Norsk Olje og gass Selbusjøen 21.5.2014

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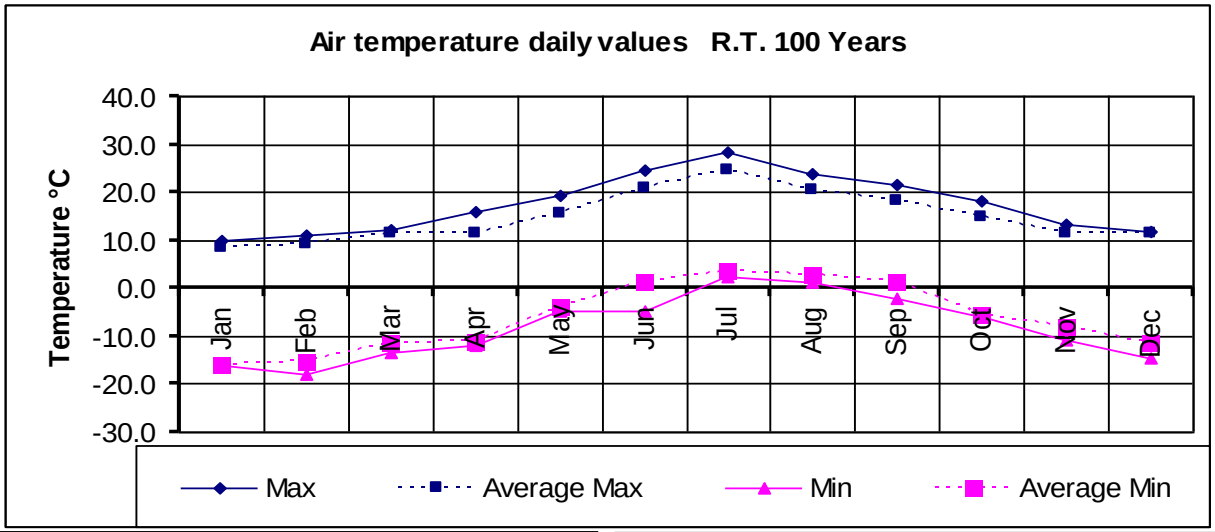
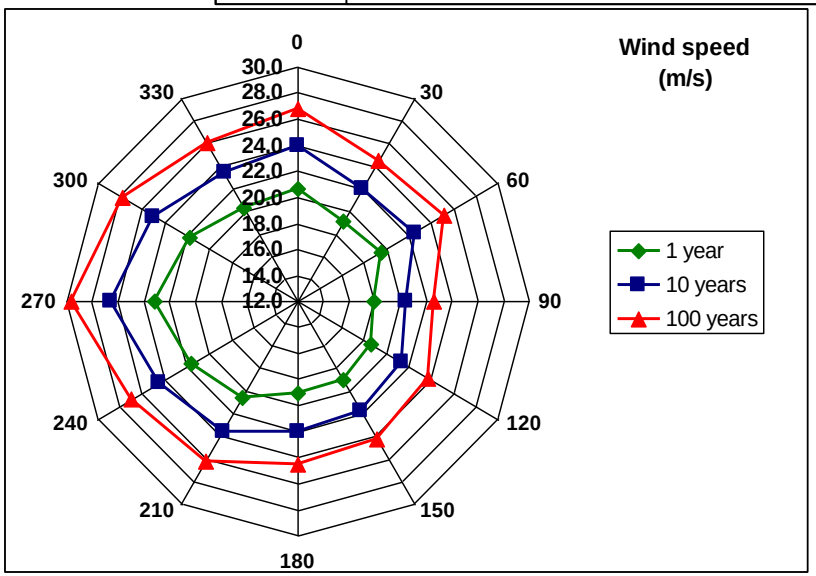
Innholdet i presentasjonen

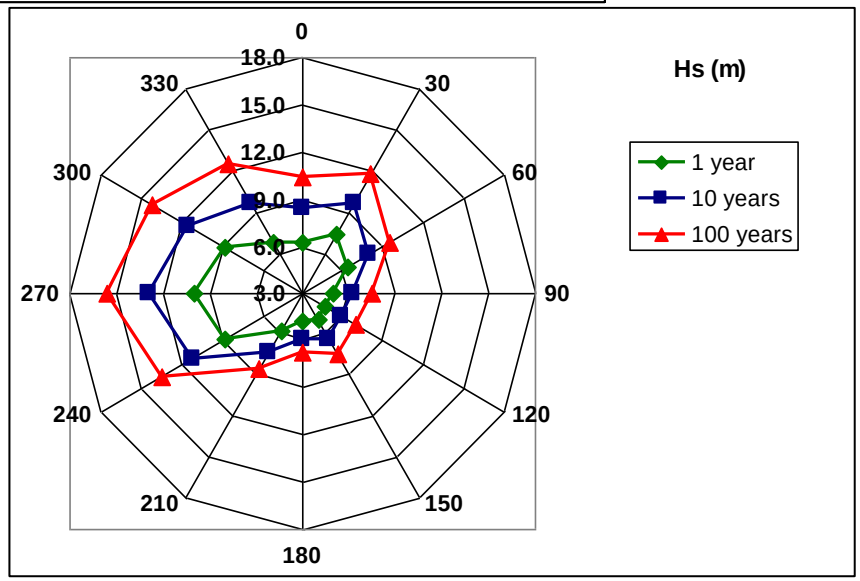
- Goliat – værdata
- Goliat innretningen – valg av løsninger
- Risikostyring i arktiske strøk

