A Holistic Approach to Arctic Marine Seismic Acquisition

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Finding Petroleum,
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London
What do we mean by “Holistic Approach”?

- Maximize geophysical flexibility
- Minimize environmental “footprint”
- Provide platforms and procedures for safe and efficient seismic operations

*** Disclaimer
Seismic Technologies and Geophysical Flexibility
Towed marine seismic techniques

- Wide-azimuth 3D “WAZ”
- Multi-azimuth 3D “MAZ” (Second pass)
- Full Azimuth Circle Shooting
- Slanted Streamers
- Over/Under Streamers

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Environmental “Footprint”
# Seismic Vessel Components

<table>
<thead>
<tr>
<th>Acoustic</th>
<th>Gasous</th>
<th>Fluid</th>
<th>Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiated Machinery Noise</td>
<td>Engine Exhaust</td>
<td>Fuel</td>
<td>Galley waste</td>
</tr>
<tr>
<td>Thuster Noise</td>
<td>Incinerator Exhaust</td>
<td>Bilge Water</td>
<td>General waste</td>
</tr>
<tr>
<td>Propellor Cavitation</td>
<td>Hydraulics</td>
<td>Ballast Water</td>
<td></td>
</tr>
<tr>
<td>Echo Sounders</td>
<td>Chemicals</td>
<td>Lube Oil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sewage</td>
<td></td>
</tr>
</tbody>
</table>
Environmental Mitigation by Vessel Design

- **ICE-1A Class**: Safe Arctic operations
  - *ULSTEIN SX133 & SX134*

- **ULSTEIN X-BOW**: Improved efficiency and reduced emissions

- **DYNPOS-AUTR**: Systems redundancy with DP2

- **CLEAN DESIGN**: High specification exhaust catalysts

- **Fuel**: MGO with low sulfur content
  - *ULSTEIN SX133 & SX134*

- **Bilge water cleaning system**: to reduce contaminants to <5ppm

- **Double hull**: – no oil contact with outer skin

- **Multiple main engines and independent propellers**: in case of failure

- **BWM-T**: Removal of invasive species from ballast water
  - *ULSTEIN SX133 & SX134*
### Seismic System Components

#### Wide Tow System
- Seismic Source
- Positioning Acoustics
- Work Boat Sorties

#### Navigation and Positioning
- Wide Tow Components
- Workboat Exhaust
- Air Compressor Exhaust

#### Acoustic
- Seismic Source
- Positioning Acoustics
- Work Boat Sorties

#### Gasous
- Wide Tow Components
- Workboat Exhaust
- Air Compressor Exhaust

#### Fluid
- Streamer Fluid
- Hydraulic Fluid
- Workboat Fuel
- Airgun Lubrication

#### Solid
- Lithium Batteries
Seismic System Mitigations

• Smaller source output

• Targeted source output
  • Broadband vs Narrowband

• Solid Streamers

• Hydrodynamic efficiency of wide tow systems

• Minimize time on prospect / Maximize acquired data volume
## Platforms for Safe and Efficient Arctic Operations

<table>
<thead>
<tr>
<th>Classification Society</th>
<th>Ice Class</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Finnish-Swedish Ice Class Rules</strong></td>
<td>IA Super, IA, IB, IC</td>
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<tr>
<td>Russian Maritime Register of Shipping (Rules 1995)</td>
<td>UL, L1, L2, L3, L4</td>
<td>II</td>
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<tr>
<td>Russian Maritime Register of Shipping (Rules 1999)</td>
<td>LU5, LU4, LU3, LU2, LU1</td>
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<tr>
<td>American Bureau of Shipping</td>
<td>IAA, IA, IB, IC, D0</td>
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<tr>
<td>Bureau Veritas</td>
<td>IA SUPER, IA, IB, IC, ID</td>
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<tr>
<td>CASPPR, 1972</td>
<td>A, B, C, D, E</td>
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<tr>
<td>China Classification Society</td>
<td>Ice Class B1*, B1, B2, B3</td>
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<tr>
<td>Det Norske Veritas</td>
<td>ICE-1A*, ICE-1A, ICE-1B, ICE-1C, ICE-C</td>
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<td>Germanischer Lloyd</td>
<td>E4, E3, E2, E1, E</td>
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<tr>
<td>Korean Register of Shipping</td>
<td>ISS, IS1, IS2, IS3, IS4</td>
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<tr>
<td>Lloyd’s Register of Shipping</td>
<td>1AS, 1A, 1B, 1C, 1D</td>
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<tr>
<td>Nippon Kaiji Kyokai</td>
<td>IA Super, IA, IB, IC, ID</td>
<td></td>
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<tr>
<td>Registro Italiano Navale</td>
<td>IAS, IA, IB, IC, ID</td>
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## Vessel ICE Classifications

