# Cruise and data report from the cruise with CGV Svalbard May 20 - May 26 2019 SARex SVALBARD 2019-2020

Terje Brinck Løyning, PhD.
Editor

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Maritimt Forum Nord SA
Havnegata 28
8514 Narvik

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# Contents

# Preface

This report is a cruise and data report and is supposed to give the first impressions and descriptions of experiences made and data collected during the cruise with CGV Svalbard in late May 2019. It will give an overview of what we did, where we did it, who participated, and the circumstances during the data collection. In other words, a rewritten description of the participant's field notes, with a focus on the data collection. The report will not give analysis of the data or assessments of the findings, but will hopefully serve as a support to the next step of investigations and analysis to produce thorough discussions and conclusions of the observations documented here. Hopefully, some results will end up as published papers in peer-reviewed scientific journals, and all the assessments and conclusions will end up in a final SARex Svalbard report at the end of the project in 2020. The report gives a description of the activities that were conducted before and during the cruise with CGV Svalbard in Isfjorden in May 2019. The first chapter gives a brief description of the planning process and the circumstances around the organization of the project and preparations for the cruise, and the background for a reorganization in mid March. The second chapter gives a day-to-day description of the activities during the cruise and the weather conditions, based on meteorological data from the weather station at Longyearbyen airport and a mobile weather station on land at Deltaneset. The third and last chapter contain the first impression reports and description of the field work in the participants own writing. The project management will like to thank the participants in the project for their contributions, their enthusiasm and good spirit on the meetings and during the cruise, and look forward to future involvement in the upcoming events and activities. We will also express our gratitude and appreciation to the Norwegian Coast Guard for their protracted support to the work of improving the safety for all kinds of maritime activity in the Norwegian parts of the Arctic region. In particular, we want to thank the commander Geir Martin Leinebø and his crew on board the CGV Svalbard for their excellent seamanship and their competent support to the different project activities during the cruise at Svalbard in May 2019.

# Chapter 1

# Preparation

## 1.1 Organization and Planning

The project SARex Svalbard 2019-2020 was funded by the Ministry of Foreign Affairs in late November 2018, and the first meetings were held almost immediately. Former chief of staff from the Norwegian Coast Guard, Commander SG Morten Jørgensen was hired as a project manager in December 2018, and the project was soon organized by the steering group. Participants from the SARex Projects in 2016, 2017, 2018 were asked to contribute to define the detailed objectives, and they did so to a certain degree in late January and at the beginning of February 2019 in several project meetings and workshops. They were also asked to take responsibility for some working packages defined in the project plan, and discussions of how the project management should cooperate took place through February and the beginning of March.The discussions ended without an agreement.

The project management was then reorganized in mid-March 2019, with Morten Jørgensen as the project manager, professor Annette Meidell and Terje Brinck Løyning from Maritime Forum Nord as project support. They started to fulfill the project plan, and invite participants from several maritime authorities, academic institutions and safety equipment manufacturers to join the project and conduct investigations under the project goal and objectives.

One additional workshop was held at Gardermoen 3. April where most of the cruise participants were present.

### 1.1.1 Coordination with the Governor of Svalbard

Despite the short planning time and short notice, the Governor of Svalbard and her staff were positive to the project and helpful to find solutions to adapt the project activities within the regulations for such activity at Svalbard. They also took responsibility to conduct the exercise of Mass Rescue Operation the last day


Figure 1.1: Test and exercise area May 2019. Deltaneset and Hiorthamn are marked with red dots.

of the cruise. The project management had chosen the Isfjorden area as a testbed and exercise area, and in cooperation with the police chief inspector Espen Olsen and the environmental advisors at the Governor of Svalbard's office. We chose the Deltaneset as a landing site for some activities, with Hiorthamn as reserve spot in case of heavy winds from an unfavourable direction. (See Fig. 1.1)

### 1.1.2 Main goal and objectives

**Main goal:** The overall goal of the SARex Svalbard project is to increase the possibility and probability to survive long enough to get rescued in an emergency in the polar regions (see the overall project plan for SARex Svalbard).

**Objectives** : On the cruise, we focused on three main objectives:

1. Test and evaluation of equipment in order to meet the requirements of the IMOs Polar Code in terms of survival and evacuation. The activities are related to all four working packages (WP) in the project plan,

i.e. Survival (WP#1), Communication and situational understanding (WP#2), Evacuation (WP#3), and Oil spill protection (WP#4).

2. To establish and document the best practise of evacuation methods from shore to a rescue vessel, through repeated testing and evaluation of several cases of passenger conditions, and to exercise and train the search and rescue personnel in the Red Cross Longyearbyen, at the Governor of Svalbard's office and at the Coast Guard Vessel Svalbard in order to improve their skills and knowledge. This activity is a recommendation from the SARiNOR project.
3. To increase the knowledge about how leadership and organization of a group of passengers affects the probability and possibility to survive over a period of several days, on shore, waiting to be rescued after an emergency evacuation of their vessel.


Figure 1.2: CGV Svalbard May 2019 Foto: Oda Iden, Sjøforsvaret ©

# Chapter 2

# Day by day description of activities and the weather

## 2.1 Monday May 20

This day was a day of transport and preparation, with people arriving by plane from Oslo and Tromsø. The travels were either organised by the project, or by each individual. Some arrived Longyearbyen the day before. The CGV Svalbard was conveniently at quay in the centre of Longyearbyen. After embarking the ship, the participants spent some time to install on board, on safety briefings and to prepare for the upcoming events.

The ship left the port in the afternoon. The weather was calm and with a cloudy sky. Air temperature at Longyearbyen airport was just below zero degrees Celsius, and decreasing during the evening. There was a light breeze from the North during the day.

## 2.2 Tuesday May 21

The first day was used on equipment testing in Isfjorden, conducted by of Aviation Survival Support and Survitec Group and a group of security and field organisers from the University Studies at Svalbard (UNIS). The UNIS group wanted to test their personal safety equipment, but borrowed a life raft from Survitec Group. These tests are described in the sections 3.1 and 3.2, and the photo 2.1 shows some of the UNIS test personnel entering the life raft from the water.

University Studies in Svalbard's (UNIS) main goal with participation in the SARex Svalbard project was to study and train leadership in one exercise at sea and emergency and survival in another exercise on land. The main training audience was the UNIS employees since they will have responsibility for the students and

Figure 2.1: Foto: Oda Iden, Sjøforsvaret ©

scientists in the field, and the UNIS small boat navigators since they will have the responsibility for the students and scientists in small boat operations. In addition, the UNIS exercise planners wanted to look at the use of various types of rescue equipment. These activities fit well into the work package Survival in the project plan.

On board the ship the other participants and personnel responsible for the upcoming investigations prepared for their tasks. Representatives from the Norwegian Coastal Administration (NCA) and Kongsberg SeaTex AS prepared their setup of maritime broad band communication for tests of data transfer from the CGV Svalbard to the main land Norway. A more detailed description is provided in section 3.3.

Another group was in intense preparation for the start of their investigations later in the evening. They wanted to investigate how organization, leadership and management can have an effect on probability of survival, together with scientists who wanted to investigate the need for sufficient nutrition in a survival situation, and the quality of rest and sleep in the same situation. All investigations were conducted on the same personnel.

The investigations were planned to take place on shore, over an interval of 36 hours. The participants in the experiments were organized in four groups of four. All groups were provided with some personal survival equipment, but not sufficient for all persons in the group, i.e. two sleeping bags per group as an example. Some group survival equipment were also provided, as well as emergency rations and water.

There were plenty of drift wood on the beach, and the groups were allowed to improvise and use what they found to build shelters and improve their survival conditions. The researchers regurlarly visited the groups, making interviews, and taking samples during the experiment. The experiment started in the afternoon at 5 P.M., where the groups and the responsible scientists were put on shore. A group of naval officers from the CGV Svalbard were responsible for polar bear protection and advisory support during the experiments.

From the weather station at Longyearbyen airport (https://www.yr.no/sted/Norge/Svalbard/Longyearbyen) the air temperatures varied from $-3.3°C$ to $-1.2°C$ with a light breeze from a northerly direction, changing the direction from East to South East in the evening. (These data are averaged values over an hour).

A mobile weather station borrowed from UNIS, was also put up on the beach before the personnel arrived to conduct the experiments. Figs. 2.2 and 2.3 shows the temperature and wind speed during the beach experiments, which lasted to Thursday morning. We can see that the temperatures are a bit higher than the measurements from Longyearbyen airport, and this can be explained by direct sunlight on the temperature sensors on the mobile weather station.

## 2.3 Wednesday May 22

On Wednesday the investigations continued on the Deltaneset beach, and during the day a group of UNIS personnel arrived at the beach to test and update their routines and group survival kits and camp equipment. The UNIS conduct a field safety course every fall for new students and new employees. This is obligatory for all UNIS personnel doing field work. The different groups did not interfere too much, the Deltaneset areas was vast enough. Fig. 2.4 shows a photo of a participant from the CGV Svalbard in front of a camp fire on Deltaneset. Details about how they constructed a wind protection of drift wood shows clearly on the photo.

On board the CGV Svalbard, the NCA and Kongsberg SeaTex AS continued and ended their experiments and testing of their maritime broad band set up. According to the report in section 3.3, the tests were successful.

Another technological communication device was also installed and tested on Wednesday. The Norwegian Coast Guard had given the SARex Project admission to install a tracking device on the SARex cruises, from the Norwegian shipowner's

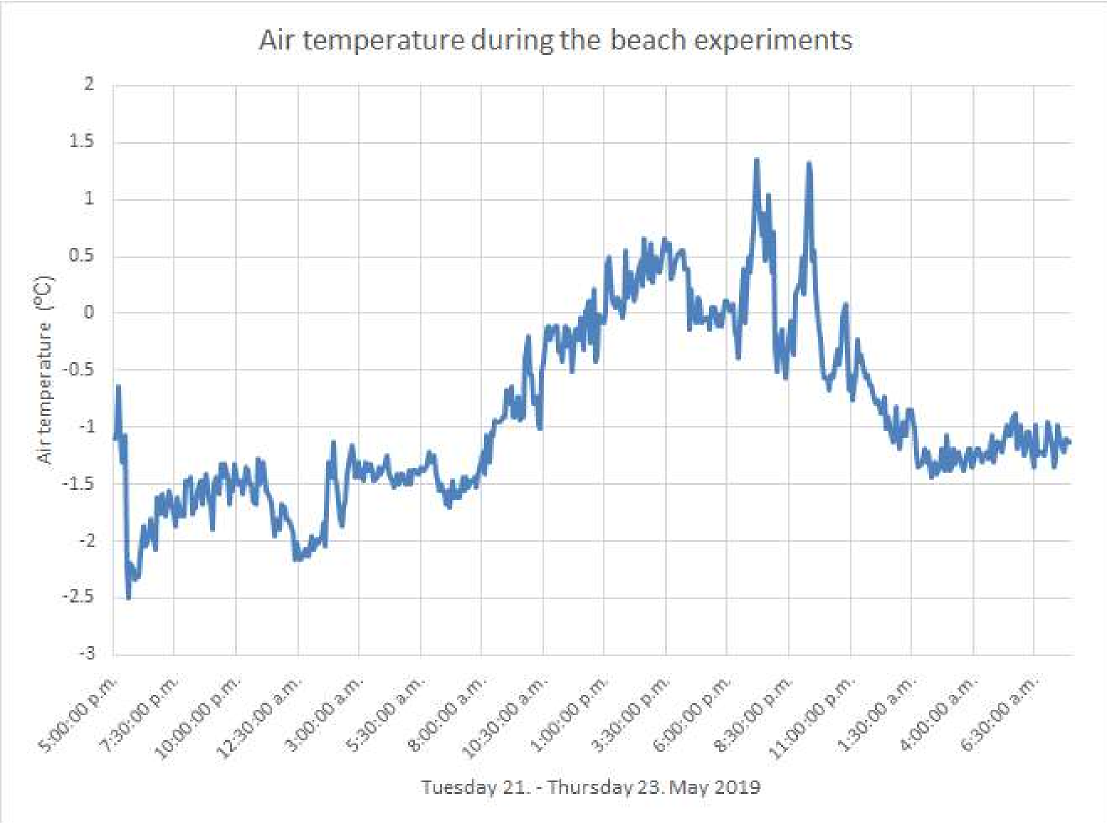


Figure 2.2: Temperature (°C) from the weather station at Deltaneset during the studies of leadership and organization, nutrition, rest and sleep.

Mutual War Risk Insurance Association (DNK), called Raptor. From their website https://www.warrisk.no/raptor-tracking/ we copy that

> «DNK now offer Members of the association sensor technology for all vessels covered by DNK, enabling a two-way, secure data connection with vessels worldwide. The Raptor antenna is free of charge and free of use for DNK Members. DNK will use the antenna to secure automatic collection of premiums in war risk areas, and to enrich our security offering. All members with Raptor antenna will be released of the legal obligation, and workload associated with reporting calls and transits through areas with additional war premium. In addition, the antenna opens a range of opportunities for DNK members to strengthen the digitalization process in the maritime domain.
>
> The unit communicate via dedicated satellites, providing members and DNK with updates from the vessel every 7th minute. The unit can also

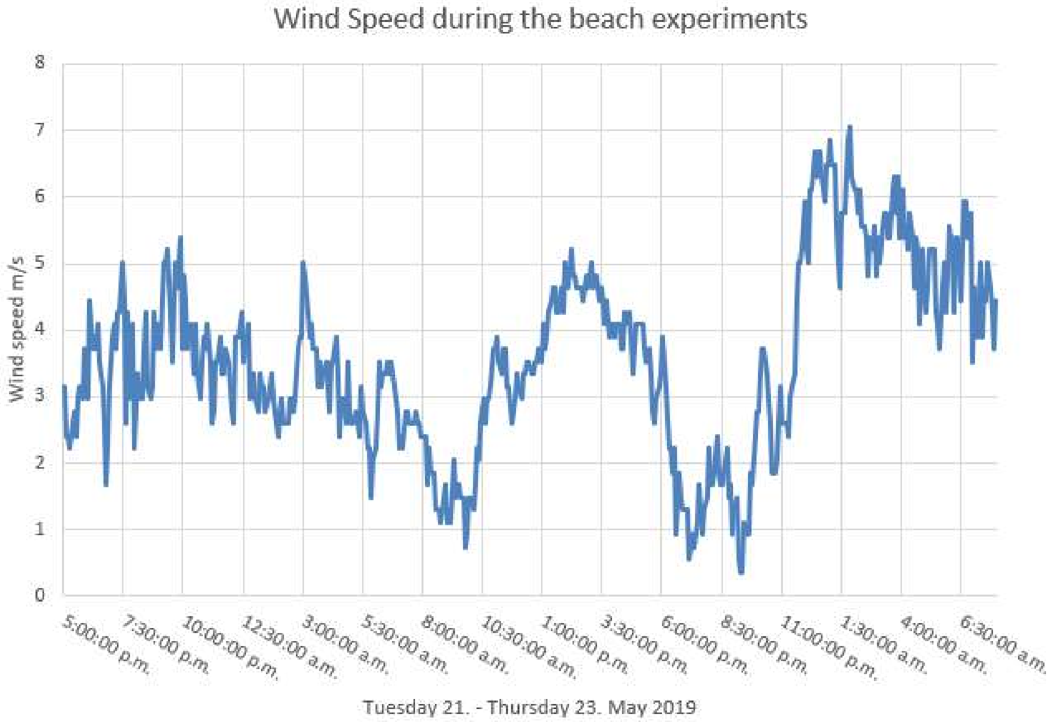


Figure 2.3: Wind speed in m/s from the weather station at Deltaneset during the studies of leadership and organization, nutrition, rest and sleep.

> be programmed to report according to Members specifications, via the Clearwater/DNK portal, which all Members with Raptor units will have access to. This system cannot compare with AIS, and is not supposed to replace AIS reporting.»

Some results from these days in May are presented in the section 3.7.

The air temperatures at Longyearbyen airport was on this day increasing from $-3$°C up to around 0°C and a light to gentle breeze changed from an East-South East direction to North West during the evening.

## 2.4 Thursday May 23

The personnel on the beach were returning to the ship this morning, using the rest of the day to recover. Some cruise participants left the expedition and returned home, a few others arrived to participate on the remaining days of the cruise. There was some unloading and loading of equipment, and a focus on

Figure 2.4: Camp fire with wind protection. Foto: Oda Iden, Sjøforsvaret ©

the remaining activities, especially a coordination of the mass rescue operations (MRO) on Saturday was intensified.

The Longyearbyen airport reports on fair weather, sunny, temperatures close to 0°C and a light breeze from North-North West.

## 2.5 Friday May 24

The coordination continued with the Governor of Svalbards office and the other actors for the Mass Rescue Operation event on Saturday. A briefing for the personnel from Longyearbyen was conducted on board the M/S Polarsyssel in the evening.

During the day the representatives from ISPAS group investigated several aspects of detecting personnel in the water with a radar. Their first report (see section 3.8) discuss how different survival suits may have different temperature signals, and therefore may be seen differently using an infrared camera. After a relatively short time period in the sea water, approximately 1 hour, the outer surface will have the same temperature as the sea water, and the person will be even more difficult to detect with an infrared camera.

The next report from ISPAS in section 3.9 explains how an electronic radar can detect persons in the water at a distance of approximately 1000 m after one hour in the sea water and in waves of about 1 meter. In short, this electronic radar scans a sector of 100 degrees in 0.2 seconds, and will by this feature get a «continuous» surface overview/picture. This is not possible with a standard radar, which constructs a picture with a rotating beam.

Several initial tests were also conducted with at radio transmitter on board an Unmanned Aerial Vehicle (UAV). This radio transmitter was connected to the maritime broadband radio on board the CGV Svalbard, and in this way we were able to get a picture from the UAV to the bridge of the coast guard vessel. Unfortunately, the wind conditions were hampering at proper test, with the UAV flying at the distance from the ship.

There was a plan to use this UAV with a radio transmitter and a power supply from the ground (i.e. the deck of M/S Polarsyssel) through a 100 m power cable. The concept has been developed by three bachelor students at the UIT – The Arctic University of Norway. Again, the wind conditions made it difficult to execute the experiments, and the UAV crashed on the ground during execution of the experiment.

Vladimir Sovilj, representating Viking Norsafe Life-Saving Equipment AS, tested and demonstrated how measured values (temperature, humidity, $CO_2$, etc.) from sensors on board a life raft or a life boat can be transferred to SAR-vessel or SAR-aircraft. He managed to transfer sensor data at a distance of about 5 km in a peer-to-peer based communication, independent of emergency radio frequencies. This can be useful information for search and rescue personnel in remote areas, approaching a life boat or a life raft. See section 3.6 for further details.

During the day the air temperature decreased from just below $-1°$C down to below $-5°$C. The wind speed increased from light to a moderate breeze, shifting from a Northerly direction to South East.

## 2.6 Saturday May 25

The Governor of Svalbard, represented by police chief inspector Espen Olsen, conducted the exercises and training this Saturday. His command post was on board M/S Polarsyssel. The participants from Longyearbyen gathered on board M/S Polarsyssel in the evening on Friday 24th for briefings and preparing for the day after. The activity on the 25th is described in section 3.11

During this event, CGV Svalbard had the role as "On-Scene-Commander" in "NO PLAY" events. In phase 1 they played the ship in distress and a large group personnel (97) on board the Coast Guard vessel were evacuated to the beach. The commander of CGV Svalbard had the role as «AIR COORDINATOR» during the exercise.

**Meteorological parameter statistics Saturday 25. May**

| Parameter | Average | St.dev. | Max | Min | Spread |
|---|---|---|---|---|---|
| Air Temp. (°C) | -5.6 | 0.4 | -4.6 | -6.5 | 1.9 |
| Wind Speed (m/s) | 3.9 | 1.6 | 7.8 | 1.3 | 6.5 |
| Relative Humidity (%) | 76.7 | 7.2 | 87.6 | 64.9 | 22.7 |

Table 2.1: These parameters were measured with at mobile meteorological station at the beach. (Spread is the difference between max and min.)

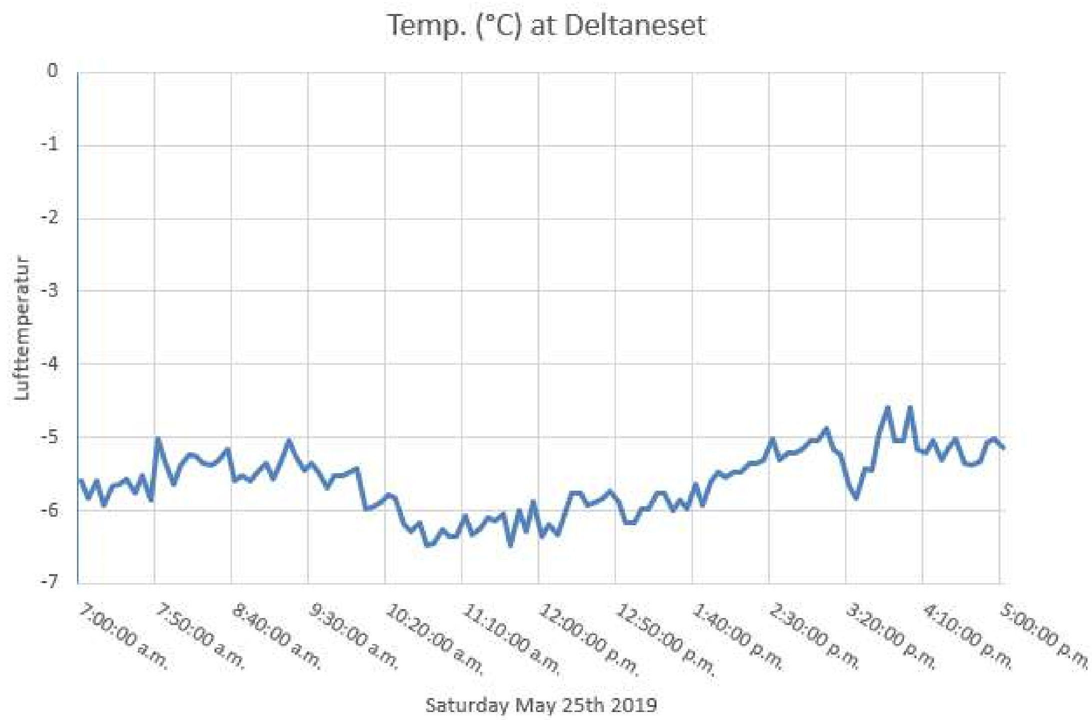


Figure 2.5: Temperature from the weather station at Deltaneset.

