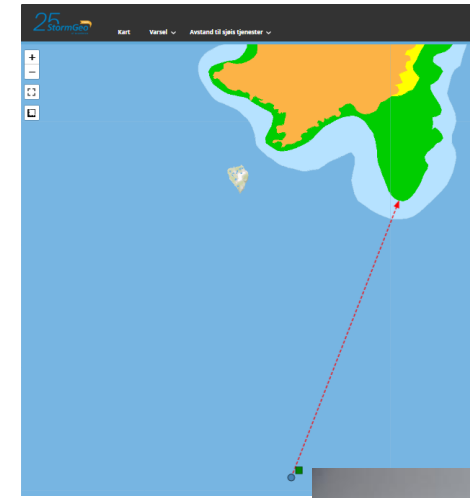
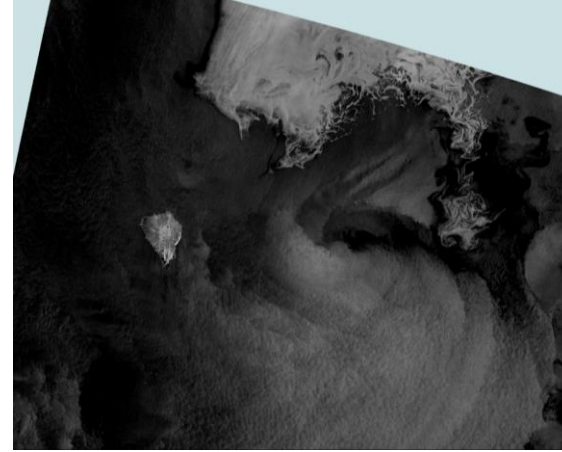
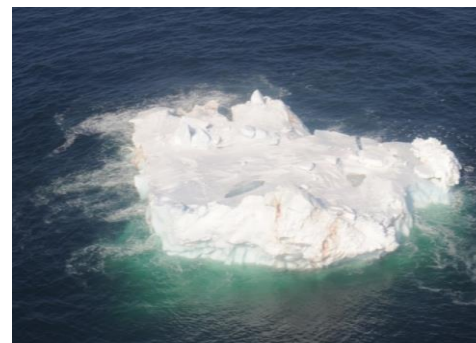




Ice Risk Management – Johan Castberg

Presentation prepared for Konstruksjonsdagen
Havtil, Stavanger, 27 August 2025

Slides are prepared by Sigurd H. Teigen, Claire Bernard-
Grand'Maison, *Kenneth Eik*, Vegard Hornnes & Richard Hall

