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Limitations related to marine operations in the Barents Sea

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Abstract. Some marine activities in the Barents Sea are normally ongoing year-round; others are dependent on limited weather windows. The limitations for the marine operations are the special weather conditions characterized by unpredictable Polar Low situations during the fall, winter and spring seasons, as well as cold temperatures that also are causing sea spray icing and the potential for drifting ice in certain parts of the Sea. It must also be realized that large distances combined with challenging meteorological and oceanographic criteria as well as darkness during the winter period represents a concern for evacuation and rescue, should it be necessary to abandon ships and platforms. The long distances to the locations farthest away from shore are, furthermore, out of reach of helicopter assistance. These aspects make it necessary to conduct hazard identification studies and to include all relevant historical knowledge in the hazard identification session, prior to the execution of marine operations in the Barents Sea.

1. Introduction

Marine operations in the Barents Sea are carried out by the oil and gas industry, by the fishing industry through activities for collecting cods and crabs and other kinds of fish, by the commercial transport industry as well as by personnel transport companies, including the cruise traffic.

Unpredictable Polar Low situations during the fall, winter and spring seasons characterize the Barents Sea as well as cold temperatures, causing sea spray icing and the potential for drifting ice in certain parts of the Sea. The Polar Lows limit the predictability of suitable weather windows, necessitating planning for emergency disconnection of marine operations. The cold temperatures give rise to needs for winterization of vessels and equipment. Sea spray icing limits the possibility for operability of equipment and raises concerns as to stability of certain kinds of smaller vessels. Furthermore, possible drifting ice represents a danger to any operations towards the north of the Barents Sea and needs to be monitored carefully. Particularly valuable areas in the Svalbard – Barents Sea – Lofoten area are shown in Figure 1 [1].

Figure 1. Particularly valuable and vulnerable areas in the Barents Sea–Lofoten area (shown in green), From [1]

2. Activities in the oil and gas industry

All activities in the oil and gas industry are vulnerable to the physical environmental conditions, in particular to the wave conditions. Both wave heights and wave periods are critical parameters [2] to ensure that resonant motions with rigs and offshore support vessels are avoided. Orimolade [3] and coauthors [4], [5] have discussed weather limitations for safe marine operations in the Barents Sea. An important finding is the potential for waves in Polar Low situations growing very quickly to large waves, confirming a model for waves in Polar Lows as proposed by Dysthe and Harbitz [6].

Without doubts the low temperatures in the Barents Sea (Figure 2, from reference [7]) will also influence the marine operations in the Barents Sea. Limitations due to combination of low temperatures and winds have to be considered due to the strong wind chill effects in low temperatures. In very low effective temperatures, personnel should not work outdoors.

Furthermore, winterization [8] of facilities and equipment is important where safe operations and safe escape be given highest priority, i.e. safety critical equipment must be prioritized. It will, however, be necessary to limit the amount of energy spent to keep the facilities free of ice, therefore, the consequences of heavy icing situations may be limitations in operational uptime for the facilities. Such situations may cause large pressure on the operating staff and the management of Barents Sea operations must be aware of the potential for lower production uptime in Barents Sea operations as compared to work in more temperate climate [9].

