Combining ice conditions and envisaged operational scenarios to derive the design basis for ships operating in ice

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Today's presentation

The objective of today's presentation is …

- To demonstrate how a design basis (or "operational envelope") for ships in ice can be derived using operational scenarios and ice conditions

Today's presentation …

Why design and assess ships using ice conditions and an operating scenario approach?

- Used in a systematic manner should contribute to the operational safety of the ship
- Used in a systematic manner should allow regulators and operators a more realistic view of the capability of the ship

What is today's presentation about …

- Discuss some current practices for determining the design basis for ships operating in ice
- Review of a case study where operational scenarios have been used to derive the ships design basis
- Present an outline of a scenario based approach for future ships designed to operate in ice
- Look towards future approaches and expected practices to determine the design basis for ships operating in ice

Current areas for operating in ice

Currently, there are three significant areas where ships operate in ice

- GULF OF ST LAWRENCE & GREAT LAKES
  - First year ice
- BALTIC SEA
  - First year ice
- ARCTIC: Canadian Arctic, Alaska, Russian Arctic (Northern Sea Route)
  - First year and multi year ice

Current practices for deriving the design basis for ships operating in ice

- Baltic & Gulf of St Lawrence (escort-supported ships in first year ice conditions)
    - Select ice class based on trading pattern and regulatory regime
    - Use selected ice class as a design basis for operating in ice
- Arctic operations (and non-escort-supported ships in first year ice)
    - Select ice class based on trading pattern and regulatory regime
    - Use selected ice class as a design basis for operating in ice

    Experienced operators and designers:
    - Add further strengthening based on operational experience, previous ship designs, damage learning and full scale measurements

Current practices for deriving the design basis for ships operating in ice…using operational experience

- For Arctic ships additional strengthening is often specified by the owner or designer based on experience of operating in ice

- Additional strengthening using operational experience is based around owners and operators considering previous ships were damage has occurred:
    - In specific ice conditions
    - Performing specific operations
    - On specific hull areas and machinery components

- Example

  Additional strengthening may be specified above ice class requirements based on bottom damage encountered below the ice belt when operating on a specific route

Defining operational scenarios

- Requirements above ice class are effectively considering additional ‘scenarios’ for operation, based on experience.

- A scenario is considered to be a combination of the operational mode of the ship (how it is operating) and the conditions it is operating in (prevailing ice conditions)

  Definition of operational scenario:

  operational mode + prevailing ice conditions

- This operational scenario is required in order to more rigorously define appropriate areas for ice strengthening based on the actual operation of the ship

Why operational scenarios have been used to derive a design basis

- Designers and operators have considered operational scenarios when designing a ship to operate in ice in addition to ice class requirements

- Operational scenarios may be considered in addition to a specified ice class for a number of different reasons:
    - **Provide more confidence for the ships operation**
    - **Fulfill an owner's requirement based on operational practices**
    - **Provide consideration for novel or new modes of operation not considered by standard rule application**

Case study where operational scenarios have been used to derive a design basis…Mastera

Mastera, a ‘double acting’ ice class tanker, will be considered as a ship designed based on operational scenarios and ice class rule requirements

Case study where operational scenarios have been used to derive a design basis…Mastera