- Lysarkene er hovedsakelig skrevet på engelsk

Metocean Data





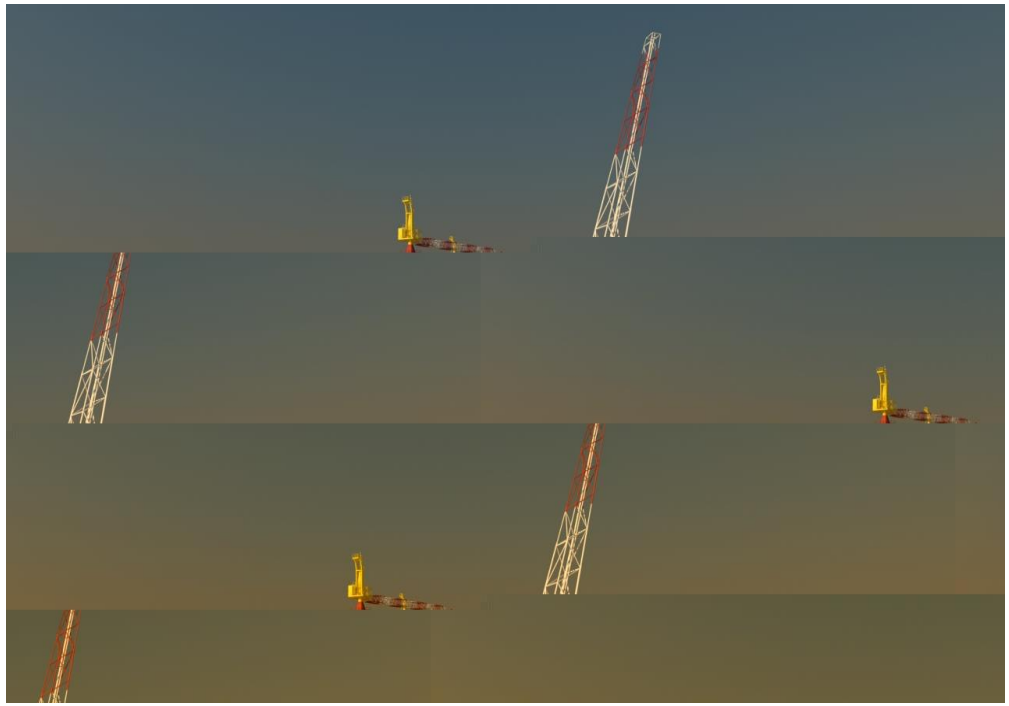


Atmospheric icing

- There is no risk for in-cloud icing at Goliat below 200 masl
- The risk for in-cloud icing above 400/500 masl is rapidly increasing with height
- Low risk for freezing rain at Goliat
- The atmospheric conditions are from time to time favorable for wet snow icing:
  - Calculated values of 100 years precipitation ice loads ca. 7 kg/m on a free rotable cable and also ice lattice constructions etc.
  - The ice has a typical density of 500 kg/m^3
  - Several years may pass without any icing
  - Strong wind just after the icing may break the ice and blow it around the platform

