Ice Class Rules
Description and Comparison

Claude Daley
Professor
Memorial University
St. John’s, CANADA
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Outline

- Main ice class rules and areas of application
- Short History
- Rule Comparisons
  - Design scenarios
  - Ice mechanics concepts
  - Strength formulations
  - Performance issues
- Equivalency Issues

Brazilian Research Vessel Mar Sem Fim, sunk by ice pressure, April 2012, Antarctica, Source: sometimes-interesting.com
Ice Class Areas

Ice Class Rules have evolved from:

Government Policy and

Classification Society Response to Clients
Short History of Ice Classes

- **1890s-1960s**
  - Finnish-Swedish (Baltic) rules evolved (1AS in 1965)
  - Early classification society rules

- **1970s-1980s**
  - Baltic Rules revised in 1971,
  - First ASPPR Rules 1972, revised 89 (‘95)

- **1990s-2000s**

- **2012** - IACS UR fully adopted in ABS
- **2014** – IMO Polar Code (discussions underway)
The Polar Rules were developed by experts who represented the knowledge base behind the main ice class systems in the world, including Canada, Russia, Finland and Class Societies.
Comparing Ice Class Rules

All rule system are unique. Each system uses its own unique approach to ice loads and strength, and arrives at a set of class requirements in its own way:

- Design scenarios
- Ice mechanics concepts
- Strength formulations
- Operational
- Parameters considered
Ice Class Design Scenarios

Most scenarios are ‘nominal’, IACS scenario is explicit

- **ASPPR Rules**
  - Independent Ops
  - Heavy Ramming

- **Russian Rules**
  - Icebreaker Escorting
  - Arctic ice

- **Baltic Rules**
  - Icebreaker Leading
  - Ice in Channel

- **IACS Polar Rules**
  - Independent Ops
  - Heavy Glancing
Ice Load Models

Force or pressure based

<table>
<thead>
<tr>
<th>ASPPR Rules</th>
<th>Russian Rules</th>
<th>Baltic Rules</th>
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</thead>
<tbody>
<tr>
<td>Design load: Ramming Model - Fmax + Pressure-Area Effect</td>
<td>Design load: Popov Glancing load + Khesin-Kurdumov (extrusion model)</td>
<td>Design load: empirical pressure $k = \sqrt{\Delta p}$</td>
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</tbody>
</table>

IACS Polar Rules

Design load: Popov Glancing load + Pressure-Area Effect
Ice Strengthened Hull Areas

Bow + others

**ASPPR Rules**
- 4 hull areas
- bow, mid/stern, bottom
- + ice skeg

**Russian Rules**
- 13 hull areas
- 3x4 +bow

**Baltic Rules**
- 3+2 hull areas
- lower and bottom

**IACS Polar Rules**
- 10 hull areas
- 3x3 +bow
Structural Strength Approaches

Plastic vs Elastic

- **ASPPR Rules**: Plastic Capacity Models
  - Plate (folding)
  - Frame (3h)
  - + shear

- **Russian Rules**: Plastic Capacity Models
  - Plate (folding)
  - Frame (3h)

- **Baltic Rules**: Elastic Strength Models
  - Plate (bending)
  - Frame (bending)

- **IACS Polar Rules**: Plastic Capacity Models
  - Plate (folding)
  - Frame (3h)
  - Frame (end shear)
Traffic Management and Ice Performance

Safety Only vs Safety & Performance

Question: Do power and IB support help safety?

**ASPPR Rules**
- No performance requirements
- No Icebreaker support
  - independent navigation
- No Icebreaker support
  - independent navigation
- Canada uses Zone/Dates
  + Ice Regime System

**Russian Rules**
- Ice performance assessed
- Icebreaker support may be required for access
- Russia uses Sea Areas and Winter Severity Table

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<th>E.G.</th>
<th>Laptev</th>
<th>Ex H M E</th>
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<tbody>
<tr>
<td>Arc8</td>
<td>IN</td>
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**Baltic Rules**
- Power Required
- Icebreaker support provided (more strength = lower fees)
- TRAFI Manages with IB Fleet

**IACS Polar Rules**
- No performance requirements
- Just a construction standard
  - actual navigation control left to others
  - performance guidance (e.g. safe speed) under development
Polar Classes

- **Lowest Polar Class (PC7):** should have general levels of strengthening roughly comparable to RRS Arc 5 and Trafi 1A.

- **Highest Polar Class (PC1):** capable of independent operation without limitations, above Arc9 required for Russian Waters.

- The Polar Rules provide a minimum level of ice strengthening. All Polar Classes can encounter ice conditions that could damage the structure.

- Ice Class is evolving. Experience needed!
Icebreaking Hull Forms

Correspondence depends on hull form (formulations differ).
# Ice Class Correspondence Tables

Correspondence depends on what is assessed.

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Source: Appolonov et al. 2007

Source: CNIIMF (Russian Federation)
**RMRS Arc6 Double Acting Arctic Tanker**

### Framing

<table>
<thead>
<tr>
<th>Icebelt</th>
<th>Bow</th>
<th>Bow Intermediate</th>
<th>Midbody</th>
<th>Stern Intermediate</th>
<th>Stern Icebelt</th>
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</thead>
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### Plating

<table>
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<tr>
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<th>Midbody</th>
<th>Stern Intermediate</th>
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<tbody>
<tr>
<td>Lower</td>
<td>Bow Intermediate</td>
<td>Midbody Lower</td>
<td>Stern Intermediate</td>
<td></td>
<td></td>
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<tr>
<td>Bottom</td>
<td>Bow Intermediate</td>
<td>Midbody</td>
<td>Stern Intermediate</td>
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</tr>
</tbody>
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**RMRS Ice Class Arc6 – Ice Hull Areas**

**IACS Polar Class PC4 – Ice Hull Areas**
Thank You For Listening

Grounded Icebergs near St. John’s