BREA Results Forum

OVERWINTERING OF BARGES IN THE BEAUFORT - ASSESSING ICE ISSUES AND DAMAGE POTENTIAL

Agenda Item 6.1

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Outline

- How this project fits into BREA
- Background – Overwintering of vessels in ice
- Project description
- Recommendations
- Discussion

Where this project fits – BREA Purpose and Priority Research

- BREA Research Priority:
  - Worst-case environmental design limits for ice
    - Examine the potential ice loads that a vessel overwintering in ice could experience
- Community-driven initiative
  - A long-standing concern of Inuvialuit and governments, increasingly a pan-Arctic issue

Why do we care about overwintering vessels?

Risk of damage to an overwintering barge and an associated spill can be a relatively low likelihood...**but** the consequences of such an event would be very high

Project Objectives

- Assess likely ice loads
- Likelihood of significant ice loads
- Provide best-available means of reducing the likelihood of high ice loads
- Outline key considerations for overwintering

Gathering Background Information

- Work was focused on determining quantitative ice loads, completed in Ottawa.
- Meetings in Inuvik, Winnipeg and Ottawa were held as well as a visit to McKinley Bay and Tuktoyatuk Harbour, to observe ice conditions there.

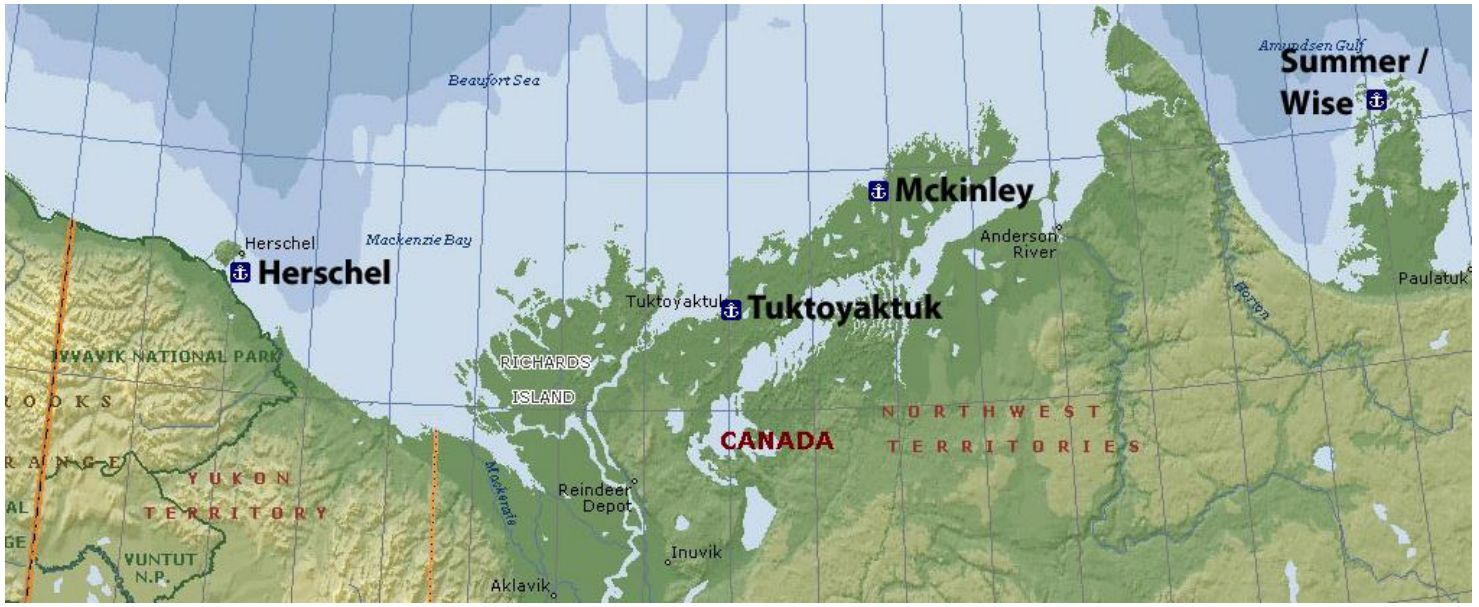
Gathering Background Information

- Comments and input gathered locally from:
  - Transport Canada community consultations
    - Inuvik and Hay River (September 11 and 20, 2011)
  - BREA Results Forum – December 5, 2011
  - Local stakeholders in Inuvik
    - Willie Moore, Norm Snow, Jennifer Lam, Steve Baryluk, Frank Pokiak, James Malone
  - Government of the Northwest Territories spill database
- Incorporated into either commentary about the practice of overwintering, or considerations that feed into best practices for overwintering in ice.

Project Structure

1. Gather historical data
2. Select an analysis approach to determine ice loads
3. Analyse ice loads for representative scenarios
4. Determine key ice loading considerations
5. Provide recommendations

Overwintering Practice Overview



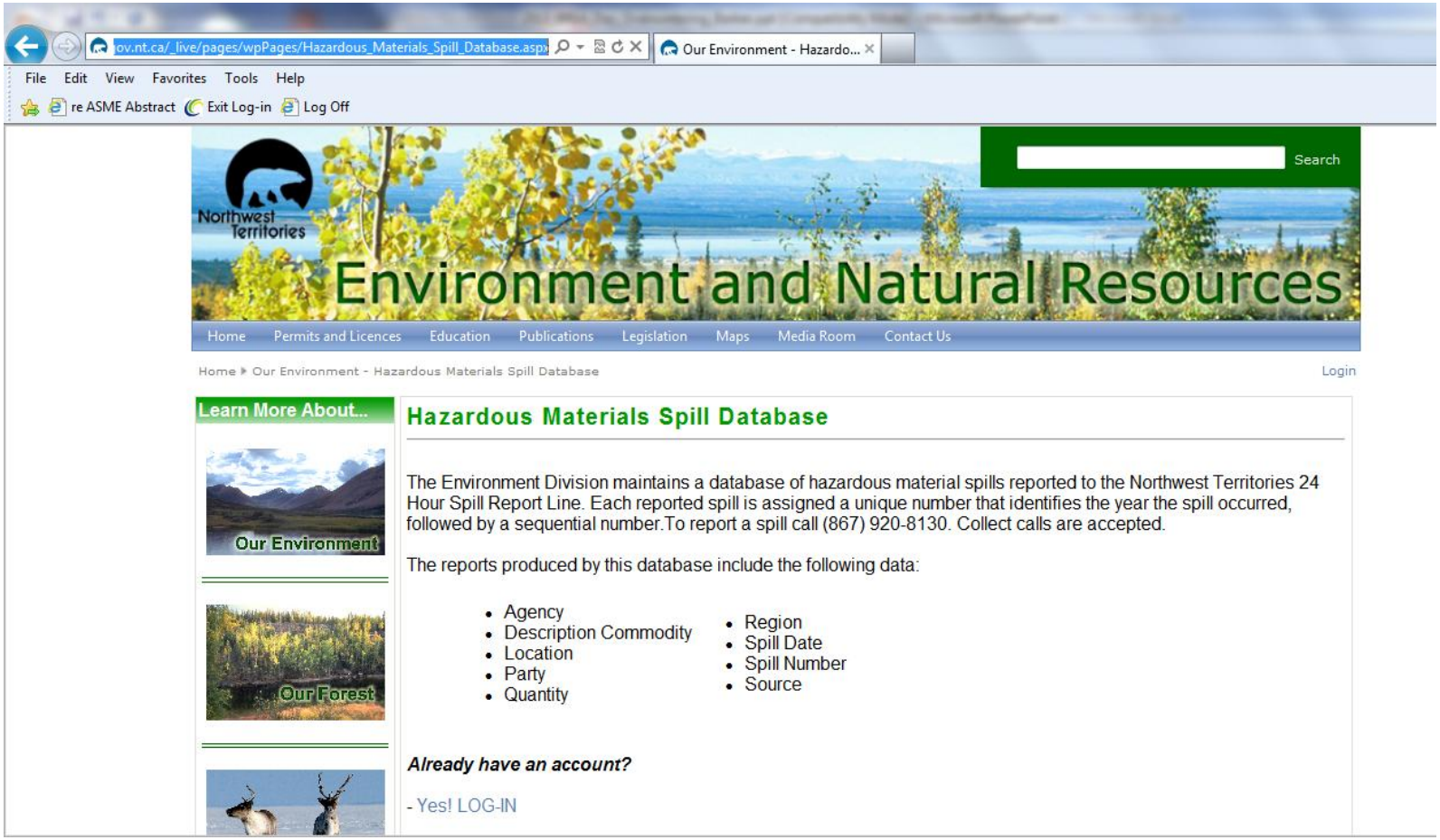
- Gather historical data
  - Historical overwintering records
  - Spill database search
  - Transportation Safety Board database
  - Local commentary

