Challenges for design for areas with low probability of encountering sea ice

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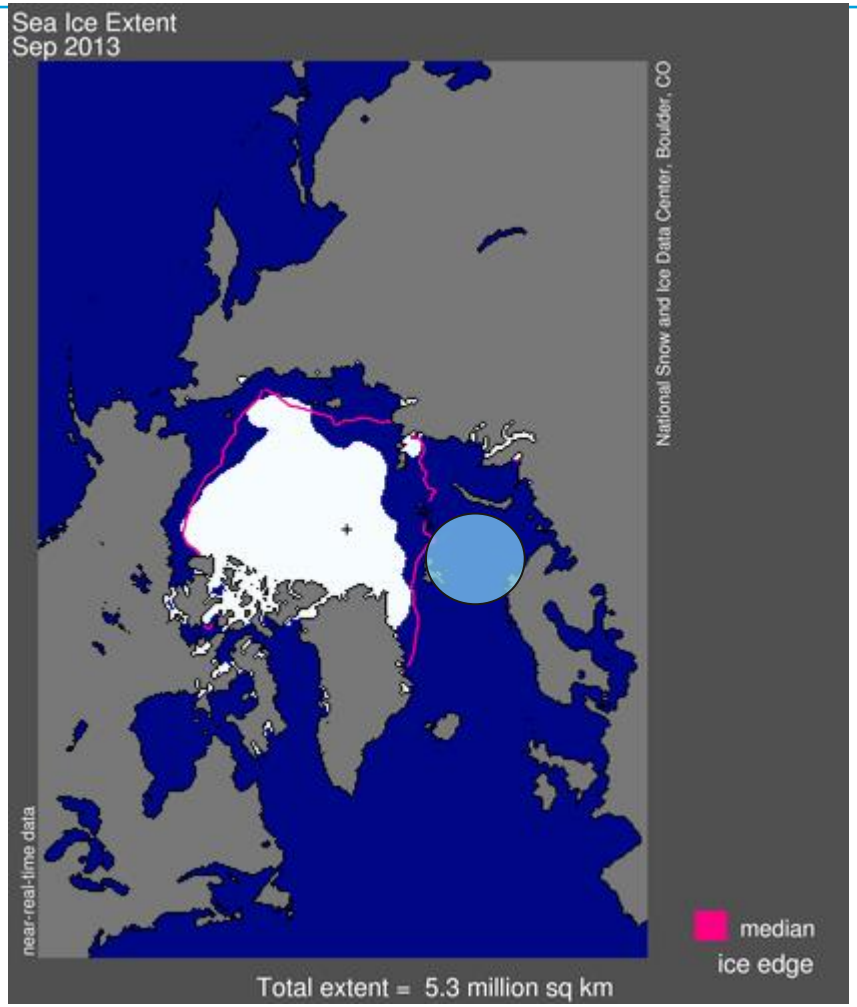
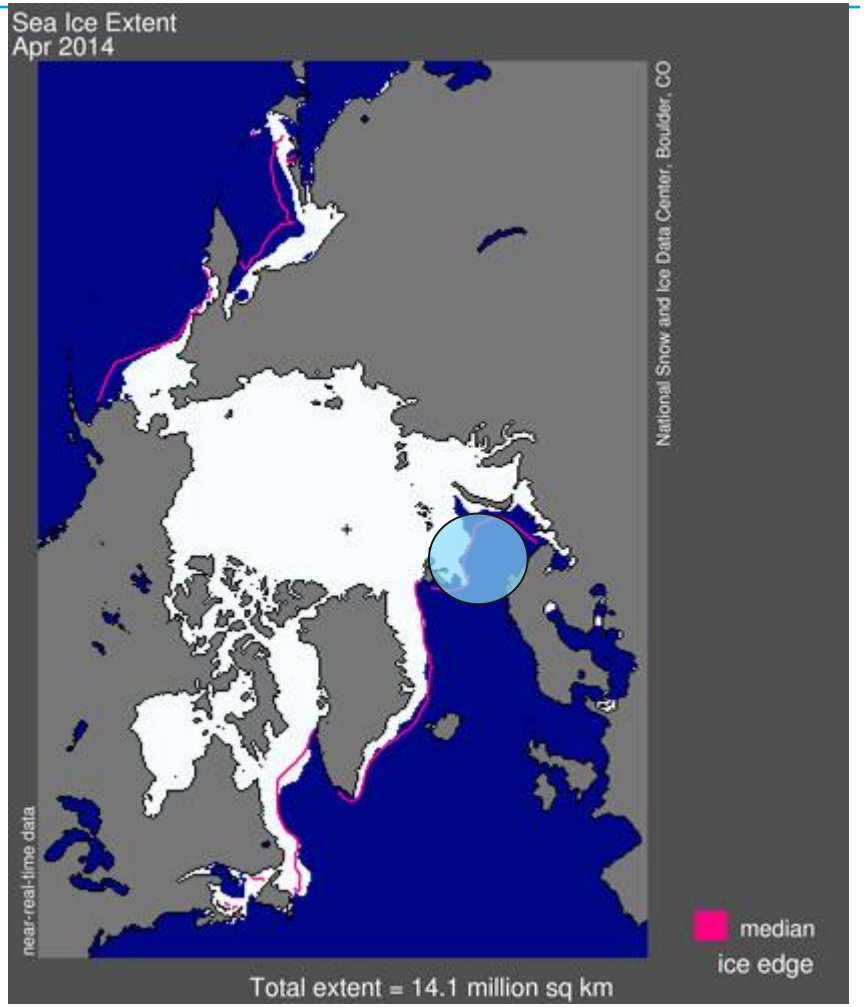
Sea ice extent in Arctic Ocean, Minimum vs maximum 2013/2014