Goliat FPSO - Inherent design features

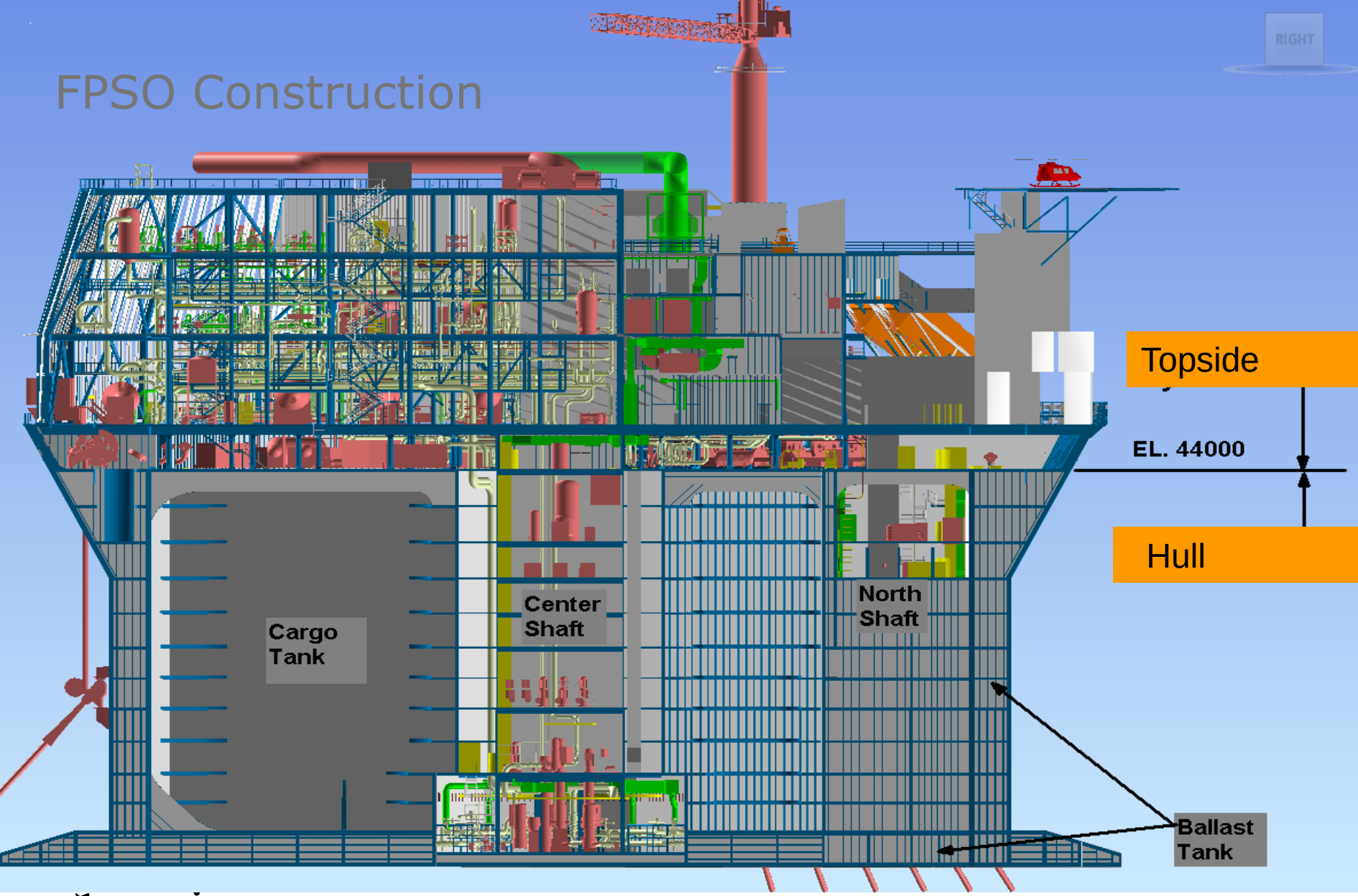
- high freeboard (less sea spray on deck)
- double hull
- risers protected inside the hull
- segregated lifeboat stations (2 x 100 %) with different launch directions
- easier to accommodate electrification from shore
- available capacities to accommodate future tie-ins
- When offloading the tanker is not pointing at Goliat, incase of DP failure



Goliat characteristics – inherent design features

- Process deck elevated 6m above Main Deck
- Large process area
  - high explosion loads
  - high fire water demand (Main Deck is adjacent area)
- Cargo tanks adjacent to LQ
- Cargo pump room in bottom of Central Shaft
- Limited space available in process and utility areas
  - challenges wrt. layout and location of equipment
  - confinement
  - more equipment on Main Deck than planned
- Lifeboat drop heights
- Dropped object loads and protection

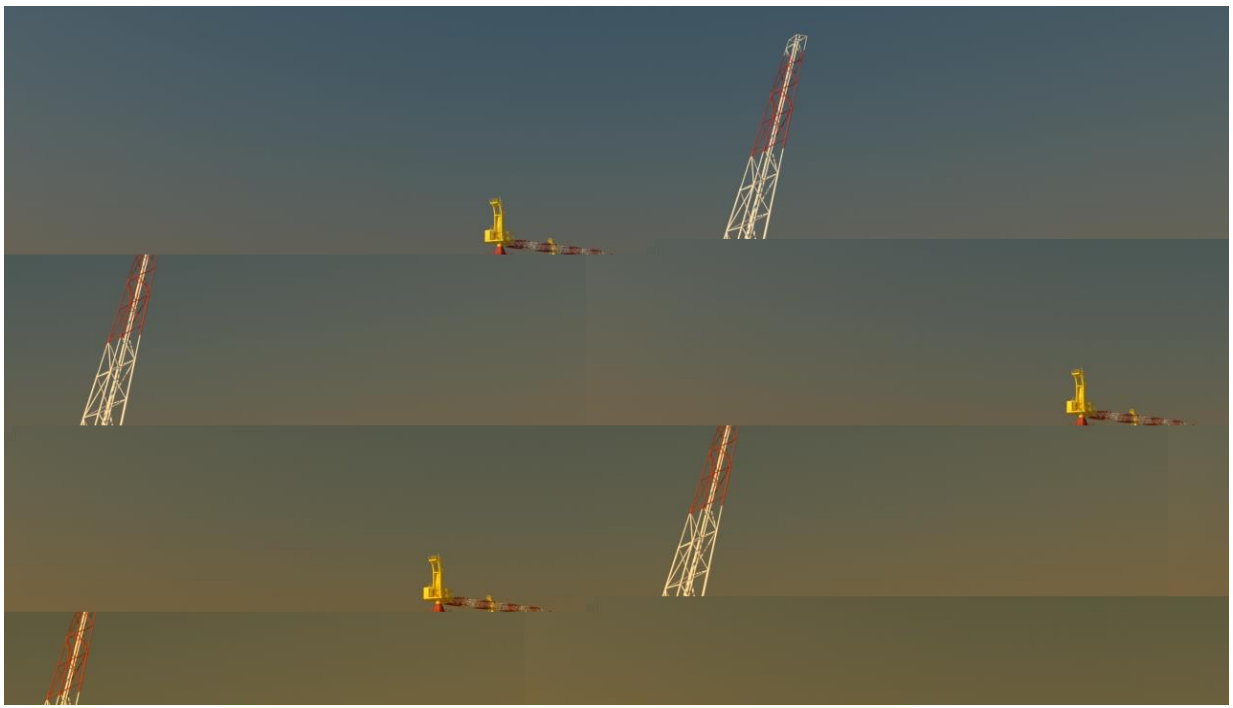
FPSO Construction



Winterization solutions

The chosen winterization solution will be a compromise between explosion risk and Working Environment (WE)