106 000 dwt Crude Oil / Product Carrier

-Designed for year round independent trading in the Baltic

-Classed with Lloyd's Register to Ice Class 1AS

Ice Conditions

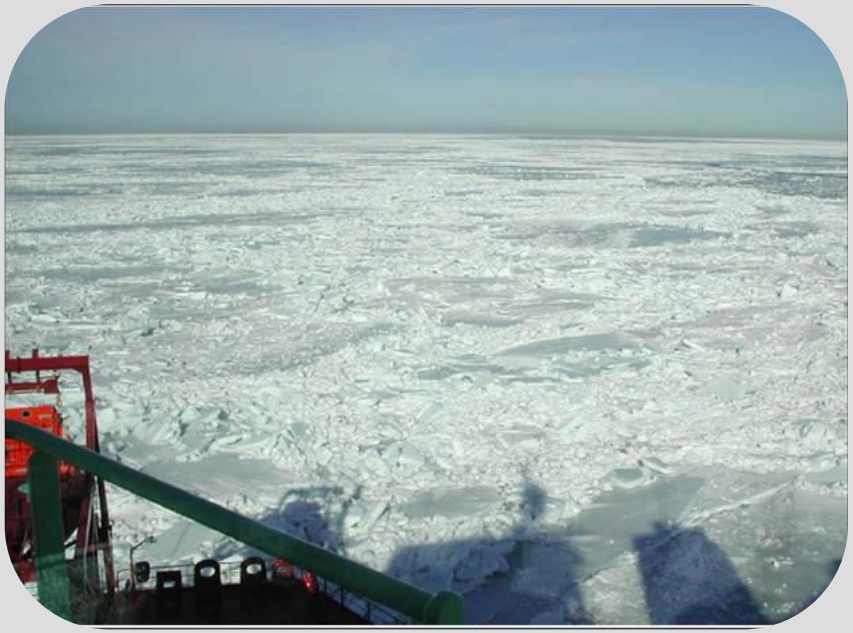
In heavy Baltic Sea ice conditions

Modes of operation

Stern first and bow first

Case study where operational scenarios have been used to derive a design basis: ice conditions

- Prevailing ice conditions in the Baltic for Mastera (e.g. Bothnian Bay)
  - First year level ice up to 1 meter thick
  - Ridges up to ~15m keel depth
  - Brash ice channels



Case study where operational scenarios have been used to derive a design basis: modes

- Modes of operation in the Baltic for Mastera in addition to conventional bow first operation:
  - Continuous ice breaking stern first
  - Maneuvering/turning in ice stern first
  - Milling/flush ice ridges stern first

Case study where operational scenarios have been used to derive a design basis: scenarios

- Using the prevailing ice conditions and modes of operation additional operational scenarios can be considered:

- For example
  - Continuous icebreaking in level ice going stern first
  - Maneuvering in level ice going stern first
  - Flushing/milling ice ridges going stern first

- These additional scenarios are reflected in the additional ice strengthening regions for Mastera

Ice strengthening regions for Mastera (schematic showing additional strengthening based on operational scenario application)

Additional strengthening area:

Scenario: transiting stern first in ice

Additional strengthening area:

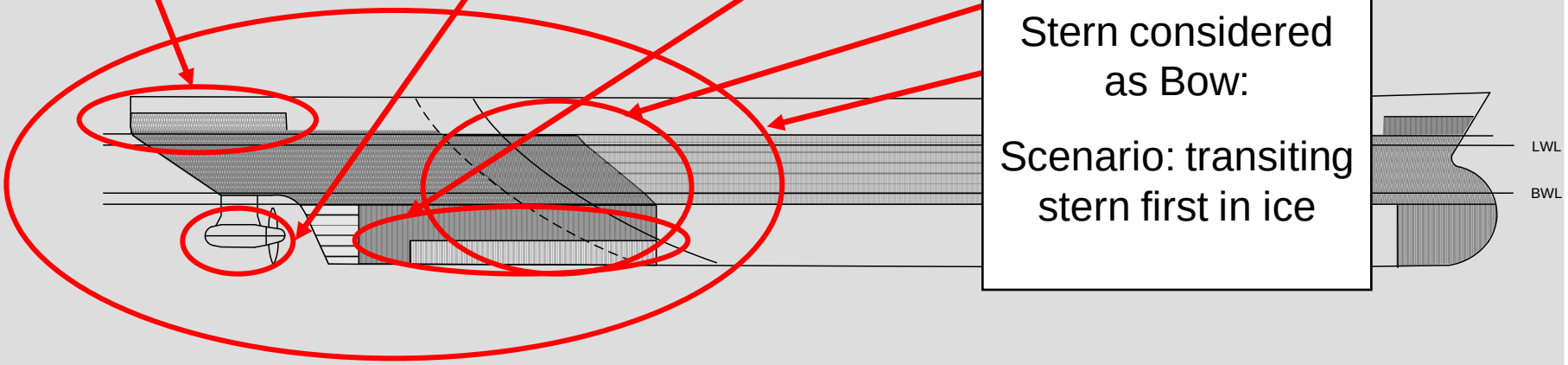
Scenario: milling/flushing ice

Additional strengthening area:

