Challenges Faced by the Marine Contractors Working in Western and Southern Barents Sea

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Ove T. Gudmestad, University of Stavanger
Motivation

• The Cold climate areas hold huge potential for Oil and gas
• It could be expected that large offshore oil and gas development projects soon will be carried out in these areas, work is underway for the Goliat project
• It is not realistic that all construction activities can take place during the short summer season
• Work will continue into the early fall and possibly longer
• Operations (for example production support) will be ongoing all year round
Motivation

- This presentation will discuss the challenges associated with construction and operation work in cold climate regions
- Long periods of “waiting on weather” are expected to result
- Management must have the patience to wait until safe operations can commence
- Emphasis will be on the W and SW Barents Sea
The 2010 agreement

Following the 2010 border agreement, Norway and Russia are, potentially calling for joint Norwegian - Russian development projects.

The new delimitation line in the Barents Sea, note the strategic locations of Kirkenes harbor (star lower left) and Murmansk. (Illustration: Sherpa Konsult, Kirkenes).
**NORSK SIDE:**
81 lettebrøner i Barentshavet
Det er boret 81 lettebrøner i Barentshavet per februar 2009. Det ble 12008 gjort funn i seks av åtte lettebrøner, og nærmere 60 oljeselskaper har sikt konsesjon for leteboiling i den 20. konsesjsrunden. Det er påvisst 11,2 mill. Sm3 olje og 6,8 milliarder m3 gass i felt som det kan være aktuelle å bygge ut – det tilsvarer ca. 5% av ressursene i Nordsjøen.

**RUSSISK SIDE:**
Shtockmanfeltet
Main challenges

• **Construction work in cold climate regions**
  – Emphasis on the physical conditions
    • Polar Low Pressures
    • Potential for icing (spray icing and atmospheric icing)
    • Long periods of low visibility (e.g. fog)
    • The logistics of working long distances away from established supply bases
    • Emergency response far away from base stations

• **Operations will be ongoing all year round**
  – Includes drilling and well support
O&G fields
Main challenges

- **Large uncertainties in weather forecasts:**
  - Proper management decisions accounting for the specifics of the area
  - Long periods of “waiting on weather”

- **Construction vessels might be called upon during the winter/ ice covered season for special work**
  - for support and/ or maintenance of equipment
  - in particular related to subsea equipment
DNV Barents 2020 Regionalization

- We refer in this presentation to Zone II
Operations versus Stand by

- The **key to successful construction and operation work** is the ability to work under the actual conditions of the physical environment:
  - Having sufficient time to finalize the construction work in safe and proper manner **(Operational mode)**
  - Being able to ride off a storm in a safe way without damaging the vessel or the equipment **(Stand-by mode)**
Iceberg occurrence

- In the areas where icebergs can occur, **disconnection** of vessels is important
  - Failure to disconnect could lead to immediate loss of vessel
  - Failure to disconnect an FPSO could lead to huge pollution from FPSO Storage
- Probabilities to be carefully evaluated
  - The total safety level to be in the order of $10^{-5}$ probability of exceedance
- Potentially we could require better safety level in cold climate areas.
  - Map shows 10-2 and 10-4 levels (Norsok N-003). This map will be updated.
Annual occurrence probability of $10^{-4}$ for icebergs (AARI) per 100 x 100 km

(What will the future hold?)
Polar low pressures

Their characteristics are as follows:

- Formed at sea in cold air outbreaks winter time;
- often having rapid development;
- gale or storm force winds, seldom hurricane;
- heavy snow showers, icing, changing wind direction;
- life span 6h to 1-2 days;
- diameter 100 - 500 km
- difficult to detect by weather stations
- Dependant on satellite pictures for predictions
Spray Icing

- Under adverse situations, when cold temperature is combined with cold sea water temperature and waves, *spray icing* could occur on vessels.

- The critical air temperature range for icing is from -18 °C to 0 °C.

- The critical range of sea surface temperatures are -1.9 to 8.9 °C.

Heavy vessel icing, Illustration from Norwegian Meteorological Institute.
Wave climate

- Wave climate generally as in North Sea
- Long periodic waves in W and SW Barents Sea
- With less ice in northern regions, the wave climate might be worsening with large waves from north and east
- Map: Norsok N-003
Winterization, ISO 19906

- Elimination of pockets or dead ended pipes or legs in piping and design of piping to be self-draining;
- Maintaining a flow in lines (such as fire water mains and cooling water branch lines) which are sometimes filled with static liquid;
- Insulation;
- Protective heating, generally combined with insulation; heating may be internal or external (e.g. when heat tracing tapes are on instrumentation and piping);
Winterization, ISO 19906

- use of an enclosure, generally accompanied by heating from an internal heating element or by a heating/ ventilation system;
- use of chemical or mechanical seals on instrumentation;
- use of wind walls to reduce rate of heat loss;
- addition of chemicals (for example methanol) to reduce the freezing point of fluids
New ISO standards for Arctic Offshore Operations are being developed

- New standards:
  - Escape, evacuation and rescue
  - Environmental monitoring
  - Working environment
  - Ice management
  - Physical environment for arctic operations
  - Arctic materials

- Initiative continued from Barents 2020

- Meetings:
  - Start up meeting: Moscow 2012
  - 2nd plenary meeting: Rotterdam, May 2013
  - 3rd plenary meeting: St Johns, October 2013
Risk = Probability x Consequences