- Explosion risk is reduced by keeping Process Area as open as possible
- WE will be improved when Process Area is as enclosed as possible



Snow and ice

- Topsides deck structure will be elevated sufficiently to avoid sea spray
- Hull design will allow for sea spray icing
- Structure will have sufficient capacity to account for ice and snow loads

- Flare structure will be cantilevered off the deck structure to avoid ice fall off
- Snow drift simulations have been performed to identify accumulations of snow pile-ups
- Equipment will generally be shielded to avoid direct effect of snow and ice

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Winterization Philosophy

Main principle:

Install proactive shielding of exposed area.

This will ensure that the functionality of all systems and arrangements onboard, safety critical and production regularity critical is maintained during all climate conditions.

Utility Area on Process Deck:

Everything that can be fully enclosed will be

Process Area on Process Deck:

Process Area will be protected by semi-open wall with closed roof on top

Winterization Philosophy

The winterization issues have been addressed through a systematic approach to ensure that the:

- Functionality of all systems and arrangements onboard, safety critical and production regularity critical is maintained also at minimum design temperature for the Goliat field.

- In the same manner, a systematic approach has been applied in order to ensure that acceptable working environment conditions are maintained at all times during operation.

- Risk reducing measures are included in the design the design development to achieve an acceptable HSE design with regard to winterization and with a HSE risk level as low as reasonably practical (ALARP).

- Risk reduction process include:
Design Workshops, HAZIDs, HSE Register, Experience Exchange, ALARP Workshops

  - **If it is quick and cheap – it ain't quality**
  - **If it is quality and cheap – it ain't quick**
  - **If it is quick and quality – it ain't cheap**

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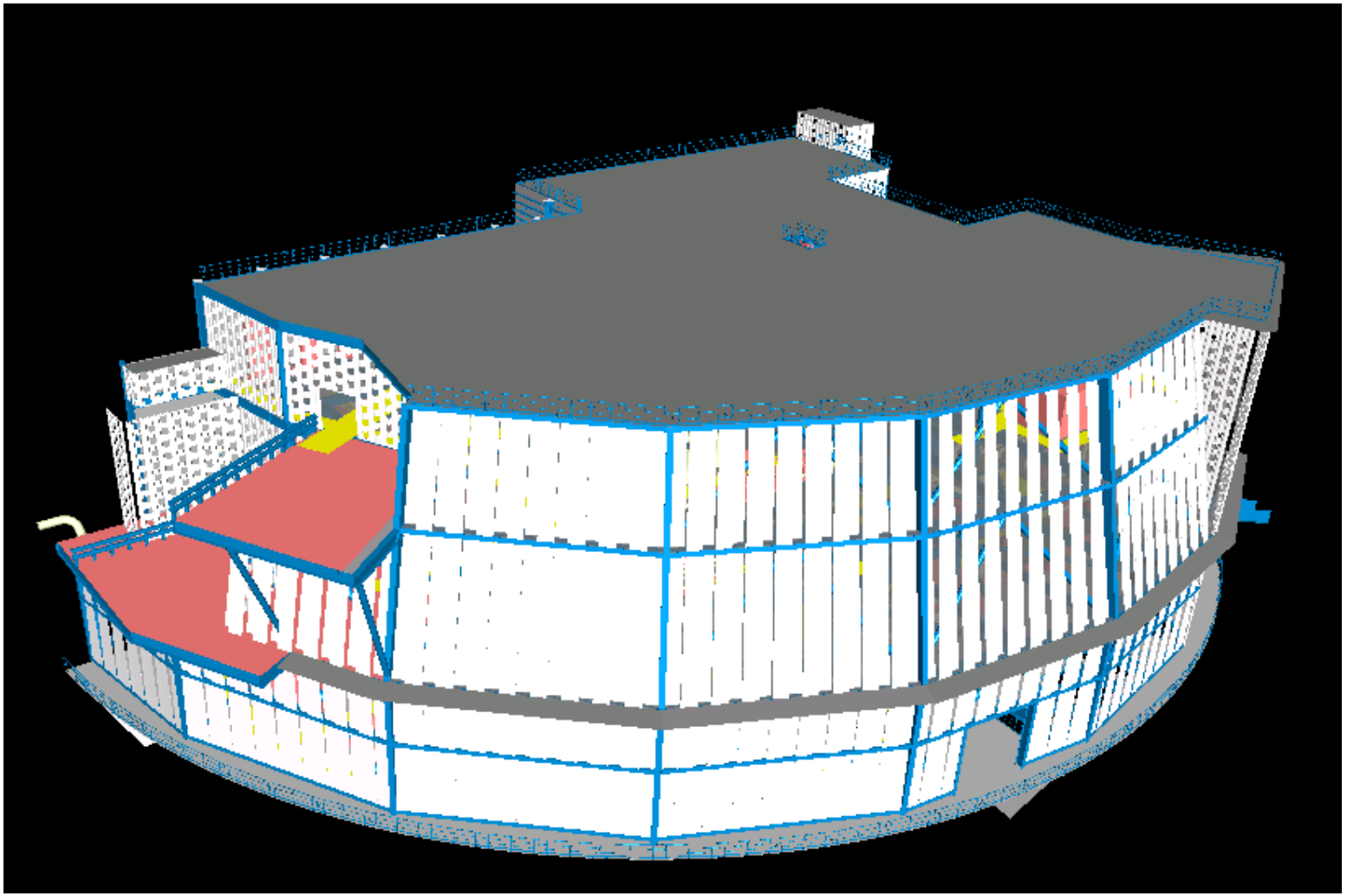
Winterization of process area - Requirements