This exercise was conducted in two phases:

**Phase 1 MRO AIR:** There were two helicopters in action, training on mass evacuation from CGV Svalbard. An exercise alarm were sent to the airbase, and the cabin in the helicopters was swept clean from unnecessary equipment

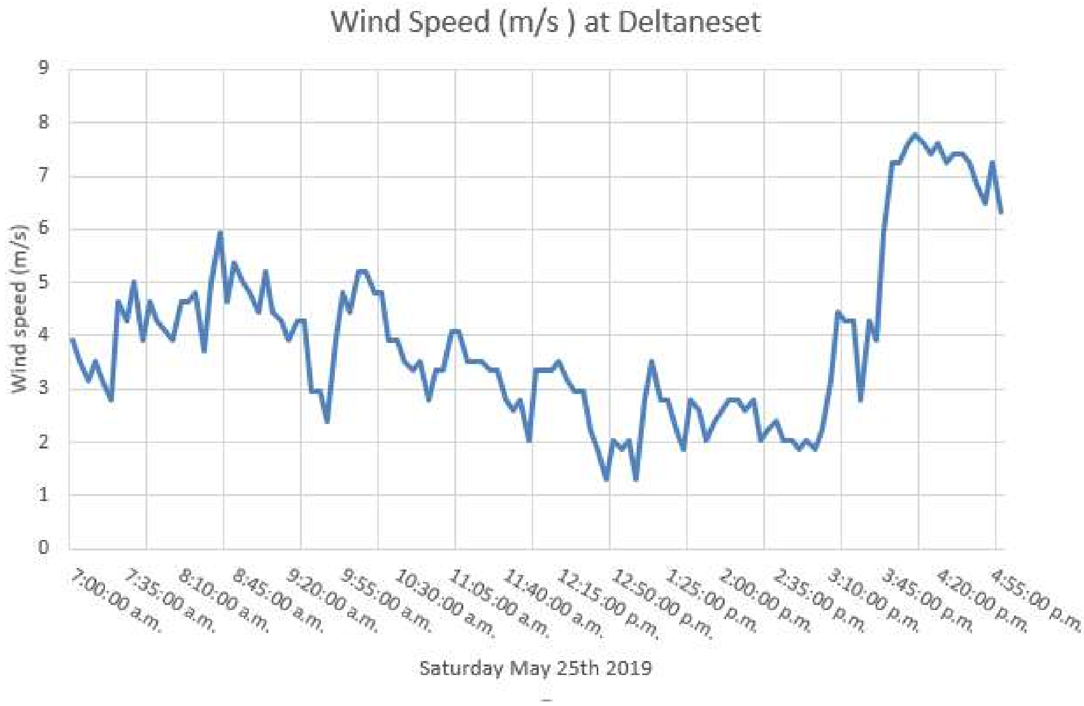


Figure 2.6: Wind speed from the weather station at Deltaneset.

to create space for as many evacuees as possible. The helicopters arrived on the scene approximately 20 minutes after the alarm. At that time 97 personnel were gathered and prepared for evacuation on the helicopter deck at CGV Svalbard. The helicopter rescue crew used new knowledge and experience from the incident in Hustadvika in May 2019, where close to 500 passengers were evacuated from the cruise vessel Viking Sky. There they lifted two persons in one heave, and this procedure was tested in this exercise. The helicopter crew managed to take 20 personnel in the cabin at the same time and flew to the beach at Deltaneset were the evacuees started on phase 2. The Fig. 2.7 depict this activity.

Personnel control on the helicopter deck at CGV Svalbard was handled by naval officers from the coast guard crew

**Phase 2 MRO LAND and SEA:** Phase two started on the beach with triage and preparing the players for transport to MS Polarsyssel for further treatment.
The players were transported by MOB-boats to the MS Polarsyssel were the boat was lifted of to the main deck, and the evacuees were transferred to the reception facilities. These facilities were tents on the sheltered working deck


Figure 2.7: Evacuation two by two. Foto: Oda Iden, Sjøforsvaret ©

on board MS Polarsyssel, were personnel from Longyearbyen Red Cross to care of the treatment. The figure 2.8 shows how personnel from Red Cross and evacuated personnel take part in the care of «injured» personnel as a part of the exercise. The photo 2.9 shows a the Governor of Svalbard Kjerstin Askholt and her police chief superintendent Ole Jakob Malmo observing the activities on Deltaneset. All activities ended about 5 P.M.

Scientists from Nord University studied the organization and management of the MRO on the landing site, the transfer of evacuees to the rescue vessel M/S Polarsyssel and the reception on board. Their report can be found in section 3.12.

The weather on Saturday the May 25 was fairly cold with an air temperature between $-5°$C and $-6°$C degrees in the morning, slightly decreasing to a minimum of $-6.5°$C, then increasing to a maximum of $-4.6°$C around 4 P.M. (See Fig. 2.5 and table 2.1).

The wind speed varied between $3 - 6$ m/s in the morning, decreasing to a minimum around 1 P.M., and then increasing up to maximum around 4 P.M. This increase created some swells on the beach, and made it difficult to enter the Man-Over-Board boats with personnel and equipment at the end of the exercise. (See Fig. 2.6 and table 2.1).

Figure 2.8: Triage and transport of «injured» personnel. The «injured» were prepared as a part of the exercise. Foto: Oda Iden, Sjøforsvaret ©

## 2.7 Sunday May 26

Participants in the SARex Svalbard project, the crew from KV Svalbard, the participants from the Governor of Svalbard's office, personnel from Longyearbyen Red Cross, volunteers from Longyearbyen, and the pilots, rescue team and managers from Lufttransport AS gathered in an auditorium at the UNIS facilities and discussed the lessons identified, experiences, and first impressions of the last day activities of mass rescue operations in air, on land and at sea. The Governor of Svalbard Kjerstin Askholt, and the Norwegian Coast guard executive officer, captain (N) Steve Olsen, addressed the audience and thanked them for their efforts, support, and enthusiasm during the exercises.

Figure 2.9: The Governor of Svalbard Kjerstin Askholt and Police Chief Superintendent Ole Jakob Malmo visiting the triage and evacuaton site at Deltaneset. Foto: Oda Iden, Sjøforsvaret ©

# Chapter 3

# Reports from the participants

This chapter contains reports from the participants, in their own writing. The heading and page-numbering may have been edited, but the rest is included as pdf-files directly into the document. The contributions from each participants may contain repetitions from other participants' description of the same events, but in this context it may be of value for the general overview to have descriptions of events and observations from a different angle, from at different view point and with a different background. With this in mind, it is my assessment that all the essential details about the activities and observations are most likely included in the reports, for the benefit of future analysis and assessment of the findings.

## 3.1 Liferaft and Immersion Suit in Polar Climates.

*By Iain McLean, Survitec Group and*

*Stein Bexrud, Aviation and Survival Support AS*

Fig 1 - Testing immersion suits in F10R Liferaft

### 1.0 Summary

During the last week of May 2019, Aviation & Survival Support together with our main supplier SurvitecGroup has been part of a cross-functional team that gathered in Svalbard, Sptizbergen to test the efficiency of lifesaving appliances and to discuss polar survival strategies.

Testing and evaluation took place using Aviation & Survival Support and Survitec equipment – F10 R Heliraft, fig 1, Endurance Immersion suits, 1000 Series and Artic Survival suits. The exercises and evaluations were both on and in the Barents Sea, with liferaft boarding tests and a novel radar for detecting volunteers in the water being evaluated. The Survitec suits performing extremely well as the volunteers were in the water for over an hour.

The week's exercise concluded with a mock vessel evacuation by helicopter to the beach where the local Red Cross had to triage the 'casualties' and evacuate them from shore to a support vessel.

SARex provides an excellent research platform for cold climate testing, as all the support infrastructure is in place, including safety boats, volunteers and logistics.

### 2.0 Testing Programme

#### 2.1 Tuesday 21st

- The University in Svalbard (UNiS) regularly run field trips with transfer by boat so wanted to test that the Regatta suits they use are suitable if you have to swim to a liferaft and wait onboard for recovery. Seven (7) students and staff involved, fig 2.
- The Survitec F10R Aviation Liferaft was set into the water and inflated by the students. They then left their FRC and swam 5-10 m to the raft boarding it without issue. They were all wearing a Regatta floatation suit, and some had an integrated life jacket., walking boots or short sailing boots, gloves and hat. No specialized equipment was worn or used. Once onboard the group worked out how to set up canopy, sort out the E pack, stream sea anchor etc.
- After about a 45 mins, the Group dropped the canopy down for fresh air and in turn, some of the students got out of raft, swam from one boarding ramp to the next and climbed back onboard, some with assistance.
- 3 students then transferred to FRC at about 75 mins saying feet and hands starting to get to cold - they returned on board CVS Svalbard for dry clothing. Remainder of students transferred to FRC after an hour and a half.
- Liferaft recovered onboard CVS Svalbard and inspected for any issues – none found.

Fig 2 – UNiS testing Regatta Suits

### 2.2 Wednesday 23rd

***2.2.1 Test Objective*** - how easy is it to board, and undertake duties in the F10R using different suits & capture feedback on the suits with recommendations for improvements
*Equipment* 3 x Endurance Immersion suits (2 x Nor Coast, 1 x Sealift), 2 x PAS (2 x Norwegian Coastguard), 2 x Series 1000 Suits (2 x Survitec)
*Personnel* 4 x Norwegian Coast Guard, 1 x Sealift, 2 x Survitec and Aviation & Survival Support (Dunmurry & A-SS)
*Conditions* Air temp minus 2.5 deg, Water temp +2.2 deg, Wind speed 10kts, ENE – ESE, negligible wave

***2.2.2 Testing***

- None of the volunteers had used the Survitec equipment before or had a marine background.
- All participants briefed on the expected events and advised if they wished to put on additional thermal protection.
- Allowed to select their own suit - selections as above

- Boarded rescue boat, and liferaft lifted into the water.
- Liferaft allowed to free drift away from vessel.
- Once second FRC on water as a safety boat, boarding commenced (0915)
- All participants in turn lowered themselves into the water, and swan 5-10 m across to the liferaft, and used boarding ramp to access raft.
- All boarded without issue under their own efforts.
- Equipment in the E pack was shown and explained to all. Sea Anchor was streamed. Canopy erected.
- All agreed that colour inside and combined with the enclosed space/loss of horizon could lead to seasickness quite quickly. Ventilation through the doorways opened.
- Canopy dropped back down into place.
- All team members in turn got out the raft, swam around at least other boarding ramp, and boarded again. Others went full 360 around the raft and boarded. One member floated about for 5 mins relaxing.
- Floating (rescue) line was streamed and 4 persons got back in the water (3 x Endurance, 1 x 1000 Series) and floated behind the raft for 20 mins to 30 mins.
- 2 x Endurance suits came back onboard - starting to feel cool
- 1 x 1000 series was back a few minutes after that as feet feeling cold
- 1 x Endurance was back onboard saying that just starting to feel the cold, and that feet and hands cold.
- Personnel transferred back on FRC and returned onboard. (1050)
- Raft lifted back onboard
- Wash up session with feedback - (see Appendix A)


Fig 3 – Testing different Immersion suits

Fig 4a –Endurance Immersion Suit

Fig 4b – PAS (Personal Abandonment Suit)

Fig 4c – 1000 Series Immersion Suit

### 2.3 Friday 25th - In water Casualty Detection

- New radar system being trialed for detection small objects in water.
- System looks at the waves and highlights anything unusual - it filters out the background confusion of the waves to leave a target. System has been trailed before with hard target - coke tin.

- 10 volunteers (5 female, 5 male) - all civilian, (using Arctic Survival Suit x 1, Viking work suit x 2, Endurance Immersion suit x 2, Helly Hansen x 5)
- Vessel moved out into the main fjord, with 1 m Hs, sea temp 2.5 deg, air temp -5.3 deg, wind 8-10m/s, 71% RH (it had just been snowing)
- Volunteers split into male and female groups. Each group had a 50m floating line and got into the water spaced apart approx 10 m from each other. At this point some 200m from CVS Svalbard, fig 5
- For each test, the vessel moved 100-200m further back, until was 1200m away.
- Time in the water was just over an hour.
- Every 20 mins the volunteers were checked by Rescue Boat - asked for how cold we felt 1 warm 5 cold, and suit temperature measured.
- All participants were okay body temp wise, with one of the Viking team suffering from extremely cold hands
- Initial results from the radar indicate that it was able to locate persons in the water comfortably out to a range of 1000m, beyond that not enough definition between the confused sea state and the persons in the water.
- Feedback and comments on the suits are listed in Appendix B

Volunteers

Fig 5 – Testing the Artic Suit and Novel Radar

**2.4 Saturday 26th**

- 100 volunteers assembled in the hanger on CVS Svalbard – local persons, SARex team, and crew, even though it was foggy and snowing outside.
- 2 x Super Puma SAR helicopters from local SAR unit then hoisted the volunteers from the deck onboard and transferred them to the beach about a 5-minute flight away.
- The whole exercise commenced at 0900 and concluded at 1700.
- During the whole day – the 2 x 1000 Series and 1 x Artic Suits were worn.

- Both the volunteers who wore the 1000 Series commented that extremely comfortable to wear and would not mind wearing for longer. Balaclava was too large for one volunteer. Toilet access was also queried as a potential longer-term issue, Fig 6.
- The Artic suit with the built-in boots was very comfortable to wear for the whole day. It did become very warm during the stretcher carries, with the lifejacket being removed and the main zip being opened. Even when cooling down afterwards, suit did not feel overly cold. Own gloves were worn when onshore to allow stretchers to be carried easily. 7 km walked in the suit during the day.

Fig 6 – Mass Evacuation exercise & Triage

### *3.0 Feedback*

All the 'volunteers' had no experience in suits or Life Saving Appliances (LSA). At most some had completed the 1. day basic sea survival course, therefore the feedback should be considered as raw and unbiased.

All volunteers were asked was there anything that could be improved or added.

| ***Endurance Immersion Suit*** | |
|---|---|
| *Positive / constructive Comments* | *Comments for Improvement* |
| • Comfortable/straightforward to don<br>• Comfortable to wear for extended period | • after an hour or so getting cold - toes & hands and then shoulder, back and backside<br>• Inner glove sealed hands in, could get stuck in zipper<br>• additional boot/foot straps, for better fit<br>• pockets for storing kit - better storage |

| ***1000 Series Suit*** | |
|---|---|
| *Positive / constructive Comments* | *Comments for Improvement* |

| | |
|---|---|
| • Comfortable to wear,<br>• Easily donned | • leg length makes kneeling/bending a bit more awkward if short legs - kit in pockets needs moved first,<br>• additional storage/pockets<br>• feet get colder quicker than rest of body |

| ***PAS (Personnel Abandonment Suit)*** | |
|---|---|
| *Positive / constructive Comments* | *Comments for Improvement* |
| • free & easy to move around in<br>• Balaclava worked well | • on floor getting cold backside first and relatively quickly<br>• Hands got cold over mitts were lighter |
| ***Arctic Survival Suit*** | |
| *Positive / constructive Comments* | *Comments for Improvement* |
| • Easy to don<br>• Easy to move around<br>• Comfortable<br>• 3 finger gloves allow tasks to be easier<br>• Insulation works well | • Need assistance to start main zip and to start jacket zip<br>• Potential to heat up quickly when onshore and carrying out survival tasks |

### *4.0 Conclusion*

The SARex expedition cruise has provided an excellent opportunity to gather real world feedback from volunteers using equipment they are not familiar with.

The consensus would be that all the products worked well and would provide protection against the elements and prolong the opportunity for survival.

A number of the products on test were not specifically designed for Polar regions, and it is clear that there is insufficient insulation and protection to provide long term survival in a Polar climate.

The feedback and comments on the products are being passed back to the respective design teams to be incorporated into future designs.

### *5.0 References*


- International Lifesaving Appliance Code Res MSC 48(66) & Testing & Evaluation of Life Saving Appliances MSC 81(70), IMO, 2003

**Appendices**

***1.0 Appendix A – Suit Evaluation – Wednesday 23rd***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | ***Suit No*** | | | | | | |
| | | | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** |
| | ***Volunteer*** | *Male/Female* | M | F | F | F | F | M | M |
| | | *Height* | 182 | 160 | 165 | 167 | 165 | 205 | 175 |
| | | *approx weight* | 78 | 56 | 65 | 63 | 70 | 80 | 90 |
| | | *Under clothing worn* | wool leg & top, USN working trousers | wool top & bottom, USN work trousers | wool top & bottom USN work trousers | wool top & t shirt, USN work trousers | thermal leggings, shell trousers, 2 x thermal tops | fleece bear, shell outer trousers, t shirt | thermal legging, shell trousers, thermal top and jumper |
| ***8800MK2-SHU Crew Endurance Plus*** | | can you exercise safely/move around to stay warm | | possible but difficult in the raft | | possible but difficult in the raft | possible, as raft warmed up | | |
| | | Donning - ease of donning | ok but difficult to close around the neck | straightforward | | reasonably straightforward | comfortable | | |
| | | how comfortable to stay in for extended period in survival craft/water | getting cold - toes & hands and then shoulder, back and backside | water leak in at zip, outer glove was to long, strap to keep on, as falls off easily, large hand size problem for doing activities | | comfortable for short good weather | in liferaft ok, 30 min in the water starting to get cold and water inside just over zipper, (air collected in chest area, and 'burped' out, easy to damage inner glove, got stuck in zipper, | | |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Comments* | | gloves, water leak in at zip, outer glove was too long, strap to keep on, as falls off easily, large hand size problem for doing activities | | | neck sleeve, additional boot/foot straps, pockets for storing kit - litter, better storage | , mouth piece - needs securing - velcro - zipper clashes with mouth | | | |
| ***1000 SERIES GEN 2 Immersion Suit*** | *Ergonomics* | can you exercise safely/move around to stay warm | | | | | | | yes, freely | relatively easily, although leg length makes kneeling/bending a bit more awkward if short legs - kit in pockets needs moved first |
| | | Hygiene/bathroom! | | | | | | | | awkward when ashore! |
| | | Donning - ease of donning | | | | | | | easy | straightforward |
| | | how comfortable to stay in for extended period in survival craft | | | | | | | comfortable & free movement | cold feet could prove to be long term issue |
| | | how comfortable to stay in for extended period on shore | | | | | | | | no significant testing, but on 30 min office visit ashore was comfortable to warm |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Comments* | | | | | | | neck collar works well when swimming backwards from water hitting directly on the neck, additional storage | zip at the front of neck colar to protect neck in open transit in FRC, internal braces to keep legs up, additional storage pouches/pockets |
| | *Thermal properties* | establish what is best underlayer system to use for extended stay outside | | | hands cold, starting to get cold after an hour, | | | | |
| | *Ergonomics* | can you exercise safely/move around to stay warm | free to move around | | easy to move in it | | | | |
| ***PAS (personal abandonment suits)*** | | Donning - ease of donning | concerned that neck collar was too tight, tightening up cords not intuitive, not obvious | | very tight fit on the neck and over the head, after while started to forget about it, easy to get arms and legs into | | | | |
| | | how comfortable to stay in for extended period in survival craft/water | sitting on floor getting cold backside, on buoyancy ok. Hands got cold quick, even when using gloves. Had to use neoprene for a while | | would prefer to be in the immersion suit, would not look forward to spending back amount of time in suit, loss of heat through | | | | |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | backside when sitting on the floor | | | | |
| | *Comments* | | self-tightening neck seal, not easy to warm yourself up, possibly integrate the balaclava, buddy line to be fitted, no hauling in line/handle | | straps for the gloves as they can easily fall off. If swimming the gloves fill with water and did fall off, need to take off gloves to do activities, suggestion to put gloves on before putting on the suit, and then take off. Balaclava worked well | | | | |
| | *Ergonomics* | Donning - ease of donning | easy | | | | | | |
| | | how comfortable to stay in for extended period in survival craft | would prefer to use a suit like this than the immersion or PAS | | | | | | |

Aviation and Survival Support

survitecgroup

***2.0 Appendix B - In Water Detection – Friday 25th***

| *(1 easy - 5 difficult)* | **Female** | | **Male** | |
|---|---|---|---|---|
| | ***Endurance*** | ***Viking*** | ***Artic*** | ***Viking*** |
| *Ease of donning?* | Ok to put on, but was large size made more difficult, needed assistance. Worked well with a life jacket. Feet up, few splashes in face due to neck support. Head to weather | Poor fit of balaclava - borrowed a 1000 series one | Lots to connect - needed assistance to start main zip & to attach jacket | |
| *How easy to move around in?* | No issues.<br>Sweater with a hole in the arm is good idea to keep hands warm | Good | Good - possibly easier than 1000 series even though more insulation. | Good |
| *Did hands stay warm?* | No | No | Yes - hands actually warmed up. Could be brought out of the mitt and balled to heat thumb and first finger. | No |
| *Did feet stay warm?* | Y - 1 ok, 1 got cold | Y | Y | Y |
| *Could you keep yourself warm in it?* | 45 mins started to feel cold on arms and legs | - | Yes - was able to comfortably swing arms & legs. Could not bring legs under body, as to much buoyancy | |
| *Could you have stayed in a survival craft for an extended period of time?* | Believe so - pulled hands inside arms and they heated up quickly | - | Yes - but would potentially get very warm quickly | - |

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| | | | | |
|---|---|---|---|---|
| *How much longer could you have stayed in the water?* | 1 got sea sick (does get car sick in back seat), 1 ok | Similar | Same again, at least | No - gloves meant hands cold - withdrew |
| *What underclothing did you have on?* | 2 x wool top & bottom and seater on top, 2 x socks wool & knitted | - | Leggings and shell trousers. Thermal top and fleece jumper | - |
| *General comments?* | Pulled hands out of gloves and up sleeves was next plan to keep hands warm.<br>Hard to connect buddy line to safety line - size of hook & gloves. Access to buddy line was difficult as lifejacket in the way. Hands staying dry is good feature. It was easy | - | Didn't realize how big a hood was on lifejacket. | - |

## 3.2 Exercise with standard UNIS flotation suits and life-vests.

***By Martin M. Eriksen, UNIS Logistics***

### Introduction

At 09.45 on 21.05.2019, eight people participating in the SARex exercise left Longyearbyen by a Polarcirkel-boat, arriving at Deltaneset and KV Svalbard at 10.20. The purpose of this exercise was to test the scenario where we were forced to abandon a Polarcirkel-boat and swim to a life raft, wearing standard UNIS/ SAG boat-excursion flotation-suits and life-vests. We wanted to see how a normal person wearing this equipment would react to the air and water temperature as well as the exposure of sitting in a life-raft for two hours. Two hours is within the time frame for expected response from SAR-capacities in Isfjorden.