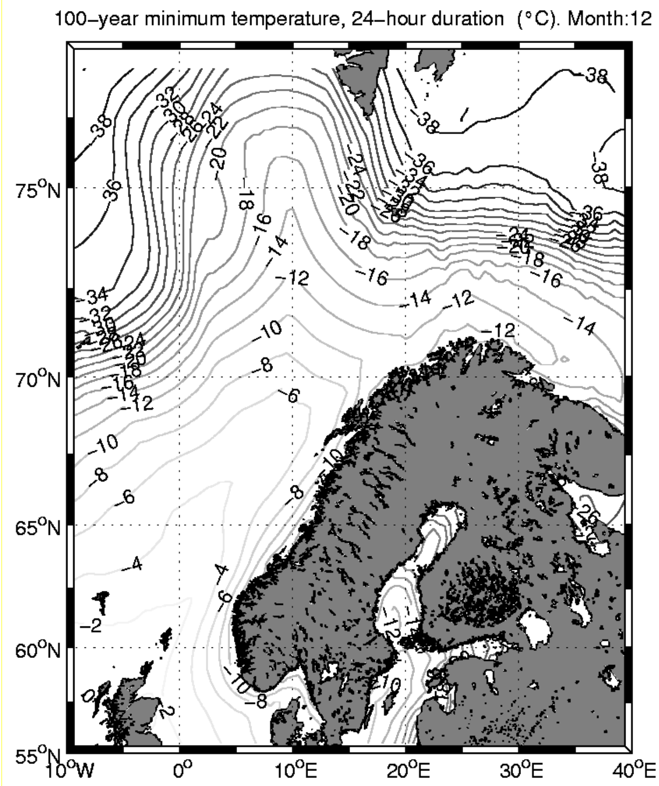

Figure 2. December: 24-hour duration minimum temperature at 2 meters above SWL on the Norwegian Continental Shelf (= minimum in data base -2°), data period 1958 – 2011. Figure 27 from [7]

There is an ongoing discussion in Norway regarding the limit for sea ice, “the ice edge”, where year around operations could be halted by sea ice in certain years, see Figure 3, [10]. The discussion relates to whether only recent years or a longer period shall be taken for the estimate of the expected ice limit. Ice conditions in extreme years are shown in Figure 4, [11].

Limitation to year-round operations will be encountered in years with ice. Of particular concern is drifting bergy-bits or smaller icebergs, drifting near to facilities. Norsok N003 [7] and the relevant International Standard [12] call for ice management and evaluation of the possible need for disconnection should dangerous situations be threatening the facilities. The monthly maximum number of icebergs in May within a cell of 100 x 100 km is given in Figure 5 according to reference [13].

3. The fishing industry

The fishing industry has been operating in the Barents Sea for hundreds of years. In the past, the lack of models to forecast Polar Lows have caused considerable concern with the loss of a large number of persons.

As the fishing industry is one of Norway’s most important industries, much attention has been paid to provide rescue possibilities for the fishermen. There are also situations when Norwegian authorities close fishing ports in the north to limit fishing vessels from leaving the ports for the fishing grounds.

The main concerns regarding technical issues are still the reliability of weather forecasts and the possibility that sea spray icing will lead to lack of stability, [14]. Also in recent years loss of fishermen and fishing vessels are reported. It should be noted that the fishing fleet follows the ice retraction and that the fleet now is active in the waters around Svalbard and that new seafood resources are explored when opportunities arise [15]. Figure 6 shows the area where snow-crabs can be found. The catching of snow-crabs is very profitable; this area represents challenging meteorological and oceanographical challenges [15].