- Facilities regulations §8: Qualification and use of new technology and new methods
- Requirements: S-001, 16.4.1 Natural ventilation in hazardous areas
- Requirements: S-002 wrt Wind chill Index
- Explosion loads shall be "acceptable" (within the range that has been experienced in recent development projects)
- An explosion the process module shall not result in flying objects
- Wind induced noise and vibrations within defined limits

Winterization structure



Winterization of process area – description of solution

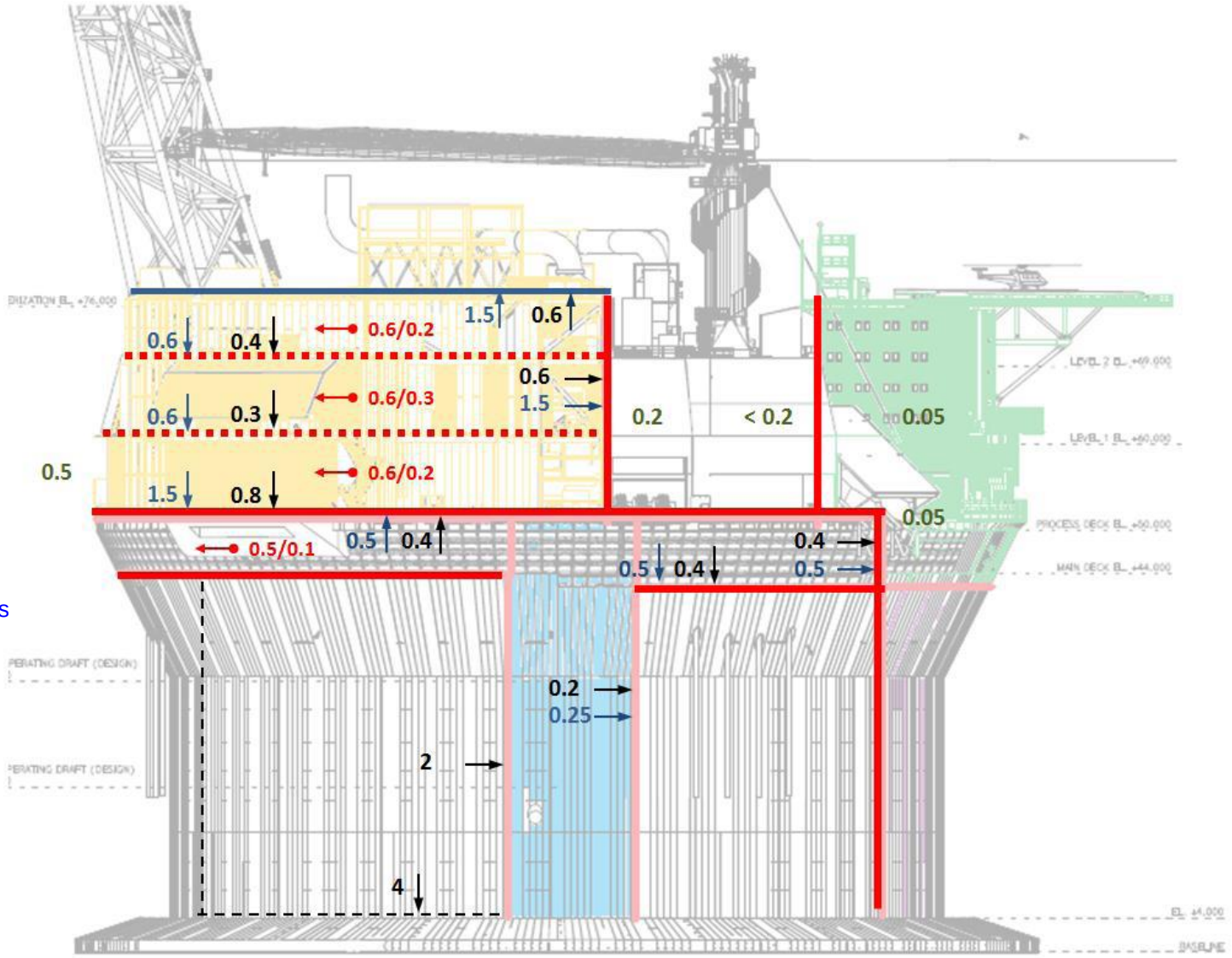
- **Design**
- The process area shall be covered by protective structure consisting of a partly open surrounding wall with roof on top.
- Firewall and roof is tight structure
- Winterisation walls are partly open structure
- Lower level in the process module is tightly plated deck and acts as a barrier (H-0 rated deck) towards main deck

- **Load acceptance philosophy**
- Firewall and process deck shall withstand dimensioning explosion pressure and remain intact, i.e not deform in such a way that main barriers are intact also after a dimensioning explosion
- Roof and winterisation walls are dimensioned for other loads and can deform during an explosion, but shall not be released from underlying support structure and result in flying objects.