Air temperature was -2 degrees Celsius, water temperature + 2,7 degrees Celsius, 4 m/s NE winds and calm sea. The participants included five UNIS (University Center in Svalbard) and three SAG (Svalbard Adventure Group) boat-operators, all in normal physical condition.

### The exercise

Exposure to the water was cold as expected, but we did not spend more than a minute in the water before climbing onto the raft. Soaked from the neck down, climbing onto the raft was manageable. Getting an «unconscious» person from the water and onto the raft was also manageable, due to the life-vest which provides something to grab on to. Once in the raft, we struggled a bit getting the roof up. The way this is designed calls for a "levelheaded" person or two to take the lead. The plastic clips and Velcro joining the roof-sections together worked fine in mild conditions, but we were unsure how the system would hold up in strong winds and crashing waves. There should also be something more efficient than sponges to empty the raft of seawater. We ended up using one of the plastic bags, the leak-sealer and the air-pump for this task. An "inner pontoon" or some sort of raised platform to sit on, allowing for the survivors to get their bodies completely out of the water, would be a good asset for the raft, both for comfort and safety reasons. We ended up taking our life-vests off and using them as sitting-mats, which was very effective. After 0.5 hours, five of the participants took another swim, exposing themselves to the cold water for a second time. After 1.5 hours the first person wanted to leave the raft due to cold and wet feet. This person had complications due to former frostbite on his feet. Two other participants decided to join him for comfort reasons, going back to KV Svalbard for a change of clothes.

| Person # | In the water 1st time | In the water 2nd time | Leaving the raft | Comments |
|---|---|---|---|---|
| 1 | 11:04 | 11:38 | 13:11 | |
| 2 | 11:05 | 11:35 | 13:11 | |
| 3 | 11:06 | 11:39 | 11:45 | Comfort reasons |
| 4 | 11:06 | 11:40 | 13:11 | |
| 5 | 11:06 | 11:39 | 12:45 | Cold feet |
| 6 | 11:07 | | 12:45 | Comfort reasons |
| 7 | 11:07 | | 13:11 | |

The remaining four participants took down the roof to see the temperature difference. It was considerably colder after just a minute or two. After exposure to the moderate breeze for 10 minutes, it was decided to put the roof back up again. When two hours had passed we ended the experiment as planned. The four remaining participants were all in all OK, three showing no sign of hypothermia, and one starting to shiver a bit.

## 3.3 Communication test of Maritime Broad Band Radio.

***By Bjørn Helge Utne, Norwegian Coastal Administration***

The main objective of the Norwegian Coastal Administration (NCA) on this cruise was to test communication in the NCA's network of Maritime Broad Band transmitters at Svalbard. The result of this test, if successful, will be a confirmation of the possibility to transmit messages, documents, images, and video to a community of actors with the proper equipment. Sharing radio band demanding information is the main purpose of this experiment, in order to improve the common situational understanding in SAR events within the community of institutions and units responsible for SAR operations during an emergency event.

During the cruise, updates and adjustments were implemented on the equipment, in order to make the equipment optimal for the test. The test was successful, and information of the kind mentioned above, was exchanged between the Coast Guard Vessel Svalbard, and institutions at the mainland Norway.

Another test was video transfer from personell in small boats to the CGV Svalbard. The video received was of good quality and the video was transmitted over more than 10 000 m. The equipment is depended on a direct line of transfer, and was prepared to be attached to a UAV for similar testing later on the cruise.

MS Polarsyssel was to far away to be included in the tests.

## 3.4 Investigations in a simulated evacuation situation on the shore

### 3.4.1 Group Survival Leadership Concerns in Polar Conditions: «If everyone is bored then something must be going right».

***By Professor Scott N. MacKinnon, Chalmers University of Techn.***

#### Prologue

> « ... but what factors were shared by shipwreck societies that were most successful? In our sample, the groups that typically fared best were those that had good leadership in the form of mild hierarchy (without any brutality), friendships among the survivors, and evidence of cooperation and altruism – all key elements of the social suite» (Christakis, N.A. (2019). Blueprint: The Evolutionary Origins of a Good Society. Little, Brown Spark, New York. page 31)

#### Introduction

There were several research activities addressing the aims of the Svalbard trials in May, 2019. These were to support a better understanding of the directions of IMO's Polar Code toward human survivability in inhospitable situations and scope included:

1. Guidance towards nutrition intake and energy expenditure
2. Personal and Group Equipment for protection against the environmental elements
3. Fit for purpose of abandonment and survival equipment.

#### Purpose of the Report

The purpose of this report is to understand better the role of leadership and cohort organization during a simulated survival exercise on a beach environment. Location and environmental conditions are reported in the chapters 1 and 2. This is a preliminary report and more observations will be conducted in more environmental valid conditions in 2020.

### Experimental Protocol of Report

These experimental elements are defined and data collection outcomes described in other sections of this report (sections 3.4.3, 3.4.4 and 3.4.2). In summary, four groups of «survivors» that undertook the questionnaire and physiological data were subsequently interviewed post-scenario on board the vessel. All participants signed an informed consent, indicating that while an audio recording will be taken throughout the interview, none of the participants could be identified and all subsequent report transcripts would be denominalized.

There were two interviews conducted with two of the four groups taken at each time. The groups were divided upon the basis of either having pre-insertion intelligence or not. This experimental control was undertaken on the assumption that perhaps pre-knowledge of the survival gear contents, and food and water supply would better prepare them for the quality of decisions and actions taken once the survival scenario began the next day.

### Data Analysis

Field research is a qualitative research method that observes, interacts and understands people while they are in a natural environment. Social scientists conducting field research may conduct interviews or observe people from a distance to understand how they behave and react to situations around them. Field research employs various social research methods and include direct observation, limited participation, analysis of documents and other information, informal interviews, surveys etc.

The data were not analyzed using traditional methodologies such as grounded theory or thematic analysis, and there was no follow-up questioning, so the themes discussed were much less saturated than desired, but it certainly can be considered thick data due to 1st hand experiences recorded from the participants.

### Theoretical Framework(s) for the Interview Analysis

#### *Physical and Security Needs*

The assumption is that when organizing a survival strategy, victims (after dealing initially with injuries and shock, which was not the case in this exercise) would tend to physical, then security needs in early stages. Longer-term needs would have to also be addressed, although this exercise ended after 36 hours. These challenges are defined in Maslow's classical Hierarchy of Needs (Maslow, A.H. (1943). «A theory of human motivation». Psychological Review. 50 (4):

370–96) and are depicted in Figure 3.1.

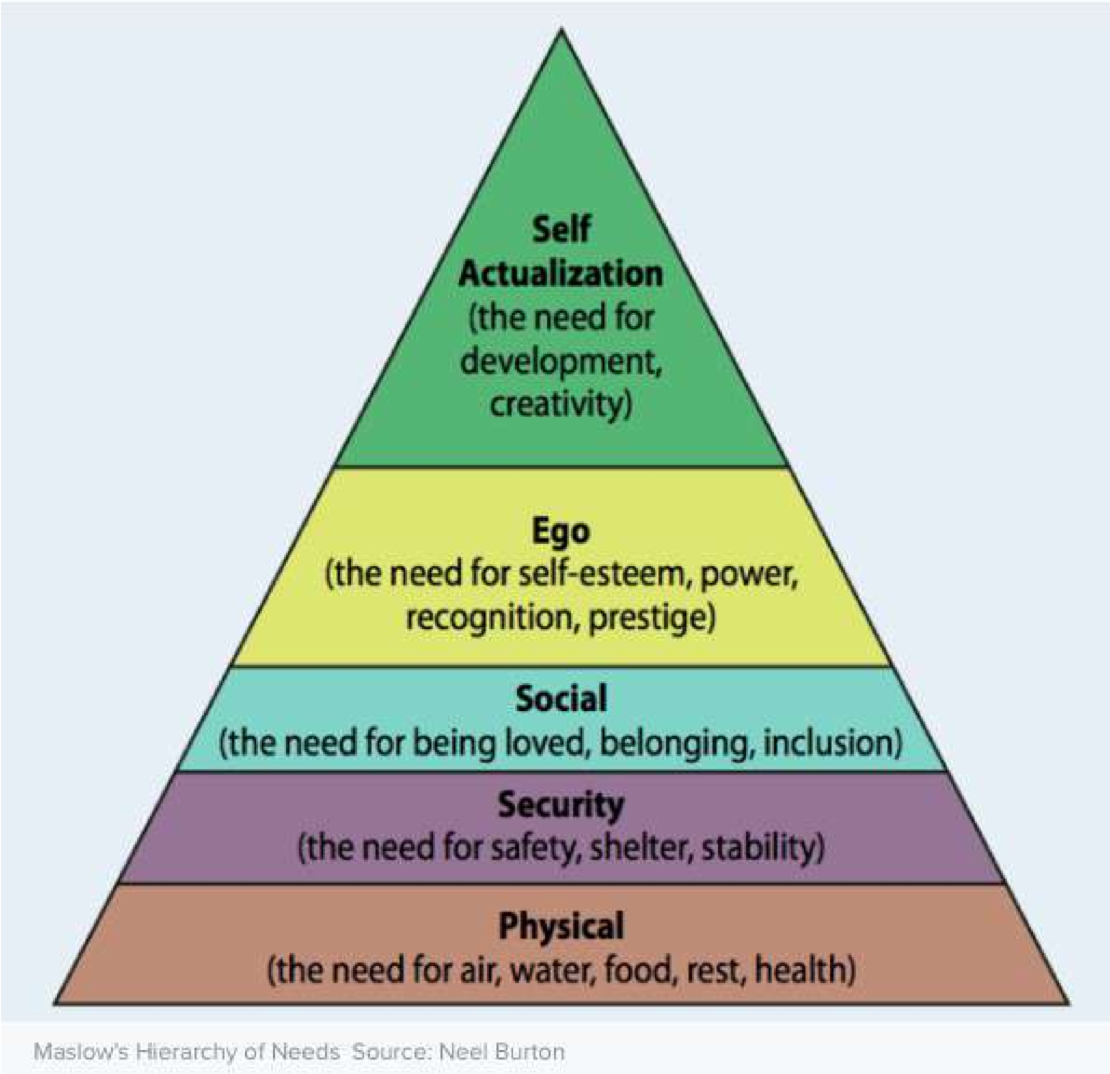



Figure 3.1: Maslow's hiearchy of needs.

***Leadership Competencies***

While there are certainly technical skills and demands associated to evacuation, escape, survival and rescue situations, non-technical skills are equally important to sustain survival, particularly in harsh, resource scarce locales. While these skills can be taught within an emergency duties' curriculum, often these are innate, tacit qualities from which a leader within a group will emerge.

The European Space Agency (ESA) has examined the leadership qualities important to group survival and moral in a document entitled International Space Station Human Behavior & Performance Competency Model (NASA/TM –2008 –214775 Vol 1). The following describes a list of competencies and observable behaviours (complete description in Appendix 1) and action of both leaders and group members in collaborative «survival» situations (while this was developed for space station situations, it can be easily adapted for survival strategies and experimental design). These leadership areas and corresponding competencies include:

1. TEAMWORK AND GROUP LIVING
   (a) Competency: Active team participation
   (b) Competency: Interpersonal relationships
   (c) Competency: Group living
2. LEADERSHIP
   (a) Competency: Execution fo designated leader's authority
   (b) Competency: Mentoring skills
   (c) Competency: Followership
   (d) Competency: Workload management
3. CONFLICT MANAGEMENT
   (a) Competency: Conflict prevention
   (b) Competency: Conflict resolution
4. SITUATIONAL AWARENESS
   (a) Competency: Maintenance of an accurate perception of the situation
   (b) Competency: Processing of information
5. DECISION-MAKING AND PROBLEM-SOLVING
   (a) Competency: Problem solving an decision-making methods
   (b) Competency: Preparation of decision
   (c) Competency: Execution of decision

### Findings and Discussion

Ethnographic research is important to inform how «work is done». This is particularly important is emergency situations like survival and rescue activities which often do not proceed via expected standard operating procedures.

The Polar Code was developed using a goal-based approach. Typically, these types of technology describe how technologies are exploited to meet performance needs. In situations where technology also relies on human understanding of its proper usage, past training/experience and mental state during its usage, a better understanding of the variability associated with decision-making is critical. Furthermore, how groups organize themselves (survival routines) in a social context for survival is also important. This gives some insight into the fitness of purpose of the survival gear recommended by the Polar Code and provided during these trials.

This report considers some of these issues during the survival periods of the Svalbard Trials. Observations and post-scenario discussions are described under two sections relating to basic survival needs using a Maslow framework and leadership elements described using the ESA framework.

#### *Biophysical and Psychosocial Elements*

*Food*
Of the four groups participating, two groups were briefed prior to the scenario about the type of food and water, its rations per person and the recommended timing of consumption in order to maintain theoretical blood glucose levels during the survival period.

From a biophysical perspective the suggested guidelines for food rationing and consumption were abandoned (by the informed groups) and frequently altered throughout the course of the survival period (by all the groups). There were, however, some misconceptions such as they thought it was important to conserve food and water to role-play that rescue was not imminent. Some also believed that they did not think that there was a need to eat in the first 24-hours because there was not much physical exertion and that stored energy would get them through this period. Clearly, there was not sufficient tacit knowledge throughout the participants about the importance of sustained nutrition. It was generally agreed that the food directions were not easy to follow, was not very palatable and caused negative outcomes such as constipation.

From a psycho-social perspective, there was general agreement that it was, for morale purposes, good to set up an eating routine (preparation, clean up etc), including eating together (which in some cases required waking people up who were on their sleep rotation).

*Sleep*
Due to the equipment provided, it was clear for four group members there needed to be a 2 on 2 off rotation. There were some confounding issues precipitated by the experimental protocol. The regular 2-hour data collection periods for blood sampling and questionnaire data collection disturbed the sleep routine. As it was already difficult to fall asleep, these interruptions made REM sleep even more difficult. Participants indicated that they woke up tired and grumpy. Those awake complained about the snoring, which is likely to occur with uncomfortable, disrupted sleeping cycles. There were also sleeping equipment provisions which were mentioned and are discussed in the next section.

*Provided Survival Gear Equipment*
It should be noted that the description of the personal and group survival gear is specified for the coldest and adverse conditions that might be found in the Polar regions. That said, the summary of the feedback is based upon trials conducted in May, so the conditions would be considered benign compared to the expected extreme environment. However, passenger movements through Polar regions are expected to occur year-round, so the survival gear has to be robust enough to accommodate all seasonal conditions.

In general, the survival gear and food were found to be adequate but not ideal. The following items were noted:

Sleeping equipment:

1. Irregular sizes
2. Too warm
3. Doubled up to allow more breathing, but any movements interrupted the sleep of the sleeping bag partner
4. Mattress was of poor quality

Missing Items:

1. Shovel
2. Rain ponchos
3. Knife or multi-tool

4. Lighter or water-proof matches

«Good to have» survival equipment:

1. Deck of cards (small and light)
2. Paper and pencil
3. Rope/strong twine

***Leadership Elements***

While leadership skills (non-technical skills) may come naturally to some, these should have a greater focus in the maritime training curriculum (See the Appendix to this section on page 46). In this survival situation, many of the unknowns typical of survival and rescue were not present (duration of stay, food supply, management of large groups of persons). The leadership elements noted during this exercise debrief are listed below.

*Teamwork and Group Living*
Most participants highlighted the boredom factor (even after 24 hours). One group erected a basketball like hoop and found a ball (deflated) on the beach and created a competitive game. This helped relieve the boredom for several hours but not the duration of the exercise. This was the only group of the four that clearly indicated a strategy which was discussed to relieve boredom although most people identified it as a factor. In trying to manage group living and interpersonal relationships, leadership must move beyond solving the issues identified by Maslow.

*Leadership*
Most groups, given the known conditions and small group size, suggested that it was not necessary to appoint a leader. There are certainly pros and cons to this leadership style, especially if consensus can be easily reached within the group. However, this would not be applicable to larger numbers within a survival cohort.

Groups agreed to establish routines (and periodically revisit these) for activities such as eating/drinking, sleep and watch duties. However, it should be noted in one case, a group member wandered off (eventually to go to the toilet) and did not indicate this to the remainder of the group that was sleeping. While harmless in this situation, would cause undue angst in a real situation.

*Decision-making and Problem-Solving*
There were several examples of groups discussions regarding shelter construction,

fire maintenance and garbage management. In particular, one group spent considerable time with shelter design, drawing it out on the sand, surveying available building materials and estimating prevailing weather conditions. Ultimately, this group built the best situated shelter and were not required to do modifications, as other groups had to do.

### Recommendations

The evolution of the regulations within the Polar Code were done using a Goal-Based Framework. This particular approach to regulatory reform is desirable, as it is technology and context independent. It is tremendously important that Goal Based Regulations be informed and supported by research. Research activities must be well-planned in advance to the data collection periods. While these plans should include some resilience in their execution, major changes to protocol in the field are dangerous to participants and researchers, and in hindsight, will likely compromise the quality and integrity of the data.

In a situation such as these trials where multiple research activities are done in collaboration, one researcher, independent of the individual research teams, should be appointed oversight. This will create a safer and more productive research environment and coordinate better with the support staff providing services on site.

There are considerable risks associated with such research activities. As such, all data collection protocols should be scrutinized by a third-party research ethics board. Furthermore, this oversight in needed should academics want to publish their works in scientific, peer-reviewed journals. This process should not be limited to GDPR regulations (https://edpb.europa.eu/edpb_en) as this is not an ethical review process, but solely a data security process.

### Summary

The funding provided to the Maritimt Forum Nord provides an excellent opportunity to gather researchers, regulators, technology companies and other shipping industry stakeholders to question issues about safe Polar Region shipping activities. As such, it is important to monopolize upon these supports to undertake safe, well-planned and focused research (and other exploratory) activities that can inform all stakeholders. This also provides a platform to build industry consortiums that can move beyond Norway and include other countries that have activities in the polar regions.

## APPENDIX TO SECTION 3.4.1: ESA Leadership Competencies

1. **TEAMWORK AND GROUP LIVING**
   (a) **Competency: Active team participation**
      i. Act cooperatively rather than competitively
      ii. Takes responsibility for own actions and mistakes
      iii. Puts common goals above individual needs
      iv. Works with teammates to ensure safety and efficiency
      v. Respects team member's roles, responsibilities, and task allocation
   (b) **Competency: Interpersonal relationships**
      i. Demonstrates patience, respect and appreciation for crewmembers
      ii. Provides emotional support to crewmembers
      iii. Encourages participation in team activities
      iv. Develops positive relationships with team members
   (c) **Competency: Group living**
      i. Adapts living and working habits to improve team cohesion
      ii. Volunteers for routine and unpleasant tasks
      iii. Offers and provides assistance if accepted
      iv. Balances own needs with those of crewmembers
      v. Shares attention and credit for achievements with teammates
2. **LEADERSHIP**
   (a) **Competency: Execution of designated leader's authority**
      i. Accepts leadership responsibilities
      ii. Assigns tasks according to capabilities and individual preferences
      iii. Assigns tasks with clearly defined goals
      iv. Adapts leadership styles to situation
      v. Responds to information, suggestions, and concerns of team members
      vi. Maintains team cohesion in adverse and uncertain circumstances
   (b) **Competency: Mentoring skills**
      i. Provides direction, information, feedback, and encouragement and coaching as needed
      ii. Leads by example
   (c) **Competency: Followership**

i. Supports leader
ii. Reacts promptly to situations requiring immediate response

(d) **Competency: Workload management**

i. Plans and prioritizes tasks
ii. Adapts plans according to progress and changing conditions
iii. Ensures team members have the appropriate tools and authorization to complete tasks

3. **CONFLICT MANAGEMENT**

(a) **Competency: Conflict prevention**

i. Addresses potential sources for conflict
ii. Prevents disagreements from influencing personal and professional relationships

(b) **Competency: Conflict resolution**

i. Reviews causal factors of a conflict with all involved team members
ii. Adapts conflict management strategies to resolve disagreements
iii. Exchanges views and positions
iv. Seeks resolution
v. Keeps calm in interpersonal conflicts
vi. Focuses on what is wrong rather than who is wrong
vii. Mediates between conflicting parties
viii. Defines agreement and positive closure

4. **SITUATIONAL AWARENESS**

(a) **Competency: Maintenance of an accurate perception of the situation**

i. Monitors people, systems, and environment
ii. Monitors self and others for signs of stress, fatigue, complacency, and task saturation
iii. Reduces distractions while performing operational tasks
iv. Maintains awareness of the environment while focusing on a task or problem
v. Maintains the required level of vigilance for low and high workloads
vi. Uses the two-person approach to execution of critical tasks and procedures

(b) **Competency: Processing of information**
  i. Analyses information to determine operational relevance
  ii. Assesses impacts of actions, plans, and decisions on others
  iii. Anticipates potential problems
  iv. Verifies team readiness to meet operational demands
  v. Communicates when situations "feel" wrong
  vi. Identifies and resolves discrepancies between conflicting data or information

5. **DECISION-MAKING AND PROBLEM-SOLVING**

(a) **Competency: Problem solving an decision-making methods**
  i. Adopts a problem-solving method to meet situational demands

(b) **Competency: Preparation of decision**
  i. Involves team members in the process as applicable
  ii. Assembles Facts
  iii. Considers different Options
  iv. Evaluates Risks and benefits
  v. Decides on an option

(c) **Competency: Execution of decision**
  i. Executes decision
  ii. Checks results of decision, and if necessary, reapplies process

### 3.4.2 Influence on leadership and routines on anxiety state in an on shore survival exercise.

*By Helle A. Oltedal, Western Norway University of Applied Sciences*

#### Introduction

One of the main objectives of the SARex Svalbard project is to increase the knowledge about the probability and possibility to survive over a period of several days, on shore, waiting to be rescued after an emergency evacuation of their vessel. As a part of the SARex Svalbard Cruise (20 – 27 May 2019) a simulated on-shore survival exercise exploring the influence leadership and routines may have on individual's anxiety state was carried out. In the following field report, the background for the study and methodological approach is presented.

#### Background for the study

According to the International Maritime organization's (IMO) Polar Code, passenger ships that operate in remote areas shall develop a voyage and passage plan that considers the potential hazards of the voyage. This should include refuge and survival support for passengers – a challenge in harsh conditions and in areas remote from search and rescue (SAR) resources. The Code requires that the survival equipment and support provided should enable people to remain alive for at least 5 days following a maritime abandonment in polar regions.