Historical Beaufort Sea Overwintering

Report included in overall NRC project report

- Contract to Captain Don Connelly
- Examined the four most common overwintering locations for petroleum industry, primarily 1980s
  - Included small section on river as well
- Overview of vessels, practices, incidents and advantages/disadvantages to those locations
- General list of their overwintering procedures

NWT Hazardous Materials Spills Database



http://www.enr.gov.nt.ca/_live/pages/wpPages/Hazardous_Materials_Spill_Database.aspx

Database Searches

- NWT Hazardous Materials Spills database
  - Challenging to convincingly link any reported spills to overwintering, except for one event in McKinley Bay (1980s) and one in Iqualiut (2000)
  - McKinley Bay spill was not because of damage to fuel barge, but due to fuel handling when removing the fuel from the barge, to prevent a spill

Database Searches

- Transportation Safety Board MARSIS database
  - Reported incidents of any kind, not just spills
  - Up to 4 cases in the ISR maybe related to overwintering
    - 1 of the 4 was the McKinley Bay event
    - 2 of the 4 due to vessel being frozen to the bottom of the lake/river
    - All prior to 1992
  - Many other events related to problems occurring with vessels moored at harbours, when moving ice is present

Local Experiences and Knowledge

- Comments related to ice loads on vessels were collected from:
  - Transport Canada community consultations
  - 2011 BREA Day
  - meetings held by the authors with local authorities
- Comments incorporated into report
- Comments that were within the scope of the project were identified and addressed

Ice Load Analysis

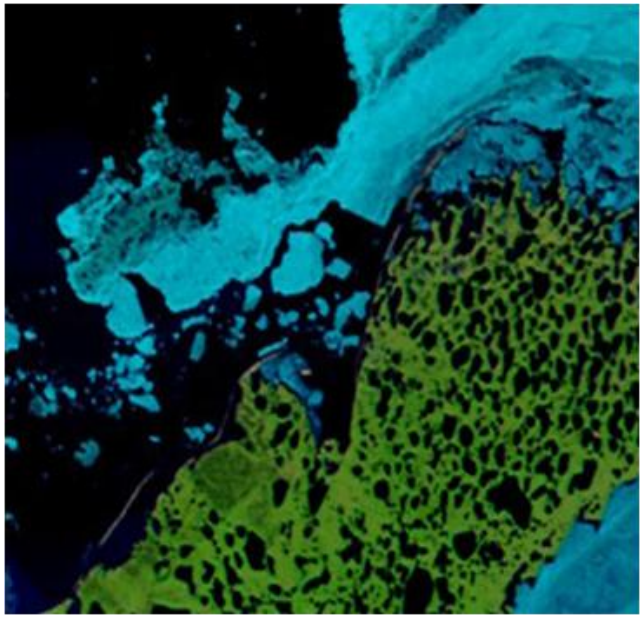
1. Pick representative locations, based upon historical overwintering occurrences
2. Three “seasons” of ice:
   - Freeze-up
   - Winter
   - Break-up
3. For each season, and each location, examine:
   - What ice loads are likely
   - Methods of calculating those loads

