RADEX 2019
TABLE-TOP EXERCISE
JANUARY 2021
Final report
RADEX 2019 table-top exercise Final report

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THE EMERGENCY PREVENTION, PREPAREDNESS, AND RESPONSE (EPPR) WORKING GROUP

The Arctic is an environmentally sensitive area with an extreme climate characterized by low temperatures, winter-time darkness, snow, ice and permafrost. These harsh conditions and the sparse and limited amount of infrastructure in much of the Arctic increase risks and impacts and hinder response activities. Actions for prevention, preparedness and response must be carefully pre-planned and adapted to the conditions and remoteness of the Arctic to maximize the use of available resources. Accordingly, international co-operation in this area is of major importance.

The Arctic Council was established in 1996 as a high-level forum to provide means for promoting cooperation, coordination, and interaction among the Arctic States (Canada, Finland, Iceland, Kingdom of Denmark, Norway, Sweden, Russian Federation, United States) with the involvement of the Arctic indigenous communities and other Arctic inhabitants. Arctic Council assessments and recommendations are the result of analysis and efforts undertaken by the Working Groups. The Emergency Prevention, Preparedness, and Response (EPPR) Working Group is one of six standing working groups under the Arctic Council. The EPPR WG is mandated to contribute to the prevention, preparedness and response to environmental and other emergencies, accidents, and Search and Rescue (SAR).

While not an operational response organization, EPPR conducts projects to address gaps, prepare strategies, share information, collect data, and collaborate with relevant partners on capabilities and research needs that exist in the Arctic. Projects and activities include development of guidance and risk assessment methodologies, coordination of response exercises and training, and exchange of information on best practices regarding the prevention, preparedness and response to accidents and threats from unintentional releases of pollutants and radionuclides, and to consequences of natural disasters. EPPR is assigned the responsibility for maintaining the Operational Guidelines of the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (MOSPA) to which all Arctic States are signatories. EPPR also supports the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue (SAR) in the Arctic by addressing relevant lessons learned from SAR exercises and real incidents.
EPPR Vision: EPPR strives to be the premier international forum for collaboration on prevention, preparedness and response issues in order to advance risk mitigation and improve response capacity and capabilities in the Arctic.
The views expressed in this document are the responsibility of the authors of the report and do not necessarily reflect the views of the Arctic Council, or its Observers, contributing institutions or funding institutions.
EXECUTIVE SUMMARY

The EPPR RADEX 2019 exercise was a half-day tabletop exercise (TTX) conducted on Monday June 3rd, 2019 as part of EPPR-I WG meeting in Bodø, Norway. RADEX 2019 followed up ongoing work in the EPPR ARCSAFE and RADSAR projects (see http://hdl.handle.net/11374/2395). The TTX scenario covered a maritime radiological/nuclear event involving search and rescue (SAR) operations in radiologically hazardous environment at sea. The exercise was planned and organized by Norway through the Norwegian Radiation and Nuclear Safety Authority (DSA, lead), the Joint Rescue Coordination Centre North Norway (JRCC-NN), and the Norwegian Coastal Administration (NCA), with contribution also from The United States through the US Department of Energy (US-DOE) on the development of the exercise scenario. Approval, steering and guidance of the TTX was provided by the EPPR WG through its regular meetings.

The scenario of the RADEX 2019 TTX called upon coordinated actions from several Norwegian and Arctic States’ response organizations. During the exercise, the participants were encouraged to discuss the information provided, exchange experiences and identify challenges related to SAR operations in radiologically hazardous environment in the Arctic. Each participant took an active role in responding to the TTX scenario and relating the response to their own capabilities and experiences. They were also critical in identifying best practices and areas for improvement within the context of Norway's response.

The main goal of the exercise was to identify possible challenges and to further improve national and international emergency preparedness and response to radiological scenarios. Five ‘assessed actions’ were used to sort the response activities into broad categories for analysis. In this report the response challenges identified within the five assessed actions are identified as areas for improvement. Where a plan or process was regarded as excellent, it is identified as a best practice. The following table summarizes the findings of the TTX evaluation process and assigns each Area for Improvement as either a SAR issue, a RAD EG issue, or an issue for both.