Systematic control to reduce the frequency of failures, mitigating possible effects and consequences, as well as increasing the possibility for survival may be attained through design, procedures and training. Survival equipment certified under the Polar Code should be designed for use in polar environments. With respect to training and qualifications, the IMO provides the Standards of Training, Certification and Watch keeping for Seafarers (STCW) newly adopted minimum standards for masters and deck officers on ships operating in Polar Waters. These requirements include specification for safety and SAR arrangements; however, the requirements are very general regarding the nature of training and qualifications for polar conditions where crew and passengers have evacuated and are waiting for rescue.

Studies of disasters and debriefs of survivors have identified certain behaviour and actions that increase the chances of surviving a disaster. Leach (1994) indicates that training and knowledge of what to expect and to do under extreme conditions and appropriate leadership are some factors increasing the chances of survival. Leach (1994) further indicates that a lack of leadership in a survival situation can be fatal, since most people in a disaster will desperately seek out leaders, with a need to be told and shown what to do. One example of the significance of leadership in a maritime survival situation is found in the sinking of the fishing vessel West I in 1986. The eight crew members on board split into two life-rafts, drifting closely together for 10 days before rescue. Although the two life-rafts were only few meters apart, had the same amount of water and food, the group dynamic and survival conditions on board each life-raft developed in two different ways. One raft came immediately under firm leadership, with an organized watch keeping arrangement, food and water were rationed and issued to each survivor publicly, daily routines for mopping and cleaning of the life-raft and so on. In the other life-raft, leadership and routines did not exist –instead of discipline there was disintegration and the survivors onboard fell quickly into despair. One of the crew died of dehydration and at the time of rescue, their physical and psychological condition was found to be far below the survivors in the other life-raft (Leach, 1994). While there may have been other factors at play in this incident, it seems clear that the role of leadership is important in a survival situation, particularly for extended time frames as would be the case following a ship abandonment in the Arctic.

In the report from the SARex 2018 exercise (Solberg et al. 2018), the authors observed that leadership over the two-day survival exercise appeared to have an impact on the level of fatigue among the group members. The authors argue that the "prohibition of development of fatigue would be one of the main tasks for the group leaders" (p. 42). However, to our knowledge, the SARex 2018 exercise did not specifically examine the effect of leadership on fatigue, since it was difficult to prove whether the participants' perception of fatigue was due to other factors such as access to or quality of equipment. In the SARex 2018 exercise, each survival group had access to different equipment – ranging from almost no equipment to tent, sleeping bags, sleeping mats and warm clothing.

The present study builds on the findings of the SARex 2018 exercise and aims to further examine how leadership in a simulated survival situation might affect the participants' anxiety level.

### Methodological approach

The exercise was carried out in a simulated onshore survival situation at Deltaneset close to Longyearbyen Svalbard. In addition to the current study, two other groups of researchers explored other research questions at the same group of people (1) sleep quality (reported in section 3.4.3), and (2) food intake and blood sugar level (reported in section 3.4.4). It is highly probable that the disturbance from researchers may have influenced the results of the current study.

**Measurements**

Leadership is measured indirectly through establishment of fixed routines on sleep and food intake. The impact of leadership was determined with the State-Trait Anxiety Inventory (STAI). STAI comprises separate self-report scales for measuring state (S) and trait (T) anxiety. (Spielberger et al, 1983).

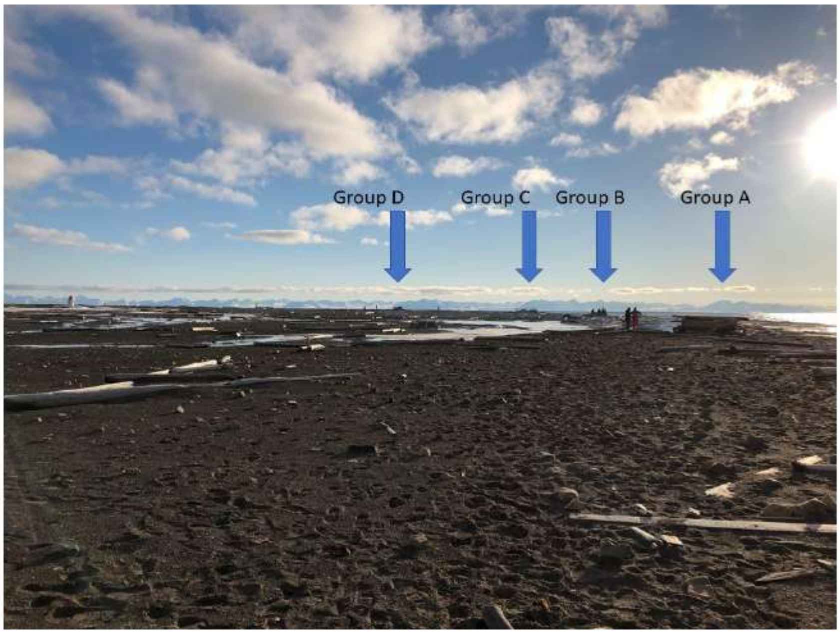
**Participants and design**

16 volunteers participated in the study, one female and fifteen males. Eight of the participants were recruited from the staff at Norwegian Coast Guard SARex-Svalbard cruise vessel, and eight of the participants were recruited from the SARex-Svalbard cruise participants The participants were divided into four groups (A, B, C and D), with four participants in each group. Each group had two participants from the Norwegian Coast Guard. Group A and B were before the exercise informed of the background of the exercise and instructed to establish group leadership, and to have fixed routines for sleep and food intake (organized group). Group C and D did not get any information or instructions (unorganized group). All four groups began the exercise in the same condition – dry, hydrated and having eaten recently. Participants were not told how long the exercise was expected to last. The groups were positioned in the same general area onshore and was not be permitted to interact with each other. However, interaction was inevitable as they for safety reasons due to possible polar bear attack had to be in range of visibility of the Polar Bear Watch, and they had to pass each other when using the provisory toilet. The four group was located by shore with a distance of 100-150 meters from each other. See figure 3.2 below for group locations.

**Survival equipment**

The participants were only permitted to utilize the equipment provided as well as what was available from the environment within their specific exercise area. At the beginning of the exercise each group got a grab bag containing the equipment listed in figure 3.3 and four standard emergency rations – one ration per person and two litres of bottled waters per participant. After 24 hours, additional water and emergency rations were provided. An additional grab bag was provided 6 hours into the exercise – one grab bag per group. Content of the second grab bag is listed in figure 3.4.

Figure 3.2: Group locations overview



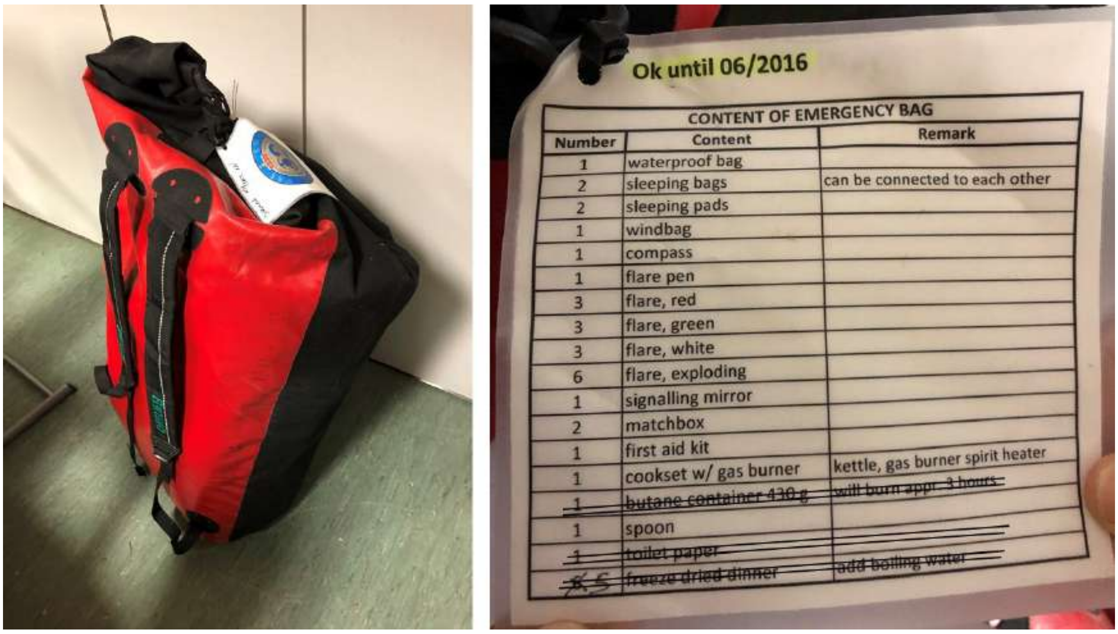

**Determining survivability**

Given that all participants will start the exercise in roughly the same condition, have access to the same survival equipment, and experience the same exposure conditions, the main variables of leadership will allow us to determine the overall survivability of an Arctic survival situation for the types of participants involved.

Psychological stress and fatigue can impact on a person's ability to remain alive in an extended survival situation. Direct measures of psychological stress can be challenging and unreliable in a field setting due to the need to measure an appropriate baseline but also since the participants understand that despite their discomfort, they are in a safe condition and will be able to return to the ship at any point. Thus, questionnaires will be used to give an indication of psychological stress, as noted above.

An important physiological indicator of fatigue relates to sleep duration and quality, resting heart rate, heart rate variability and temperature changes of the body. To give a field-level assessment of sleep quality and activity level, we will use the "ŌURAring" (https://ouraring.com/) which was validated by Zambotti et al. in 2017. Each participant will be asked to wear the ŌURA ring upon first boarding the CGV Svalbard in order to collect relevant baseline data before the exercise begins. While this instrument provides a validated measure of sleep quantity and quality, it will also provide a general measure of activity level while

Figure 3.3: The content of grab bag one.



Ok until 06/2016

| CONTENT OF EMERGENCY BAG | | |
|---|---|---|
| Number | Content | Remark |
| 1 | waterproof bag | |
| 2 | sleeping bags | can be connected to each other |
| 2 | sleeping pads | |
| 1 | windbag | |
| 1 | compass | |
| 1 | flare pen | |
| 3 | flare, red | |
| 3 | flare, green | |
| 3 | flare, white | |
| 6 | flare, exploding | |
| 1 | signalling mirror | |
| 2 | matchbox | |
| 1 | first aid kit | |
| 1 | cookset w/ gas burner | kettle, gas burner spirit heater |
| ~~1~~ | ~~butane container 430 g~~ | ~~will burn appr. 3 hours~~ |
| 1 | spoon | |
| ~~1~~ | ~~toilet paper~~ | |
| ~~6~~ 5 | ~~freeze dried dinner~~ | ~~add boiling water~~ |

awake and an estimate of calories burned. (see section 3.4.3 for more information).

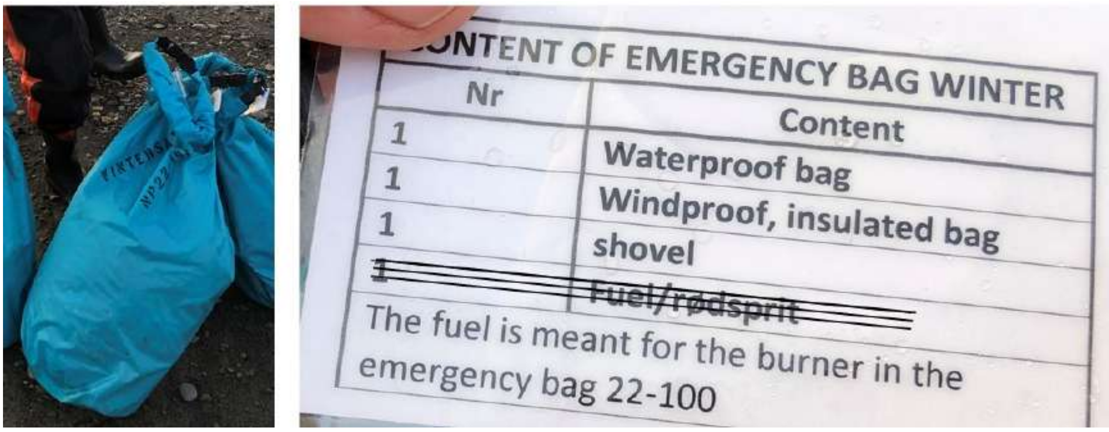
Together it is expected that the methods employed will enable us to provide a field-level assessment of leadership, fatigue and stress on the participants' ability to survive a ship abandonment in the Arctic. It is hoped that the results from this study will provide the basis for continued scholarly activity to better understand the relative importance of different factors that affect long-term survival in Arctic settings. Eventually, we hope this research will help make it possible to identify where the greatest effort should be expended by the maritime industry to ensure the safety of people who sail in Arctic waters.

### Conduct of the exercise

The exercise started May 21st and ended May 23rd 0800. May 21, approximately 1730, all researchers arrived the location, the volunteers arrived approximately 1800. The STAI was administrated every 4th hour. The first 24 hours participants blood sugar was measured every second hours (see section 3.4.4 for more information), which may have influenced the results of current study. When ending the exercise only group A and C was intact. In group B one participant completed the exercise and in group D two participants completed the exercise.

Please see table 3.1, below for information on time of administration of STAI and remaining group participants at each time.

Figure 3.4: The content of grab bag two.




### Data analysis

The data will be analysed using IBM SPSS statistics, and results will be discussed in relationship with results of the other two studies on (1) sleep quality (reported in section 3.4.3), and (2) food intake and blood sugar level (reported in section 3.4.4).

Table 3.1: Time of adminstration of STAI and remaining group participants

| Group | Date in May | Time STAI | Pax |
|---|---|---|---|
| A | 21 | 1845 | 4 |
| A | 22 | 0300 | 4 |
| A | 22 | 1100 | 4 |
| A | 22 | 1900 | 4 |
| A | 23 | 0300 | 4 |
| A | 23 | 0730 | 4 |
| B | 21 | 1850 | 4 |
| B | 22 | 0300 | 4 |
| B | 22 | 1100 | 3 |
| B | 22 | 1900 | 2 |
| B | 23 | 0300 | 1 |
| B | 23 | 0800 | 1 |
| C | 21 | 1905 | 4 |
| C | 22 | 0330 | 4 |
| C | 22 | 1138 | 4 |
| C | 22 | 1910 | 4 |
| C | 23 | 0310 | 4 |
| C | 23 | 0730 | 4 |
| D | 21 | 1915 | 4 |
| D | 22 | 0340 | 4 |
| D | 22 | 1150 | 4 |
| D | 22 | 1920 | 2 |
| D | 23 | 0320 | 2 |
| D | 23 | 0815 | 2 |

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### 3.4.3 Sleep measured by the Oura-ring before, during and after demanding situations/operations in the arctic waters.

*By Alvhild A. Bjørkum, Tiril Knutsen, and Kristina Lærdal,*

*Western Norway University of Applied Sciences.*

**Introduction**

It is well documented that personnel being sleep-deprived can have a strong impact on alertness and performance (Bjørkum et al. 2004). In the review by Bjørkum et al. they concluded that shift work generally, and night shifts particularly seem to increase the risk of injury. When newer data are considered, these clearly indicate that shift work is associated with reduced safety and productivity. It is therefore encouraging that newer Sleep-Sensitive Watch Schedules Boosts Crew Performance and Efficiency are recently been implemented in the US Navy and thereby also most likely increase alertness and performance among the crew. The US Navy ordered late 2017 that all surface ships create watch standing schedule that allowed sailors to sleep at the same time every night with seven hours of uninterrupted sleep.

Increasing cruise traffic in arctic waters as around Svalbard with large number of passengers as well as crew will also be exposed to possible sleep deprivation and social- as well as ordinary jetlag creating fatigue. The National Transport Safety Board in US routinely list fatigue as a major factor in maritime accidents (Cordle, 2019). In 2012, The Navy Times cover story highlighted the use of circadian watch rotation to decrease crew fatigue. Also, Naval Safety Centre with others as Naval Postgraduate School have published a series of videos to highlight the importance of natural sleep cycles, the risk of fatigue, and the role of adequate rest in readiness and mishap prevention (Naval Safety Center, US on Sleep and Fatigue, cited 21 August 2019).

Survival criteria as proper decision making can be crucial for survival and are dependent on optimal physiological and psychological functioning before and during highly demanding operations in the arctic waters (Cordle, 2019).

Sleep status might be crucial and prerequisite for physiological as well as psychological performance before and during demanding operations in the arctic water. Recently U.S. Naval Institute reported that New Sleep-Sensitive Watch Schedules Boosts Crew Performance and Efficiency (Eckstein, 2019).

Working memory performance is one factor affected by lack of and skewed sleep as little as the loss of one single night of sleep (Rångtell et al., 2019).

Implementing information/educational programs as well as new sleep-sensitive watch schedules could improve sleep-status and raise the alertness about the sleep and circadian rhythm's impact on being adequately rested, having optimal alertness and thereby effective performance during demanding situations on see and on land especially in arctic waters since it can be crucial for reducing and hinder accidents, saving life and reduce damage and loss of equipment.

**Participants and habitat, onboard CGV Svalbard and on shore at Deltaneset, Svalbard**

Totally sixteen participants all Caucasian sailors/marine recruits and volunteers were divided in four groups, two organized (advised to select a leader, when to eat, sleep, etc.) - and two self-organized. The participants were set on shore at Deltaneset, Svalbard with limited and insufficient survival equipment. A water ration of two liter per person per day in bottles was provided, as well as a standard SOLAS Emergency Ration providing the approved energy intake per 24 hours.

**The ŌURA ring**

The OURA-ring **(https://ouraring.com/)** is a waterproof, ceramic ring with several sensors that continuously track several physiological parameters or bio-signals and can transmit the signals via Bluetooth to a dedicated application/App. The ring weigh about 15 g with a battery life of about three to five days. The collected bio-signals are treated in an algorithm and the app allows access to the summary night data possible to download in several data formats. The Ōura-ring-company was not involved in any aspects of the study and the Ōura-ring did not have access to participant information. All data from the ŌURA ring were anonymized using ad-hoc/on-site created codes. The ŌURA ring collected data from the participants' finger continuously and an algorithm determined sleep stages (wake, light-sleep, deep-sleep and REM sleep). **The Oura-ring is validated against the Gould standard for measuring sleep, the so-called polysomnography (de Zambotti et al. 2017).** In addition to sleep/wake stages, other biometrical measures as temperature, heart rate, heart rate variability and respiratory rate/breathing frequency were logged by the Ours-ring during the recording period.

Participants had one overnight OURA-ring recordings onboard the ship before transfer to the remote shore on Deltaneset, Svalbard. The participants wore the ŌURA ring on a finger of the non-dominant hand. Participants self-selected lights-out and lights-on times on board the ship. On shore, the participants were exposed to the midnight sun during their stay, but several had eye-mask and used sunglasses to protect themselves from light during the night period.

**References - we hereby include some additional relevant references than the ones mention in the above text.**

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### 3.4.4 The Nutrition Project – a Pilot study SARex Svalbard spring 2019.

***By Line Husjord and Annette Meidell, UiT - The Arctic University of Norway***

#### Background

The increased activity in the Arctic, in particular tourism and cruise traffic, also increases the risk of accidents and rescue operations. If, however, an accident occurs or a rescue operation must be carried out in polar waters, the extreme environmental conditions (e.g. long distances and harsh weather conditions), search and rescue (SAR) is challenging.

Low temperatures, wind, hypothermia and stress in an evacuation situation may be parameters influencing on the blood sugar level. In particular, is interesting to study the blood sugar effect connected to energy and fluid intake regarding the cognitive response. In this pilot study we perform a simulated evacuation situation in realistic cold climate conditions onshore in Isfjorden at Svalbard, see Picture 1. In these surroundings, we studied the variation of the blood sugar level in 16 volunteer participants for twenty hours. After twenty hours, a simplified cognitive test was conducted for every participant.

*Picture 1. The view from the beach at Deltaneset in Isfjorden where the pilot study was completed.*

To avoid accidents or increase the probability of survival if an evacuation situation occurs, decisions taken should be best possible. The decision makers should always endure and perform their best. Several factors are crucial when it comes to human decision making. Preventing fatigue is a major factor.

Many parameters can influence human decision-making. One of the parameters that seems to affect the cognitive response and alertness is the glucose level in the blood (Feldman and Barshi, 2007). Both excess glucose consumption and low glucose levels in the blood seems to be linked to function memory and cognitive deficiencies, and poor attention and cognitive, respectively. Both too high and too low blood sugar level can make you feel e.g. woozy, nervous, fatigued, and shaky (Teresa Aubele, 2011). Commanders and crew members must be alert in order to make good decisions during navigation and evacuation situations. In polar waters, the consequences of fatigue and poor decisions may be fatal. The necessity of maintaining cognitive function can be crucial.

## Survival for 5 days

There has been an increased interest in human factors in addition to the focus on technical specifications, in order to develop new methods related to survival, search and rescue in polar waters. Experience from exercises shows that technical requirements for equipment are not enough and that survivability must be understood in light of human factors in addition to the external factors that are involved in an accident. IMO has suggested several risk-reducing procedures to safeguard the basic human factors that are essential for surviving multiple days in polar climates. Among other things, it is important to prevent hypothermia (cooling down). In order to ensure the motivation to survive, IMO has proposed to prevent fatigue (Report St. 30 (2018–2019) Samhandling for betre sjøtryggleik («Collaboration for better maritime safety»).

## The nutrition project

Every part in a rescue operation is equally important. The requirements for maritime operations are described in the Polar Code (The International Code for Ships operating in Polar waters). Section 8.2.3 of the IMO Polar Code states that it must be a "system to provide sustenance" for 5 days whether evacuated to lifeboat/raft, ice or land. For ships operating in polar waters, the IMO Polar Code promotes a survival requirement of 5 days after evacuation before one can expect to be rescued. When it comes to nutrition, a "system for supplying energy and fluid" is recommended. Existing performance-based emergency rates can be one of several factors that can reduce the survival period. In a fleet, there are requirements for energy bars. The bars must include 600- to 1400 kcal (200 kcal per bar) (SINTEF, 2016). Regarding liquid containers, it is emphasized that they should not freeze, cf. US Coast Guard standard (SINTEF 2016). The total energy content and nutritional composition of the emergency ration can be important for ensuring adequate shivering response when the body temperature decrease (Maritimt Forum Nord / SARiNOR, 2016), (SINTEF, 2016). How much nutrition/kcal that is needed as a minimum for 5 days of survival in cold climates, are not uniquely described, probably due to lack of research results (SINTEF, 2016). We note that the existing emergency nutrition to be used have different energy content per 100 grams, but we have not studied this in detail.