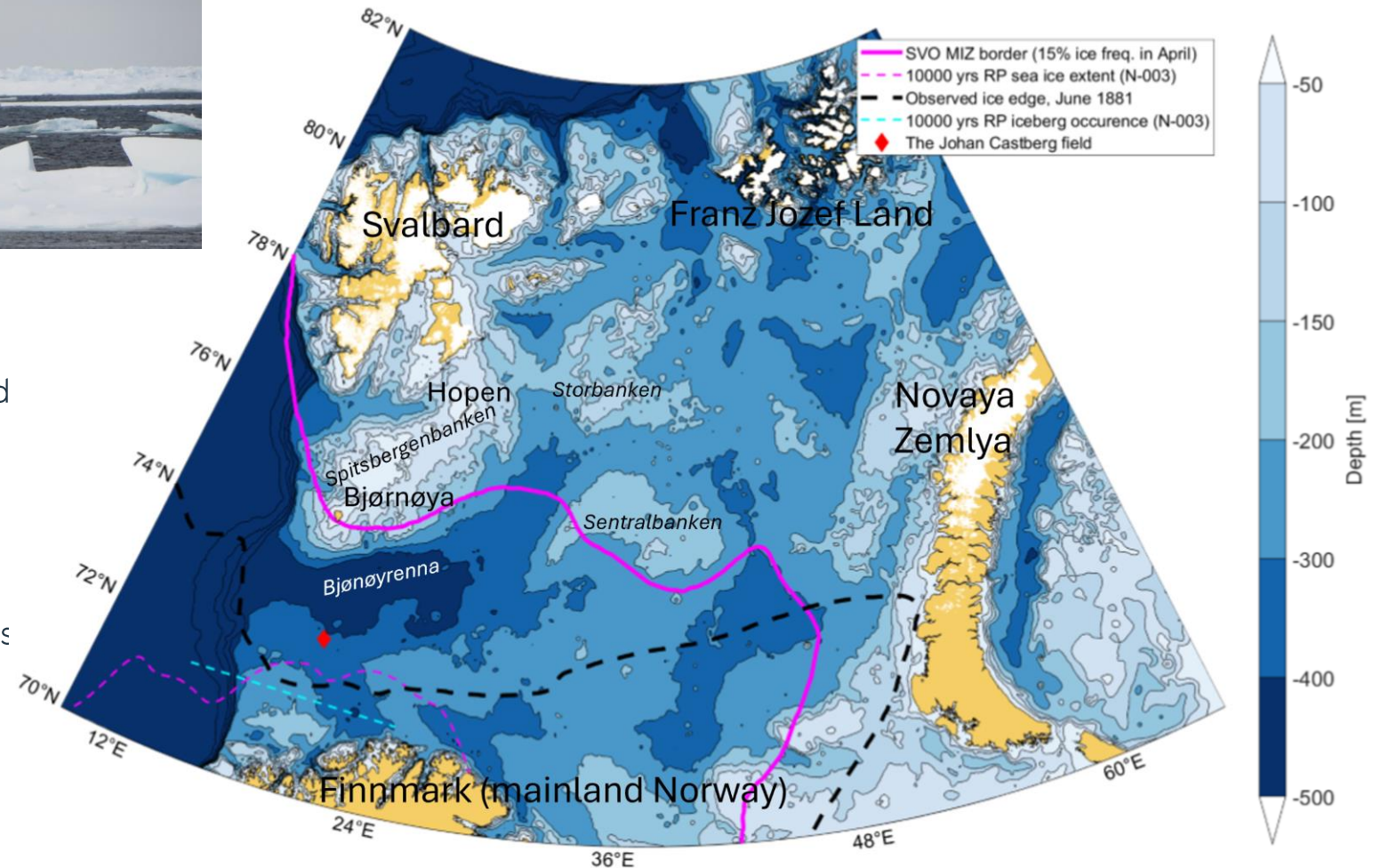




Sea ice in the Barents Sea and at Johan Castberg



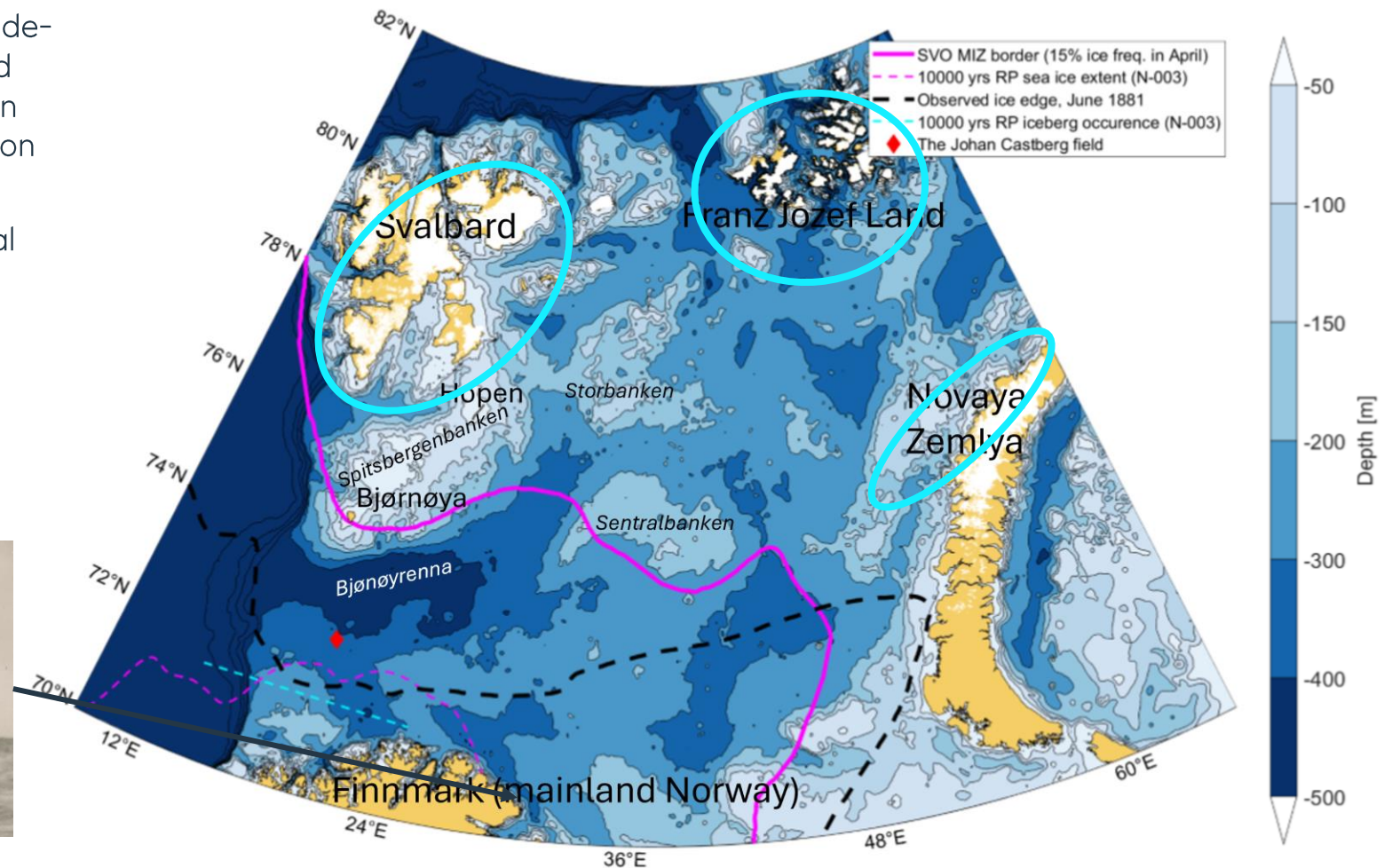
- **Sea ice** does not form locally at Johan Castberg, but could encroach from the shallow banks south of Svalbard under influence of sustained wind and current from the north
- **Main risks** associated with sea ice is loss of position and local hull damage
- The return period for sea ice at Johan Castberg is ~10,000 yrs