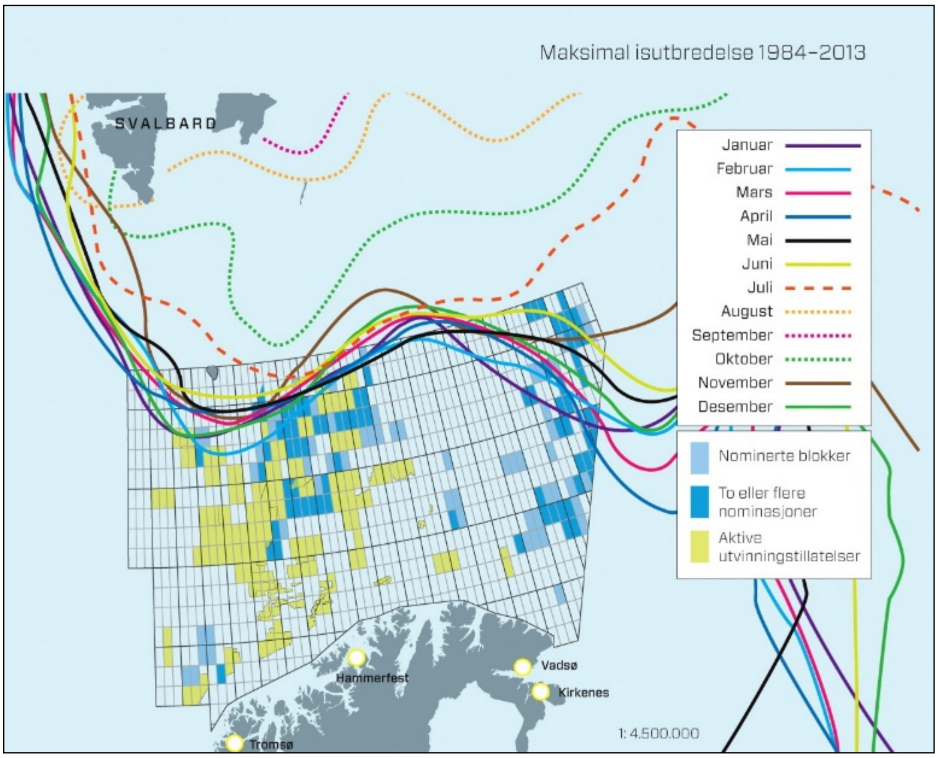

Figure 3. Ice in the Barents Sea during 1984 to 2013, [9].

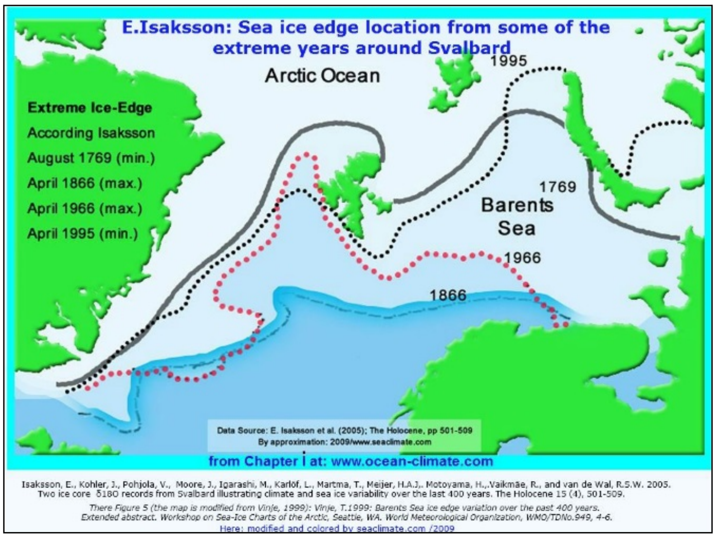

Figure 4. Sea ice edge location from some of the years with extreme ice [10], see http://www.arctic-warming.com/wp-content/uploads/2014/02/91.jpg.

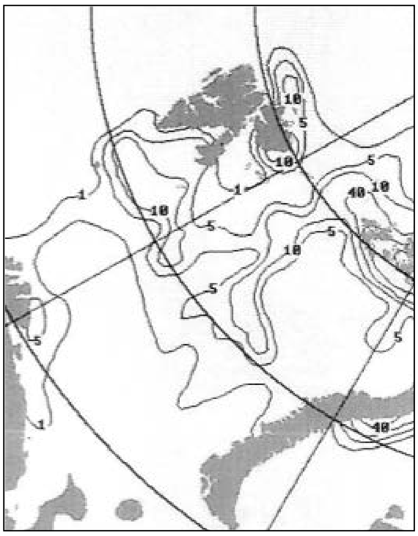

Figure 5. Monthly maximum number of icebergs in May within a cell of 100 x 100 km according to reference [13].

In order to ensure that agreed fishing quotas and agreed regulations are respected, the Norwegian Coast Guard is present in the Barents Sea and in the waters of the Svalbard archipelago. The Coast Guard vessels, furthermore, ensure a rescue backup to the rescue helicopters stationed at Banak airport.

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4. Transport in the Barents Sea

Transport along the coast and across the Barents Sea is limited by weather conditions. Some days every year, ships from the coastal express fleet leaving from Bergen in the south for Kirkenes in the north have to seek shelter.