Ice Load Analysis

Sheltered Bay

For example, McKinley Bay

Preferred location

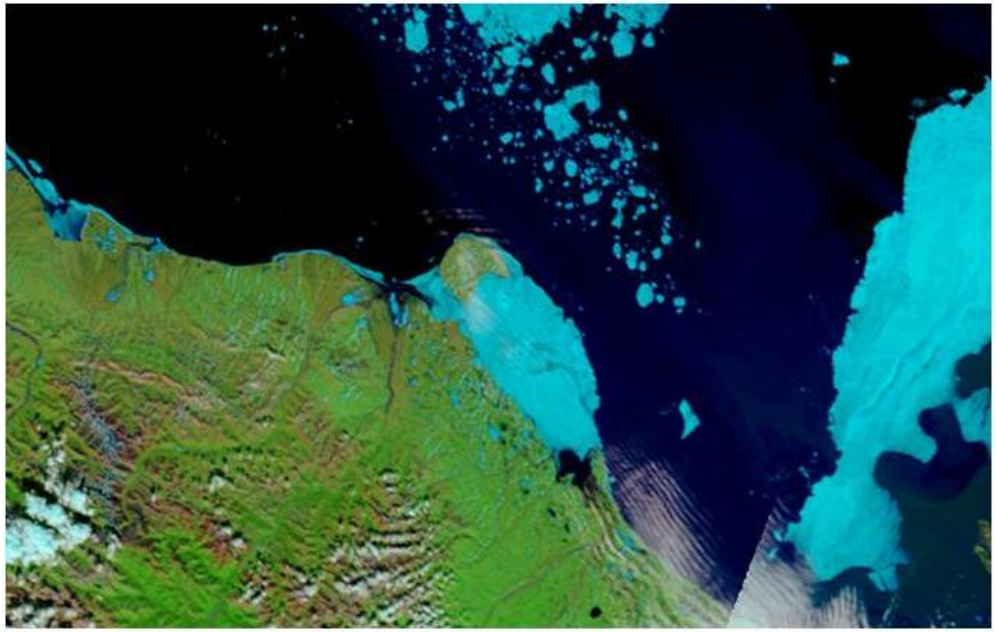


Ice Load Analysis

Semi-Sheltered Bay

For example, Herschel Island

Secondary choice or safe haven

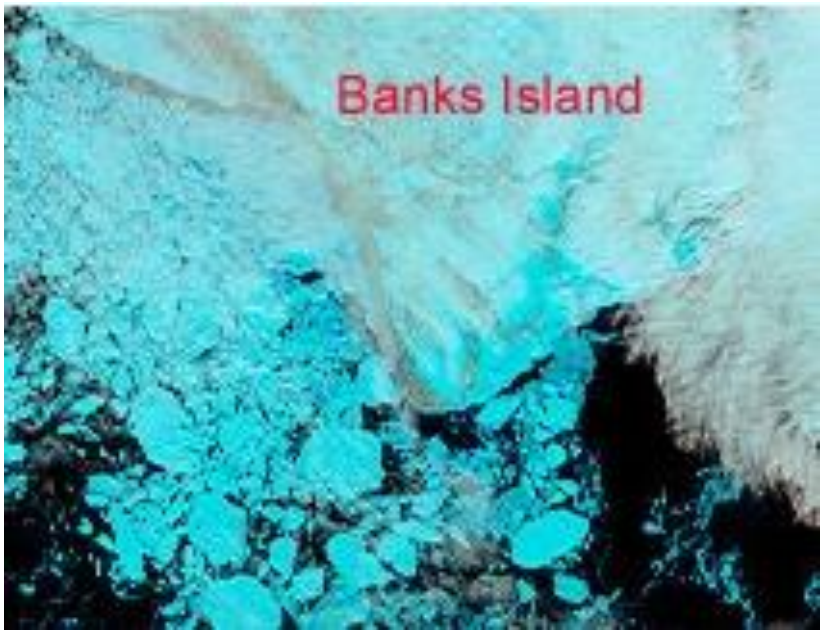


Ice Load Analysis

Non-Sheltered Region

For example, DeSalis Bay, Banks Island

Last resort

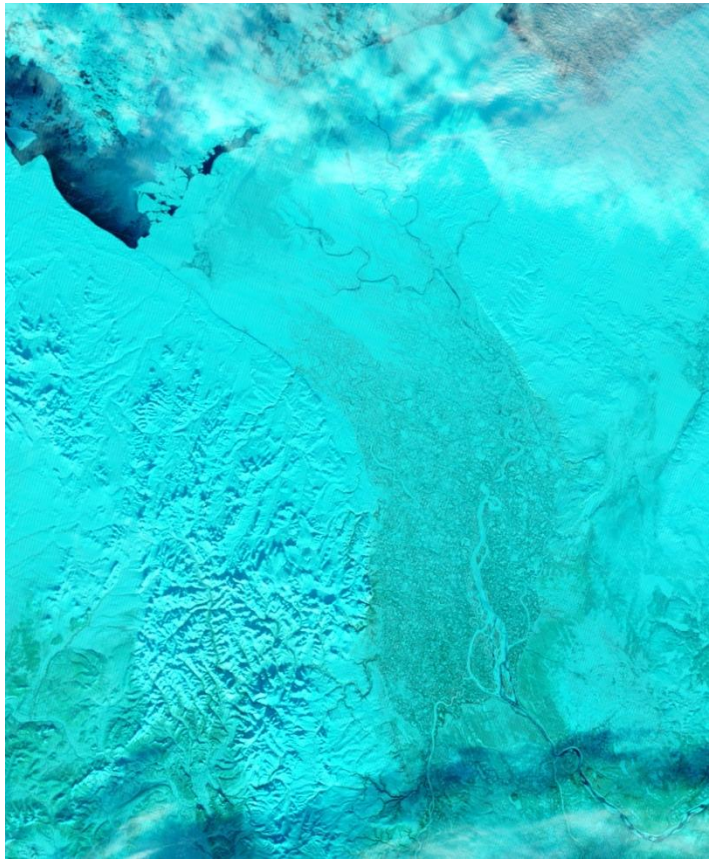


Ice Load Analysis

River

Mackenzie River, location not specified

Industry fuel barge locations



Illustrative Line Ice Loads

- Ice loads will be site-specific
- Loads that a vessel can withstand depend upon the type and class of vessel
- Calculation approaches described in report, for each region and each ice "season"
  - **Sheltered bay, semi-sheltered bay, exposed offshore, river environment**
  - **Freeze-up, Winter, Break-up**

- Likelihood of damage is greater with either:
  - **an exposed overwintering location**
  - **and/or during any dynamic spring break-up events**