Key features of wall

- Side wall is a semi-transparent winterization wall with 100mm opening at bottom and 1000mm at top
- 4mm slender plating with 2 x 100x6mm vertical FB stiffeners supported by horizontal girder every 5 meter.
- Wall is not a blast wall and is allowed to fail during a blast. Wall is similarly not required to open at a specific pressure
- Side wall is not part of global load bearing structure
- Wall is designed with weak spot to avoid detachment and flying object scenario. Vertical flat-bars are sniped at one end to control local failure point. Horizontal support girder is significantly weaker than main vertical support members.
- The wall is not designed to take the 0.9 bar local blast pressure without deforming
- Key design aspects of the wall are wind and noise/vibration

Some explosion DALs



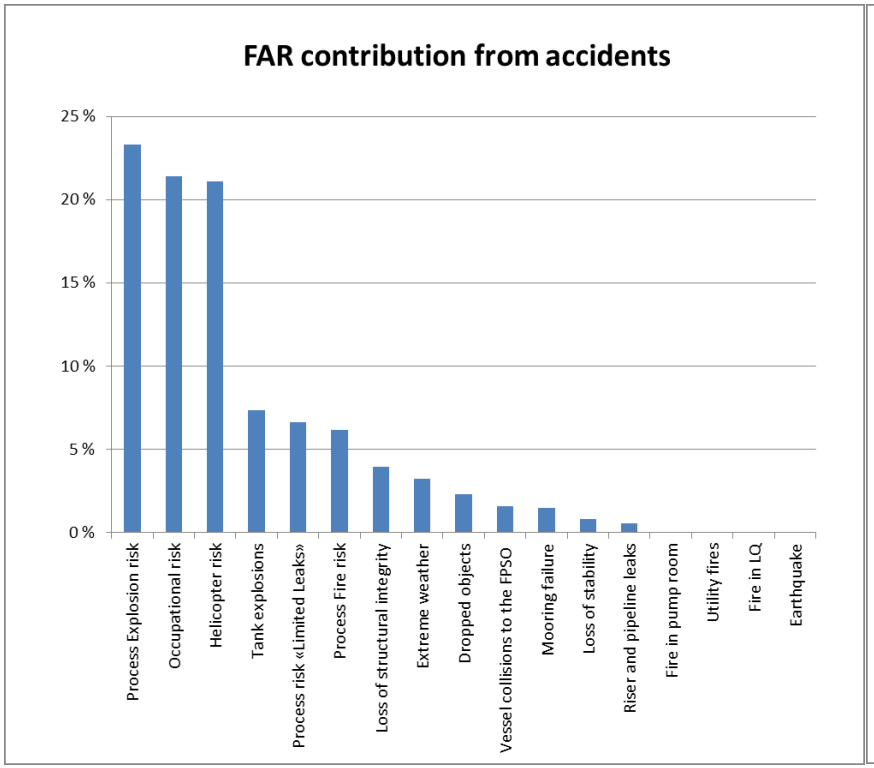
- Global overpressures (in black text)
- Local explosion pressures (typically 5m x 5m @ process and main deck areas) (in blue text)
- Drag at different levels (d>2''/ d<2'') (in red text)
- Winterization panels & external LQ and utility (in green text)