Furthermore, collisions between south-going and north-going vessels are of concern. Separate transport corridors have been established for southbound and for northbound vessels, respectively, Figure 7 [1]. More than 80 % of the total distance sailed in the Barents Sea–Lofoten area by vessels of gross tonnage over 10 000 within the areas covered by the traffic separation schemes between Vardø and Røst, and this includes almost 100 % of all tanker traffic. Tug boats are also stand by in harbours (including the LNG shipping harbour at Melkøya) to ensure that vessels losing propulsion can be towed so they will not be grounded.

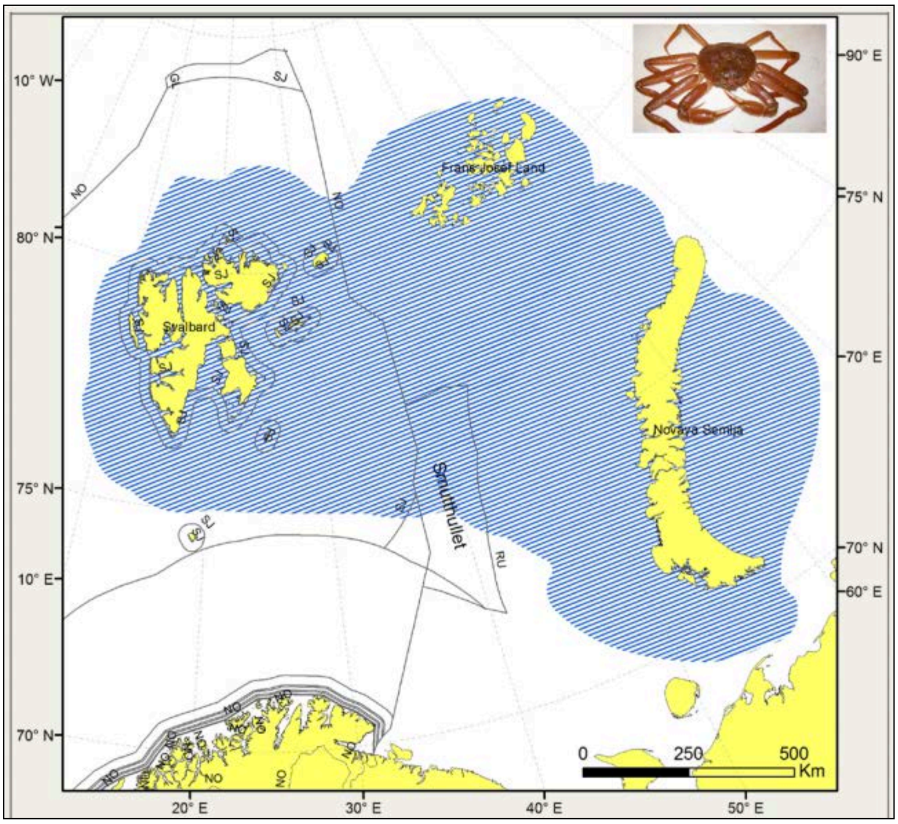

Figure 6. Area where snow-crabs can be, or is expected, to be found [15]

Measures implemented between 2005 and 2010 to improve maritime safety include [1]:

- An Automatic Identification System (AIS) for ships (information, tracking and collision prevention) has been introduced. It is estimated that the system has reduced the risk of collisions by 20 %.
- Satellite-based monitoring of sea areas has been further developed.
- The Vardø VTS Centre was established in 2007 and monitors high-risk traffic along the entire Norwegian coast, including Svalbard.
- The traffic separation schemes between Vardø and Røst were established in 2007.
- The emergency tugboat services have been further developed and three new tugboats have been hired on short-term contracts.
- The new Act relating to ports and navigable waters entered into force in 2010. It applies in Svalbard, and the earlier Harbour Act was made applicable to Svalbard in 2008 in regulations.

- The Norwegian Coastal Administration has developed a procedure for coordinating the actions of the authorities in situations where a vessel needs to be brought to a port of refuge. A prior assessment of suitable geographical areas has been made.
- To limit the damage in the event of a spill, a provision was introduced in 2007 forbidding ships calling at the nature reserves in eastern Svalbard from carrying or using any fuel other than light marine diesel. Since 1 January 2010 a corresponding provision has applied in the three large national parks in western Svalbard as well. A temporary exception until 2015 has been made for the approach to Ny-Ålesund and the Magdalenefjorden.