Key Ice Loading Considerations – see handout

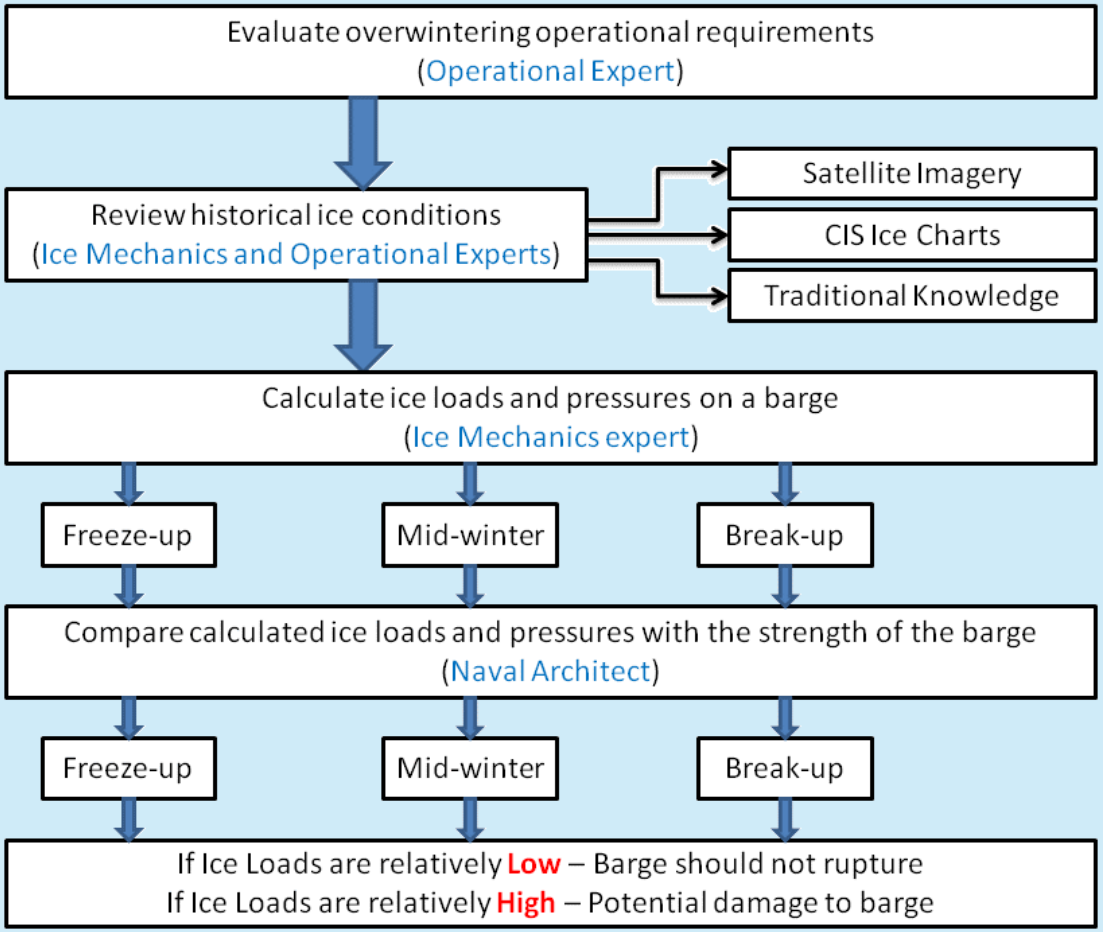
Location / Scenario	Sheltered Bay	Semi-Sheltered Bay	Exposed Offshore	River Environment
Freeze-Up	Because the bay is largely sheltered, the fetch area for developing a driving force to move the ice is limited. This means that the ice would likely freeze as level ice or with some light ridging.	Protection from the prevailing direction of moving ice, especially during storms, is an important consideration in site selection.	Ice can be very dynamic during the freeze-up process. The highest loads will likely occur just before the ice becomes landfast. Global loads from dynamic ice would likely exceed typical mooring line capacity.	Freeze-up loads will depend upon river ice dynamics at the mooring location, just before freeze-up.
Winter	**Adfreeze**: Not likely an issue, providing adequate clearance under keel. **Thermal**: Only the upper one-half meter of the ice is influenced by thermal loading. Thicker ice does not necessarily mean that higher thermal loads will be generated on the structure or barge. A snow cover will help to attenuate air temperature changes, so a thick snow cover will help to reduce thermal loads. If the shoreline in the bay has a gentle slope, the thermal expansion could take place through a movement up the slope. This also would reduce the loads.	**Adfreeze**: Not likely an issue, providing adequate clearance under keel. **Thermal**: As with the sheltered bay, only the upper one-half meter of the ice is influenced by thermal loading. Thicker ice does not necessarily mean that higher thermal loads will be generated on a structure or barge. Also as with the sheltered bay, a snow cover will help to attenuate air temperature changes, so a thick snow cover will help to reduce thermal loads.	**Adfreeze**: Not likely an issue, if in landfast ice and adequate clearance under keel. Otherwise, could have break-out forces. **Thermal**: If the barge was moored close enough to shore to be frozen into the thin strip of landfast ice, it would experience thermal loads during the winter months, similar to the previous scenarios. Creep buckling: If the landfast ice edge is relatively near to the vessel, the vessel could be subjected to creep buckling ice loads.	**Adfreeze**: Not likely an issue, providing adequate clearance under keel. **Thermal**: As with previous locations, thermal loading will be a consideration. Thermal loads could be higher than in the offshore, as freshwater river ice is stronger than sea ice.
Break-Up	Ice will likely deteriorate in place with very little dynamics and with thermal loading being the dominant loading scenario.	If the ice melts in place, then the loads (largely thermal) would be the same as the sheltered bay. However in a semi-sheltered bay, there could be more dynamic ice. This could lead to higher loads on a vessel or barge, but driving force is probably limited by size of bay.	Highly dependent upon overwintering location. Scenario should be avoided since the loads would be quite high at this time of year.	Break-up loads will be dependent upon ice dynamics at mooring location and water level rise. A barge caught in moving ice could be subjected to high loads, including pressured ice conditions (ice jams). Ice pile-up and grounding could also occur.

