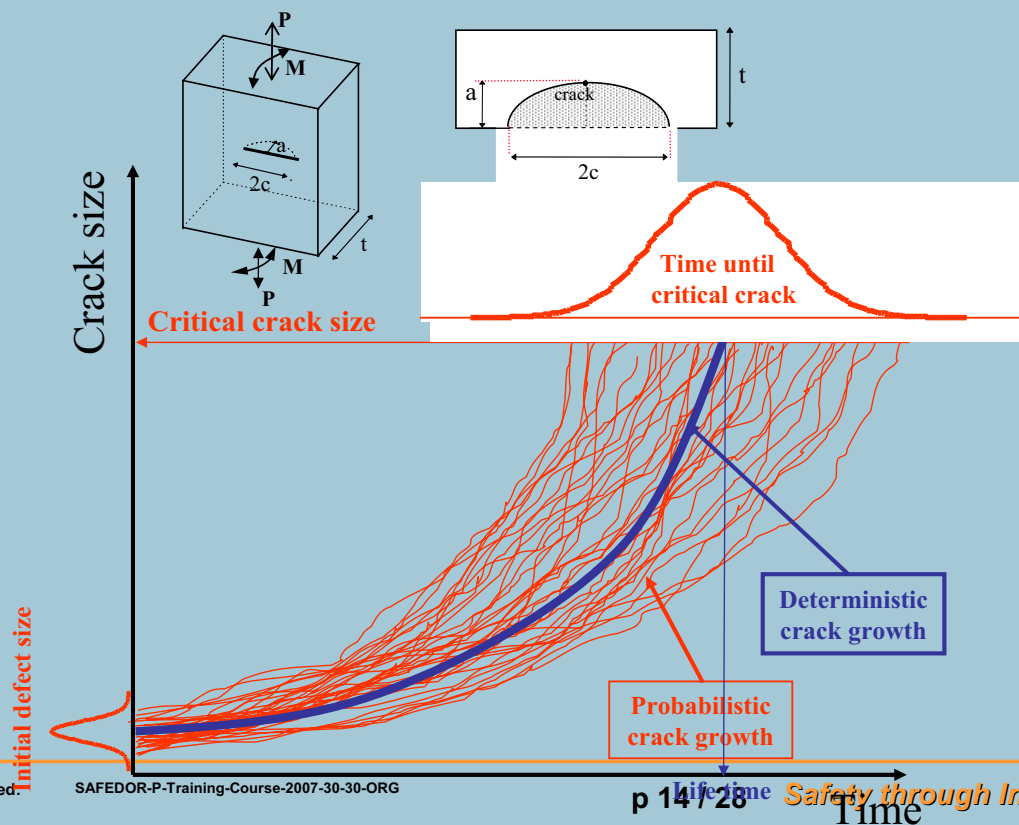
- SN-curve for new component $\log(N)=\log(K)-m\cdot\log(S)$
- Experience from similar components :



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novation

Deterministic vs. Probabilistic Approach

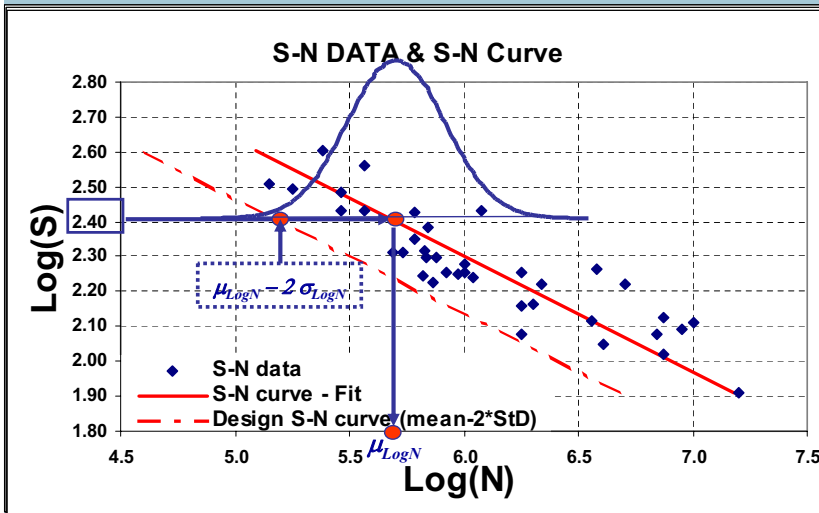
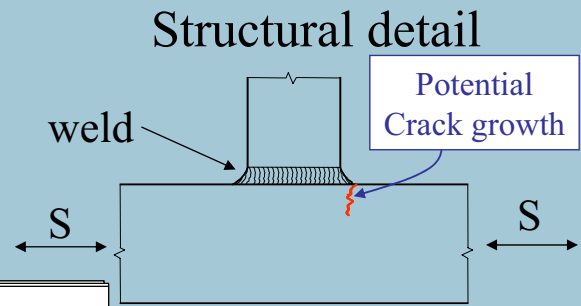


