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# Recent Norwegian Research Relevant to Evacuation, Search and Rescue under Arctic Conditions

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**Abstract.** Marine traffic is increasing in the Arctic Region. As ice in the Arctic Region retracts, opportunities for the marine industry increase. This relates to the fishing industry, which is moving further into the Arctic Seas, the shipping industry, which is using the Northern Sea Route, particularly for transporting liquefied natural gas, and the cruise industry, which is transporting passengers to the last frontier on the globe. The question has been raised: Are the marine industry's activities in the Arctic Region safe for people, the environment and assets? The International Maritime Organization's (IMO) Polar Code, which came into force in 2017 sets requirements for ships and procedures, as well as for the competence of those involved. In particular, there have been uncertainties regarding how people on board a ship in distress can be saved should it be necessary to abandon ship. The question is of considerable concern in Norway, which is a main stakeholder in the Arctic Region, with the involvement/passage of many fishing, cargo and cruise vessels. Over several years, considerable research has therefore been carried out to review the status of safe operations in the Arctic Region and to identify methods to improve the safety of all involved in the Arctic maritime traffic. This paper presents a summary of recent Norwegian research relevant to safe evacuation, search and rescue under Arctic conditions. The summary includes the outcome of the Norwegian research programme, Sarinor, the SARex exercises carried out by the University of Stavanger, the Norwegian Coast Guard and the industrial company GMC (Stavanger) in 2016, 2017 and 2018, as well as follow-up research carried out later. Its implementation in the IMO is also discussed. Finally, thoughts on continuing the work to further improve safety are presented.

## 1. Introduction

The countries bordering the Arctic Seas have signed an agreement on how to share the responsibility for Arctic Search and Rescue, SAR [1]. The agreement covers the entire area north of the Polar Circle and, in some areas, also to the south of this latitude; see Figure 1. The area to be covered by Norway represents one of the busiest areas of the Arctic, including the rich fishing in the Northern Barents Sea, as well as the open sea north of Svalbard, and the commercial and cruise traffic to the Svalbard archipelago. Furthermore, all ship traffic to western Russian ports passes through Norwegian territory. In order to handle the SAR obligations that Norway has undertaken in this area, considerable research activities and several exercises have been carried out during the last decade.





**Figure 1.** Area covered by The Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic [2].

A main concern regarding the safety of cruise vessels and passengers was raised after the evacuation and rescue of passengers from the cruise vessel, Maxim Gorkiy. The vessel collided with an ice floe on its way to Svalbard on 20 June 1989 and was close to sinking. All 995 passengers and most of the ship's crew evacuated in open lifeboats, and some were transferring to ice floes when the lifeboats were impacted by the ice floes. The Coast Guard vessel KV Senja was not far away on normal Coast Guard inspection missions and arrived within a few hours of the evacuation, in time to rescue all [3]; however, the length of time for a Coast Guard vessel or other ship to arrive at the remote site would normally be much longer. This incident and another in Antarctica in 2007, when the M/V NordNorge rescued all from the sinking vessel M/V Explorer [4], raised the question of whether the SAR capability offered within the country's area of SAR obligation in the Arctic is adequate and sufficient.

The question regarding necessary SAR capability has raised the concern of politicians, authorities, research centers and industry, and it may be prudent to summarize the efforts and results obtained in Norway on this theme and share the results and experience. First and foremost, the Norwegian Maritime Authority has actively contributed to the preparation of the International Maritime Organization's (IMO) work on the International Polar Code, which was agreed in 2014 and came into force in January 2017 [5]. This code covers ships operating in polar waters, although not fishing vessels, and is to be regarded as a supplement to the SOLAS and MARPOL codes [6], [7] for the safety of vessels and the environmental aspects of polar shipping, respectively. Figure 2 shows the area covered by the Polar Code.