Icebergs in the Barents Sea and at Johan Castberg

- **Icebergs** in the Barents Sea originate from the tide-water glaciers in Svalbard, Franz Jozef Land and Novaya Zemlya. The largest observed icebergs in the Barents Sea have had a mass of several million tons.
- **Main risk** associated with iceberg collision is local hull damage
- The annual impact probability for the Johan Castberg FPSO is estimated to $2.7 \cdot 10^{-4}$, corresponding to a return period of 3,678 years





Johan Castberg Field Development

- First oil discovery in 2011, started production in March 2025 and has ramped up to full production capacity (220 000 boe /day)
- At 72.48°N it is the world's northernmost offshore oil field, with a planned lifetime of 30 yrs
- Developed with a permanently turret-moored ship-shaped FPSO unit
- Qualified for survival when exposed to sea ice and iceberg interaction scenarios that could be expected at the site (i.e. maintain all main safety functions when exposed to ice actions at annual probability of $1 \cdot 10^{-4}$)
- First asset on the NCS that implements a permanent Ice Risk Management System
- Implementation of Ice Risk Management follows the ALARP principle (As Low As Reasonably Practicable)



September 2024: The Johan Castberg FPSO in the Barents Sea



April 2013: Ice tank tests of the Johan Castberg hull



Operating Limits

1. **Sea ice** is observed closer than **50 km** from the FPSO
2. An **iceberg** is confirmed observed closer than or about to drift closer than **22 km** from the FPSO, regardless of size and shape

Legend

Marine Infrastructure

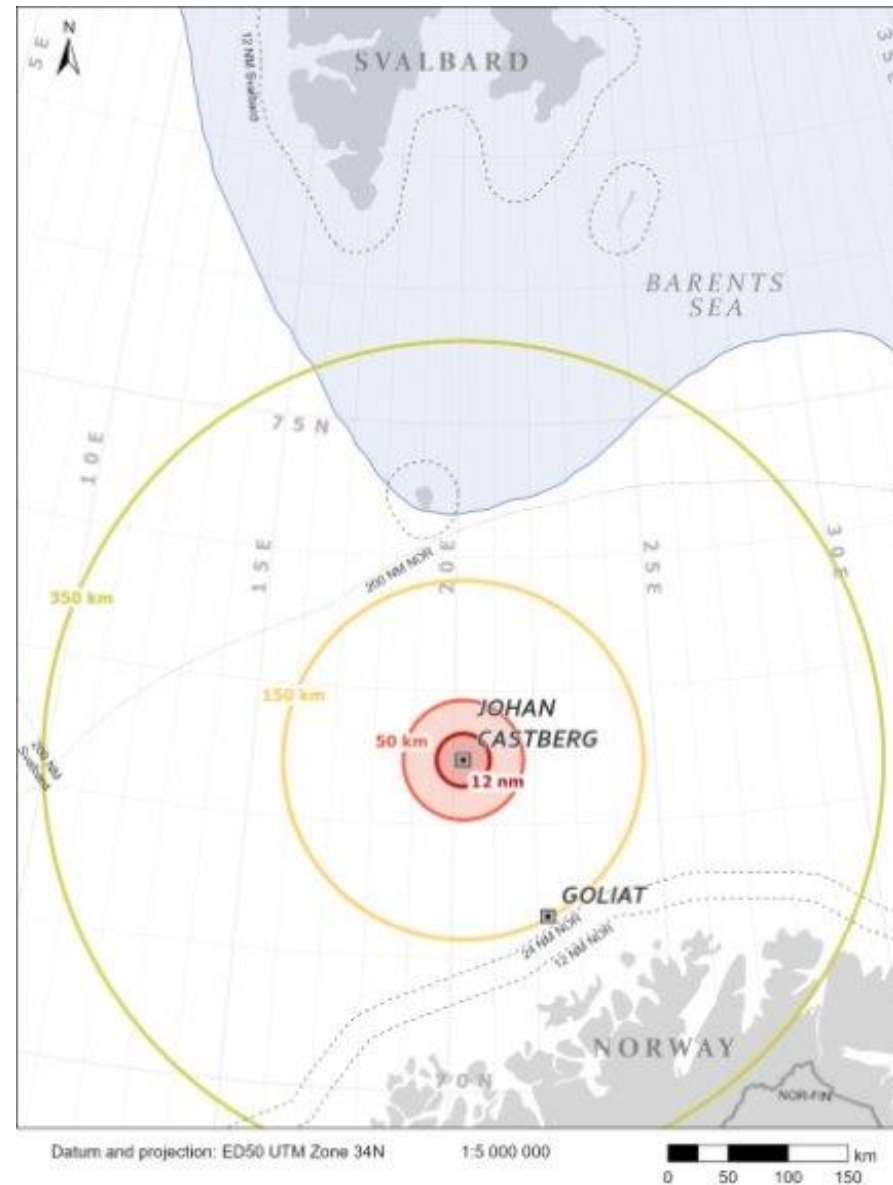
- Equinor Platform / FPSO (planned and installed)