The composition of nutrients in the energy intake (from the emergency ration) will affect the blood sugar, which in turn can affect the cognitive abilities, which among other things, enable us to receive, understand and carry out instructions. With a holistic approach, these will be important factors according to the Polar Code's requirements for survival for 5 days after evacuation, before rescue could be expected to take place.

## Recommended intake of energy and fluid - in Activity and rest

The nutrition policy in Norway today is a result of ongoing and active Norwegian and international efforts over a long period. The recommendations from the Norwegian

Directorate of Health (Helsedirektoratet)[1] concerning national nutrient recommendations and food-based dietary advice are based on the Nordic Nutrition Recommendation (NNR). A group of representatives from the Nordic countries has prepared this. Based on the current nutritional situation in the Nordic countries a basis for planning a composite diet for, among other things, primary nutritional needs for function and growth, is provided. NNR applies to groups of healthy people with a low to moderate level of activity, and in principle does not apply to sick people in need of special diet. NNR is expected to be used as a basis for nutritional policy decisions. In Norway, the Norwegian Nutrition Council (Nasjonalt Råd for ernæring) and the Norwegian Food Safety Authority (Mattilsynet) are the two public institutions/organizations responsible for coordination and follow-up of the nutrition policy (Helsedirektoratet.no) and (Anette Hjartåker et al., 2017).

According to the health authorities in Norway, the average need for energy intake for men under everyday conditions is approximately 2600 kcal and approx. 2200 kcal for women. When resting, the need for energy is reduced to the half (Directorate of Health, 2018). According to EFSA (Eropean food Safety Authority), a normally recommended intake of liquid / water is 2 liters per day for women and 2.5 liters for men. Both activity level and climate are important reasons why one may have an increased need for fluid. This also applies to causes such as diarrhea, vomiting and when consuming high fiber and protein intake. Dehydration  can occur if the fluid intake is too low or the fluid loss is too high. Cognitive abilities can be affected by dehydration (Norsk Helseinformatikk, nhi.no).

## Survival

In an evacuation situation, after a transfer from a casualty, one may be spend time "resting" in a raft or in a tent. In this context, shivering is crucial to maintain heat production. Heat production can be increased up to 5 times the metabolism by shivering, compared to resting, while in physical activity it can be increased 25 times (SINTEF, 2016). Cold and extreme weather conditions will increase energy and fluid consumption. Age, gender, body weight, fluid and electrolyte balance, and core body temperature, are factors that will have an impact on the need for fluid and nutrition. These factors will also have an impact on survival. Liquid intake and the composition of nutrients in the energy intake from emergency rations may also have an impact on survival in cold climates for up to 5 days.

## Low blood sugar can increase the risk of accidents

The brain cells cannot store glucagon or produce glucose, and the brain function depends on a normal blood sugar level (glucose level). Low blood sugar level leads to impaired attention, longer response time and an increased risk of accidents (Marit Bjørgaas, 2011).

Normally, the brain can only use blood sugar/glucose as a source of energy and has  only a storage capacity of 2 minutes. Other energy reserves, such as fat, are used to a small extent as it is difficult for the nerve tissue to use fat in the burning. If there is not enough sugar in the

[1] The Norwegian Directorate of Health (Helsedirektoratet ), Kostrådene og næringsstoffer https://www.helsedirektoratet.no/tema/kosthold-og-ernaering/kostradene, retrieved 30. August 2019.

blood to nourish the brain, this can cause mental dysfunction in a short time. When the blood sugar drops below 2-3 mmol it can cause mental impairment (Nhi.no).

Cognitive failure may lead to irrational actions and fatal decisions related to survival and evacuation.

## Beach exercise

During the beach exercise in polar climate that was conducted to simulate a survival scenario, the pilot project in nutrition was carried out with 16 volunteer participants. Picture 2 shows parts of the beach area, and how the groups were located.

*Picture 2. The beach exercise was carried out on Deltaneset in Isfjorden.*

The polar code requires survival for 5 days from evacuation to rescue. In an evacuation situation, we know little about the evacuated people on an individual level, both in relation to general food and eating habits. When and what they last ate and consumed fluid before evacuation are unknown, as well as any individual disease conditions. The first blood glucose measurement related to the beach exercise was put in the same context - the participants' intake of fluid and energy was unknown.

### Description of the participants in this pilot study

The volunteers that participated in the beach exercise consisted of 16 people. All of the participants in the beach exercise were on board KV Svalbard during the SARex Svalbard cruise in May. They also participated in other projects carried out during the beach exercise. The participants have been anonymized in the process and production of data. Each of the participants has given written consent for participation in the research project. All participants had the opportunity to leave the project at the beach whenever they wanted (picked up by Mob boat).

## The execution of the beach exercise

After dinner at KV Svalbard, all participants in the project were transported to the beach in the Mob boat, see Picture 3.

*Picture 3. The participants were transported to the beach by KV Svalbard's mob boat and crew.*

The participants in the beach exercises were divided into 4 groups with 4 people in each group. The participants had been told to dress for an unknown period of time outdoor on the beach. They received evacuation equipment on the beach.

The groups were given individual instructions on the beach, and did not know what information that was given to the others. All groups got the same amount and type of emergency ration and water. Two of the groups received guidance / instructions on when to eat and drink. The other two groups could freely consume the emergency rations and fluid intake.

Each group established a base on the beach with approximately 100-150 meters distance from the other groups. All the groups chose to start by rigging their base at the beach by building shelters and making campfire from the driftwood available on the beach, see Picture 4.

*Picture 4. Driftwood on the beach where the beach exercise was conducted.*

In the first phase included a lot of activity in the groups, see Picture 5.

*Picture 5. Building of a base with shelter on the beach.*

When the groups had established their own base, the activity level was reduced. During our stay at the beach, we noticed that the groups to varying degrees started a "sleeping regime". Two and two participants in the group slept simultaneously and used the two sleeping bags and mats. The other two then acted as a campfire guard.

The blood glucose measurements on the beach were taken every two hours at the group's own base, and we could therefore observe the activity in the groups regularly.

## Measurements of the blood sugar level

The participants in the beach exercise were divided into groups, coded and anonymized throughout the exercise. The first blood glucose test for the 16 participants on the beach exercise started on Tuesday 21th May 2019 at 16.00 before dinner on board in KV Svalbard. After dinner, at 17.00, the participants in the project were transported by mob boat from KV Svalbard to the beach. They were not given information for how long they would "survive on the beach".

The blood sugar measurements were performed with spot tests, where blood glucose was measured from the fingertip. No biological waste. All of the needles and measuring strips were taken care of in plastic containers which were brought back to KV Svalbard after completed measurements and properly destroyed.

The measuring of the blood glucose levels continued every two hours until the last measurement at 11.40 on Wednesday, 22th May (20 hours and 160 measurements). After 20 hours, selected parts of a standardized Mini-Cognitive Test were performed in parallel. The test is approved for use and translated into Norwegian by Siri Rostoft et al. 2016.

Procedures for the blood glucose measurements were performed as stated in the FreeStyle Freedom Lite blood glucose measurement system. Briefly summarized: Clean hands, insert the test strip into the measuring device, select the correct needle depth. Hold the pen firmly to the finger and stick (preferable) into the sides of the fingertips.

The equipment used for the blood glucose measurement was FreeStyle Freedom Lite - Measurement apparatus, lancets and test strips - blood sugar measurement system. The device shows results from 1.1 to 27.8 mmol / L. Two hours after meals, the blood sugar level of an adult without diabetes should be less than 7.8 mmol / L. FreeStyle Freedom Lite uses WHO (World Health Organization) as a reference in its guides.

The measurements were carried out by the authors, associate professor Guy Beeri Mauseth, UiT and with assistence from the bioengineering students Kristina Lærdal, HVL and Tiril Knutsen, HVL.

## Facilities

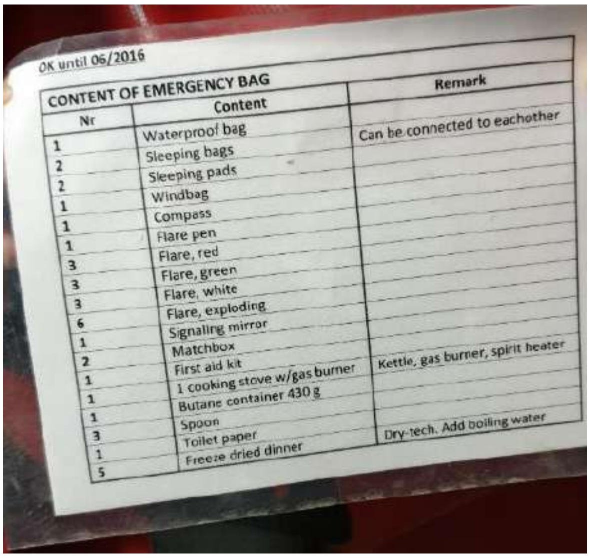
KV Svalbard's crew were very helpful during the beach exercise both by attending the exercise and also by contributing as polar bear guards, which secured the participants on the beach during the exercise period. They had an own base with a tent on the beach, located at a good distance from the 4 groups, and near the leaders of the other projects on the beach exercise. A tent with toilet facilities was also set up on the beach by the polar bear guards, which could be used by everyone.

The project management in SARex Svalbard placed a mobile weather station on the beach, which was borrowed from UNIS (The University Centre in Svalbard), see Figure 6, which also collected and logged the weather data during the beach exercise. Data concerning temperature, wind conditions and humidity are therefore available for the whole period.

*Picture 6. Mobil weather station from UNIS.*

## Gear for the groups

Emergency/survival GSK (group survival kit) from the Polar Institute, designed for winter survival, was provided for each group of 4 people. All equipment came in a waterproof emergency bag, see Picture 7. Each emergency bag contained the following equipment, see Picture 8.



OK until 06/2016

CONTENT OF EMERGENCY BAG

| Nr | Content | Remark |
|---|---|---|
| 1 | Waterproof bag | Can be connected to eachother |
| 2 | Sleeping bags | |
| 2 | Sleeping pads | |
| 1 | Windbag | |
| 1 | Compass | |
| 1 | Flare pen | |
| 3 | Flare, red | |
| 3 | Flare, green | |
| 3 | Flare, white | |
| 6 | Flare, exploding | |
| 1 | Signaling mirror | |
| 2 | Matchbox | |
| 1 | First aid kit | |
| 1 | 1 cooking stove w/gas burner | Kettle, gas burner, spirit heater |
| 1 | Butane container 430 g | |
| 3 | Spoon | |
| 1 | Toilet paper | |
| 5 | Freeze dried dinner | Dry-tech. Add boiling water |

*Picture 8. The list of emergency equipment in the emergency bag..*

Note that the freeze-dried emergency ration in the emergency bag was replaced with selected emergency ration in the beach exercise.

Eventually, the groups were also provided with a wind proof shield and a shovel.

## Final comments

To increase survivability in evacuation situations in polar waters for up to 5 days, it is important to gain more knowledge about the correlation between the following factors:
- instructed and non-instructed intake of fluid and energy
- blood glucose/sugar level
- cognitive failure (behavior)
- weather data
- fluid and energy

## Acknowledgement

We would like to express our gratitude to Maritimt Forum Nord for the opportunity to attend the SARex Svalbard project, for support to conduct the nutrition pilot study project. We also want to thank all the participants in the project for interesting and valuable discussions, for a lot of new input and knowledge and of course  a lovely time together. Without The Norwegian Coast Guard, and particularly the skilled, nice and helpful crew at KV Svalbard this project had not been possible to perform.

Finally, we thank our employer UiT the Arctic University of Norway for supporting our research and taking interest in the SARex Svalbard project. The project is important for improving the rescue and preparedness situation in the polar climate, and to increase the possibility to survive in case of unwanted evacuation situations.

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### 3.4.5 Field observation of the survival on land exercise.

*By Guy. B. Mauseth. UiT Narvik*

**INTRODUCTION**

This report covers the observations done during the field survival exercise on the Deltaneset between the 21st and the 23rd of May 2019.

The survival on land exercise is a part of the Norwegian Coast Guard Vessel Svalbard Cruise which was taken at the end of May (20th – 27th).

The main goals of the on-land survival exercise were

- Study of leadership as a survival factor
- Study the variations of blood sugar level/ nutrition as a survival factor

The study is conducted on 4 groups with 4 members each.

The writer of this report was a part of the team working on the monitoring of blood sugar level and was present on the Deltaneset in between the 21st and 22nd of May.

The writer represents the master study Engineering Design which is offered at UiT faculty in Narvik.

**Description of the activity**

The 4 groups and the scientists conducting the study (approx. 8) put on shore and positioned according to the layout illustrated in Figure 1. Means of transport from CGV Svalbard to the shore are CGV Svalbard MOB boats.

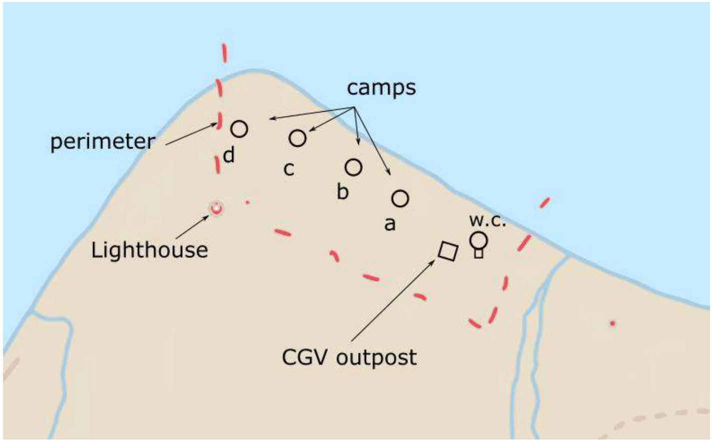



*Figure 1 The Deltaneset arrangement.*

Prior to the landing of the exercise participants, a team of CGV Svalbard personal established an outpost on land and constructed a temporary landing dock which enabled the participants easy and dry landing on land, see Figure 2

*Figure 2 Temporary landing dock built by the CGV Svalbard personal*

The CGV personal's main role was as polar-bear guard and safety. Participants were restricted to stay within the perimeter (striped red line) illustrated at Figure 1.

**Gear list supplied to each group**

All four groups and the group of participants in the experiments were given the same Group Surviving Kit (GSK) which supposed to answer to the guidelines given by the polar code/ SOLAS.

The gear was packed in a waterproof kitbag as seen in Figure 3:

*Figure 3 Waterproof kitbag containing the group survival gear.*

The kitbag content:

- 2 sleeping bags* by which are rated as summer or 3 seasons at best.

- 2 sleeping mats/ pads (thinnest type).
- windbag
- compass
- flare pen
- flare red
- flare green
- flare white
- flare exploding
- signalling mirror
- matchbox
- first aid kit
- 1 cooking stove with gas and spirit burner#
- Butane container
- Spirit container
- Spoon
- Toilet paper
- Freeze dried dinner (removed and replaced with another emergency food) ##

Additional gear:

- Jervenduk which is a multi-purpose wind blanket. The type supplied was of the thin type (no isolation.
- Shovel

* The sleeping bags supplied in the GSK kit can be connected to each other.

# The cooking stove by the Swedish outdoor company Trangia was a complete “storm kitchen” and included two types of burners. One burner is dedicated for burning gas (Butane/ iso Butane – Propane) and the other one was a spirit burner (paraffin/ red spirit etc.) A dedicated liquid bottle with paraffin was included. The kit had an integrated windscreen solution and a dedicated kettle.

The gas supplied in the GSK was rated as winter gas (iso butane propane). This type of gas can be used in sub-zero temperatures but there are known drawbacks and issues related to using such burners in extreme low temperatures. The spirit burner, however, is a very robust solution which can operate at about any temperature. The main drawback of this type of burner is rather low output and limited options of regulating the flame intensity.

## Due to the study of blood sugar level of the participants during the first 24 hours the freeze-dried meals where removed from the GSK and replaced with another emergency food. More details about the nutrition and blood sugar measuring are presented in the section written by Line Husjord and Annette Meidell in this report.

**Personal gear**

Most group members where pretty well-prepared regarding clothes, by using proper outdoor clothing or professional outdoor clothing intended for work in the North Sea.

**Description of the Deltaneset:**

The Deltaneset shoreline can be characterized as a rather flat and sandy "beach". The profile of the area within the safety perimeter (from the water and to the lighthouse) can be divided into 3 sections as illustrated at Figure 4:

- Wet area/ coastline which variates slightly in height due flow and tide.
- The driftwood area which can be described as moisty to wet sand/ earth covered by a vast amount of driftwood.
- The mire

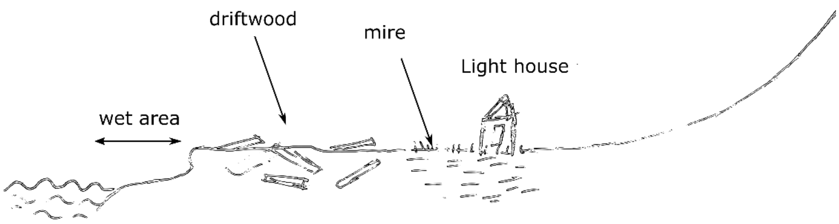



*Figure 4 Deltaneset shore profile*

The wet area can be described as easy to land onto by boat/ raft due to shallow coastline and soft soil. As figure 5 illustrates, there are no steep slopes or slippery rocks, which can cause difficulties when approaching land by a boat or a raft.

We can also see that there are still many patches of ice and icy snow covering the ground in this time of the year.

*Figure 5 Deltaneset shoreline, looking east*

Another interesting aspect related to the Deltaneset is the vast amount of driftwood which accumulates there over the years which can be found everywhere, as seen on figure 6.

*Figure 6 Deltaneset, driftwook (looking west)*

The weather conditions during the whole period can be described as very good for this time of the year. Weather data was collected by a mobile weather station placed at the exercise area. A plot of some of the data gathered by the station can be seen in figure 7. The left side axis has the units m/s for wind speed, ºC for temperature and %/10 for humidity reading. The right-side axis units are degrees, E.

We have experienced no precipitation during this period and the sky variated from mostly clear to light overcast.

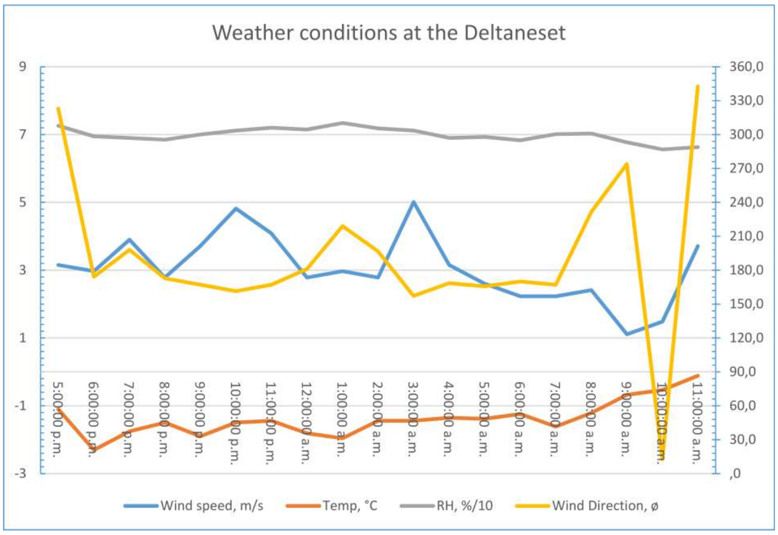



*Figure 7 The weather conditions at the Deltaneset during the first 24 hours.*

Note that wind direction reading might not be correct due to failure in compass calibration. Wind direction from our observation was mostly from sea and towards land.

Humidity is plotted as % divided by factor 10 in order to use the same axis scale as for wind speed and temperature.

**Observations during the time spent on land:**

Landing on the Deltaneset showed itself to be an easy challenge as we came by MOB boats which where piloted by the experienced personal of the CGV Svalbard, and their construction of a temporary landing dock which enabled the participants easy and dry landing on land. Nobody got wet while trying to get from the MOB boats to land.

Dry evacuation from the Deltaneset after the land project had been completed, turned out to be considerably more challenging. Higher waves during the night destroyed the temporary dock, and higher wind speed with the addition of higher waves meant that the MOB boats could not come sufficiently close to land in order for people managing to come on or off the boats without getting wet.

**Observing the groups**

All four groups of participants started immediately with the survival stage – which was to establish a basecamp. The vast amount of driftwood meant that it didn't took a long time before all groups had some kind of a shelter made out of driftwood and live campfire nearby. These shelters evolved through the first hours and by the middle of the night most groups had a shelter which features wooden floor, 3 walls and a minimal roof. Figure 8 illustrates the shelter raised by one of the groups.

*Figure 8 A shelter made out of driftwood*

Since the GSK contained 2 sleeping bags and 2 sleeping pads, most of the groups practiced shifts where two group members were resting in the sleeping bags while the other two gathered driftwood and kept the campfire alive.

Initially none of the participants gave the impression that they suffered from being cold. Having raised a shelter from the wind and having a heat source such as the campfire boosted the shield for the participants against the cold wind blowing almost constantly from the sea and towards land.

However, there have been two cases of participants quitting the experiment due to getting cold. In one case, the cause was a candidate lacking both isolation layers and wind breaking layers. The explanation from the candidate was that initially he was fine by the campfire but after a while, he needed to move away from the campfire due to too much smoke. Moving away from the fire was a crucial factor for the candidate that were getting too cold.

Another matter that can be a survival factor is the exposure to smoke.

Exposure to smoke seemed to be a matter of concern especially when the fatigue started to affect the participants.

**Additional notes:**

Due to the presence of driftwood, two survival factors in cold climate, such as

- obtaining a shelter which blocked cold wind and contributed to additional isolation,
- obtaining a heat source such as campfire,

were “served on a plate”.

As the group of scientists conducting the experiments did not build a shelter or a campfire, our experience during the time spent on Deltaneset was a bit different.

While we had the same GSK as the four groups and were dressed properly for outdoor activity, we didn’t have any shelter to go into in order to take a break from the constant wind.

The cold wind blowing mostly from the seaside and the rather high humidity played a major factor on our ability to rest. Without a shelter it was not possible to lay down and try to sleep or just rest in general.

During the night, at least four of us have sought “rest refuge” in the tent that was intended for the CGV bear guards crew, see figure 9.