<table>
<thead>
<tr>
<th>Assessed Actions</th>
<th>Best Practice</th>
<th>Area for Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Rapid notification of responsible authorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Details on stricken vessel obtained rapidly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• SAR deployment within 15 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Crisis Committee takes “worst case” approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urgent Protective Actions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Notice to Airmen and Notice to Marines will be issued to avoid area where hazard may be present</td>
<td></td>
<td>Prepared questions for the CO of a stricken vessel to obtain critical information quickly (RAD Issue)</td>
</tr>
<tr>
<td>• Continuous production of dose rate models</td>
<td></td>
<td>Define role of RAD/JRCC Liaison Officer (Issue for both)</td>
</tr>
<tr>
<td>• Prepare for deployment of expertise to scene (RAD Issue)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Prioritize evacuation or non-essential crew from a stricken vessel (SAR Issue)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Protection of Emergency Workers and Helpers
- JRCC prepared to guide stricken vessels to appropriate safe harbours
- Dose monitoring capability for responders is required (RAD Issue)
- Prepare training for tugboat crews (Issue for both)
- RAD/JRCC expectations for each other require definition (Issue for both)
- Define procedures of shelter port use in RN emergency (RAD Issue)

### Medical Care
- Life saving is prioritized above contamination concerns
- RAD prepared to detect and decontaminate evacuees and to respond to concerns of worried-well
- RAD will monitor shoreline for contamination and change strategy as required
- RAD may send expertise to stricken vessel to gather information critical to planning response
- Retrieving casualties for a contaminated zone requires procedures (RAD Issue)
- Procedures to minimize crosscontamination are required (RAD Issue)

### Public Information
- Media response activated quickly
- Media roles and responsibilities are predefined
- Media lines addressing public concern can be pre-scripted (RAD Issue)

Arctic States should now consider these findings when examining their own plans and procedures to ensure they are adequately addressed against the possibility of a RADSAR event within their own Arctic regions.

By conducting RADEX 2019 and making this report available to all, the EPPR WG wants to share its experiences and the lessons learned. Shared experiences, either during exercise conduct or through real operations, are essential on allowing emergency planners to anticipate issues and prepare for the potential impact of those scenarios on their operations in the event of a radiological incident in the Arctic environment.
1. INTRODUCTION

1.1. BACKGROUND

Due to the environmental sensitivity of the Arctic, the extreme conditions and the lack of immediately available resources, emergency preparedness and response must be carefully preplanned. This also includes possible international cooperation.

The Arctic Council’s Emergency Prevention, Preparedness and Response (EPPR) Working Group works to develop guidance and risk assessment methodologies, coordinate training and exercises, and exchanges best practices, with the goal of minimizing the impact of manmade and natural disasters on the Arctic environment.

RADEX 2019 was an international exercise related to a rescue operation in a radiological hazardous area, and with risk for radioactive contamination of people and the Arctic environment. RADEX 2019 was organized as a tabletop exercise (TTX) with participants from relevant national and international authorities and organizations with responsibilities for search and rescue (SAR), oil spill response or radioactive contamination and radiological and nuclear emergency preparedness and response. The exercise was held in Bodø, 3rd of June 2019, in connection with the biannual EPPR Working Group meeting.

The exercise was funded by the Norwegian Ministry of Foreign Affairs, via the Norwegian Ministry for Climate and Environment. DSA was responsible for planning and organizing the exercise.

1.2. AIM OF THE EXERCISE

The aim of RADEX 2019 was to identify challenges in responding to a radiological or nuclear (RN) event, identify best practices and areas for improvement in response, and facilitate an exchange of experiences related to SAR operations in radiologically hazardous areas and with risk for radioactive contamination at sea in the Arctic. An additional aim was to further improve national and international emergency prevention, preparedness and response to such events and to find issues for follow-up in the future work.

The scenario created for RADEX 2019 was specifically designed to:

- Present a challenging RN scenario to the TTX participants and generate discussion on the TTX topic;
- Identify and reinforce national roles and responsibilities;
• Reinforce international cooperation, including notification, information exchange, and assistance;

• Identify available resources, both radiological and non-radiological response units, and competencies, resource needs and resource utilization in an RN SAR environment;

• Identify support available to non-radiological emergency helpers so that the response is not compromised due to a lack of knowledge and/or a concern over a heightened perceived risk;

• Challenge the health and safety for emergency responders and emergency helpers and identified the protective measures available to face these challenges; and

• Other challenges related to emergency response in these scenarios.

1.3. EXERCISE FORMAT

The injects for the TTX were presented through a PowerPoint presentation, where vital information was passed to the participants for their consideration and potential response. Each inject necessarily complicated the RN scenario, with the goal of broadening the discussion around RN response. After each inject the floor was opened for discussion as guided by a moderator. Each participant took an active role in responding to the TTX scenario and relating the response to their own capabilities and experiences. They were also essential in identifying best practices and areas for improvement within the context of Norway’s response. The discussion focused on the objectives of the TTX, best practices and areas for improvement. Important elements form the discussions were captured by the exercise coordinators and collected for inclusion in this report. Evaluation of the response to the scenario was conducted against the evaluation criteria as detailed in the RADEX 2019 Evaluation Guide.