Ice Risk Management Surveillance Zones

- General Surveillance Zone: 350 km
- Specific Surveillance Zone: 150 km
- Sea ice Reaction Zone: 50 km
- Iceberg Reaction Zone: 12 nm (22.2 km)

Particularly Valuable and Vulnerable Areas (NEA)

- BH06 Marginal ice zone



Mitigation Actions

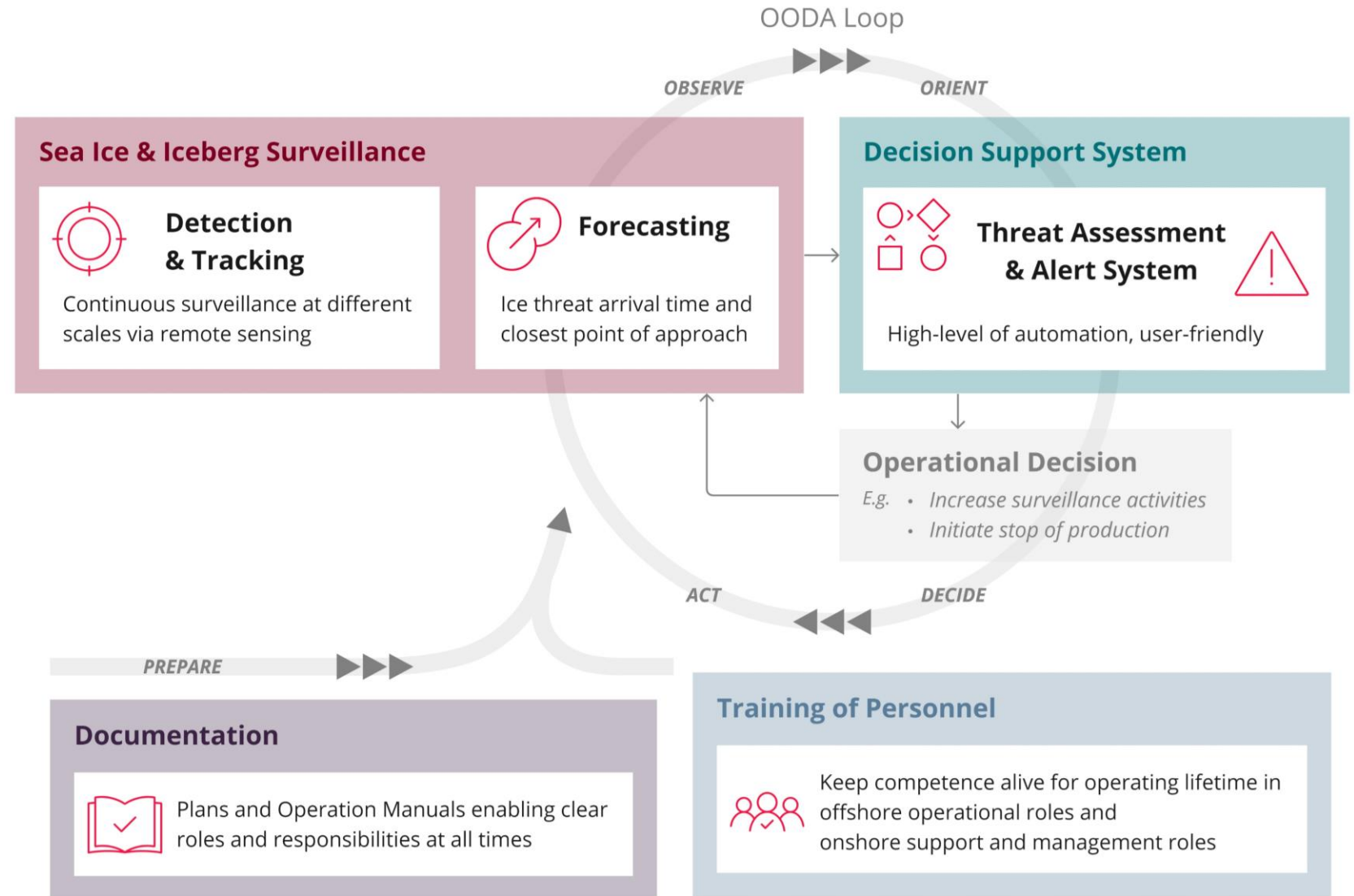


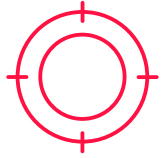
- Stopping offloading operations and disconnecting shuttle tanker
- Stopping production
- Unmanning of non-essential personnel
- Consider ballasting to increase draft
- Orient the FPSO with the bow against incoming ice
- Consider use of water cannon(s) on stand-by or supply vessels to deflect ice