**Figure 2.** The Arctic area covered by the Polar Code [5].

## 2. Methods

### 2.1. Research Activities Initiated in Norway Relevant to Evacuation, Search and Rescue under Arctic Conditions

The Norwegian Foreign Ministry and the maritime industry represented by The Maritime Forum (a foundation representing the entire maritime industry in Norway) took the initiative in 2013 to establish the **SARINOR** project. The main objective was to suggest measures for technical and organizational improvements in the different phases of a search and rescue operation in Arctic waters. The reports of the project are summarized in [8], while the individual reports (in Norwegian) can be downloaded from SARINOR's homepage [9]. The reports emphasize the responsibilities of Norway's Joint Coordination Centres (JRCC) located in Bodø (Northern Norway) and at Sola (in the south, near Stavanger), as well as the SAR resources located on Svalbard.

Furthermore, the specifics of Arctic SAR due to the cold climate challenges are highlighted, with an emphasis on avoiding hypothermia. Alerting and notification are discussed, and the role of the Norwegian Coast Guard during search and rescue is highlighted. It should be noted that the Norwegian Coast Guard is exercising authority over a sea region comparable to the size of the Mediterranean. The search situation in the Arctic is discussed, as satellite coverage is limited, and helicopter search is constrained by long distances. It is, furthermore, emphasized those organizational challenges are present and harmonization between relevant SAR actors is needed. Survival in a cold climate is a key theme in the reports, with an emphasis on "life-saving appliances enabling a minimum of five-day survival", as requested by the Polar Code. In order to retain the attention of those involved, regular training and exercises are needed. Several of the reports were prepared by researchers at Nord University, Bodø, Norway; see also [10-13]. Much of the follow-up research carried out in Norway has been based on the SARINOR recommendations. It should be noted that The Norwegian Coast Guard was an active participant in the SARINOR project, providing advice to the researchers.

The work at Nord University continued with the international **MARPART** project [14], funded in part by the Norwegian Research Council. The main purpose of this project was to assess the risk of the increased maritime activity in the High North and the challenges this increase may represent for the institutions responsible for the preparedness in this region [15-18]. Emphasis has also been placed on cooperation across the borders in the north [19], as “to provide an adequate and timely emergency response, it is critical to pool resources especially when it comes to large-scale emergencies and emergency preparedness in the remote areas of the High North”.

The introduction of the Polar Code [5], and particularly the requirement for a minimum of five-day survival, spurred the Universities of Stavanger and Tromsø to join the Norwegian Coast Guard to carry out search and rescue exercises in the waters off Svalbard at 80 degrees north, from 2016 to 2018. These **SARex** exercises involved researchers, industry and equipment manufacturers, as well as the authorities. Of particular value was the participation of the Norwegian Maritime Authority. The ice-strengthened Coast Guard vessel KV Svalbard was used for the exercises, also providing training for the personnel on board. The emphasis was on rescue equipment and survival. During the 2016 SARex, standard SOLAS rescue equipment was tested, with the conclusion that the equipment would not be sufficient to fulfil the IMO Polar Code requirements [20]. Improved equipment was, therefore, tested in 2017, with the conclusion that smaller improvements gave huge benefits [21]. The key improvements were as follows:

- for the life raft, the bottom of the raft had a double layer to protect the rescued from the cold water below. The raft was also taller, to allow people to stand up, and the ventilation was better arranged
- for the lifeboat, the seats were equipped with insulation, the heating and ventilation were better arranged and there was improved space to move around.

A summary of the findings is presented in [22]. Of particular concern were the rapid build-up of CO<sub>2</sub> concentration within the rescue means and the need for more calories and water than prescribed by SOLAS. In this respect, it should be noted that much energy is needed to keep the body warm in a cold environment. Another finding was the low capacity of rescue helicopters: insufficient in a mass rescue situation. Further to these exercises, SARex 2018 was carried out to test personal protective and group protective equipment packages provided by the industry. Large deviations between the quality of the equipment were evident [23]. The main benefits of the SARex exercises were the rapid inclusion by the IMO in 2019 of the main findings of the exercise through new interim guidelines for life-saving appliances and arrangements for ships operating in polar waters [24]. This was made possible through the participation of the Maritime Authority of Norway in IMO committees and the availability of the SARex reports [20], [21] and [23].