<table>
<thead>
<tr>
<th>Classification</th>
<th>Condition Description</th>
<th>Ice Floe Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICE-1A*</td>
<td>Extreme ice conditions.</td>
<td>1.0 m</td>
</tr>
<tr>
<td>ICE-1A</td>
<td>Severe ice conditions.</td>
<td>0.8 m</td>
</tr>
<tr>
<td>ICE-1B</td>
<td>Medium ice conditions.</td>
<td>0.6 m</td>
</tr>
<tr>
<td>ICE-1C</td>
<td>Light ice conditions.</td>
<td>0.4 m</td>
</tr>
<tr>
<td>ICE-C</td>
<td>Light ice conditions</td>
<td></td>
</tr>
</tbody>
</table>
Vessel ICE-C Classification

Class notation for ships operating in light ice conditions.

**Purpose**
Vessels without ice strengthening are not intended for operation in ice-infested waters. Vessels with additional strengthening of the fore ship in accordance with the requirements of ICE-C notation can operate in light ice conditions. **They are not intended to operate in waters with solid ice where higher ice classes are required.**

**Benefits**
*You get a vessel which can operate in light first-year ice and call into ports which occasionally experience some ice.*

**Features**
This class notation verifies that the vessel can operate in light ice conditions and thus call into ports which occasionally experience some light first-year ice. The forward region of the ship is strengthened with thicker plates and heavier stiffeners and frames in the defined ice belt region.
Vessel ICE-A Classification

Class notation for ships operating in ice conditions of 0.8 m level ice thickness.

Purpose
The notation verifies that the vessel has sufficient strength, engine power and equipment to operate in the specified northern Baltic ice conditions or similar areas.

Benefits
You get a vessel which can operate in the Northern Baltic or similar areas in the winter season. Assistance from Ice Breakers is assumed when navigating in ice-bound waters.

Features
DNV’s Baltic rules are applicable to ships operating in broken channels made by icebreakers in first-year ice or in open waters with small ice floes.

The following areas are subject to requirements:
• Hull – ice belt
• Machinery output
• Shaft – System
• Propeller
• Mooring
• Heating of ballast tanks
• Sea chest
• Rudder and steering gear
• Corrosion protection
Polarcus Vessels’ ICE Classifications

ICE-1C Rated Vessels
- Polarcus Nadia
- Polarcus Naila

ICE-1A and 1A* Rated Vessels and Winterized Capabilities
- Polarcus Asima
- Polarcus Alima
- Polarcus Samur
- M/V Vyacheslav Tikhonov**
- Polarcus Adira (Q2 2012)
- Polarcus Amani (Q2 2012)
What do we mean by “Holistic Approach”?  