Ice Risk Management System Overview

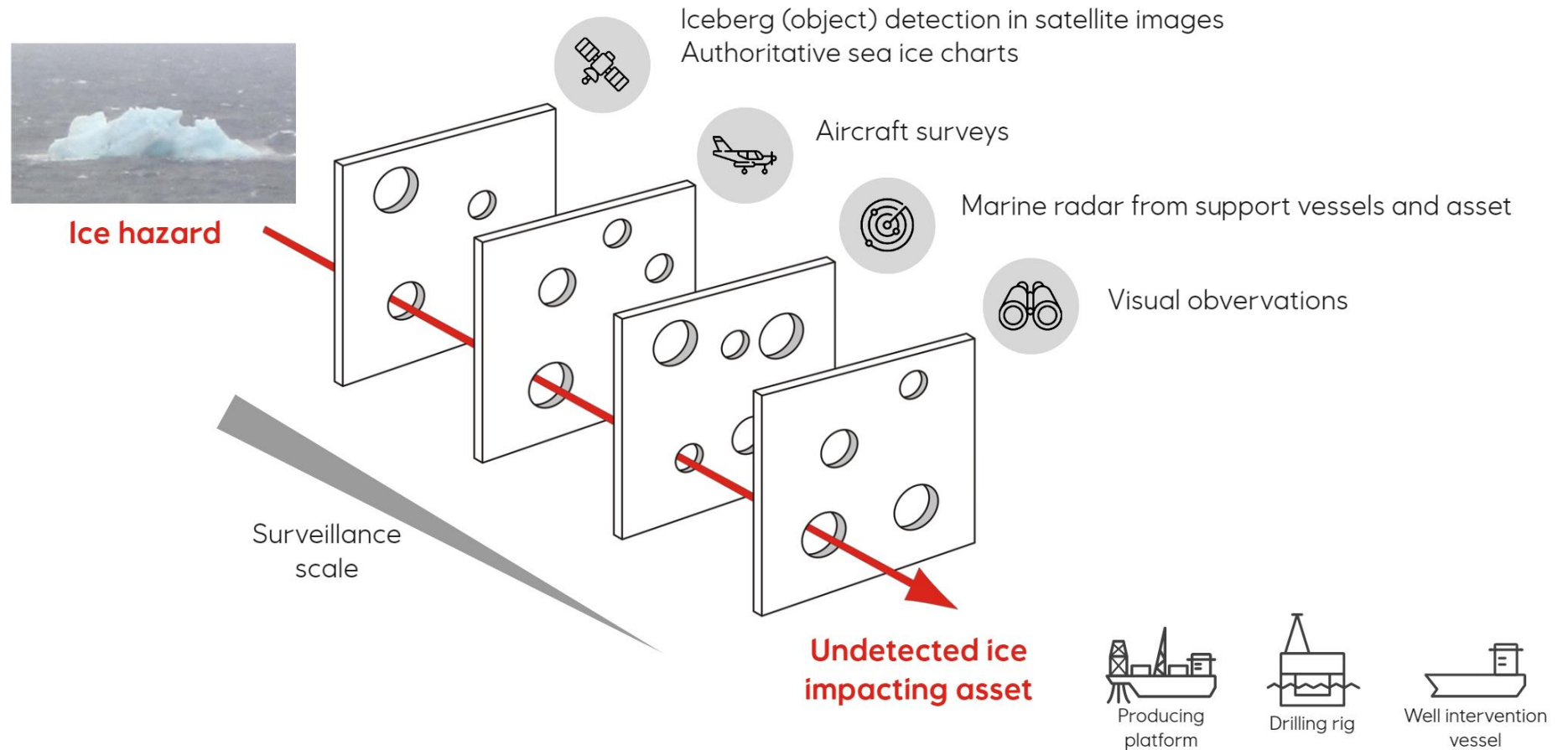
- **Objective:**
Ensure that the probability of adverse consequences of sea ice and iceberg encounters is as low as reasonably practicable
- System designed to be **future-proof**: valid for the FPSO lifetime of **30 years**
- Improvement of each component as **new technologies** become available and cost effective

