



Tanker Structure Co-operative Forum

**Guidance Note on Fatigue for
Double Hull Oil Tankers
Complying with the Common
Structural Rules**

TSCF - Guidance note on fatigue

Agenda

- Background
- Guidance note
 - Assumptions in CSR
 - Scope of CSR
 - Methods to improve fatigue life
 - In service experience



Background

- Calculation of fatigue life became an industry standard in the 1990's.
- No uniform industry standard or scope for fatigue calculations:
 - Owners specification:
 - "Fatigue Life 25 years in North Atlantic service."
 - Class Notation:
 - Enhanced class notations beyond the 25 years exists in various class society Rules, and intended for application where the Owner or Builder wishes to take additional measures to ensure the risk of fatigue failure is minimized.
- What standard is to be applied?
 - Scope, what structure to be checked?
 - Trading pattern?
 - Loading conditions?
 - Effect of corrosion?
 - Definition of North Atlantic?



Background

- Introduction of the CSR represents a major step in unifying the approach to fatigue calculations.
- However, it is still important for the Owner to:
 - Understand the **assumptions** used in the fatigue calculation and adjust them if necessary.
 - Understand the **scope** as to what is actually checked, and increase the scope if necessary.
 - Understand what can be done to **improve** the fatigue performance.
 - Draw on **experience** from ships in operation.



Basis for development of the guide

- To develop a guidance note about fatigue analysis based on the IACS Common Structural Rules for Double Hull Oil Tankers (CSR).
- The guidance note should describe the scope of fatigue analysis in CSR, including clarification of criteria and assumptions included in CSR and critical locations required for fatigue analysis.
- The guidance note should use pre-CSR service experience of critical locations on double hull tankers with regards to fatigue performance to supplement the service experience on CSR ships (as experience on CSR ships is limited).
- The guidance note should include a list and description of additional measures available which the owner may wish to consider for inclusion in his specification with shipyards at the pre-contract stage.



Terms of reference

- The guidance note covers:
 - Areas to consider in connection with specification of new contracts for double hull oil tankers with length of 150 meters or greater to which the IACS CSR apply.
 - Specification of longitudinal elements and critical locations on transverse primary members in the cargo region.
- The guidance note does not cover:
 - Voluntary application of the CSR to other ship types.
- The guidance note includes:
 - Details of additional items that would need to go into a specification.
 - Practical explanation of the background of CSR fatigue requirements.



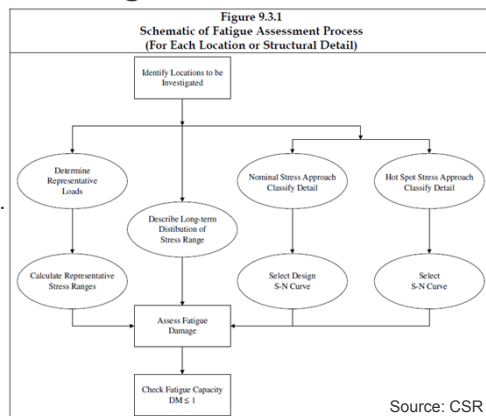
Content of the guidance note

- Introduction to basic fatigue theory
- Scope of CSR fatigue strength assessment
- Pre-CSR service experience
- Recommendations to enhance fatigue performance
- Additional voluntary class notations available
- Participation from class societies, oil majors, and independent owners; BV, CCS, DNV, LR, NK Statoil, A.P. Moller - Maersk, Shell Shipping, BP Shipping,



Scope of CSR Fatigue Strength Assessment

- Scope of fatigue analysis
- Ship operational profile
- Structural arrangement and response.
- Construction standards and residual stresses
- Various assumptions



“My vessel has a calculated fatigue life of 25 years.
Why did it experience cracking after only 13?”



- A harsher trade than assumed in the calculations? North Atlantic instead of world-wide?



- Included in the scope of fatigue calculations?



Assumptions in CSR

- Idealized operating profile, and “standard” tanker design.
- Design life: 25 years
- Assumed life at sea: 85%
- North Atlantic wave environment
- Simplified trading pattern (either homogenous load condition or normal ballast condition)
- Mandatory items are a) longitudinal stiffener end connections, and b) the lower hopper knuckle.



Scope of CSR Fatigue Strength Assessment

- Some of the problems addressed, are:
 - Is 85% for time at sea realistic?
 - How does the CSR wave environment compare to that used in pre-CSR?
 - Can scantlings be reduced if the ship operates outside the North Atlantic?
 - Are the CSR assumption of wave environment reliable for all trade routes?
 - CSR only uses two loading patterns. Is this valid for all tanker types?
 - Can design draught and metacentric height be optimized to minimize impact of the requirements?
 - Are still water bending moments taken into account in the fatigue assessment?
 - Which longitudinal end connections are affected by the mean stress correction?
 - At what level could inert gas pressure have influence on fatigue life?
 - What happens if a sour crude or high corrosive cargo is being carried?
 - Is the CSR approach to structural flexibility reliable for all designs?

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Recommendations to Enhance Fatigue Performance

- Analysis
 - Specified fatigue life
 - Level of fatigue analysis
 - Trade routes
 - Loading conditions/low cycle fatigue
 - Hull vibration
 - High tensile steel
 - Hull outfitting
 - Corrosion protection
- Enhanced detail design
 - Weld improvement
 - Structural enhancement
- Non destructive testing

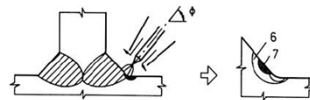
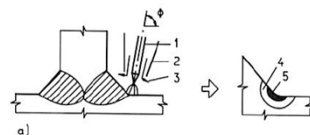
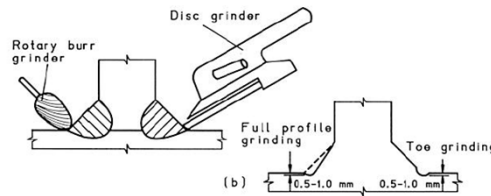


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Recommendations to Enhance Fatigue Performance

- Describes, beyond the scope of CSR:
 - how an enhanced fatigue analysis can be performed.
 - additional structural connections to be considered.
- Enhanced Details Design
 - Weld improvement
 - Grinding
 - TIG-dressing
 - Peening
 - Structural enhancement
- Selected areas for NDT

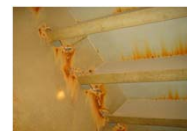


Example of weld improvement methods. TIG dressing, rotary burr and disc grinding; Source Fatigue Handbook.



Pre-CSR Experience

- Secondary member end connections
 - Deck
 - Side shell, longitudinal bulkheads, bottom and inner bottom
 - Hopper and inner skin
- Transverse Bulkheads
 - Various stool connections
 - Transverse bulkhead stringer to double side structure
- Primary Members
 - Transverse web frames



Pre-CSR Experience

- Examples of different structural hull details, and related contributing factors to fatigue damage, such as:
 - Stress concentrations
 - Load effects
 - Weld details
 - Misalignments
 - Lack of continuity
 - Secondary effects
 - Asymmetrical connections
 - Corrosion