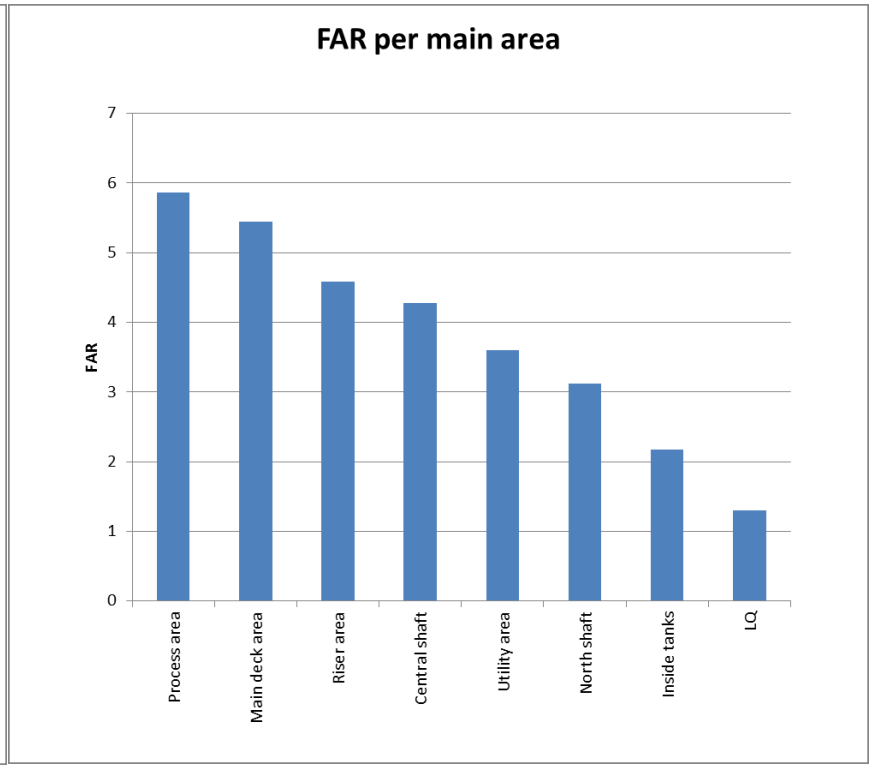
QRA - challenges

Explosion loads versus enclosures and lay-out concerns. Studies/evaluations performed

- At Goliat, the process area is large and the design explosion cloud size is significantly smaller. Therefore, there is quite some distance from the gas cloud to the winterization for most of the design explosion scenarios. This means that the winterization at the sides have little effect for the explosion loads.
- For explosion at the upper level, the roof contributes to increased explosion loads.
- The effect on gas dispersion from winterization is probably more important than the increased confinement.
- The confined process area also leads to design fire scenarios with high heat loads

FAR values per Main Areas





Overall FAR: 2,4

QRA - challenges

Challenges with respects to Risk Tolerance Criteria

- Gas explosions are challenging for Goliat as it is for most other units with large process plants.
- Cargo (and possibly also ballast-) tank explosions are challenging for FPSOs in general.
- Material handling and lifting is different with roof on top of the process plant. High potential drop heights may result from this, but also good protection in some cases.
- A general concern for floating installations is the reliability of the mooring system (ref. to relatively high frequencies for anchor and anchor line failures)

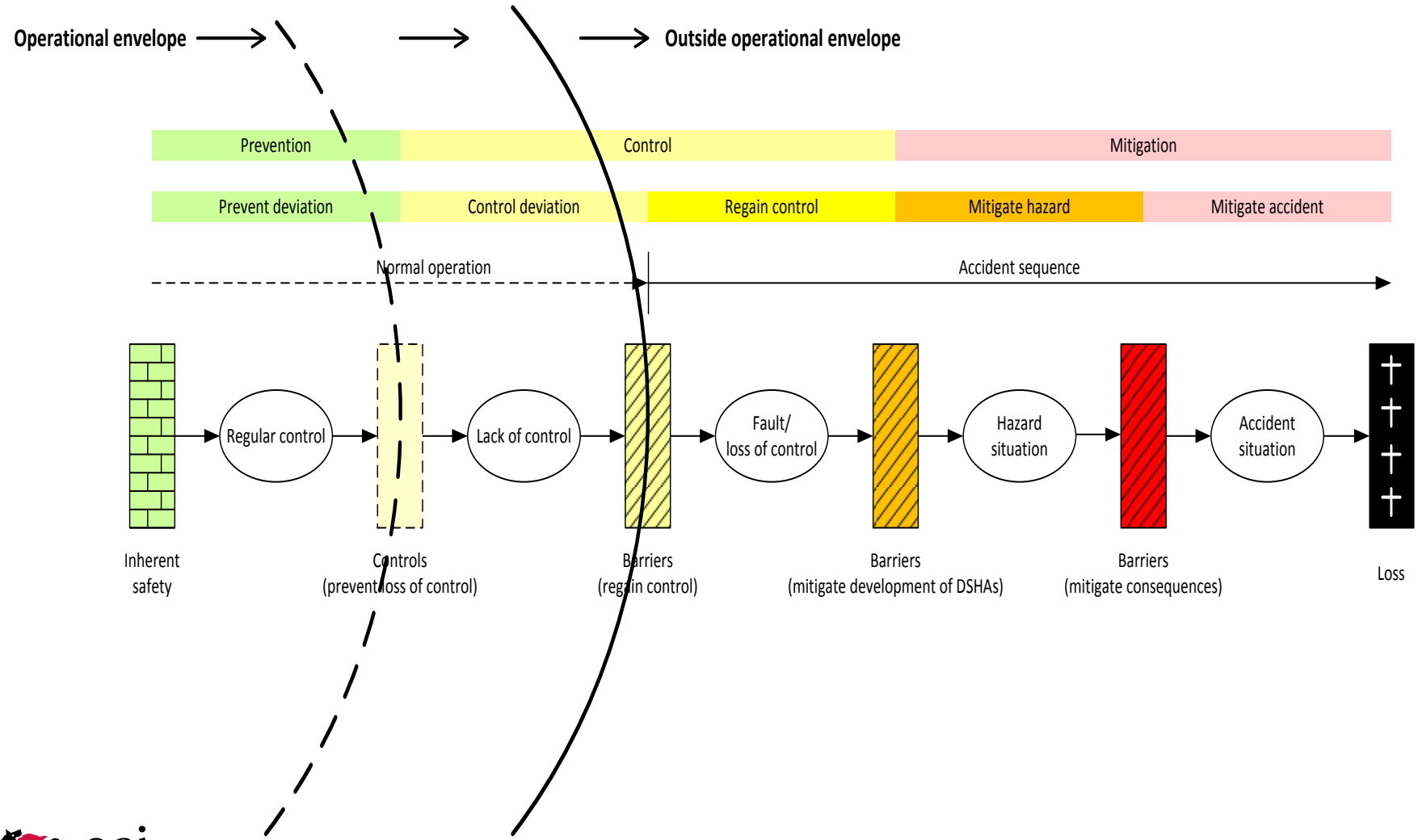
Barriers - challenges

- Emergency power
- Escape routes – heat tracing
- Helideck availability
- Firewater

