Standards and Guidelines for the Use of Satellite-Based Ice Information in the Oil and Gas Sector

A proposal from

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Outline

• The Context of High Latitude Oil and Gas
• O&G Requirements for Ice Information with Examples
• Rationale for Standards and Guidelines
• Overview of Proposed Project

Alaska Pipeline © BP p.l.c.

The Molikpaq platform, February 2009, Sakhalin-2 project, courtesy Sakhalin Energy

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BEAR ICE TECHNOLOGY INC.
Context: O&G in ice-prone regions

[Map showing ice-prone regions such as Barents Sea, Greenland, East Coast, Canada, Caspian Sea, Bohai Sea, Sea of Okhotsk, Beaufort Sea, Chukchi Sea, Falklands, and Bohai Sea with annotations for O&G locations.]
Context: reduction in sea ice
Context: Legislation and Standards

- International maritime agreements including:
  - the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78);
  - The London Convention 1972
- National and regional requirements
  - Indigenous populations
- O&G industry standards
  - e.g. ISO 19906
- Non-binding Arctic O&G guidelines
  - E.g. Arctic Council
Ice information and the O&G lifecycle

Pre-license acquisition

**OVERVIEW OF THE ICE ENVIRONMENT**

Exploration

**DESIGN AND PLANNING**
- Design of structures in ice
- Ice management planning

Development

**OPERATIONS SUPPORT**
- Seasonal ice outlook
- Regional monitoring
- Tactical support (sea-ice/icebergs)
- Custom re-supply and offloading
- Emergencies (oil spills, SAR, etc)

Production

De-commissioning
Ice hazards

- High concentration ice
- Multi-year ice
- Ridged / rafted ice
- Stamukha
- Pressured ice
- Icebergs
- Icing

Significance of hazard depends on ice climatology, design of infrastructure, type of operation, ice management facilities, etc.

Credit: National Oceanic and Atmospheric Administration/Department of Commerce (Rear Admiral Harley D. Nygren, NOAA Corps (ret.))
Examples: design of structures

Satellite data application to descriptive overview of ice environment

ISO 19906 ice design methodology

Satellite data application to probability functions relating to determination of action values

For each scenario

Ice environment for the development location

Structural design concept
- Fixed or floating facility

Define ice action scenarios

Estimation of expected number of ice-structure interaction events and their duration

Determination of action values

Employ extremal analysis to assign probability distribution to ice actions on the structure

Provide representative actions for design

Ice conditions

Operational conditions ice management and disconnection capabilities

Ice properties and strength

Ice morphology

Environmental driving forces

Example: design of structures

The Molikpaq platform, February 2009, Sakhalin-2 project, courtesy Sakhalin Energy

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Examples: design of structures

18 years of ERS-1/2 SAR data in the archive

ERS SAR Polarization: VV until mid 2009

The most complete and consistent SAR archive

Reproduced courtesy of ESA
Examples: regional ice monitoring

Envisat © ESA 2010, Radarsat-2 © MDA 2010 and MODIS courtesy NASA
Examples: Navigation

IceNav system courtesy Enfotec
**Examples: iceberg tracking**

## C-CORE Iceberg Monitoring

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**REMARKS**

This message was generated automatically by the Canadian Ice Service using the target detection system.

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Input Data Type: RADARSAT

Image Acquisition Time: Feb 02 09:24:50

Beam Mode: W3

CFAR Parameter: 2.460e-005

Total Number of Targets: 8

Number of Icebergs: 7

Number of Ships: 1

Number of Unknown targets: 0

Start Left Point: 53.089542 -50.314575

Start Right Point: 52.901230 -48.401142

End Left Point: 51.610027 -48.777653

End Right Point: 51.798183 -50.635201

END

**Google Earth File**
The need for standards and guidelines

- Exceptionally challenging environment – all available data should be used effectively
- Stringent obligations in relation to HSE and environment – important to be seen to be setting and advancing standards
- Growing number of Arctic players, each with valuable experience that can be combined and learnt from
- Satellite earth observation technology is essential for Arctic O&G but increasingly diverse and complex to apply
- Important to establish standards early in the O&G lifecycle
Satellite radar imaging sensors

Graph showing the timeline of SAR (Synthetic Aperture Radar) platforms from 1990 to 2015, with labels for ERS-1, ERS-2, JERS-1, Radarsat-1, ALOS-1, Sentinel-1A, Sentinel-1B, Cosmo-Skymed-1, Cosmo-Skymed-2, Cosmo-Skymed-3, Cosmo-Skymed-4, TerraSAR-X 1, TerraSAR-X 2, TanDEM-X, Risat-1, Risat-2, HJ1C, SAOCOM-1A, SAOCOM-1B, Kompsat-5, and PAZ.

The graph also includes a timeline at the bottom with milestones:
- 30m → Best resolution, single look → 1m
- 100km → Best instantaneous coverage → 500km
- Days or worse → Typical available revisit, 70°N → Hours
Examples of technology questions

• How best to detect icebergs embedded in sea ice?
• Is it recommended to use polarimetric rather than conventional single polarisation radar and, if so, when?
• What strategies are available for dealing with the coverage/resolution/revisit trade-off for different applications?
• What data are best for detecting pressure ridges and stamukha?
The proposed project: identify minimum standards and best practices

Phase 1 (6 months)
- Draft requirements and current practices
- Requirements and Current Practices (draft)
- Update report
- Requirements and Current Practices Report
- O&G community

Phase 2 (12 months)
- Propose guidelines and standards
- Guidelines and Standards (proposed)
- Workshop
- Update report
- Guidelines and Standards Report
- EO and O&G communities
Benefits

- Capabilities of satellite earth observation defined for O&G industry
- Process established for standards to adapt to increasing satellite capabilities
- O&G industry can build procurement, processes and systems around standards
- O&G industry can be assured that service providers who adhere to the standard will be compatible with their systems
- Knowledge of satellite earth observation capabilities are not lost with staff attrition
- Defining minimum standards encourages competition and therefore lower costs and/or upward pressure on standards
1. The O&G lifecycle and Ice Assessment and Monitoring Needs
   a) Pre-license acquisition
   b) Exploration (seismic, surveys, drilling etc.)
   c) Development (structure design criteria, tow out, installation, etc.)
   d) Production (re-supply logistics, HSE, pollution monitoring etc.)
   e) Decommissioning

2. Ice Assessment and Monitoring Product/Service Requirements by Region
   a) Beaufort Sea
   b) Chukchi Sea
   c) Sea of Okhotsk
   d) Canada East Coast
   e) Greenland
   f) Barents Sea (Shtokman Field)
   g) North Caspian Sea
   h) Bohai Sea
   i) Southern Atlantic (Falklands)

3. Current Practices (regions as above)
4. Preliminary Identification of Constraints and Opportunities
   a. Sensors useful in design, planning and operations
   b. Design and Planning
      • Overview of the ice environment (e.g. for assessment of a new lease, precursor for structure design criteria, etc.)
      • ISO 19906 (recommendation for action equations and ice environment input criteria)
   c. Operational Support
      • Seasonal outlook (e.g. ice freeze-up and break-up date)
      • Regional ice monitoring (e.g. weekly regional ice charts and forecasts)
      • Tactical sea ice support
      • Iceberg monitoring
      • Regional ice navigation needs for re-supply logistics and offloading on an as required basis.
      • Emergency support

5. Conclusions and Recommendations
We acknowledge the European Space Agency for funding support that led to the formulation of this project concept.

We would be interested in your comments.

Thank-you!

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