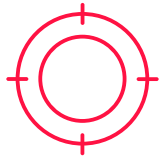




Surveillance Strategy: Safety Barrier Management

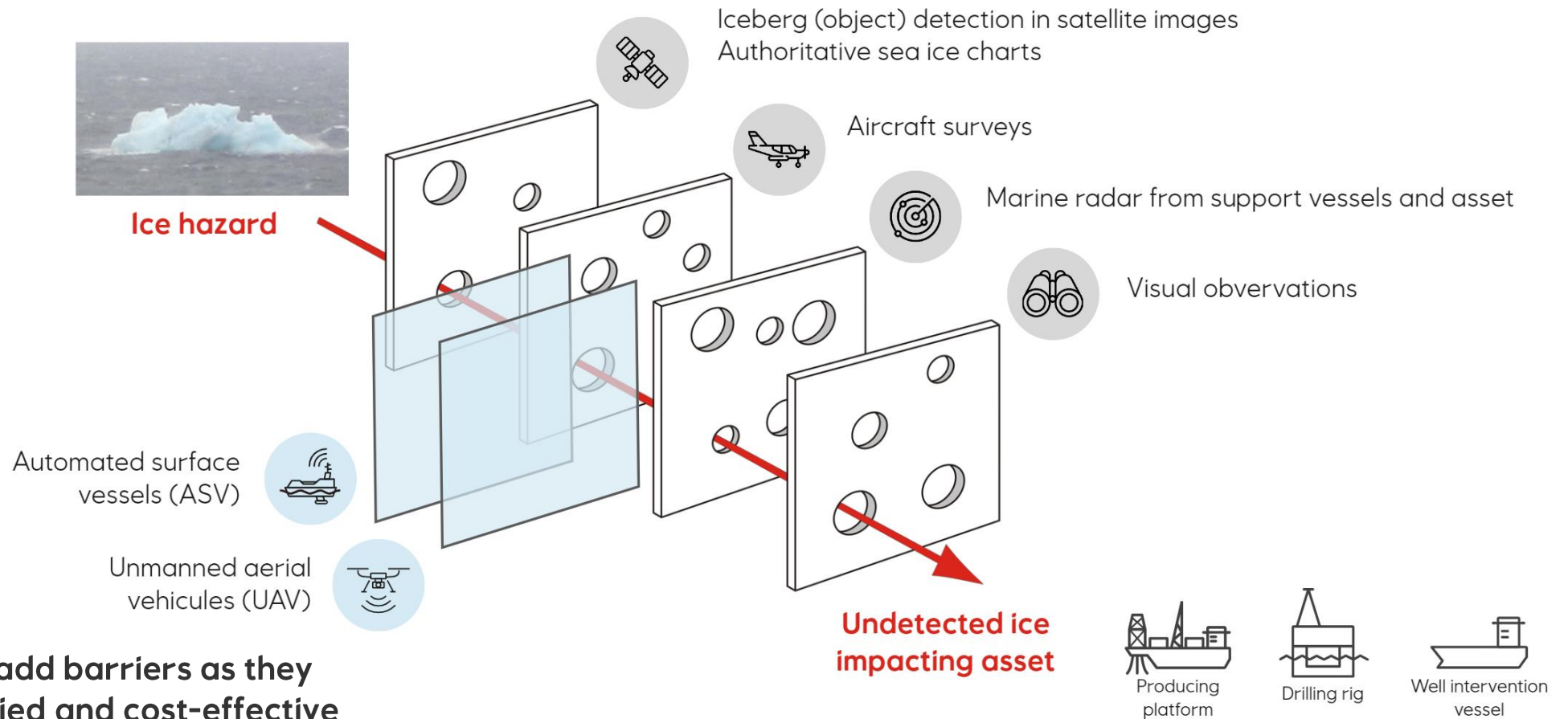
Selection of surveillance solutions considering cost and benefits to reduce risks
As Low as Reasonably Practicable (**ALARP**)





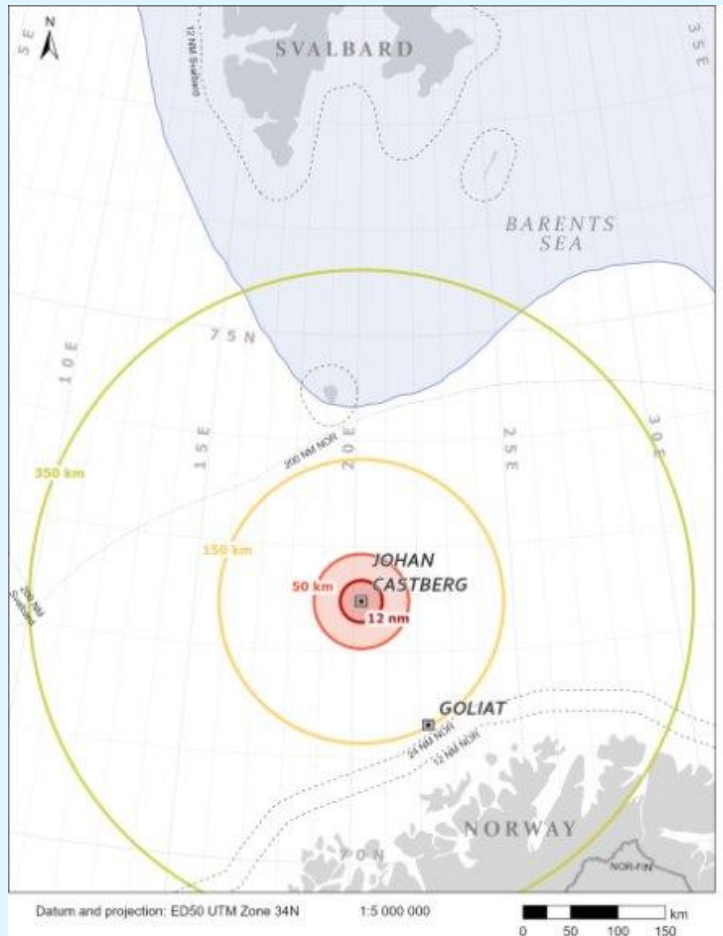
Surveillance Strategy: Safety Barrier Management