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S-N Fatigue Assessment

- S-N data - experimental data



- S-N Mean Curve:

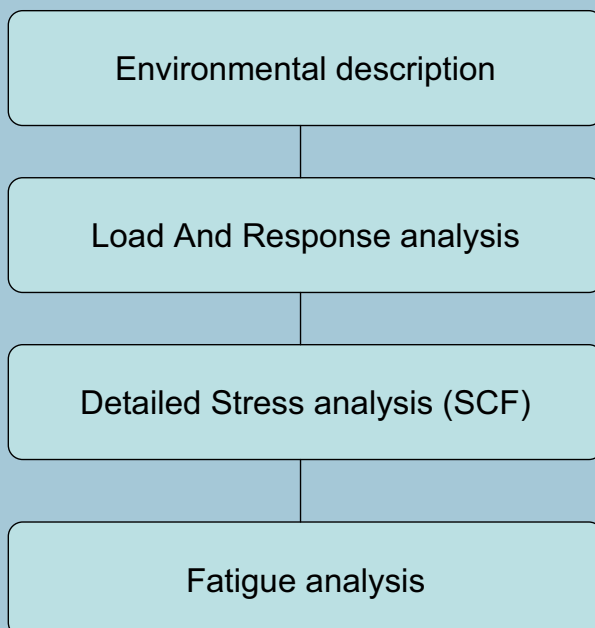
$$\text{Log}(N) = \text{Log}(\bar{a}) - m \cdot \text{Log}(S)$$

$$N = \bar{a} \cdot S^{-m}$$

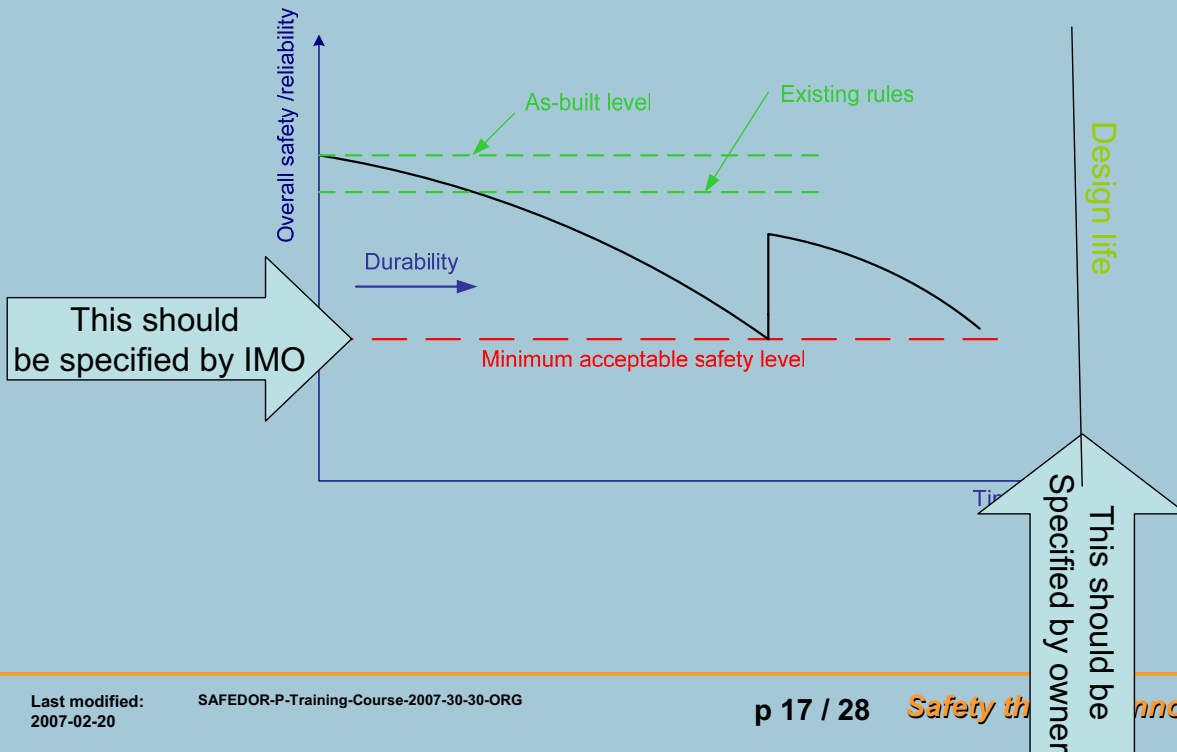
- S-N Design Curve:

$$\text{Log}(N) = \text{Log}(\bar{a}) - m \cdot \text{Log} S - 2 \sigma_{\text{Log}N}$$

Integrated Fatigue analysis - Uncertainties



Specify Design Life?



High Level Goal – Tradition (NKB/DNV/ISO/CEN)

Calibration against well established codes that are judged acceptable or best practices for the same type of structures

Calibration against well established codes that are judged acceptable or best practices for similar type of structures

Calibration against tabulated values, using distribution assumptions that are judged to be (slightly) conservative

High Level Goal – Tradition (NKB/DNV/ISO/CEN)

Table 1: Annual Target Probabilities (and Target β_T) from DNV Classification Note 30.6

Class of Failure	Consequence of Failure	
	Less serious	Serious
I- Redundant Structure	$P_F = 10^{-3}, \beta_T = 3.09$	$P_F = 10^{-4}, \beta_T = 3.71$
II - Significant warning before the occurrence of failure in a non-redundant structure	$P_F = 10^{-4}, \beta_T = 3.71$	$P_F = 10^{-5}, \beta_T = 4.26$
III - No warning before the occurrence of failure in a non-redundant structure	$P_F = 10^{-5}, \beta_T = 4.26$	$P_F = 10^{-6}, \beta_T = 4.75$

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Goal – High Level Goal?

- 🌐 *We have some goal based standards*
 - 🌐 *SOLAS II-2, Reg 17*
 - 🌐 *New damage stability regulation ($A < R$)*
- 🌐 *Is this a relevant model?*

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Justification for Regulating - Goals