Scenario: lateral movement due to pod

Additional strengthening area:

Scenario: ahead & turning stern first in ice

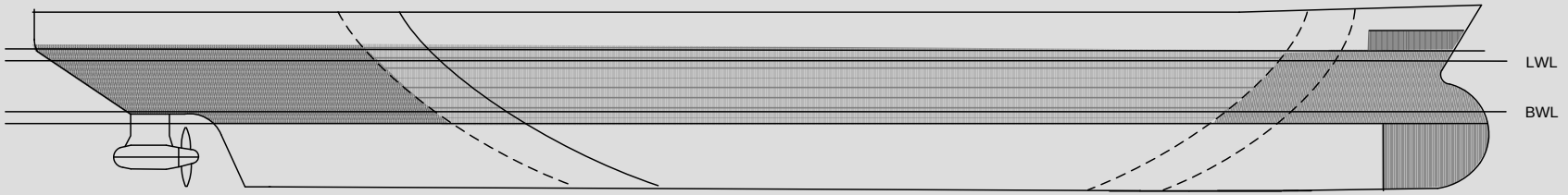


Stern considered as Bow:

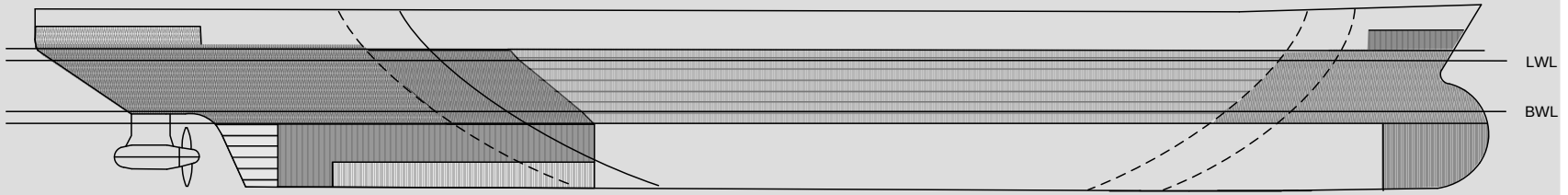
Scenario: transiting stern first in ice

Ice strengthening regions for Mastera (schematic showing comparison bow-first Vs stern first additional strengthening based on operational scenario application)

Ice class 1AS rule application – bow first



Additional strengthening based on operating scenarios– stern first



Case study concluding remarks

- The ice strengthening for the regions indicated are based on existing ice class requirements and operational scenarios
- Tempera is classed Ice Class 1AS operating forward and astern although her strengthening and arrangement make her a more capable ship than one designed using a direct ice class design approach
- This shows how ship owners and designers have used operational scenarios as part of the design basis for ships operating in ice
- However a recognized approach to incorporating operational scenarios is needed to support new Arctic projects