The Barents Sea is also the gateway to the North-Eastern Passage, The Northern Sea Route, Figure 8. The Norwegian city close to the Russian border, Kirkenes, is a good harbour for repair of vessels, for shelter in case of challenging weather conditions and for ensuring that Russian travel permits are obtained.

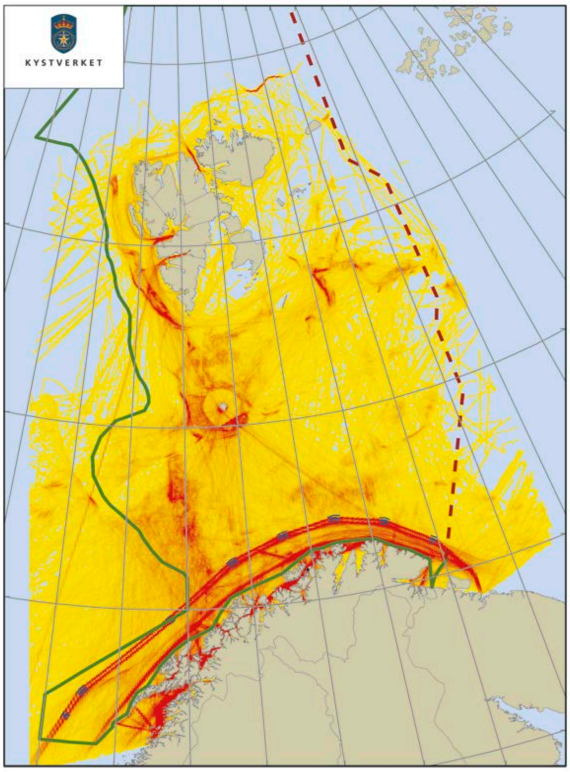

Figure 7. Traffic density in the management plan area, the traffic separation schemes between Vardø and Røst (thick red line) and near coast areas in the second half of 2010. The highest traffic density is indicated by the red shading [1].

Figure 8. Kirkenes is the gateway to Northern Sea Route

5. Other commercial activities

Commercial activities have in the past included seal hunting and whaling. The risks involved to the participants were extreme, in some years a large percentage of the vessels and the hunters were lost, [16]. Figure 9 shows the situation with large ice floes riding on big waves.

Figure 9. Outside the ice edge, large ice floes surfing on waves [16]. Photo: W. Warholm

Recently, the cruise industry has shown considerable interests in the Barents Sea and in particular the coast of Svalbard. The cruise ships are normally travelling in the summer season; however, the Norwegian Coastal Express takes passengers all year along the Norwegian coast.

Of main concerns are the pollution from the vessels in the harbours and at sea and the search and rescue operations in case of accidents. The rescue capacity is limited in this region to a limited number of persons. For a discussion of evacuation, search and rescue see below.

6. Evacuation, search and Rescue

6.1. Helicopter rescue

When examining the feasibility of providing long-range search and rescue for personnel in the Barents Sea, we should consider a helicopter accident while en-route to or from an offshore petroleum installation in the Barents Sea or to a maritime accident. In [17] a combination of a SAR helicopter and multipurpose emergency response vessels is proposed, whereby improved search and rescue capacity is obtained both for personnel involved in the petroleum industry and others i.e., fisheries, maritime transport and tourism.

The basis for the paper [17], is the petroleum exploration activity in the far North-Eastern area of the Norwegian sector of the Barents Sea, Figure 10. The area is currently opened for oil and gas exploration. There is currently little or no infrastructure in the area beyond the coast. A method to provide SAR coverage over a distance of 260 nautical miles with a minimum rescue capacity of 21 persons within two hours is considered in [17]. Issues related to survival in cold water, immersion survival suits and performance requirements for search and rescue resources are challenging in order to provide an optimum combination and enhanced probability of survival if an incident should occur.