Summary

- What makes for a good location for overwintering, from an ice perspective, irrespective of the type of vessel that is overwintering?
  - A **sheltered spot**, with a limited fetch area, to limit pack ice driving forces.
  - Sufficient water depth to have **clearance under the vessel** so that it does not freeze to the bottom or strike the seabed at low tide.
  - **Minimal dynamic ice movement** in the spring, to avoid ice crushing forces or large floe impacts on a vessel and/or ice loads sufficient to break mooring lines.

Recommendations – see handout

- Determining the safe location and loads for a vessel overwintering in ice requires input from operational experts, ice mechanics experts and naval architects.
- TK is an important component
  - Could inform through local knowledge of water levels, ice conditions, ice break-up patterns, past successes/issues in a region, winter community activity in area, for example
- A general methodology for selection of an overwintering location is presented.



Recommendations

- River locations for overwintering require an intimate knowledge of the site specific locations and the ice dynamics at those sites – TK valuable input here.
- Non-sheltered regions should be avoided for overwintering unless as last resort.
- Appropriate monitoring of ice conditions (ice thickness, ice temperature, snow depth and others) is essential.
- Record-keeping of overwintering fuel barges should be established. A simple record of vessel type, location, cargo and point of contact and follow-up would be a good start by ISR.

Informing BREA Outcomes

- Report has:
  - Produced overview of the types of ice loads relevant to the ISR region for overwintering vessels
  - Presented calculation examples for representative ice loading scenarios
  - Highlighted key ice loading considerations for overwintering
  - Presented a framework for how site selection for overwintering should proceed
  - Strengthened assessment process for overwintering practice

Informing BREA Outcomes

- How are results being used or how could they be used?
  - Communities and Inuvialuit Game Council
    - Concerns have been re-iterated in report and to Transport Canada
    - Recommendations for local monitoring of practice until such a time as it is picked up Federally
    - Monitoring and notifications to local communities paramount
    - Reiterate that likelihood of damage is low if best practices are followed
    - Has been carried out safely for decades – many industry members are good examples of incorporating best practices, especially in the absence of Federal guidelines

Other Contributions

- Academia
  - Have had preliminary discussions with University of Laval professor Dr. B. Morse to discuss his research on static ice loads on dams, to assess similarities and relevance of results to other areas of study
- Industry Interest
  - Shipping companies have expressed interest in the report
  - Other interest by organizations that overwinter research vessels
  - While concern is primarily for barges carrying fuel, relevance to any type of vessel that is overwintering
- Transport Canada – Headquarters
  - BREA report was well received
  - Developing new pan-Arctic guidelines for overwintering practices
    - Will be incorporating historical information and framework into guidelines

Thank You

Questions?

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