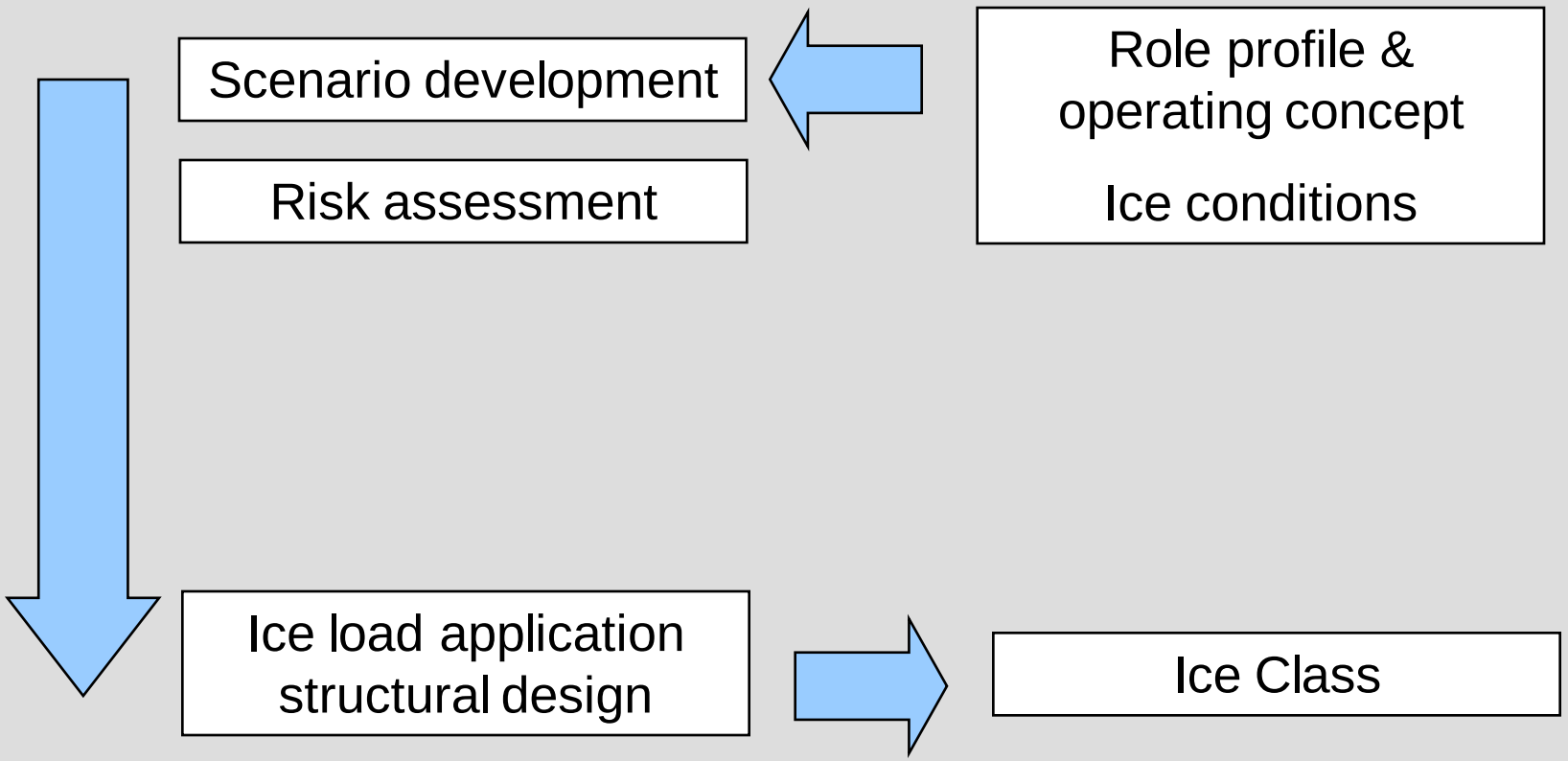
Expected best practices to derive the design basis for ships operating in ice for future projects

- Case study has shown that operational scenarios have been used to derive the design basis for ships operating in ice.
- In addition there are other specialist ships trading in the Arctic that have used operational experience, in addition to ice class rules