The SARex exercises encouraged further research at the University of Stavanger. The question “How long will it take from the life-saving means being detected until the survivors are safely rescued” was discussed, with a warning that rescue may take a long time in the case of mass evacuation, in remote areas of the Arctic [25]. Furthermore, the fact that the Polar Code is a functional goal-based code, providing very few specific requirements and specific solutions, has been studied, with an attempt to understand how the requirements of the code are understood in different cultural environments [26] and [27]. Furthermore, a thorough summary regarding the challenges of emergency preparedness and rescue in Arctic waters has been prepared by participants of the SARex exercises [28].

The aspect of training and exercises is important, to ensure the competence of the personnel involved in rescue operations. IMO puts particular emphasis on this in the Standards of Training, Certification and Watchkeeping for Seafarers (**STCW**) [29]. The thoroughness of Polar Code training courses has been investigated [30], with the conclusion that personnel involved must participate in exercises, not only in desk-top evaluations and classroom teaching. It should be noted that the Coast Guard carries out regular exercises, as the young staff on board change every year. The Maritime Forum North has also recently (2020) carried out exercises for young cadettes, to ensure their familiarity with evacuation and rescue equipment.



At the Western University of Applied Sciences (Haugesund Branch), studies are ongoing to investigate the evacuation time onto life-saving means in cold slippery weather conditions when the vessel is heeling. Onshore corridors simulating the situation on board a vessel in distress have been used [31]. This research forms part of the general research at this institution on the management of maritime safety [32].

## 2.2. Gap Analysis, Further Research Needs

International research, particularly that carried out at the Memorial University of Newfoundland on both evacuation and rescue means, is appreciated, although this paper summarizes only attempts and projects carried out in Norway. However, there remain gaps when it comes to evacuation, search and rescue in the Arctic:

- In the case of drifting icefloes, evacuation onto ice floes remains an option; however, the stability of ice floes cannot be guaranteed, and the evacuation is particularly of concern in the case of drifting ice, as collisions between ice floes represent a potential hazard.
- Searches in the Arctic region are particularly challenging, due to the darkness during the long winter, the snow during several months and the fog during summer. Efficient satellite communication reaching all over the Arctic is needed, in order to identify vessels in distress.
- The rescue capacity cannot be increased to cover all the areas where vessels may wish to go. The huge distances take days to travel, and the limited number of vessels in the area does not warrant the build-up of a large and oversized rescue capacity. Therefore, the authorities will have to issue warnings and fines when vessels decide to go beyond rescue limitations. A recent rescue operation in the Hinlopen Strait, between Spitzbergen and North East Island in the Svalbard archipelago, ended in very narrow success, as the helicopter from Longyearbyen had only minutes left to finalize the rescue before having to return to base. The vessel owner was fined, as the safe vessel operation limit was breached [33].
- The limitation of use of helicopters must be clarified, regarding distance that can be travelled due to lack of fuel, the weather situation when helicopters can be used, and the limited number of persons a helicopter can rescue back to base.
- The “Buddy concept”, where several vessels travel together, should be investigated. Note the success of the Antarctica rescue [4].
- The capacity to rescue persons from a vessel carrying a very large number of passengers is limited, and the cruise vessels should therefore limit the number of passengers. It is surprising that the insurance companies allow vessels with a large number of passengers to be insured when entering Arctic waters [34].

## 3. Conclusions and Recommendations

Recent Norwegian research relevant to evacuation, search and rescue under Arctic conditions has concentrated on mass evacuation situations, following the almost disaster of the near sinking of the cruise vessel Maxim Gorkiy. This paper summarizes the key findings and lists the key papers published by Norwegian researchers. There is no doubt, however, that the research activities should continue and that the authorities will keep an eye on the progress.

Authorities may also pose restrictions on activities while attempting to increase the SAR capacity. However, the most important parts are safe travel, where the probabilities of an unwanted event are minimized and where the consequences are limited and in no case catastrophic.

Furthermore, the SAR capability is never better than the competence of the rescuers. Therefore, every generation of rescuers needs to ensure that the competence is in place and that training is undertaken regularly. The author particularly admires the efforts of the Norwegian Coast Guard and the Norwegian Joint Rescue Coordination Centres. There is no doubt that the work to prepare for safe search and rescue, as performed in Norway, can be studied by people from other nations.

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