Ice conditions in Barents Sea

- Sea ice
  - Level ice
  - Ridges
  - Old ice
- Icebergs
- Varies with location from heavy ice conditions just east of Svalbard to rare occurrences of ice in the southern Barents Sea
- Limited background data for the calculation of the probability of encountering sea ice and icebergs
- Icecharts (satellites from 1978) which only contain extent and coverage
- Irregular observations of icebergs

Pictures by Ekeberg from the Fram Strait between Greenland and Svalbard in 2012.

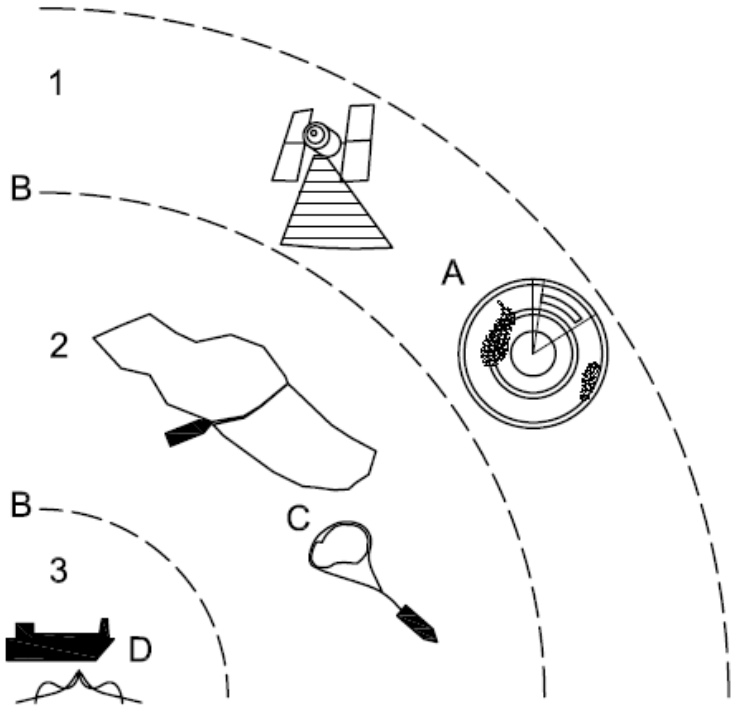
Design considerations – depends on exposure