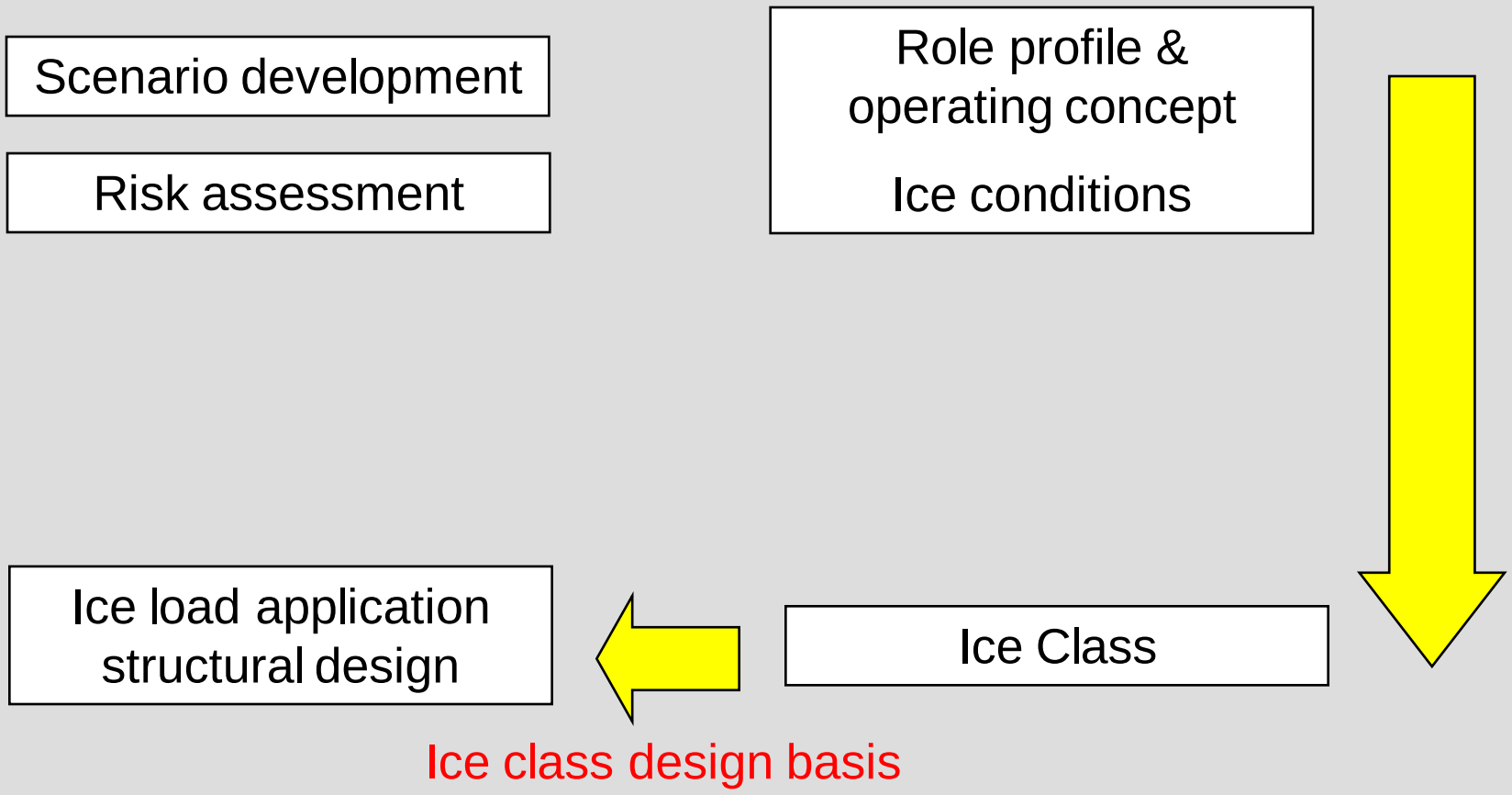
- However as more bespoke ships are designed for specific trades and operations in the Arctic a systematic approach should be adopted for incorporating operational scenarios into the design basis

    - This would give confidence to the owner that the design basis is correct for the intended operation and trade route
    - This would give confidence to the national administrations that the ship is correctly strengthened for the intended operation and trade route

Expected best practices to derive the design basis for ships operating in ice for future projects



Expected best practices to derive the design basis for ships operating in ice for future projects



Expected best practices to derive the design basis for ships operating in ice for future projects

Benefits of the scenario based approach

- *Scenario based approach benefits for the owner and designer*
  - Ice strengthening better reflects the operational profile of the ship
  - Ice strengthening can be optimized for intended operations

- *Scenario based approach benefits for the regulators*
  - Ice strengthening better reflects the operational profile of the ship
  - Ice class assigned could consider additional operational scenarios
  - Additional scenarios could be considered when assigning ice numerals

… a safer ship for the operating ice conditions

Conclusions

- For Baltic and Gulf of St Lawrence trades
  - Ice class design basis is considered appropriate … lots of experience with year round commercial traffic
- For Arctic trades
  - Scenario based design basis or “operational envelope” is considered appropriate … more novel concepts and much less commercial traffic and experience
  - Ice class would be assigned based on a validation against regulator requirements
- Using the scenario based approach in a systematic manner should contribute to the operational safety and ability of the ship

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