Method of analysis

Issues needing regulations – Distributed Goals

Goal Based Standards

Safety

Environment

Security

Interfacing

Accident Scenarios

Intact
Strength

Damaged
Strength

Fire
Protection

Nav.
Safety

Freeboard

Opera-
tional

LSA

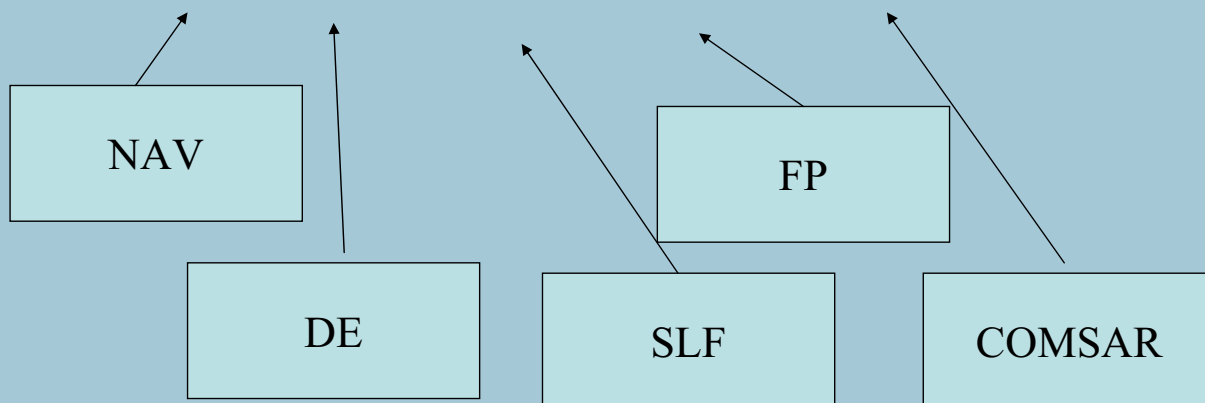
Systems

Rules
Structure

IMO Subcommittee Structure

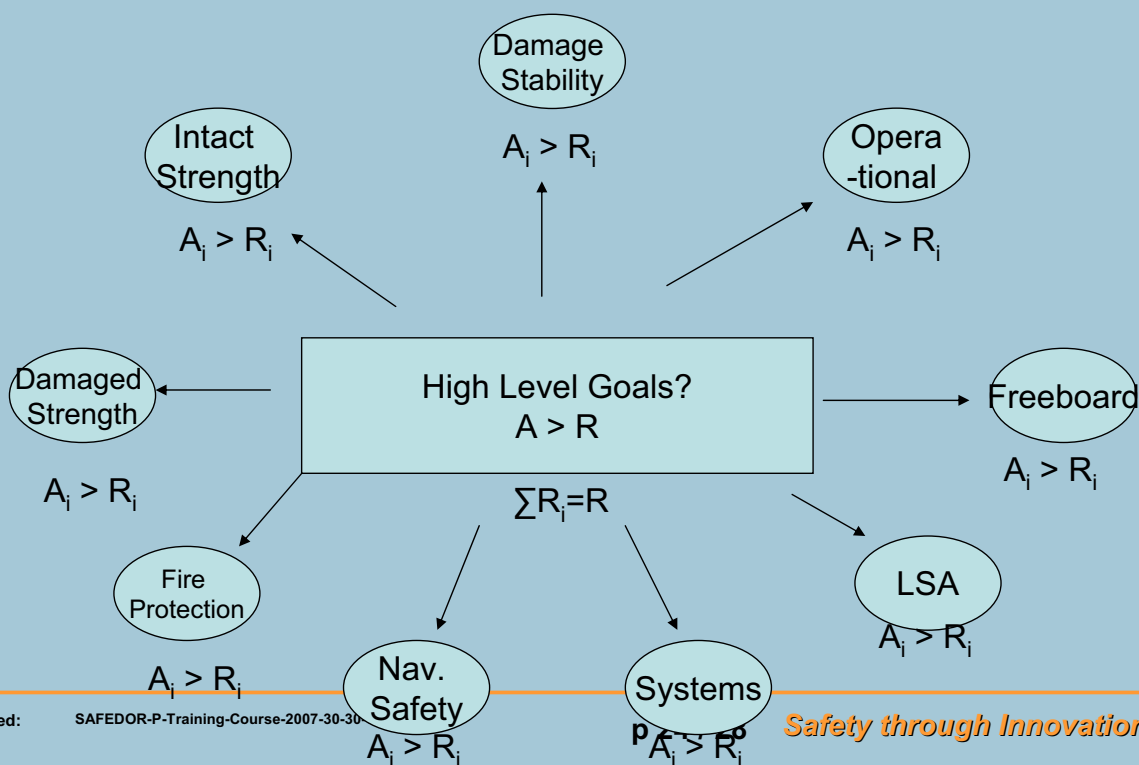


$$R = P_c \times P_{i|c} \times P_{s|i|c} \times P_{f|s|i|c} \times P_{r|f|s|i|c} \times N$$



- NAV = Navigation Sub-committee
- DE = Design and Equipment (Strength Issues)
- SLF = Stability Load Lines and Fishing Vessels
- FP = Fire Protection (dealing with evacuation)
- COMSAR = Communication, search and rescue