- Norwegian oil and gas regulations mainly suggest functional requirements through NORSOK which currently is under revision
- For practical purposes ***ISO19906:2010 Petroleum and natural gas industries – Arctic Offshore Structures*** will be the main design document
- Ice must be considered if the probability of encountering ice is greater than that specified by the exposure level.
- Exposure level is a function of:
  - Life safety category
  - Consequence category

Table 7-1 — Determination of exposure level

Life-safety category		Consequence category		
		C1 High consequence	C2 Medium consequence	C3 Low consequence
S1	Manned non-evacuated	L1	L1	L1
S2	Manned evacuated	L1	L2	L2
S3	Unmanned	L1	L2	L3

Ice management system



Key

1	observation zone	A	detection
2	management zone	B	threat evaluation
3	critical zone	C	physical management
		D	disconnection

Figure A.17-1 — Typical components of an ice management system

Ice management

- ISO19906: The following design and operating **approaches** may be used for floating petroleum installations in ice-prone waters:
  - a) passive: no move-off capability, no ice management capability;
  - b) semi-active: move-off capability, no ice management capability;
  - c) active: move-off capability, ice management capability.

- ISO19906 defines ice management as "**active processes** used to alter the ice environment with the intent of reducing the frequency, severity or uncertainty of ice actions"
- Management of icebergs
  - Towing icebergs to reduce frequency of interactions with facility (example: Grand Banks)
- Management of sea ice
  - Breaking up icefloes/ridges to smaller fragments reducing severity and uncertainty (example: Sakhalin)

Ice management in design

- ISO19906:2010: Ice management "intended to ensure appropriate levels of safety should be properly **identified, considered and quantified, along with expected levels or reliability**"
- PERD(2005) (iceberg management)
  - **Operational Success:** *"A tow can be considered successful if downtime was avoided"*
  - **Technical Success:** *"A tow can be considered technical success if: a) A demonstrated change in course was achieved and: b) The towed iceberg achieved a course made good with one or more attempts"*

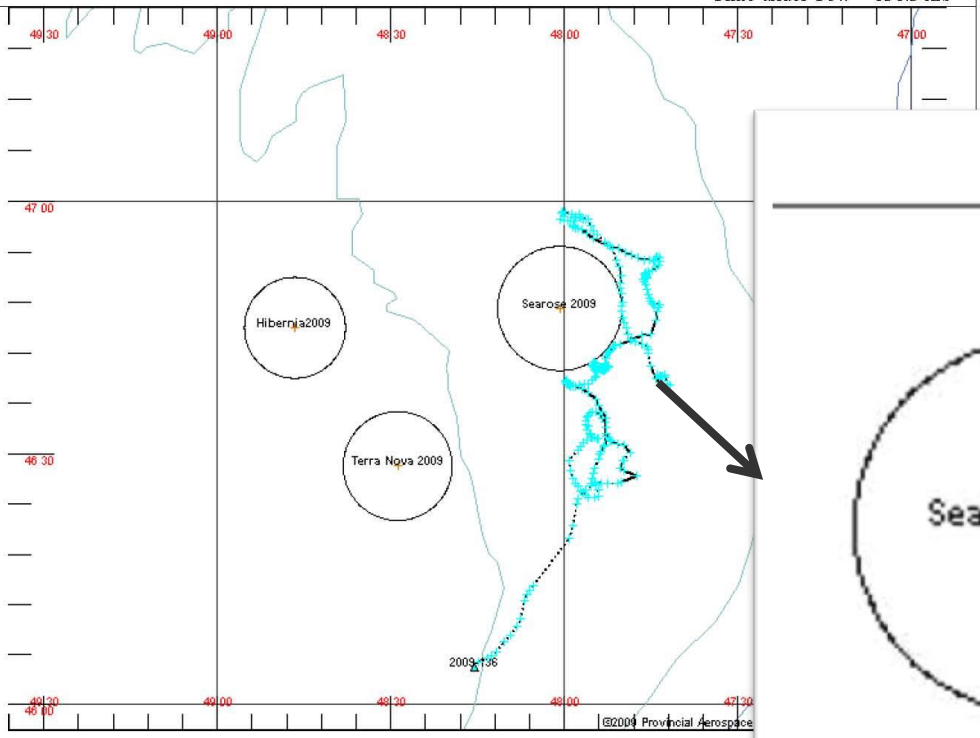
- For design ***the technical success is not defined which gives room for interpretation***
- PERD found by using two different definitions of the towing success a success rate of 73 % and 83 % (Grand Banks) and 71 % and 87 % (Labrador)