*Figure 9 The CGVS crew tent*

**Overall impression of the GSK**

Not all gear from the GSK have been used during the survival exercise.

The sleeping bags, sleeping pads, wind blankets and Jervenduk have been used by all groups, and the scientists conducting the experiment.

My impression is that the sleeping bags ratings are too low in order to deal with colder temperatures experienced at the Deltaneset during the exercise period. In particular, if one considers that the sleeping pads were too thin and a lack of a shelter.

The lack of a shelter such as a tent is a major drawback as one cannot count for the existence of driftwood nearby or for the lack of precipitation. The type of a shelter to include in the GSK have to be a solution which can be raised up quickly and with no experience or previous knowledge.

An example of a shelter solution which wasn't easy to set up came by observing the experienced crew of the CGV Svalbard setting up an Hilleberg group tent see figure 10.

The NoCGV Svalbard crew had used rather long time setting up the tent. As one can see, the tent has a "dome construction" which usually gives very good stability in windy conditions, even without setting up additional pegs. However, such a construction is often more time consuming to set up.

*Figure 10 Hilleberg 4 seasons dome tent*

As described by the CGV Svalbard crew, this tent was acquired during an earlier SARex cruise and was described by the crew as a “difficult and finicky” tent to set up in good conditions such as the conditions met at the Deltaneset that day. It did not seem like they will want to try to set it up in colder conditions as it was almost impossible to set up with gloves.

The “storm kitchen” by Trangia is a welcome part of the GSK. The storm kitchen included two kinds of burners, integral windscreen and a dedicated kettle plus frying pan. One remark regarding the storm kitchen is the amount of fuel (gas or liquid) needed in order to melt snow and ice in order to obtain sufficient amount of water for a whole group over a period of 5 days.

**Final remarks and possible future projects**

Representing the UiT master program in Engineering Design, two challenges were observed during the exercise on the Deltaneset which looks like a type of a problem that can be studied in a master thesis:

1. Finding a better solution for a group shelter. This shelter should be compact and sufficiently light so it can easily fit in the GSK kitbag. It can be modular and multifunctional. Easy to set up during harsh conditions and with gloves on. In addition, the shelter price tag must be sufficiently low.
2. Finding a solution for dry landing on shore (or ice). This solution must light, robust, compact in storage format. It can be modular and multifunctional.

### 3.4.6 Participant report from Association of Arctic Expedition Cruise Operators (AECO).

*By Brede Valanes, Assosiation of Arctic Expedition Cruise Operators*

Disclaimer:

The views expressed in this report are solely based on personal experience from SARex.

#### INTRODUCTION

AECO was invited to join the SARex 2019 as observer and AECO's Marine Operations Specialist, Brede Valanes, participated on AECO's behalf.

AECO was established in 2003 as an association for Arctic expedition cruise operators and associates. The association's objectives are to ensure environmentally friendly, responsible and safe cruise tourism in the Arctic. AECO presently has 75 international members and more than 60 vessels operating the in the Arctic are operated by members of AECO.

#### Exercise scenario

Excerpt from cruise plan:

*"An area that will be of interest to study more closely in this project is to what extent leadership and organization affects the ability to survive under demanding conditions in cold climates, both as an individual and in groups. There is ongoing research within subjects of leadership and organization of activities where the situation and environment may change rapidly, and decision-making is under pressure in terms of time and risk. One of our academic collaborators, The Chalmers University of Technology, work with development of leadership and management of search and rescue operations both in their research- and education programs. They want to extend their knowledge by including the polar perspective, and by this include factors as the cold environment, darkness, distance, communication and limited resources. They want to compare this with other studies of the same matter, and by this map the differences and common features. They collect their data through observations, video recordings, interviews, etc. The researchers have experience as search and rescue personnel at sea and understand the importance of making observations without disturbing the ongoing activity. This research group has experience with dissemination of results into the IMO regulations and has succeeded in changing the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual vol. III. They will cooperate with the Nord University and the Arctic Safety Center in Longyearbyen"*

Info given from organizers before exercise:

- Stranded on the beach
- Transport by small boat from coast guard vessel to beach
- 4 groups, with 4 persons in each group
- No time frame of survival time.
- You will wear clothes that you have brought with you.
- There will be an equipment kit on shore
- You can arrange campfire
- Allowed to bring cell phone (for photo purpose only)
- Heated tent with a toilet available.
- Polar bear guards will be provided by coast guard personnel.
- No strings attached, if need for evacuation, notify organizer(s) on the beach.
- Blood samples to be taken every 4th hour in order to measure blood sugar.
- Sleep to be monitored by a ring, which is communicating with an app.
- Regular questioner form to be conducted, in order to measure stress level.

- Information and equipment might change during you stay on the beach.
- Not allowed to speak or interact with other groups.

Other info:

- Other members of the group were aware of the weather forecast.
- There was no cell phone signal on the beach, or other communications means.
- AECO's representative took the role as volunteer and made observations during the stay.
- One group member had outdoor experience from the northern parts of Norway.

## Instructions and gear for participant

Outfit worn during exercise:

- Down jacket from Bergan's.
- Outdoor pants from Stormberg.
- Woolen underwear for legs and torso.
- Woolen thin socks.
- Woolen tick socks.
- Mountain shoes.
- Tick wind protecting gloves
- Sunglasses
- Synthetic/cotton hat
- Synthetic/cotton neck protection

Group survival kit:

- There were 2 liters of water available for each member in group for each day of survival. Served in 0,5 liters bottles.
- Food rations from lifeboats enough to supply a group of four for 5 days
- A small windbag/tent for two persons
- Two sleeping bags
- Two sleeping pads
- First aid kit
- Primus with gas and methylated spirit and kettle
- Waterproof bag
- Compass
- One flare pen with 9 colors flares and 6-exploding flares
- Signal mirror
- Two matchboxes
- One spoon
- 1 roll with toilet paper
- Survival shelter, (Jervenduk)

## Description of experience

When the group arrived on shore, group members immediately started to build a shelter, from wood and timber found on the beach. The decisions of which direction the shelter should face was based on knowledge in the group about the weather forecast. No leader in the group was chosen and decisions were either made in small group talks, or if someone had a strong opinion.

It was impossible to dig out a foundation for the shelter because of the permafrost, so foundation was constructed on top of the ground using wooden planks.

The group decided on how they should ration the food and water. During the second ration handout, a group member read the instructions and they needed to adjust the rations, as the group had miscalculated the first time.

When sitting directly on the beach, the permafrost constantly produced cold. In order to mitigate this, wood was used as flor inside the shelter to reduce this, and sleeping pads was placed on top of this.

A group decision was made to sleep in pair, based on equipment availability. AECO’s representative slept for about 3 hours the first 24 hours period and 2-3 hours the remaining period.

During the first sleeping period, AECO’s representative tried to add the windbag in addition to the sleeping bag, this however resulted in being woken up by one of the other group members, showing that large amount of condense was produced between the sleeping bag and the wind shelter.

The wind direction shifted at some point, causing the smoke from the fire to enter the shelter, a wall solution in front of the fire was made, as seen at the picture (Figure 1).

*Figure 1 Shelter with fire and someone sleeping under the survival shelter, while boiling water. Photo Brede Valanes*

After a period on the beach, the group received more equipment, as a survival shelter (Jervenduk) was added to the kit. This was used in addition to the sleeping bag. This enabled group members to produce heat and not just keep it.

After approx. 24 hours on the beach, wind direction changed and stabilized, coming from one direction. A group decision was made to tear down the shelter and rebuild it. After 30 hours on the beach the wind shifted again, and a fresh breeze blew into the shelter. It was possible to sleep, when covered by sleeping bag and "Jervenduk". Also, under these conditions it was possible to produce heat.

After approx. 24 hours, the group were told by the organizers to put out the fire and simulated that were no wood left. This instantly made group members colder.

Lack of sleep made the AECO representative feel tired and cold. Walking around the beach and drinking warm water helped to feel warmer.

*Figure 2 Windbag. Photo Brede Valanes*

The weather was a combination of sun, partly overcast sky and a small period of fresh breeze wind force. No rain or snow showers. Temperature was below freezing point.

## Preliminary results

The group did not know what the survival kit contained, how long they were supposed to stay on the beach, what kind of shelter possibilities that was available, or how to combine these in order to achieve the highest survival probability. The group managed to find solutions based on common sense, previous outdoor experience and knowledge.

In AECO's representative's opinion:

A designated leader would have been beneficial for the group in order to make better decisions. Vessels have good systems in order to handle an emergency on board, a similar system for survival for 5 days would be beneficial.

Eating life craft food stopped the digestion system, and toilet was not used.

The group was given the opportunity to dress with clothes brought with us. All members in the group had some knowledge about how to dress.

The outcome of this exercise would have been completely different if weather conditions was different, especially in a scenario where persons get wet.

Ration of water was enough for survival.

Ration of food was enough, after the group had read the instructions.

Moral kept sinking with time.

## 3.5 Testing of an emergency shore bag in a delayed pickup situation.

***By Charlotte Sandmo and Sara Cohen, University Centre in Svalbard (UNIS)***

### Introduction

The exercise scenario consisted of a group of 15-20 students who have to manage a period of 16-20 hours in the field. The students are provided with a bag of group survival equipment only, due to a delayed pickup from a working day in the field. This could be a typical safety issue encountered at UNIS during the summer field season, when courses are dropped off at locations during the day, and risk that a pickup might be impossible due to quickly changing weather.

The test personnel were actual students at the UNIS with 1-2 observers with safety responsibility for the whole group. The exercise took place at the Deltaneset, in conjunction with the ongoing SARex Svalbard experiments. In addition to the group survival equipment the participants brought along personal equipment and clothing for a working day outdoors, including extra clothing, hot water in a thermos, and food.

The group also had the normal UNIS standard emergency equipment for field work such as a rifle, a signal pistol, a VHF radio, satellite communication telephone, emergency beacon, map, compass and GPS. The bag with the group survival equipment contained a tent, a thick tarp with insulation, a mat to sit on, 12 dried food rations, gas, gas burner, a pot, reflecting carpet, tape, matches, head light, a water bottle, a knife, and extra ammunition for the signal pistol. The main goal was to test the group survival equipment.

| **Timeline** | | |
|---|---|---|
| Date | Hour | Comment |
| May 20 | 16:30 | Information and HSE brief for all participants |
| May 21 | 08:30 | Lessons in practical use of equipment<br>Participants divided in two groups |
| | 13:30 | Departure with Rihb from Longyearbyen to Deltaneset<br>One group allowed to bring along the survivial suit on land.<br>The other group had to leave the survival suit in the boat |
| | 14:00 | The groups were left to manage the situation. |
| May 22 | 08:00 | End of exercise, packing. |
| | 10:00 | Transfer to CGV Svalbard, transport to Longyearbyen |
| | 13:00 | Debrief at UNIS |

### Learning outcome

The weather during the exercise was too mild to stress the participant, so it was not entirely realistic of a situation where a group would be stranded. The participants encountered sunshine minimal winds, and an average temperature of $-0.3°C$. The provided information, the safety course and the HSE brief gave the participants a sufficient platform to manage 24 hours in the field with the standard UNIS group survival equipment, which is a minimum standard. The group that was allowed to bring along their survival suits on land, managed better during the night compared to the other group due to the extra warmth provided by the suits.

### Back brief from the participants

The participants reported on a questionnaire after the exercise that the safety was well handled. Participants mentioned that the following could be included in the group survival equipment: Chocolate, cocoa and/or tea to mix with hot drinking water, something to filter water for drinking purposes, candle lights, plastic bags, toilet paper, rope/line.

### Conclusion

From what we observed and the feedback from the participants, we conclude that these groups will manage well for 24 hours left alone on the beach with the provided equipment, safety briefs, and safety courses in advance of the field work. The group survival equipment is a safety precaution and must be included in the standard field equipment for all UNIS field parties.

## 3.6 Use of the IOT technology in search and rescue operations.

*By Vladimir Sovilj, Viking Norsafe Life-Saving Equipment Norway AS*

INTRODUCTION

Internet of things (IOT) is a system of interrelated computing devices, mechanical and digital machines, objects or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IOT solutions in maritime industry are in early development stage, however 75% of the ship owners plans to implement IOT solutions in next 18 months. Development of the IOT in marine industry is mainly driven by the better information flow related to tracking and remote monitoring for maintenance purpose.

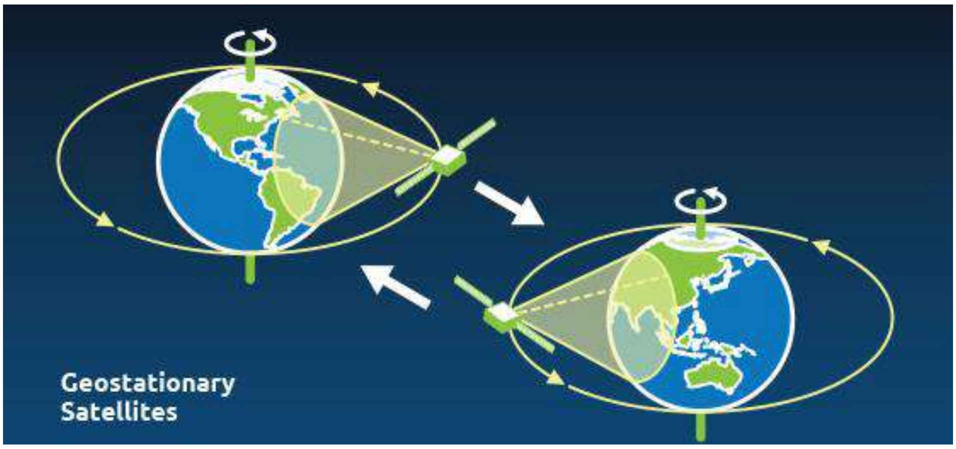
Information flow is also important in the emergency situations, and in chaotic rescue situation it may be crucial to have objective information about conditions such as temperature, CO2 level and life sign inside the lifeboat. Having the information provided automatically from lifeboat to the unit first arriving at the scene, such as helicopter or rescue boat, may in addition reduce radio noise on the emergency channel.

| | Temperature | Humidity | CO2 | Lifesign | |
|---|---|---|---|---|---|
| | | | | Sound | Motion |
| Liferaft 1 | LOW | HIGH | HIGH | YES | YES |
| Liferaft 2 | Moderate | Low | Moderate | YES | NO |
| Lifeboat 3 | Moderate | Low | Low | YES | YES |

Since IOT industry is in early stage several technologies and solutions are available on the market. Present IOT solutions can be divided in three main groups:

- LAN
  - Used mainly for short communication between devices such as mobile phones, tablets, smart TV etc.
  - Based on well-established standards such as WiFi, Bluetooth etc.
  - Short range with high data rate
  - Short battery life
- LPWAN
  - Emerging physical layer technology for digitalisation of the objects
  - Long range with low data rate
  - Long battery life (up to 5 to 10 years)
- Cellular
  - Used mainly for long range communication between devices such as mobile phones solutions.
  - Based on well-established standards such as GSM/4G technology
  - Long range with high data rate
  - Short battery life
  - Dependent on satellite/GSM coverage.

There are no established international standards for the maritime industry defining which IOT solution should be preferred in the industry. Therefore, Viking Norsafe have done their own evaluation and have chosen LoRaWAN technology for testing during the SARex Svalbard 2019-2020 project. LoRaWAN technology is LPWAN solution with long range – low data rate- long battery lifetime. Solution is also not depending on the satellite or GSM coverage and is therefore suitable for use in remote areas, such as Svalbard.



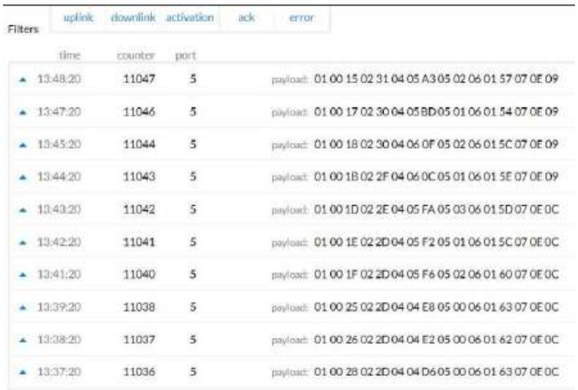

Use of point to point (P2P) communication solutions is already used in search and rescue operations. Best example of such use is Recco solution which is implemented in outdoor clothing. P2P solution integration in outdoor cloths was initiated by the outdoor clothing maker but have been implemented by the search and rescue operators due to advantages it provides even without international standard requirements.


DATAMETHODS, DATASAMPLING and DESCRIPTION OF THE DATA

To demonstrate possibilities of IOT solution based on P2P communication, without dependency of satellite or GSM coverage, one of the fast rescue boats on the KV Svalbard was equipped with Elsys LoRaWAN multisensor. Simple LoRaWAN gateway was installed on the bridge on KV Svalbard. After P2P connection between sensor and gateway was established, FRC was launched into the water and was driven away at constant speed and constant direction as practical as it was possible. Sampling rate was at 60 seconds intervals. During the sea trial VHF communication was used to determine distance between FRC and the KV Svalbard.

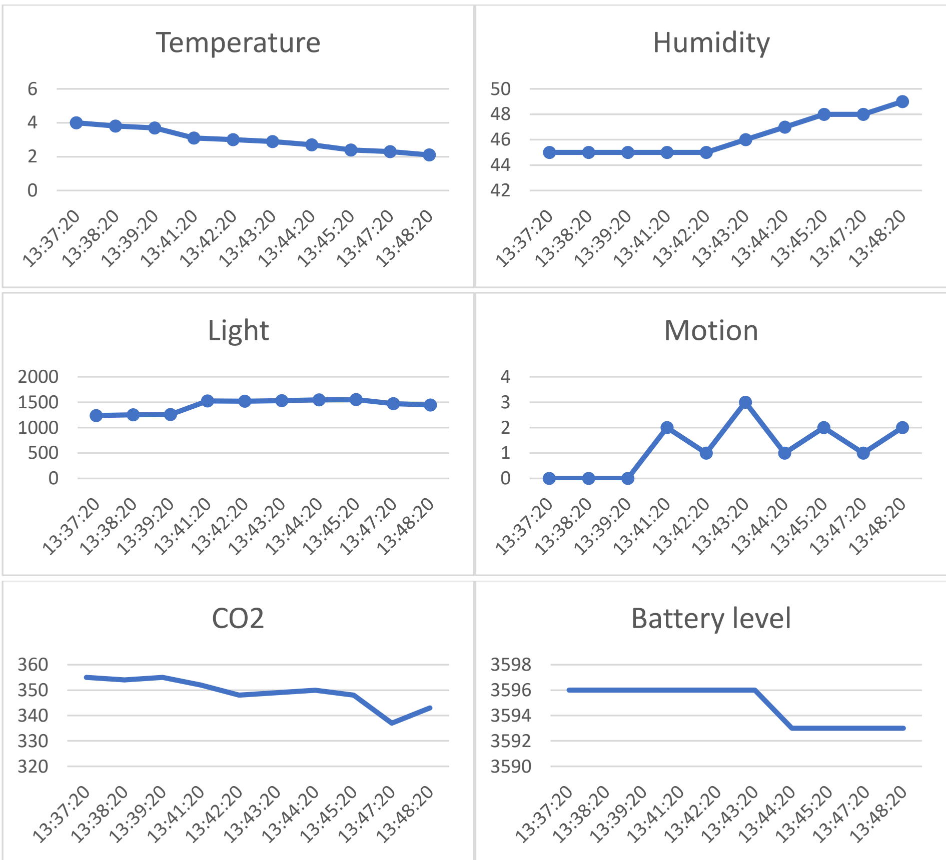
PRELIMINARY RESULTS

During the test encrypted payload of approximate 1kB was pushed from the multisensor to the gateway.


Filters: uplink | downlink | activation | ack | error

| time | counter | port | |
|---|---|---|---|
| 13:48:20 | 11047 | 5 | payload: 01 00 15 02 31 04 05 A3 05 02 06 01 57 07 0E 09 |
| 13:47:20 | 11046 | 5 | payload: 01 00 17 02 30 04 05 BD 05 01 06 01 54 07 0E 09 |
| 13:45:20 | 11044 | 5 | payload: 01 00 18 02 30 04 06 0F 05 02 06 01 5C 07 0E 09 |
| 13:44:20 | 11043 | 5 | payload: 01 00 1B 02 2F 04 06 0C 05 01 06 01 5E 07 0E 09 |
| 13:43:20 | 11042 | 5 | payload: 01 00 1D 02 2E 04 05 FA 05 03 06 01 5D 07 0E 0C |
| 13:42:20 | 11041 | 5 | payload: 01 00 1E 02 2D 04 05 F2 05 01 06 01 5C 07 0E 0C |
| 13:41:20 | 11040 | 5 | payload: 01 00 1F 02 2D 04 05 F6 05 02 06 01 60 07 0E 0C |
| 13:39:20 | 11038 | 5 | payload: 01 00 25 02 2D 04 04 E8 05 00 06 01 63 07 0E 0C |
| 13:38:20 | 11037 | 5 | payload: 01 00 26 02 2D 04 04 E2 05 00 06 01 62 07 0E 0C |
| 13:37:20 | 11036 | 5 | payload: 01 00 28 02 2D 04 04 D6 05 00 06 01 63 07 0E 0C |

Last signal from the multisensor on the FRC was registered at 13:48:20. At this time FRC was approximately 5 km away from the KV Svalbard. Encrypted payload provided following readings from the sensor:




During the test no interference with any other signals such as VHF was not observed.

Based on the results from the sea trial it is demonstrated that IoT solutions can be used to provide objective environmental information in search and rescue operation in remote areas without satellite/GSM coverage. However, technology is still in early stage and available devices are not suited for emergency situation.

In emergency situation sampling rate should be lower than 60 seconds to minimize the risk of signals not being picked up by the helicopter flying over in high speed. Sampling rate on devices available on the marked can be reduced down to the 1 second during the initial setup running. However, such sampling rate would reduce battery lifetime from 5 years to few months making the solution not practical with increased amount of maintenance work such as replacement of the batteries.

In addition, lack of international maritime standards and regulations on this topic makes it difficult to establish universal protocol for the information exchange and without such protocol it will be difficult to create a solution which can be used.

Further development on this subject should be on both hardware and regulation side. On hardware side development of the IoT solution will be driven by the condition monitoring of the lifesaving equipment in standby operational condition. Such monitoring does not require frequent sampling rate. If sensors are developed with emergency mode switch, which increases sampling rate, sensors can be used to provide key vital date in search and rescue operations as well.