Operational considerations involving departure criteria for helicopter transport should be developed in order to ensure that persons travelling on a helicopter to remote locations in the Barents Sea have a reasonable prospect of surviving a helicopter ditching and subsequently being rescued. In [17] it is documented that Multipurpose Emergency Response Vessels, ERVs, equipped with dual Fast Recovery Daughter Craft, FRDC, capable of operating in an Arctic climate deployed at the remote location and en-route, together with an onshore based search and rescue, SAR, helicopter may provide a rescue capacity for 21 persons within 120 minutes.

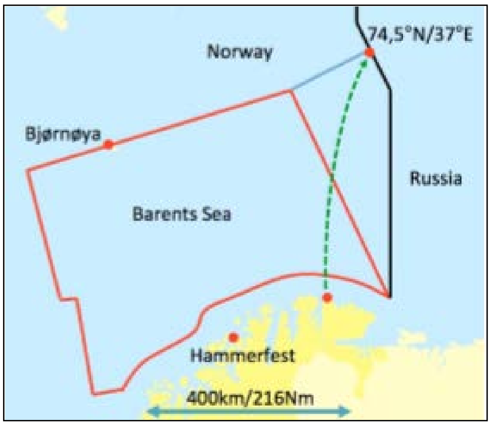

Figure 10. Map of the Barents Sea (Source: npd.no), from [17].

6.2. Rescue of persons from a cruise ship

The cruise industry's efforts to provide customers with visits to even more remote cruise locations may represent a large challenge in case there is a need to evacuate a cruise ship. Of particular concern is survivability in poorly insulated rescue means in Polar Regions. A search and rescue exercise (SARex 1) north of Spitzbergen during April 2016 [18] was, therefore, conducted to assess whether standard SOLAS rescue equipment would satisfy the five days survivability requirement of the IMO Polar Code [19], which was implemented in January 2017. Another exercise was conducted in May 2017 (SARex 2) with improved equipment, Figure 11.

The polar conditions experienced during the survival exercises arranged by University of Stavanger, GMC, Stavanger and the Norwegian Coast Guard at north Spitzbergen in April 2016 and May 2017 generated polar-specific challenges for the exercise participants and for the lifesaving equipment. It was planned to simulate relevant polar conditions, incorporating sea ice, sea swell, low air and water temperatures and remoteness.

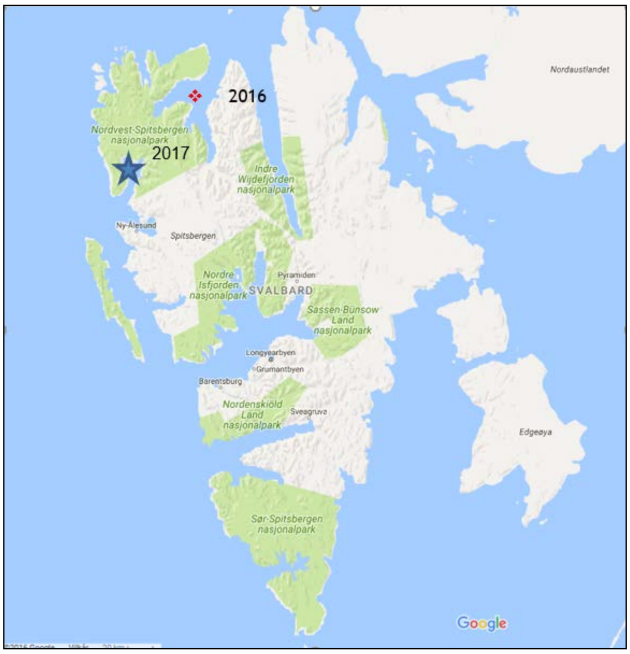

Figure 11. Locations for SARex 1 (2016) and 2 (2017)

The detailed objectives of the exercises and the associated research programs were to:

- Assess the adequacy of the lifesaving appliances (lifeboats and life rafts) as required by the IMO Polar Code.
- Identify the gaps between SOLAS [20] approved rescue craft (lifeboats and life rafts) and the requirements defined in the IMO Polar Code.
- Identify the gap between SOLAS approved personal protective equipment (PPE) and the requirements defined in the IMO Polar Code.
- Assess the personal/group survival kits as defined by the IMO Polar Code.
- Train Norwegian Coast Guard personnel in emergency procedures in ice-infested waters, with reference to evacuation and rescue from cruise ships.
- Identify the effects of improved equipment during the 2017 exercise as compared to the 2016 exercise.