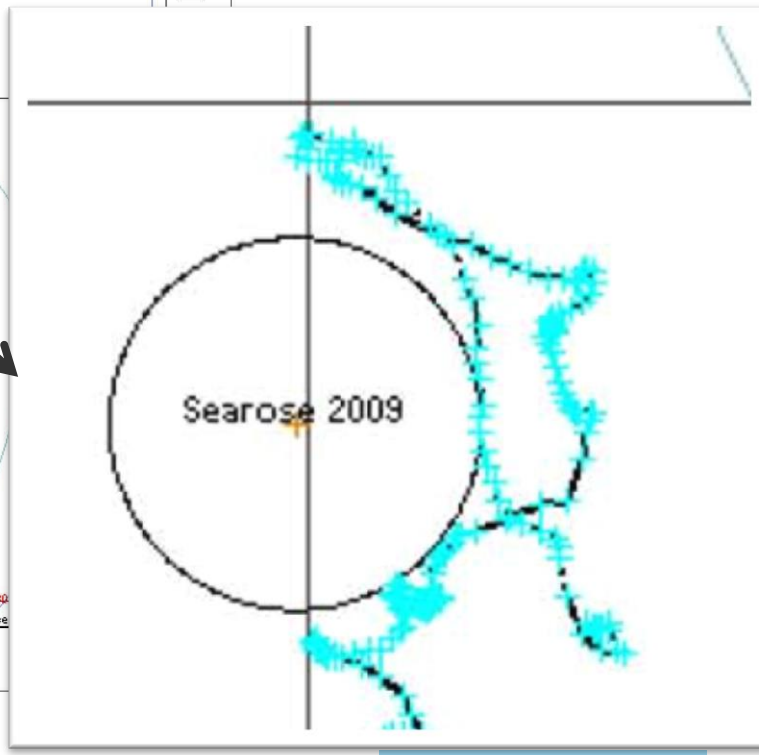
Berg 2009-136

Tracked from: 30 May 2009 @ 0230 UTC
To: 17 June 2009 @ 1200 UTC

Provincial Aerospace Limited
environmental services

Length:	120 m	Max Speed	1.0 kt	Track Distance	186.3 nm
Width:	100 m	Min Speed	0.0 kt	Elapsed Distance	152.3 nm
Height:	60 m	Mean Speed	0.3 kt	Elapsed Time	441.5 hrs
Draft:	75.6 m	Time Grounded	N/A	Number of Obs	264
Mass:	768960	Meander	3.2	Number of Tows	17
				Time under Tow	131.3 hrs





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Ice management - some variables

- Quantifying the effect from ice management will be challenging due to limited experience/measurements
- Variable vessels
  - Vessels have different properties and thus not the same success rate
  - Personnel/experience
- Methods with different application areas (PERD, icebergs)
  - Prop wash, Water cannon, Net, Rope
- Ice detection (non-exhaustive list)
  - Visual, Radar, Satellite
- Tracking and Forecasting
  - Will there be need for intervention?
- Darkness, sea ice
- How to quantify the **uncertainty**?

Barents Sea

- Many areas with low probability of encountering sea ice or icebergs
- Ice may not be present most years but annual variation may lead to years with greater amounts of ice
- How to design and comply with "All responsible personnel involved in ice management activities should be trained with respect to **the metocean and ice environment, …"**

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