Selection of surveillance solutions considering cost and benefits to reduce risks
As Low as Reasonably Practicable (**ALARP**)





Decision Support System



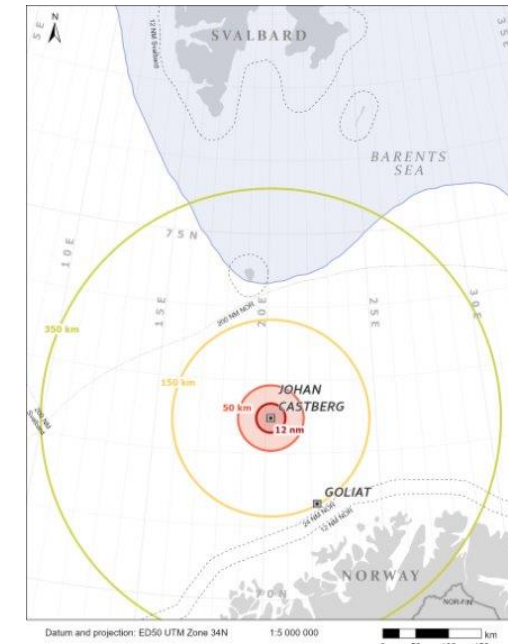
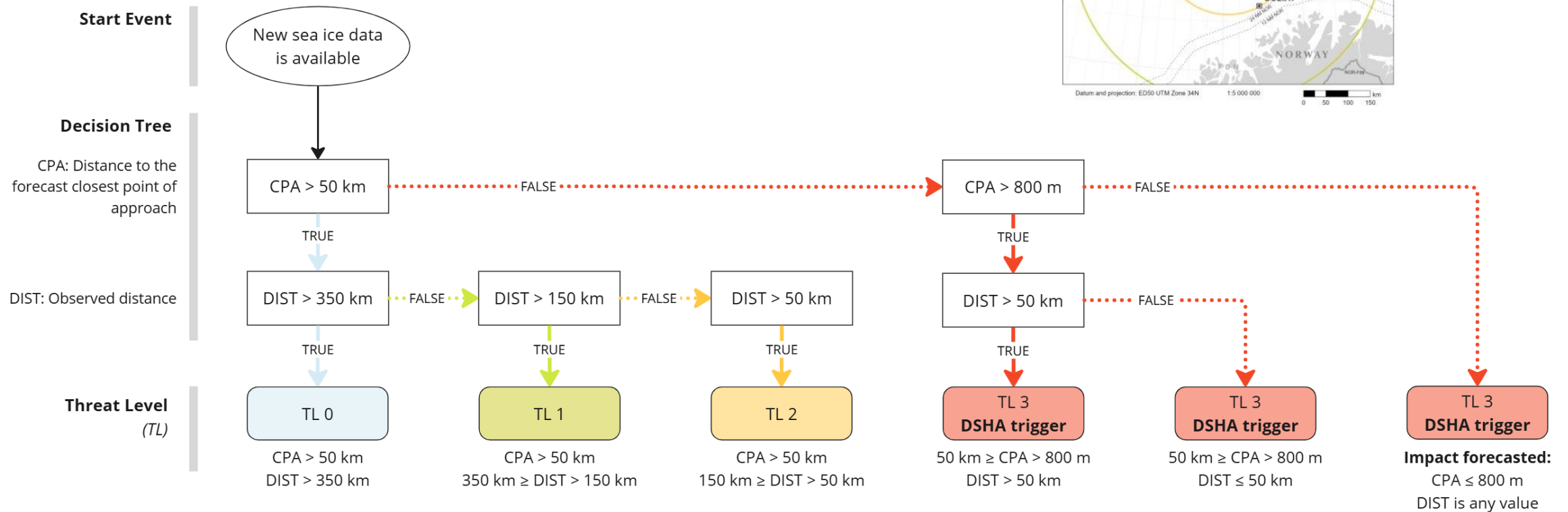
Threat Level	Description and corresponding surveillance zone radius		General actions
TL0	No ice in General Surveillance Zone (350 km)		Continue routine surveillance.
TL1	Ice in General Surveillance Zone (350 km)		
TL2	Ice in Specific Surveillance Zone (150 km)		Increase surveillance and adapt activities.
TL3	Sea Ice	Operating limits are reached or are forecast to be reached: Sea ice is incoming or in Sea Ice Reaction Zone (50 km) Further mitigation actions should be taken if ice is intruding the FPSO Safety Zone (800 m)	Increase surveillance and follow DSHA action plan
	Iceberg	Operating limits are reached or are forecast to be reached: Iceberg is intruding or is observed within Iceberg Reaction Zone (22.2 km) Further mitigation actions should be taken if iceberg is intruding the FPSO Safety Zone (800 m)	Increase surveillance and follow DSHA action plan