- Look for probability reducing measures
  - select technology that will contribute to reduce the probability of an event
  - the technology applied must always be qualified
  - focus on barriers that will stop any unwanted incidence to escalate till an initiating event
Risk = Probability x Consequences

- Efficient barriers
  - Awareness of changing weather
    - taking in weather forecasts frequently, possibly from independent weather forecasters and from satellites
    - awareness of the potential for human errors and misjudgments in cold climate operations
    - awareness of the potential for wrong management decisions misjudgments in cold climate operations (Ref the oil tanker Braer)
    - awareness of low temperature effects on crucial equipment that may freeze or halt being functional
Qualitative risk matrix, the need for hazop to identify the risk

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<th>Likelihood</th>
<th>Consequences</th>
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Construction and operations work

- Vessel design
  - Operability in actual weather situation
  - Winterization
  - Speed to get to location
  - Survivability
  - Ice class required?
Construction work

• Evacuation and rescue
  – Rescue equipment
    • Life boats
    • Survival suites
  – Helicopters and helicopter reach
  – Crew training
• Communication systems in north, lack of base equipment
Waiting on weather

• The relationship between the operational criterion and the (design) acceptable criterion for the operation is defined as the "alpha factor"

• As an example, operation planned to take 20 hours with a (design) acceptability criterion: significant wave height (Hs) to be less than 2.5m will yield an operational criterion of 2.5 * 0.71 = 1.8m where the alpha factor is 0.71
Waiting on weather

• Alpha factors should be developed for the Barents Sea

• When there is a potential for polar low pressure, all work might be set on hold
Risk analysis; Objectives and limitations

1. Regarding the risks involved in marine operations in cold climate and arctic regions
   1. We are concerned with the additional challenges the marine industry is facing when moving into cold regions
2. We will consider work in the ice free part of the Barents Sea all year round
3. We will also consider summer seasonal work in areas with potential for winter ice
Extreme challenges, Polar lows

- During Polar lows there are rapid changes of wind; say from 15 kts to 45 kts in less than 15 minutes, with maximum wind speeds of 70 kts.

- Polar lows are difficult to predict and meteorologists cannot forecast the weather with reasonable accuracy (in situations where polar lows might occur, i.e. when there are winds from the north) for more than 9 to 12 hours.

- In other situations when the weather is unstable, Polar lows may occur within few hours.

- Polar lows do in general occur in the period from October to May and the monthly frequencies of Polar lows in the Barents Sea are up to 15, recorded for the period 1999-2007, (Noer, 2009). Occasionally, Polar lows occur outside this period of the year.

- Delayed work into the polar low season might wait to next year.
Extreme challenges (cont.)

- Icing is caused by sea spray, under cooled rain, snow and atmospheric icing.
- There are occasions of rapid icing on offshore platforms and vessels caused by sea sprays (for example in an outside temperature of -15°C, the accumulation of ice on a coast guard vessel was 110 tons of ice in 17 hours, Løset, 2009).
- Ice is freezing on instruments, wiring and mechanisms; there are slippery surfaces, evacuation means may become non accessible, etc.
- Low visibility is normal due to ice fog, lack of solar radiation, frosting of windows, etc.
- There is potential for the pollution of a pristine clean environment.
- **Will this requires more stringent design measures and operational procedures than elsewhere?**
Icing on Melkøya, Northern Norway, January 2006 (from Finnmark Dagblad)
Explorer, which struck an iceberg in the Antarctic Ocean.
Accounting for arctic conditions

1. Main marine installation work only during summer months
2. High pressure on personnel due to short season
3. Planning horizon only 9 to 12 hours
4. Extension into fall season might be needed
   - Secure good weather forecasts and wait on weather
   - Only for activities that will not cause catastrophic failures
5. Winterisation in case of any late season work:
   - Equipment placed in enclosed areas
   - Heat tracing to avoid icing
   - Heated water for fire water
   - Personnel protection from cold
   - Slippery surfaces
   - Frozen or iced equipment
Vessel to approach platform at safe speed and Weather criteria adjusted for Arctic

Competent Master and crew members

Permission required for entry into 500m zone

Op. Coordinator controls the approach

Op. competent for saling in Arctic conditions

Weather criteria adjusted for Arctic

Supply boat system failure

Supply boat changes agreed route due to 'bergy bits'

Insufficient visibility

Supply boat trapped by drifting ice

Supply boat is certified, surveyed and ISM accredited

All hardware certified for Arctic conditions

Ensure harware is ice free

Vessel trapped by drifting ice

Supply boat trapped against platform by drifting ice

Master ensures manoeuvrability of vessel

Ice braker on standby in critical season

Supply boat is positioned against wind & current

A Operations in A.03 Supply boat failure in safety zone

A Bow Tie with "Arctic Barriers"
Conclusions

1. Improved comprehension of major hazards
   - Operating personnel
   - Engineers and designers
   - **Management** team
2. Involvement in safety management system
   - Emphasis on understanding the “Arctic barriers”
3. Increased resilience of the safety management system
   - Invite the “Devil’s advocate” to identify risk
4. Need for implementation of Arctic barriers
5. Need for improved weather forecasts
6. The bow-tie method presented is an excellent tool to identify needs for barriers