The following topics were addressed in the exercises:

- Functionality of life raft/lifeboat under polar conditions.
- Functionality of personal protective equipment (PPE) (e.g. thermal protection/survival suits).
- Additional training requirements for crew and passengers.
- Evaluation of Coast Guard's search and rescue procedures, including handling of mass evacuations in Polar Regions.
- Evacuation to sea ice (2016).
- Evacuation by helicopter (2017).
- Identification of the functionality of search equipment in Polar Regions (2017).

We concluded after the 2016 exercise (SARex 1) that the IMO 5-day survival requirement poses strain on all rescue means and causes the needs for improved PPE (personal protection equipment, for example improved survival suites), insulated lifeboats and insulated life rafts. The follow-up search and rescue exercise (SARex 2) was thereafter conducted with improved rescue means. We saw relatively large effects of insulation of rescue means, heating of lifeboat, use of improved personal protection equipment and of limiting the number of personnel onboard the rescue means (because of the bulkier PPE needed for survival in Polar Regions).

7. Hazard identification and risk analysis

In order to ensure safe marine operations [21] in the Barents Sea, a thorough risk analysis is suggested. The risk analysis hazard identification phase will be most important where the following aspects are of main concern [22]:

- experience from operations in the area
- experience with the technology being applied
- weather forecast's reliability during the operation
- human factors relevant for the participants
- the company's experience with activities in the area
- the company management's ability to handle activities in the high north [9].

As relevant quantitative data will be sparse, the use of qualitative risk analysis schemes may be very useful to identify risks of concern and their possible mitigating measures. Operations which can be set on hold or be abandoned quickly have much lesser risks than operations which last for longer periods and which cannot be stopped. Regarding the complexity of risk analysis for Arctic operations, see [23].

The Arctic Operational Handbook [24] reviews different themes related to operations in the Arctic and concludes that:

- It is noted from the gap analysis that there is limited guidance in International Standardization Documents (ISO documents) for pipe lay, trenching and dredging operations, let alone for the arctic areas.
- Site specific operations should be considered when planning and carrying out operations.

- Considerable effort was performed to align the knowledge on weather conditions and in particular on the requirements for monitoring and forecasting as well as the requirements for decision based tools.
- For the transportation & logistic aspects, input to the report relied heavily on the existing guidance for arctic shipping which is further developed and was evaluated and transferred to recommendations for the specific services of this guide.
- The report provides guidance as required specifically for contractors expecting to work in arctic areas on the aspects of health, safety, training and also stakeholder mapping.
- A frame work is provided to perform environmental impact assessments both in early as well as detailed stages of design in order to ensure that impacts can be managed and mitigated. Specific attention was given to the evaluation of the loads on and the operation of disconnectable floating production units.

8. Conclusions

There exist considerable more limitations to marine operations in the Barents Sea compared to more temperate areas. The activities should be handled with extreme care to avoid damage to the environment and to assists and to avoid fatalities. Risk identification and risk analysis are important tools if properly conducted. All relevant historical information about the area must be included in the hazard identification [16]. It seems, however, that “waiting on weather” should be considered to ensure safe operations in the Barents Sea.

Acknowledgments

The author would like to acknowledge the cooperation with colleagues who have worked with him on issues related to marine operations in the Barents Sea, in particular students at the University of Stavanger, and scientists at NTNU, Trondheim and at University of Tromsø, the Arctic University of Norway. He will suggest that the theme is of much importance for Norway and he will encourage further work on the subject. It would be seen as a waste of research opportunities in case the theme is abandoned at the University of Stavanger.

The author will also challenge the oil and gas industry and the Petroleum Safety Authority of Norway to ensure that all aspects of marine activities are considered prior to giving consent to perform marine activities in the Barents Sea.

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