New *Defined Situations of Hazards and Accidents (DSHA) for ice*



Example: Decision support tree for sea ice

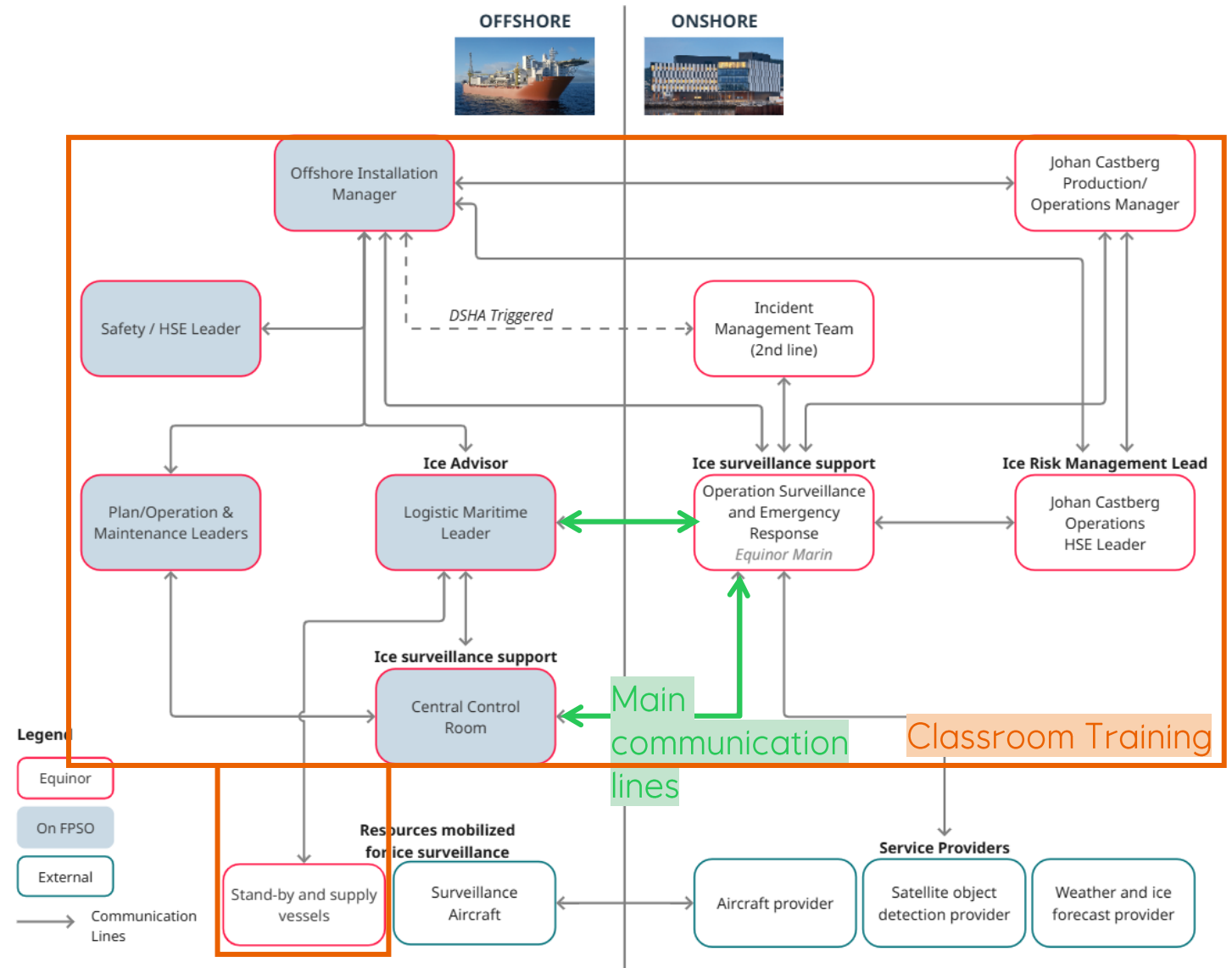
The logic of the threat assessment process has been implemented in a web-based portal, where ice information is accessible





Roles & Responsibilities

- All decisions related to initiating risk mitigating actions are taken **offshore**, by the **Offshore Installation Manager**
- **Logistics Maritime Leader** appointed as Ice Advisor
- **Equinor Marine** has a key support role with 24/7 support and communication to external service providers





Documentation and Training

- Classroom theory sessions for offshore personnel and onshore support functions/management
- Offshore: 1st line DSHA training
- Specific sessions for
 - Equinor Marine operators (onshore maritime surveillance center)
 - Officers on stand-by and supply vessels



Field-specific Ice Risk Management Plan
– Johan Castberg



Ice Risk Management Procedures





Summary

The Johan Castberg FPSO has been subjected to comprehensive analyses and concluded to be safe if exposed to 10 000 year ice loads.

Estimation of ice loads are more uncertain than any other environmental loads and consequently, ice related risks can be higher than for other environmental loads.

The objective with the Johan Castberg Ice Risk Management System is to reduce residual risks associated with the presence of sea ice and icebergs.

The Johan Castberg Ice Risk Management is set up to work for 30 years in a highly autonomous way.

More details about the Ice Risk Management system at Johan Castberg can be found in proceedings from [POAC 2025](#):

Paper 140., Teigen et al.:

Ice Risk Management for the Johan Castberg FPSO in the Southern Barents Sea

Paper 131, Bernard Grand 'Maison et al.:

Ice surveillance for Equinor's operations in the Southern Barents Sea