Implementation of the point to point (P2P) solutions which are not dependent of satellite/GSM coverage could be initiated by the maritime authorities which covers remote area close to the north and south pole as a part of additional readiness for the vessels operating in such areas. Implementation of the non satellite dependent P2P solutions as international regulation requirement is considered as not cost effective since large amount of the world sea area have satellite coverage.

## 3.7 The Raptor antenna, a tracking and secure data transfer device.

*By Morten Jørgensen, Maritime Forum Nord*

The Coast Guard is limited by very restrictive regulations regarding the mounting and use of "non-military equipment" intended to transmit real-time data from their vessels. However, SARex Svalbard has been granted exemption in respect of exercises carried out as part of the project. The RAPTOR will remain on board until the SARex Svalbard project is terminated in June 2020 but will be off line between the exercises.

RAPTOR with INMARSAT antenna, worked according to spec during tests in May 2019.
It was installed and was online from May 3 at 1434 UTC. RAPTOR transmitted data every 7.5 min when the vessel was on steady course, and every minute during turns of more than 15 degrees. This was both surprising and impressive, considering both topography and latitude, and that only the INMARSAT antenna was mounted (the tests verified that INMARSAT worked up to N 78 24).

IRIDIUM antenna is an option but was not available during this exercise. IRIDIUM will be tested during field trip in March 2020.

NOTE: The RAPTOR's INMARSAT antenna is of the type that also transmits 20 degrees below the horizontal. This may be the reason for the surprisingly good results.

Coast Guard Svalbard turned off RAPTOR after the cruise in May in accordance with the agreement.

**Fig 1: RAPTOR - the route 20-26 May 2019**

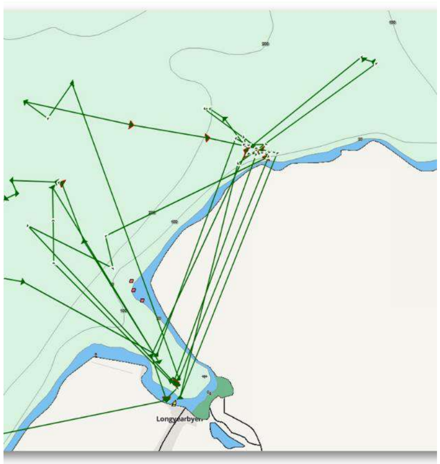


**Fig 2: Same route on other commersial AIS system**

Compared to even the most advanced commercial AIS systems on the market, the transmission frequency of RAPTOR is clearly higher (See fig 1 vs fig 2)

**Fig 3: frequency of RAPTOR-transmitted positions during turns**

Clearwater has also developed a small 180 deg camera that stores short video clips that may be sent in the same transmission as the position signal. This camera can be mounted on the bridge of the vessel. The camera also has night feature and has the size of an Iphone Plus.

All movie clips are collected by the user and can be presented as a small movie. With a 7 minute delay, onshore personnel will be presented a film of the situation.

Camera is connected to RAPTOR and video clips are sent in the same encrypted transmission.

This is placed in the same user portal on which all other tracking is registered. Only those affiliated with this user portal can access the data.

For DNK, which works with piracy and other war-related events, such a camera could in the future give shipping companies and crisis centres a better situational understanding.

During a Search and Rescue operation, or an oil spill response operation, it will be easier for emergency response operators ashore to see what is happening on the site, reducing the need for communication between on-site emergency resources and emergency management ashore.

The use of such a system is of interest to SARex Svalbard and may be scheduled to be tested in practice in March 2020.

## 3.8 Thermal and IR signature tests of survival suits in cold water.

***By Richard Norland, ISPAS AS***

INTRODUCTION

Current Maritime Search and Rescue (SAR) sensor systems for detection of people in the sea are binoculars, video camera, thermal (IR) imaging equipment or a rotating radar. For the detection of people in the sea using IR camera, the thermal difference between the person and the sea is important, the higher difference, the better contrast. However, the difference is also a function of time in the water. "The IR picture is brilliant for picking up differences in objects compared to the surroundings, fishing buoys, lobster pots, flags etc. and people that are warm and waving, or swimming," explains Thomas. "After half an hour or so, the person in the water's body becomes the same temperature as the surrounding water – as we are 62-per-cent water, the IR picture of a person not moving and cold, looks exactly like the sea surrounding them." Ref. https://www.airmedandrescue.com/features/rescues-waves

Background

During a test for detection of people in the sea using radar a total of 10 persons, 5 women and 5 men, using different survival suits were deployed into the relative cold sea. This gave the opportunity to do preliminary investigations into survival suits and to draw some preliminary experiences regarding future testing of survival suits for arctic conditions. It also gave the opportunity to test visual and IR detection of the persons in the water at different distances against different survival suits and survival suits colour (red/orange/yellow), see picture 1.

TEST

The two groups were divided into men (M) and women (K) and the surface temperature of the survival suits were measured and noted, see Table 1.

| Survival suit | Suit Surface Temperature (C°) |
|---|---|
| K1 | -5,40 |
| K2 | -2,00 |
| K3 | -2,00 |
| K4 | 6,40 |
| K5 | -6,20 |
| M1 | -3,60 |
| M2 | 4,60 |
| M3 | 4,20 |
| M4 | 13,40 |
| M5 | 0,80 |

The two groups stayed approximately one hour in the sea with significant sea height approximately 1 m. During this time each person was examined twice for the feeling of cold and surface temperature of the survival suit was measured, see Table 2. However, due to the sea waves washing over the person in the water, measuring the temperature of the surface of the survival suit was difficult to perform so it was decided not to use these measurements. In the future is recommended to use a thermal camera instead.

| Individual experience of wet & cold<br>SAREx-Svalbard May 2019 | | | | | | |
|---|---|---|---|---|---|---|
| | 10.00 AM | | 10.37 & 10.54 AM | | 11.05 & 11.17 AM | |
| | Cold | Wet | Cold | Wet | Cold | Wet |
| 5 | | | | | | |
| 4.5 | | | | | | |
| 4 | | | | | | |
| 3.5 | | | | | K4, M4 | |
| 3 | | | M1, M4 | | K1, K3, M5 | |
| 2.5 | | | K4, M5 | | | |
| 2 | | | K1, M2, M3 | K1, K4, M3, M4 | K2, K5, M1, M2, M3 | K1, K4, M3, M4 |
| 1.5 | | M4, M5 | | M5 | | K5 |
| 1 | All | All other | K2, K3, K5 | K2, K3, K5, M1, M2 | | K2,K3,K5, M1,M2, M5 |
| Sweating | | M4, M5 | | | | |
| Neck | | | | M3, M4 | | K5, M1 |
| Hands | | | | K1, K4, M2, M3 | | K5, M1 |
| Feet | | | | M3 | | |
| To cold to continue exercise: K1, K4, M4 | | | | | | |

Table 2 is the result of the individual experiences of the survival suit, i.e. how cold and/or wet, initially and after approximately 30 and 60 minutes. Men are in blue and women in pink.

The test was terminated after approximately one hour when the persons K1, K4 and M4 felt that it was very cold and wanted to terminate the test. One interesting finding is that the suit with the highest initial surface temperature and also the one where the person was sweating (M4) was the one that quickly became cold and needed to terminate the test.

VISUAL DETECTION DISTANCE

Because of the waves it was difficult to see the persons in the sea unless they were identified and tracked. This applied both to visual and thermal.

The picture shows the thermal signature at a distance of about 600 m and approximately 45 minutes in the sea.

The small boat for assistance can be clearly seen, while the five persons in the sea are more difficult to discriminate from the waves. Because of difficulty in identifying the individual suits, it was not possible to draw any conclusions regarding the visual or thermal signatures of the suits as seen from the ship.

PRELIMINARY RESULTS

The preliminary results indicate that the persons wearing the survival suits with the highest surface temperature on board the ship were also the first to experience cold. Whether this is due to the suit or clothing under the suit is unclear. If future tests are done it is recommended to use calibrated thermal camera for measuring the surface temperature of the survival suits and have approximately the same clothing under the suits. It is also recommended to test how easy it is to take the suit on under cold conditions.

It was difficult to identify the individual suits from the ship. A test for visual and thermal signature would require that the individual suits could be identified using possibly a personal AIS transmitter.

## 3.9 Detection of people in the sea with radar.

*By Richard Norland, ISPAS AS*

INTRODUCTION

For Search and Rescue (SAR) organizations detection of persons in the sea is a challenging task, especially if the sea is rough with waves and the visibility is low; which may often be the situation when a rescue operation is required. Current SAR sensor systems have a limited field of view and requires line of sight. These restrictions may make it difficult to see a person in the sea waves because of the limited line of sight due to the waves and the relatively small probability of actually looking in the direction of the person when this person is visible on top of the wave.

ISPAS has developed a Ku-band radar for detection of small objects in the sea with an electrically steered polarimetric antenna that can scan the sea surface very fast. The scanning with the electrically steered antenna is equivalent to a broad field of view while at the same time have a high resolution with a fast repetition rate. This solves the problem with occasional visibility of the person in the waves because sooner or later the person will be visible and then detected by the radar.

A larger version of the radar is installed on offshore platforms.

TEST

The radar was installed above the bridge on KV Svalbard, on the starboard side, pointing forward, see Figure 1.

*Figure 1. The radar installed on the KV Svalbard.*

Two groups of 5 persons each went into the sea and the ship positioned itself at approximately 400 m distance from the two groups with the waves moving towards the radar. Two smaller boats were following the two groups for security. The significant waveheight was estimated to be about 1 m.

Figure 2 presents the situation as seen from the bridge on KV Svalbard.

*Figure 2. The situation as seen from the bridge. The two boats are possible to identify in the picture.*

Figure 3 shows a more detailed picture of the situation.

*Figure 3. The small boat and people in the sea. Distance approximately 400 m.*

The radar easily picked up the people in the sea. A print screen of the real time presentation of the radar data and video is presented in Figure 4.

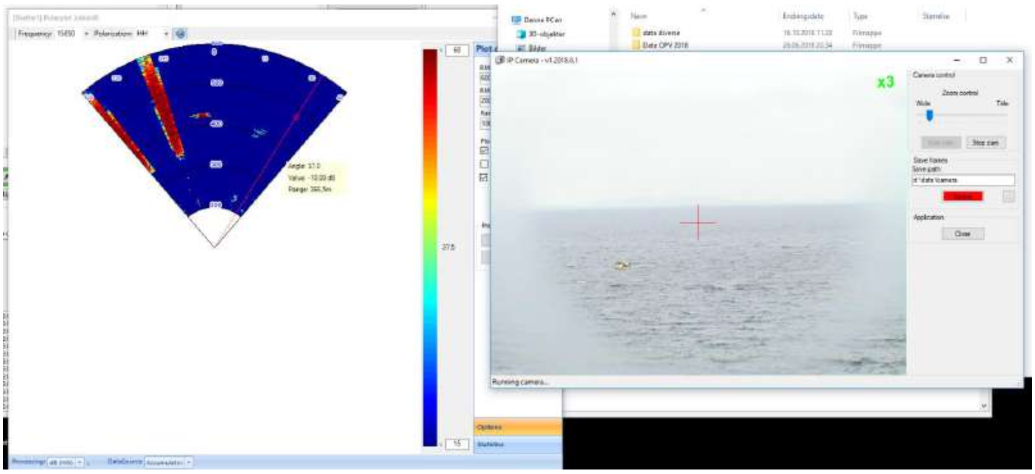


*Figure 4. Print screen of real-time radar and video.*

The zoomed view of the radar presentation is shown in Figure 5 where five persons can be identified in the radar data at 25 degrees and distance of about 400 m. The small boat is seen both in the video and at approximately 360 degrees, distance 430 m. It is not possible to see the persons in the sea on the video.

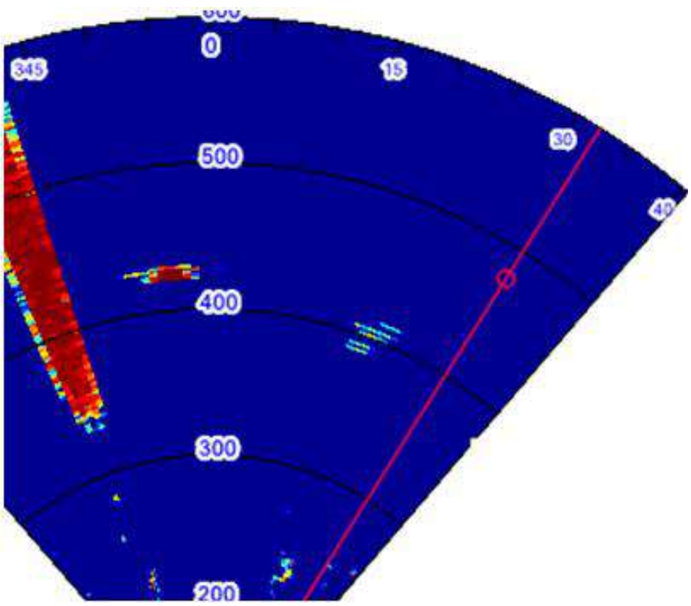



*Figure 5. Zoomed view of radar data in Figure 4. The five persons in the sea is easily identified.*

A second dataset where the radar data is combined with a handheld camera picture is presented in Figure 6. The persons are detected with the radar, but it is not possible to identify them in the picture.

*Figure 6. Radar and camera picture of small boat and five persons in the sea at 620 m.*

## PRELIMINARY RESULTS

The preliminary results indicate that the radar detects people in the sea with a significant waveheight of about 1 m where the waves are approaching the radar. The maximum detection distance was about 1 km, but this is not easily verified because of difficulty in correlating the position of the persons in the sea with the radar using only visual means. In future trials persons in the sea should have an AIS transmitter so that the correlation can be done exact.

## 3.10 MBR with UAV.

***By Espen Olsen, Sysselmannsbetjent, Governor at Svalbard***

This part of the exercise was used as a final test for an ongoing cooperation between the governors office and the 3 students, Joakim Alsvik Pedersen, Karl Fredrik Berg and Mathias Haukås, all studying drone technology at UiT – the Arctic University of Norway.

During winter and spring of 2018 the students wrote their bachelor thesis based on an operational need described by the SAR-services conducted by the governor of Svalbard.

The operational need was:

- A drone with a minimum of 1 kg payload that is connected to a 100-meter-long cable attached to a power source on the ground which gives the drone a flight time for a very long time.

- The system had to be mobile and be able to run on several power sources depending of availability on the ground, for example generator or batteries.

The main idea was to use this platform as an observation point and a communication antenna.

As responsible for the governors drone program, I was appointed as their point of contact. I provided the students with the operational needs, supported their field testing, and provided funding for needed materials. From the governors point of view, this was a good opportunity to both support young entrepreneurs, investigate possible technical solutions and overall strengthen our reputation as a capable and solution oriented organization.

We all learned a lot from this cooperation and also got positive media coverage.

On the SARex cruise the mission was to get the drone operational and mount a maritime broadband radio with a camera on the drone and provide live video from Deltaneset to CGV Svalbard.

All through this project we pushed the boundaries for what could be done, both in a very short time frame and with limited time for testing and on a very strict budget.

This generated a very steep learning curve for the students and forced them to put all their abilities and talents to the test. They described the effort close to inhuman and impossible, but extremely rewarding.

From their university they got feedback that the task they were given, was more on a masters-level, than a «simple» bachelor level.

By pushing the limits in so many ways, it was always a high risk project, relatively speaking. The students were encouraged by me saying that «failure is always an option» and «we don't fail, we learn».

With that in mind, the drone flew on Saturday and provided live-video from Deltaneset through an MBR connection. On the downside the flight time was an under a minute before the drone crashed into the ground.

The reason why the drone crashed was never fully understood or vigorously investigated, but it was evident that more field testing would be needed to put this system into operational service.

Nevertheless, we have proved that a drone can be used as a platform for lifting a payload high up in the air and it is possible to keep it there for a long time, possible acting a communication antenna and observation platform.

## 3.11 Mass Rescue Operations exercise conducted by the Governor at Svalbard.

***By Espen Olsen, Sysselmannsbetjent, Governor at Svalbard***

As the cruise industry is growing in the High-arctic areas, it is both expected and recognized within the services that the SAR-services must have a continuous focus on developing and implementing techniques and procedures and utilize equipment that will result in the most favourable outcome in case of a mass rescue operation (MRO).

IMO –International Maritime Organization, defines search and rescue as «an operation to retrieve persons in distress, provide for their initial medical or other needs and deliver them to a place of safety», and a mass rescue operation (MRO) as «characterized by the need for immediate response to large numbers of persons in distress such that the capabilities normally available to the search and rescue (SAR) authorities are inadequate».

Conducting a full scale MRO exercises can be both time-consuming and require a lot of resources. For example about 50 locals citizens had to be recruited as «casualties» and a lot of time went into coordination with the project management for SARex and the Coast Guard.

Although it is time-consuming, these processes are necessary to ensure a successful outcome. It can also be great learning experience for those involved, and creates valuable connections and insight.

It was in an early stage of the planning made a strategic decision that the exercise should not be a test of capacities or capabilities, but more oriented towards developing procedures and techniques and a general support of the SARex-project.

This would not be a full scale exercise with heavy involvement of the Rescue

Sub-Centre in Longyearbyen, run by the governor of Svalbard or other agencies. Likewise, there were no involvement on a tactical level by police officers as on-scene coordinator and so on.

There were two police officers involved, myself as responsible for the overall exercise and a colleague as a safety controller on land.

Our intention was to provide all participant with a safe and useful learning ground. This was off course done in tight cooperation with the whole SARex-team.

**In this exercise we had formulated the following goals:**

- Establish good procedures for evacuation of a large group of people under Arctic conditions (MRO).
- Create a database for these types of operations that can be used in estimates and planning for a real case.
- Contribute with basis for observations, measurements and interviews for academies associated with the SARex project.
- Provide valuable skills training at the individual and departmental level.

**We have defined the following end-state:**

The training personnel have found, developed and documented good methods and procedures for evacuating large groups of people from both land and vessels using helicopters and light boats. Heated tents have been used both on land and on board vessels. A lot of data and observations have been obtained that can be used in further development.

All activities have taken place without damage or loss of personnel or equipment. All practitioners have found the exercise useful and motivating. The emergency response actors have strengthened their reputation.

**Conclusion**

From the governors point of view the exercise was a great success. All participant was allowed to conduct their training in a safe and effective manner.

We can now give a qualified estimate of how long time it will take to evacuate a vessel in distress under good conditions. The answer is an average of one person every minute, not counting the time needed to get to the scene. We also have verified that it is possible to fit 20 rescued persons inside a Super Puma rescue helicopter and still work safely.

This is maybe not revolutionary findings or even new knowledge, but for many of us we have moved from guesswork and "hear-say" to qualified estimates.

The exercise has also initiated and provided input to local projects such as the local Red Cross project on how to best organize and equip an onshore evacuation facility and the collaborative MRO-shelter project run by the governor. The MRO-shelter project looks into choosing tent and heat sources in an MRO scenario suitable for rapid deployment in an arctic environment, with a collaboration between the governor, Red Cross and Lufttransport.

In the aftermath of the exercise Luftransport have also conducted 2 more MRO training sessions with police personnel and vessels members of Association of Arctic Expedition Cruise Operators (AECO).

The governor on Svalbard would like to thank all participants and looks forward to a continued cooperation with SARex Svalbard.

## 3.12 Longyearbyen Red Cross' role in the Mass-Rescue Operation (MR O).

*By Natalia Andreassen and Line D. Sandbakken,*

*Nord University Business School*

### INTRODUCTION

The overall goal of SARex Svalbard is to contribute to improved preparedness, increased safety and probability of survival in accidents and disasters in Arctic waters. The project lists three objectives:

1. Test and evaluation of equipment in order to meet the requirements of the IMOs Polar Code in terms of survival and evacuation. The activities are related to all four working packages (WP) in the project plan, i.e. Survival (WP#1), Information and Communication (WP#2), Evacuation (WP#3), and Oil Spill Protection (WP#4).

2. To establish and document best practice of evacuation methods from shore to a rescue vessel, through repeated testing and evaluation of several different cases of passenger conditions, and to exercise and train the search and rescue personnel in the Red Cross Longyearbyen, at the Governor of Svalbard's office and at the Coast Guard Vessel Svalbard in order to improve their skills and knowledge. This activity is a recommendation from the SARiNOR project.

3. To increase the knowledge about how leadership and organization of a group of passengers affect the probability and possibility to survive over a period of several days, on shore, waiting to be rescued after an emergency evacuation of their vessel.

Further, mass rescue operation (MRO) exercise was one of the field exercises of SARex Svalbard which was arranged Saturday 25. May 2019. The Objectives for the MRO exercise were:

● Establish good procedures for evacuations of larger groups of people in Arctic Conditions (MRO).

● Create a data base for this type of operations that can be used in forecasting and planning for a real incident.

● Provide the basis for observations, surveys and interviews for academia connected to the SARex Svalbard project.

● Provide valuable skills training at individual and organizational levels.

### Rationale for the study

SAR operations in the Svalbard area faces challenges of the long distances, cold unpredictable climate, darkness in winter months, general lack of infrastructure and remoteness to the response capabilities.

The projections of maritime activity level and risk patterns in the sea areas of the High North imply the increase in passenger and cargo transportation, fishing, tourism, research and offshore resource exploration. The MARPART project reports 1 and 2 analyse that a larger number of passengers, crew and greater diversity of the vessels are present in the region. In Svalbard, tourism and fishing are expanding and given the remoteness and lack of response resources, this may change the risk picture and consequences may be high (Borch et al., 2016a; 2016b).

The SAREX 1 results showed that there is a need for knowledge about specifically Arctic related competences within emergency response. There is a need for training of different roles and procedures in search and rescue (SAR) and OSR operations in the Arctic and there is a need to focus more on coordination and collaboration between emergency response organizations (Borch et al., 2016c).

The coordinated response within SAR operations in Svalbard areas is crucial for the improved preparedness in the Arctic waters. The joint operations involve resources from a broad range of organizations, commanders and leaders at different levels that have to coordinate and control the situation according to their roles and standard operating procedures. In volatile environments operational and tactical management may have to adapt the procedures, improvise with resource configuration and roles and procedures of the involved coordinators. Mass rescue operations (MRO) in the Arctic represent even more uncertainty. The response capabilities must be scaled up as fast as possible with competent personnel that can improvise and find solutions with the limited resources available. The main challenge in such environment would be the need for fast mobilization and smooth coordination between the available emergency response capacities, including voluntary resources. (Borch & Andreassen, 2015; Andreassen et al., 2018a).