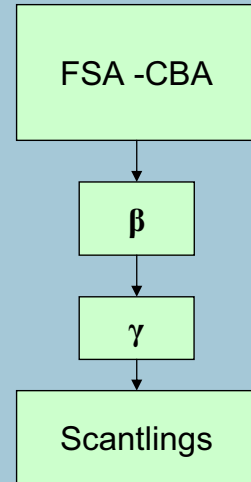
Goal Based Regulation – Trivial Version



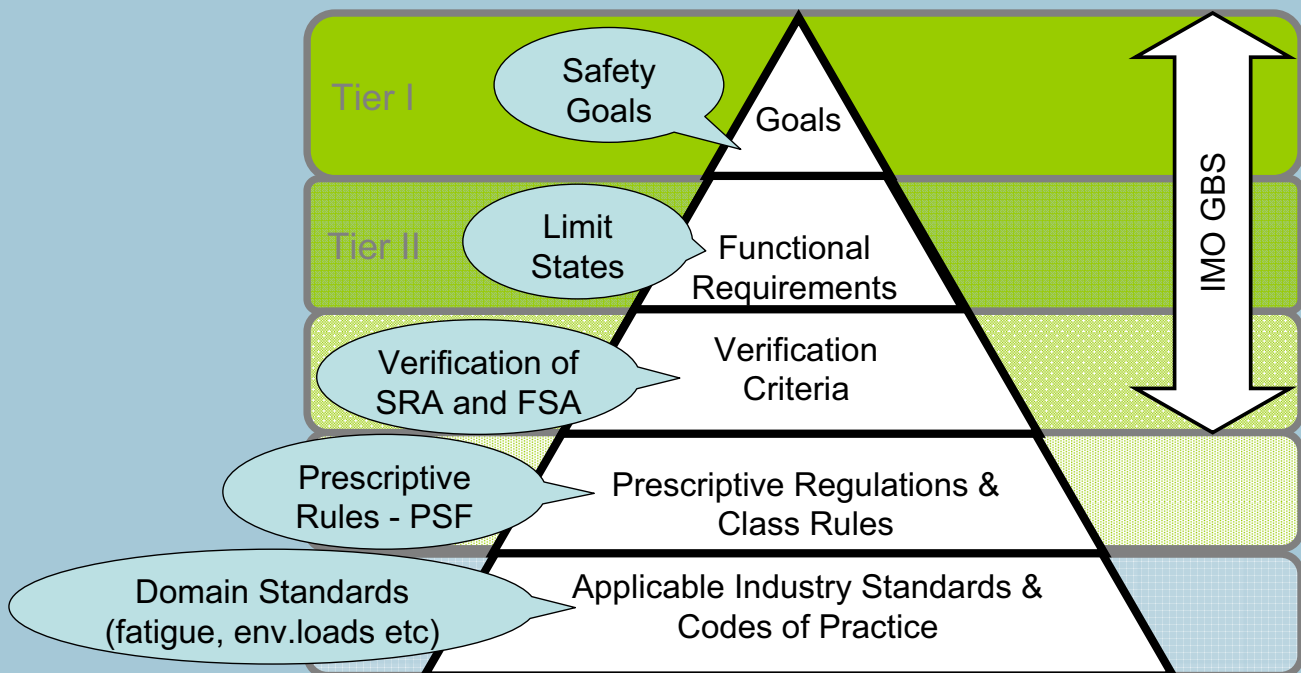
The model used: 4Δ model

- Check that design is in ALARP area









$$NCAF = \frac{\Delta Cost - \Delta B - \Delta E \cdot CATS}{\Delta PLL}$$



Significance to GBS



Conclusions

-  Some experience with GBR in other industries is worth studying
-  For structures a well developed technique exists
-  The proposed regime is probably 'goal based risk informed'
-  The relation between 'goal based' and 'risk informed' is as between style and method
-  Uniform interpretation is a challenge
-  Training is necessary
-  All elements for a Risk Based GBS exists
-  Challenge: IMO representatives to use. Need **Requirement** to use FSA

To do List

- **Agree on new structure of regulation – functional**
- **Develop amendments to FSA Guidelines if necessary**
- **Develop the missing risk acceptance criteria**
- **Formulate the functional requirements (based on decoding current regulations)**
- **Require that new regulations & amendments to existing regulations are justified by FSA**
- **Keep these FSAs as justification, and prepare a synopsis as Rule Commentary**