Winterization challenges

- Area specific safety and barrier strategy
- Communication – Fibre solution
  - Barents Sea North and East

Goliat barriere prosjekt



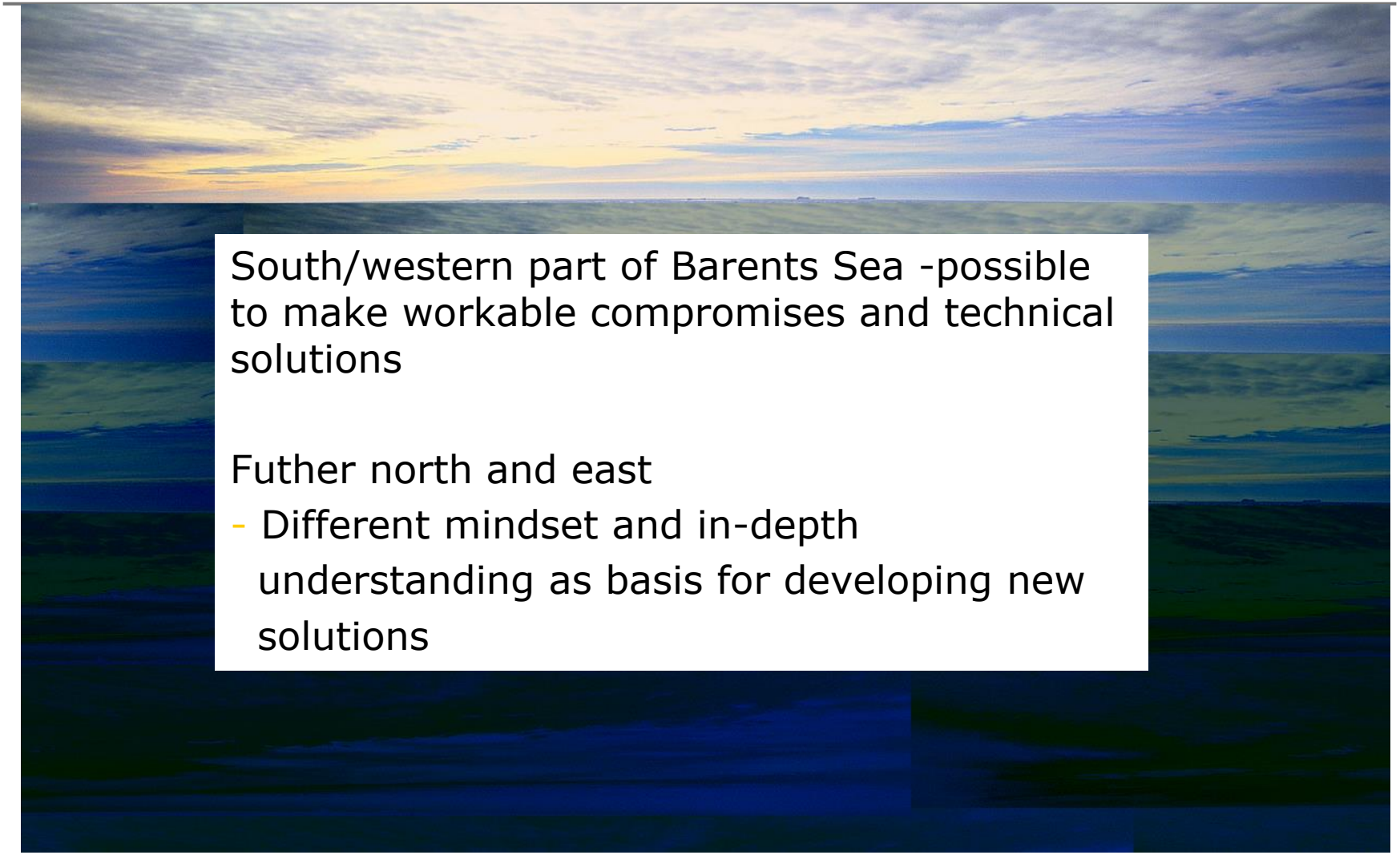
Envelope for safe operations

Commitment for safe operations – how do we know if we are within the envelope?

- Committment towards stakeholders
- Development of proactive indicators

- Barents Sea challenges
  - Cold climate management
  - Waiting on weather
  - Respecting restrictions
  - Distant location – logistics

Conclusion



South/western part of Barents Sea -possible to make workable compromises and technical solutions

Futher north and east

- Different mindset and in-depth understanding as basis for developing new solutions