TECHNICAL CHALLENGES ASSOCIATED
WITH ARCTIC LNG DEVELOPMENTS
A CLASS SOCIETY APPROACH

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1. INTRODUCTION
Global warming already effect on Arctic ecosystem

- Increasing of annual average air temperature

- Reducing of ice covered water surface area

Observed sea ice September 1979

Observed sea ice September 2003

Arctic SST Anomaly
Jan 1979 to Apr 2008
BENEFITS

- Hydrocarbon reserves in the Arctic area are estimated up to 25% of the world’s undiscovered resources.

- Large oil and gas developments at several locations:
  - Pechora Sea,
  - North Slope of Alaska,
  - Grand Banks of Newfoundland,
  - Barents Sea.
Global warming potentially offers **shorter routes** for the international trade (**Northern Sea Route** and **North-West Passage**), though subject to ability to operate in severe ice conditions and very cold climate.

8700 miles VS 9300 miles

7350 miles VS 11250 miles
CHALLENGES IN EXTREME CLIMATE

► Low temperatures
  • Hard working conditions
  • Materials
  • Equipment

► Ice
  • Ice loads and ice management
  • Icing

► Specific natural conditions
  • Navigation
  • Rescue

► Vulnerable ecosystem
  • Emission to air
  • Discharge to water
CHALLENGES IN EXTREME CLIMATE

The “Explorer” sank due to iceberg impact in 2007

Ship icing

Ice compression
CHALLENGES IN EXTREME CLIMATE

Challenging?

Normal weather conditions

Snow of fog

Polar night
Some examples of return of experience
2. SELECTED REFERENCES
HISTORICAL INVOLVEMENT

- Long standing experience with ice breaking ships

Ermack (1898)  The world’s first ocean going ice breaker was classified by BV class

Varma (1968)

Arcticaborg/Antarcticaborg (1998)
ICE CLASSED FLEET

► 880 ships in class with Ice Class IC or higher

Victoria I (2004) – Ice Class IA Super

Promitheas (2006) – Ice Class IA

Lauwersborg (2007) – Ice Class IA

Santa (2008) – Ice Class IA
References in Ice and cold environment (Offshore)

First classed FPSO, CASTELLON DELTA
For SHELL & SBM
Spain 1979
3. COOPERATIONS
Co-operations in Arctic environments

- R&D program with two objectives:
  - Improve and further develop guidance and rules for navigation of ships and operation of offshore units in arctic conditions,
  - Develop numerical tools for the direct analysis of ships and offshore units in arctic conditions.
- In co-operation or close contact with research institutes, design offices, maritime administrations, owners etc.:
  - …
Co-operations

- R&D activities are in co-operation or close contact with research institutes, design offices, maritime administrations, owners etc.:
  - Russian Register of Shipping,
  - St Petersburg State Maritime University,
  - Aker Arctic,
  - Aker Yards,
  - Krylov Institute,
  - Severnoye Design Bureau,
  - FMA,
  - Shipyards,
  - CHC,
  - IACS…
Guidelines and Rules


- NI 565: "Ice Characteristics and ice / Structure Interactions“ - September 2010

- NR 527: "Rules for the Classification of POLAR CLASS and ICEBREAKER Ships“ - September 2010.

- NR 584: "Propulsors in Ice“ - February 2012.
Winterization

- Bureau Veritas COLD(H $t_{DH}$, E $t_{DE}$) notation to deal with low ambient temperatures, frozen spray (icing of ships) and reduced effectiveness of components

- Material class and grade selection for low air temperatures
- Decks and superstructures
- Stability
- Propulsion and other essential services (e.g. firefighting, lifesaving, mooring equipment)
- Electricity production
- Navigation
- Crew protection and elimination of ice where necessary for safe access
- Lifting appliances
5. RISK ANALYSIS
Risk studies for different purposes

► To fulfill regulatory requirements

► To contribute to safety case preparation

► To evaluate different options

► To support Risk Based Verification
6. DIRECT CALCULATIONS
## IceSTAR software

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Contact region</th>
<th>Description</th>
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<tbody>
<tr>
<td>Glancing impact</td>
<td>Bow, shoulder</td>
<td>Moving in broken ice</td>
</tr>
<tr>
<td>Glancing impact</td>
<td>Midbody</td>
<td>Moving in channel, manoeuvring</td>
</tr>
<tr>
<td>Reflected impact</td>
<td>Bow, shoulder</td>
<td>Moving in broken ice</td>
</tr>
<tr>
<td>Icebreaking</td>
<td>Stem, bow, stern</td>
<td>Moving in ice field</td>
</tr>
</tbody>
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### Scenarios

- **Glancing and reflected impact**
  - Ahead icebreaking
  - Astern icebreaking
  - Moving in a channel
APPLICATION OF ICESTAR & FEM ANALYSIS

Calculation

Distribution of maximal values of ice load characteristics along the hull

FEM Analysis

Ship abilities

Maximum allowable ship speed for fixed ice thickness
or
Maximum allowable ice thickness for fixed ship speed
RESULTS

Full load

Ballast
7. CONCLUSION
CONCLUSION

► BV pays attention to the Arctic region as challenging and high potential area.

► Increasing activities in Arctic region require improvement of existing regulations and development of new ones.

► New Rules are needed to ensure safety navigation in hazardous conditions, based on direct calculations.

► A large R&D effort and cooperation with the Key actors are needed for challenging the new generation of Offshore Floating Units and Ice-Breaking merchant ships in Arctic area.
Thank you for your attention