Prior studies of the Red Cross capabilities in the Arctic pay attention to the value of local know-how of the environment and competence development for better collaboration with Joint Rescue Coordination Centres, Police, Health services, The Norwegian Directorate for Civil Protection (DSB) and other organizations at the regional level. The Red Cross and other volunteer organizations are present in local communities before, during and after incidents, and are a major asset in the rescue service. In major incidents the organizations often experience an increase in spontaneous volunteers, as local communities mobilize if something happenes in their communities. This can increase the capacity of the organizations in an emergency, but at the same time it is essential to coordinate and manage the spontaneous volunteers. Furthermore, operating in the challenging climate in the Arctic requires equipment and materials suitable for such conditions, and most organizations have equipment for handling daily incidents. Major incidents would require equipment being brought from elsewhere, even if many volunteers bring personal equipment when needed. Prior studies highlight the need for better knowledge of the role and capabilities of the volunteer organizations in the Arctic. In addition, it is essential to further develop the cooperation and coordination of organizations operating in the Arctic (Hangaslammi & Hatakka, 2018; NRR, 2018).

The MARPART Report 4 which analysed the capacity challenges in the Arctic sea areas also concludes that for the Svalbard region, a large number of volunteers from the Longyearbyen Red Cross represent a significant reinforcement of emergency preparedness capacity. The voluntary organizations also have significant local knowledge that may be of great value in major incidents. Another important aspect is, however, to have the necessary competence how to use this knowledge and in running large scale operations at both sea and on shore. This calls for much training and exercises on large scale operations like MRO with many units involved and demand for coordination in complexity. (Andreassen et al., 2018b).

There is a need for in-depth analyses of cases of major incidents and exercises in the Arctic conditions. SARex Svalbard exercise is one of the few full-scale exercises giving these opportunities. The exercise is a unique case both for training of the coordination within MRO, analyzing the roles and preparedness capabilities and the demand for competences in the Arctic region.

### Research purpose

The focus of our research is to study how the crisis management systems work in the Arctic context, to examine how the standard operation procedures of the involved organizations are adapted, and which special competences and skills are needed for different coordinators at scene during an MRO. In large scale operations it is important to understand the roles and procedures of multiple actors integrated into a functioning emergency management system. The trained disaster volunteers are the vital resources of the community that are linked to the emergency response system of different types of organisations.

In this field exercise we studied Longyearbyen Red Cross. Our research purpose was to illuminate the roles, responsibilities and procedures of volunteer groups in mass rescue operations. Volunteer organizations such as the Red Cross play an important part in the Norwegian rescue service. In remote places like Svalbard the Red Cross often play a more central role than on the mainland because there are less resources available for search and rescue. The volunteer capabilities may develop preparedness systems specialized for the Arctic conditions, material preparedness, emergency management competences, procedures and training routines.

## DATAMETHODS, DATASAMPLING and DESCRIPTION OF THE DATA

Several methods have been used to conduct this study. The main data was collected during the MRO exercise with Red Cross on Saturday 25. May 2019. Primary sources of data included observation of the coordination of the MRO during the exercise and interviews with the key personnel of Longyearbyen Red Cross. The aim was to achieve a better understanding of the organization and management of volunteers during an MRO. In particularly we focused on the challenges they experience during the coordination, developed procedures and routines in MRO coordination and competence needs. Although a few of the leaders were observed during the exercise the goal was to get a systematic overview and not identify strengths and limitations on an individual level.

The purpose of the research and main observation points were discussed with the leader of the exercise and the leaders of Red Cross in advance, and permission to do observations were granted. Field notes were written during the duration of the exercise, and we logged what was happening at which time. Right after the exercise the notes were written up more thoroughly.

The observations were executed in a manner to interfere as little as possible in the work that was done by the Red Cross-volunteers. We asked questions when something was unclear, and the situation allowed questions. Nicholls, Mills and Kotecha (2014: 246-7) refers to this as the researcher being an *observer as participant*, as outlined by Gold in 1958 as one of four approaches to conducting observations. This approach entails that the researcher is open about the intentions of the research and can visibly take notes/recordings about what is happening. Further, the observations focused mainly on the human setting, as the prime goal was to observe what the leaders were doing in terms of managing and organizing the team of volunteers on the beach and at M/S Polarsyssel. The leaders were the focal point in order to achieve a better understanding of the roles and main tasks of the volunteer organization during an MRO. The selection of site and the time frame for the observations were already set as part of the exercise (Nicholls, Mills and Kotecha 2014: 254-6).

Key personnel in Red Cross were interviewed after the exercise in order to clarify questions from the observations, the procedures of the Red Cross and to learn more about the organization in general. The interview guide was semi-structured, with loose themes/questions that were used as a starting point for further conversation (Johannessen, Christoffersen and Tufte 2011: 145). Thus, the interviews were structured as a conversation in order to achieve a better understanding of the organization and management of Longyearbyen Red Cross – both on a daily basis and during an exercise like SARex Svalbard (Marshall and Rossman 2016: 147-8).

### Description of the data

The mass rescue operation MRO exercise was carried out during Saturday 25. May 2019 in the area of Deltaneset, 78° 21.059'N 15° 50.626'Ø. The area is a long beach zone with slightly ascending terrain and exposed for wind.

The MRO consisted of two phases:

Phase one, operation MRO-AIR, consisted of two helicopters evacuating 100 people from the Coast Guard Vessel Svalbard (NoCGV) to shore.

Phase two, operation MRO-LAND/SEA started when the phase one was over, and it was twofold: During MRO-LAND on the beach Red Cross-volunteers performed triage on patients, prioritized and made patients ready for further transportation, and during MRO-SEA on the vessel M/S Polarsyssel the evacuated patients were given further care and treatment in a temporary medical facility (Figure 1).

The participating organizations in this exercise were the Governor of Svalbard, represented by a police officer coordinating and running the exercise in addition to the vessel Polarsyssel with crew; Lufttransport; Longyearbyen Red Cross; and NoCGV Svalbard. In addition, there were observers from other organizations that had participated in previous tasks and assignments during SARex Svalbard.

The desired final situation was that the participants were found, and effective methods and procedures for evacuation of large groups both on land and at sea are developed and practiced. In this exercise warm tents have been used on land and on board a vessel.

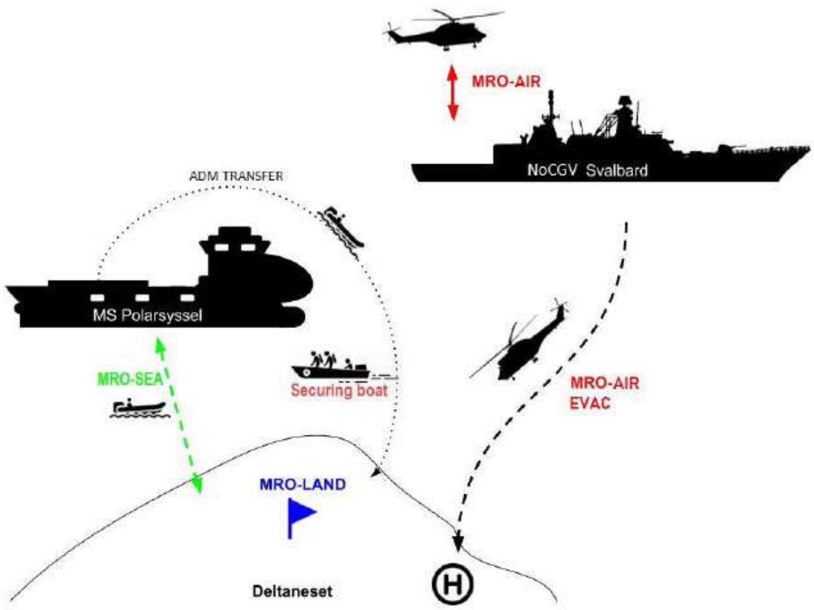



*Figure 1 The scheme of the MRO exercise SARex Svalbard, 25.05.19*

The alarm for the exercise went off at 09.25 in the morning, and endex of the exercise were called at 16.30. The helicopter operation took about two hours to conduct, and after a short break to regroup the second phase of the exercise took place. The first crew of volunteers arrived at the beach at 13.20, which were the starting point of part two of the exercise. At the same time, the volunteers at Polarsyssel started organizing the reception point where all evacuees would come in.

The Longyearbyen Red Cross participated in the exercise at the tactical management level. The organization was laying out the scenario both on the beach and on Polarsyssel. During the exercise the following key coordinators were observed:

- Operative leader of Longyearbyen Red Cross, who was managing and coordinating the efforts on the beach
- Second in command to the operative leader of Longyearbyen Red Cross, who was leading a team of volunteers on the beach and also assisting the operative leader in managing and coordinating
- Anaesthetic nurse from Longyearbyen hospital, who had the main responsibility for re-triaging the patients at the beach and prioritizing who to send first for further treatment
- Leader of the reception centre, who was managing and coordinating the efforts on Polarsyssel
- Coordinator responsible for registering patients as they arrived from the beach to the rescue vessel Polarsyssel

In addition, interviews were conducted with key coordinators in Longyearbyen Red Cross after the exercise. The aim was to gain further insight to the operation, procedures and organization both during the exercise and about the organization as a whole. The following personnel were interviewed:

- The administrative coordinator of Longyearbyen Red Cross
- The volunteer who acted as operative leader of Longyearbyen Red Cross during the exercise
- The volunteer who acted as leader of the reception centre at Polarsyssel during the exercise

During the exercise we examined the roles and main tasks of the coordinators and teams on scene of the MRO, as well as the different stages in the MRO. These stages included survival in cold climate, triage of stranded patients, transportation of patients from the beach to the rescue vessel and prehospital healthcare.

The data samples include observations from the following places:

1. operation on land during the MRO, including triage of stranded patients and survival in cold climate,
2. transportation of patients from the beach to the rescue vessel
3. organizing the reception point for evacuees at the Polarsyssel
4. registration and prehospital healthcare

The main topics for the data analysis are:

- roles and responsibilities
- challenges brought by the context
- procedures for management and coordination
- materials, communication tools
- coordination and communication between land and Polarsyssel
- competence needs in emergency management at different levels

### Limitations

There were several leaders on the beach during the exercise: One main leader and two leader-assistants with distinct responsibilities. The task of the main leader was to ensure everything was running smoothly, and through observing this leader the researcher also got insights into what the other leaders/teams were doing. At some stages during the exercise the researcher found it more relevant to follow the assistant leader for some time, due to the task and role that were executed at the time. Thus, the observations notes may have time gaps. At the same time the observations still give a fairly clear picture of what was happening during the MRO at the beach.

The operational and strategical management levels were not included in the exercise. In a real incident, the Rescue Sub-Centre Svalbard would be in charge of the onshore management of receiving passengers and establishing reception centres. The head of the Rescue Sub-Center Svalbard is the Governor of Svalbard. The Rescue Sub-Center Svalbard would coordinate care of survivors including registration, medical care, transportation and accommodation. The Norwegian Red Cross would presumably be an asset to make it work. In large-scale mass evacuation operations, the SAR mission coordinator (SMC) would have to coordinate and communicate closely with the operations leader of the Rescue Sub-Centre Svalbard for the transfer of crew and passengers to reception facilities and care. There will be also a representative of the Norwegian Red Cross in the Rescue Sub-Center Svalbard, and the coordination between management levels.

The role of The Governor of Svalbard was limited to planning and managing the exercise, and Lufttransport participated and trained their goals in phase one during the air lifts. A doctor from Lufttransport could have made decisions regarding medical injuries.

This exercise design could bring additional responsibilities to the tactical coordination of the Red Cross and make decisions that they have not previously trained or that are not mentioned in their procedures. This limitation disallowed to study the coordination between emergency management levels, towards emergency response units. However, in remote areas and with limited amount of resources available one cannot always guarantee that all organizations will be present, even if procedures state that things should be done in certain ways, and in some cases volunteers have to do tasks they are not trained for in order to save lives. Although the exercise was played out without all the roles present, we still managed to get a good overview of the voluntary organization's roles and tasks.

Due to the set-up of the exercise we did not get to study the interaction and coordination between the actors that could have been part of an MRO in a real incident, the different roles in an MRO or how the volunteer organization cooperated with other actors. We did however get a good insight into the roles, tasks and competences of Longyearbyen Red Cross.

## PRELIMINARY RESULTS

1 We observed the roles and responsibilities of the coordinators needed at:

- operation on land during the MRO, including triage of stranded patients and survival in cold climate,
- transportation of patients from beach to a rescue vessel
- organizing the reception point for evacuees at a vessel
- registration and prehospital healthcare

2 Main challenges induced by the context:

- The main challenge observed was the lack of human resources for effective dimensioning of the teams on land and at the vessel.
- There is a need for rearranging capability and ongoing role changing, in case a team leader should quickly delegate some tasks
- There is a lack of medical materials – in particular, stretchers
- Registration when the registration capacity is too little comparing with the amount of the incoming rescuees

3 Procedures for the management and coordination

- procedures observed
- developed forms were tested
- communication and connectivity

4 Materials and specific tools

- equipment boxes developed and tested
- warm tents have been used both on land and on board a vessel

5 Competence demands at the management levels

- There is a need for training in operational conditions
- The Red Cross coordinators demand competences to organise team both with trained volunteers, towards emergency response units and other agencies involved in the preparedness system.
- The competences to work with spontaneous members of volunteer teams, for example, from the distress vessel passengers, to integrate them in team with trained volunteers
- Need for better understanding how the preparedness system is functioning,
- Need for training and exercises involving all emergency management levels,
- Leadership skills to work with teams
- Collaboration skills to coordinate with operational and strategic management level

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## 3.13 Comments from on the acitivities from The Norwegian Maritime Authority (NMA).

***By Mirjam Vikingstad, Erik Landa, Jan Reinert Vestvik (NMA)***

**INTRODUCTION**

The Norwegian Maritime Authority has chaired the work in IMO to develop the Polar Code and are now implementing the requirements to passenger- and cargo ships operating in polar waters. In this context, we have experienced a need for further guidelines on several issues regarding polar survival. We have participated in the previous SARex-projects and have brought the reports back to IMO for discussion and development of Interim Guidelines.

The planning of this cruise was done over only a few months, and we appreciate the effort made by the SARex leader board. We have a few proposals for improvement of future cruises:

- Ensure enough safety personnel, including medical personnel.
- At the beginning of the cruise, all participants should have been gathered for a proper review of the cruise and a risk assessment.
- Prior to each activity, there should be meetings to evaluate the specific risks etc.
- Use the expertise that is represented on board for workshops during inactive periods.

**PRELIMINARY RESULTS**

**Survival on land:**

The May cruise included repetition of previous experiments, and we did not gain any significant new knowledge. In particular, we note that the findings from previous SARex exercises was not taken into account for possible further development of procedures or equipment. The ongoing work in IMO, with the Interim Guidelines should also have been taken into account, in order to test if the guidelines are adequate. The studies of leadership and group dynamics are interesting. However, we feel that the size of the groups was not adequate to get a realistic scenario and prove any leadership abilities. Survival crafts carries typically 12-150 persons, while these groups had only 4-5 persons. In a real case, the leader is designated by the ship's procedures, and not randomly elected by the survivors. The ship's crew are trained in leadership and survival. However, our question is if the STCW training is adequate for special polar challenges.

**Sleep:**

We have no comments on this part of the exercise.

**Nutrition:**

This is an issue we are discussing in IMO, and we are looking forward to the results of the investigation. We note that the exercise was not designed in accordance with the current IMO Guidelines. According to IMO, the energy intake should be 5000 kJ/day, while we were given 10000 kJ.

**Test of survival suits**

The purpose of these tests was not clear to us.

**MRO**

The relevance of this test for us was mainly to evaluate the operation in order to determine "maximum expected time of rescue" as defined in the Polar Code. The NMA is not responsible for SAR resources and hence, we focused on the pickup from the ship, and the time used.

## 3.14 Comments from SEALIFT SYSTEMS AS.

***By Dorthe Iselin Austevoll***

**Report / log for Svalbard Sarex :**

**Monday 20.05.19:** Took the plane from Oslo to Longyearbyen. Then went on the boat. Took a little trip into Longyearbyen before the boat was going out in Isfjorden. Travelled out to Isfjorden. Got to do a safety round with the crew and got a cabin. Then we ate dinner.

We had a joint meeting after dinner to talk about tomorrow's exercises. Those who were going to the beach were divided into groups and got their Oura rings etc. Some of us were going to test a life raft the next day, we kept in the background.

**Tuesday 21.05.19:** Breakfast 0750. Then there was a fleet exercise with UNIS from kl 09-11, as described in the project. We got to see the exercise from the vessel. Lunch 1150. After lunch, we were supposed to test some suits in a life raft, but the raft had been sent to the wrong place, so we did not do this, this day. Dinner at 16.15.

At 1700, participants were sent out to the beach.

At 20:00, some of us got to go to the beach to see how the participants were. They had already begun to build shelter for the wind, some had lit fire, and they looked like they were in good spirits. They will be there up to 36 hours, all participants can cancel when they want. (Many are still there, Wednesday at 16.00)

**Wednesday 22.05.19:** Weather; minus 2.5 degrees in the air. 1 to 2 degrees in water, blue sky and sun, no wind.

Breakfast 0750. Met Iain from Survitec Group at 0815 to go through the day's activity. As the preferred raft did not arrive, we used the same raft that UNIS used yesterday. It was a helicopter raft. The main goal was to give feedback on how we felt the survival suits were, how warm they kept us and how they were to wear, and what we would adjust if we could. We had three different types. Two participants used Survitec Group own work outfits, two persons had Australian coast guard suits, and we were three persons that had the SOLAS suits. I had the SOLAS suit.

We were taken out to sea with the Sjøbjørn while the vessel hoisted down the raft to us. When it was ready, we went out into the sea, and then we swam into the raft. Iain went first and crawled up in the raft. Then we went out one by one and got help to get in the raft. It was quite easy to get into the raft because it had a floating «flap» that we could use to get in. When everyone was onboard, we tried to take out water from the raft. The equipment we used, we got from one of the bags that were in the fleet. We put out a water anchor so that we wouldn't drift so much. We then installed the roof on the raft. It was very nice weather, but you could feel that even with this little movement, it would not take much to make you feel uncomfortable and sick. We had the roof up for maybe 5 minutes before we chose to take it down again.

We also had some exercises in the water. First, one went out to swim around the raft to get back in. That went really well. After a while we decided to use a connection line so that we could stay in the sea for a while to see how we felt. I stayed in the sea for about 20 minutes and felt that I was getting cold. It can be compared to lying too long in the snow. The other thing that happened was that my suit leaked water three times through the zip in front, close to my neck. I moved in a certain way and then water came in. The water came down in the front my neck and went all the way down to my stomach. This happened to Amalie too. My suit was approved for 2 degrees in the sea, I personally think that if it had been worse weather, I would not be able to stay in for a very long time, because after just 20 minutes it was quite cold. The toes and hands were cold, and the gloves were almost useless, but I was able to take my hands inside the jumper I was wearing underneath the suit, and that helped a bit.

After we finished the test, we had a meeting with Iain and went through the improvement potential we found. We told that the gloves were a little difficult to use, that we got water in through the zip in the front of the neck, the small "flap" that was supposed to protect the chin against the zip should be bigger because it just slipped away, and it hurt. And that it would be nice to have a pocket on the suit to put things in (some plastic from the sea got stuck on my suit when I was entering the raft. I didn't want to throw it back in to the sea, so a pocket or something would have been nice.) It was also difficult to move around in the suit I was wearing. You felt like a gummy bear.

All in all, a nice experience and I learned a lot, and I think Iain got a lot out of this too, as he will further develop the survival suits for Arctic waters.

**Thursday 23.05.19:** Breakfast.
Debrief meeting at 11.00.
Lunch 1150. Travel with Sjøbjørn to airport 1230.

**Additional comments on implementation:** We were very well welcomed by the Coast Guard, they were very accommodating and gave us a good experience on board. There has been a good atmosphere in the group, and I have experienced the cruise as very positive and educational. The only thing I miss was a more structured schedule of workshops where we get to know each other's work better, where we can share experiences and professional knowledge.

# Appendix A

# Participants

25 personnel from Longyearbyen Red Cross and 50 volounteers from Longyearbyen to participate in the mass rescue operation exercise, and Officers and crew from KV Svalbard participated in the exercises, as polar bear guards and in other supportive activities.

| **Name** | **Affilation** |
|---|---|
| Alf-Wiggo Eriksen | Kongsberg Seatex as |
| Alvhild Alette Bjørkum | West Norway University of Applied Sciences |
| Annette Meidell | Universitetet i Tromsø |
| Bjørn Helge Utne | Norwegian Coastal Administration |
| Brede Valanes | AECO |
| Dorthe Iselin Austevoll | Sealift Systems |
| Erik Landa | Sjøfartsdirektoratet |
| Guy Mauseth | UIT |
| Hans Sande | Norsk Sjøoffisersforbund |
| Helle Asgjerd Oltedal | West Norway University of Applied Sciences |
| Iain Mc Lean | Survitec Group |
| Jakob Storjord Andersson | Viking/Norsafe |
| Jan Reinert Vestvik | Sjøfartsdirektoratet |
| Kristina Lærdal | West Norway Universtiy of Applied Sciences |
| Line Husjord | UiT |
| Miriam Vikingstad | Sjøfartsdirektoratet |
| Scott N MacKinnon | Chalmers Täkniska Högskola |
| Stein Bexrud | Aviation and Survival Support AS |
| Terje Brinck Løyning, | Maritimt Forum Nord |

| **Name** | **Affilation** |
|---|---|
| Terje Herland | Lederne Equinor |
| Tiril Knutsen | West Norway University of Applied Sciences |
| Tormod Cappelen Endresen | Endresen Advisor |
| Vladimir Sovilj | Viking/Norsafe |
| Øyvind Jonassen | Norges Rederiforbund |
| Lars Nedrevåg | Hovedredningssentralen Nord-Norge |
| Natalia Andreassen | Nord Universitet |
| Line Sandbakken | Nord Universitet |
| Morten Jørgensen | Maritimt Forum Nord |
| Richard Norland | ISPAS as |
| Anders Rosnes, | ISPAS as |
| Espen Olsen | Sysselmannen på Svalbard |
| Rikard Karoliussen | Andøya Space Center |
| Mathias Haukås | Universitetet i Tromsø |
| Joakim Alsvik Pedersen | Universitetet i Tromsø |
| Karl Fredrik Berg | Universitetet i Tromsø |

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