- Maximize geophysical flexibility  
- Minimize environmental “footprint”  
- Provide platforms for safe and efficient seismic operations  
- Provide procedural framework to integrate all elements of the maritime and seismic components
Arctic Project

• Existing seismic technologies limit towed multi-streamer acquisition to ice free areas
• Ice rated vessel advantages are many.
  • Early arrival into and late departure from seasonally ice free regions = increased operational window

Arctic Project Goal

Match vessel arctic operating capabilities and individual experience with competent arctic operating procedures to ensure
• Safe passage through sea ice
• Safe operations in ice free Arctic conditions
Identified Procedures and Gap Analysis
Polarcus and DNV Initiative

Maritime
- Anti-Icing & Deicing
- Ice Navigation
- Deck and Engine Equip Em. Preparedness
- Helicopter Operations
- Maritime Training
- Arctic-Cold Weather Awareness and PPE
- Ice Monitoring

Seismic
- Back Deck Operations*
- Seismic Hardware Performance*
- Seismic Navigation
- Workboat Operations
- Marine Mammal Mitigation

Operations
- Medical Care Onboard
- Medical Evacuation
- Oil Spill Procedure
- Personnel Transfer
- Support Vessel
- Transit Planning
- Waste Management Awareness Training

*22 high level procedures + *11 sub-procedures
Arctic Project Summary

- **Arctic Manual Created**

- **New Procedures Created:**
  - Ice Monitoring
  - Anti-Icing Precautions and De-icing
  - Ice Navigation
  - Medical Care Onboard
  - Medevac
  - Oil Spill Response
  - Marine Mammal Mitigation
  - Arctic / Cold Weather Awareness and PPE

- **New Checklists Created:**
  - Entering an ice area Checklist
  - Operating in ice area

- **One New Awareness Training Module Created:**
  - Cold Weather Awareness Training (self guided)

- **Seventeen Existing Procedures ‘Arctified’**
DNV Handover Ceremony

- Arctic Shipping Summit
- Helsinki, Finland
- April 12th – 14th 2011
How will we acquire seismic in ice?

- The short answer is that we will not
- With existing technologies, multi-streamer acquisition with its large areal footprint is limited to ice free or possibly bergy water conditions with sea ice concentrations of 1/10 (10%) or less
- Taking a vessel into ice. Even with suitable ice ratings and preparation, there is significant risk involved. Extensive passage planning in close coordination with third party Ice Service information providers possibly including additional experienced ‘Ice Navigation’ personnel could be critical elements.
- We plan to acquire seismic in potentially very cold, remote regions with sparse infrastructure and sail through ice to get there
- Operating in close proximity to ice. In some situations (West Greenland, North Slope AK) we would operate near an ice edge or limit of seasonal ice retreat. It is probable that bergs and bergy bits will be present. Ice Management using daily forecasts + enhanced radars + additional watch keepers will be important.
FAQ

What about medical support?

- Polarcus is taking the position that we will consult our medical provider services for recommendation for any additional resources (again, this too will be location dependent). These additional resources could include a doctor as well as paramedic and equipment for the hospital. As we are not the experts, we will rely on those with the knowledge to advise us

- The Arctic Council (seven Arctic nations) intend to have a comprehensive international Arctic SAR capability by May 2011.

What about marine mammals?

- Marine mammal mitigation methods will be region specific. The US and Canada have their own regulations and the JNCC will likely be the guide for other regions. To date there does not exist a joint marine mammal guideline to encompass the Arctic region
And finally…

- Assessing additional equipment/resource requirements to suit the geographical location. Agree not all that different than what is currently done, however the higher latitudes, potential extreme cold and ice + remoteness will present difficulties (low orbit comm sats, curtains for back deck, hull pinger retracted, acquisition without tailbuoys, additional medical personnel, ice strengthening for workboat and frc, etc, etc…)
Voyage of the Polarcus Alima
Polarcus ALIMA was the first seismic vessel through NSR – Hammerfest to New Zealand

<table>
<thead>
<tr>
<th>NSR</th>
<th>Distance</th>
<th>Panama Canal</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>9555 Nm</td>
<td>11,745 Nm</td>
<td>2190 Nm</td>
</tr>
<tr>
<td>Duration</td>
<td>32 Days</td>
<td>40 Days</td>
<td>8 Days</td>
</tr>
<tr>
<td>Fuel</td>
<td>1274 m³</td>
<td>1566 m³</td>
<td>292 m³</td>
</tr>
<tr>
<td>CO2 Emitted</td>
<td>3660 T</td>
<td>4500 T</td>
<td>840 T</td>
</tr>
</tbody>
</table>