1.4. EVALUATION AGAINST THE GOALS OF EMERGENCY RESPONSE

In accordance with International Atomic Energy Agency (IAEA) guidance, in a nuclear or radiological emergency, the goals of emergency response are:

a) To regain control of the situation and to mitigate consequences;
b) To save lives;
c) To avoid or to minimize severe deterministic effects;
d) To render first aid, to provide critical medical treatment and to manage the treatment of radiation injuries;
e) To reduce the risk of stochastic effects;
f) To keep the public informed and to maintain public trust;
g) To mitigate, to the extent practicable, non-radiological consequences;
h) To protect, to the extent practicable, property and the environment; and
i) To prepare, to the extent practicable, for the resumption of normal social and economic activity.

Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, International Atomic Energy Agency, Vienna, 2005
2. RADEX 2019 TTX SCENARIO

2.1. INTRODUCTION

The scenario designed for RADEX 2019 was a near worst case nuclear accident that allowed for discussion of some of the most significant aspects of nuclear emergency response in an Arctic environment.

The scenario for RADEX 2019 covered a maritime event involving a reactor accident onboard a nuclear-powered icebreaker (“MV NONSUCH”), that resulted in search and rescue (SAR) operations in a radiologically hazardous environment, thus requiring coordinated response from several response organizations.
2.2. SCENARIO INJECTS

The scenario was presented using five injects with predetermined content. Each inject was crafted to engage the participants in specifics of the response requirements. The scenario became more complex as the scenario developed, forcing the participants to consider more and more aspects of the complexity of the situation. In some instances, conditional content was created in anticipation of some participant actions. Injects took the form of situational information from the vessel or other vessels in the vicinity, radiological information from assets with detection capabilities, or news injects from the media. The location of the vessel can be seen in Figure 1.

The scenario injects can be found in Annex A. The radiological information used to generate the radiological scenario can be found in Annex B. The news injects detailing the concerns of the media can be found in Annex C.

*Figure 1: Nonsuch Accident Site*
2.3. RADIOLOGICAL EVENTS LIST

The radiological events of the RADEX 2019 TTX scenario are summarized in Table 1.

**Table 1: Radiological Scenario Summary**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Inject Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 June</td>
<td>1300</td>
<td>Severe fire onboard NONSUCH resulting in the total loss of power onboard</td>
</tr>
<tr>
<td>3 June</td>
<td>1700</td>
<td>NONSUCH notifies JRCC NN of potential reactor problem.</td>
</tr>
<tr>
<td>3 June</td>
<td>1800</td>
<td>Loss of Coolant Accident onboard the NONSUCH reported. Hull shine starts.</td>
</tr>
<tr>
<td>3 June</td>
<td>1900</td>
<td>Radiological release to environment starts.</td>
</tr>
<tr>
<td>4 June</td>
<td>0800</td>
<td>Radiological release to environment ends. Hull shine continues.</td>
</tr>
</tbody>
</table>
3. CONDUCT OF THE EXERCISE

3.1. LOCATION AND SET-UP

The RADEX 2019 TTX was conducted in a conference room of the Scandia Bodø Hotel. The approximate layout of the room can be seen in Figure 2.

3.2. TTX INTRODUCTION

The TTX started at 1300 with opening remarks from Inger Margrethe H. Eikelmann, Head of Section, Section High North, DSA. Her remarks were followed by the self-introduction of each participant taking part in the TTX. The observers of the exercise were then asked to introduce themselves. The moderator, Mr. Frank Kitching, concluded the introductions and gave a brief summary of his experience in the field of nuclear emergency prevention and preparedness.

Following the introductions, the aim of the TTX was reviewed, the delivery method was discussed and the TTX assumptions were presented. Finally, the assessed actions were introduced. These actions were used to detail the findings of this report and included:

- Activation;
- Urgent protective actions;
- Emergency worker and emergency helper protection;
- Medical care; and
- Public information.

3.3. TTX DELIVERY

The scenario was presented using a PowerPoint slide deck and handouts of the media stories. The information for each inject was presented to the participants, who were then encouraged to discuss their actions after receiving the given in formation. Each inject presented contained a jump into the future as well as additional information that complicated the scenario and the response requirements.
Although the scenario was based off the coast of Norway, all participating nations were asked to contribute to the discussion. They did so by explaining how specific response actions would be conducted by their nation or by describing their own preparedness through equipment availability or training/exercises conducted within their SAR community.

Before moving on to the next inject the five assessed actions were reviewed once again to determine if any actions were not considered.

*Figure 2: TTX Conference Room Layout*
4. TTX FINDINGS

During the TTX presentation detailed notes were taken to capture the best practices and the opportunities for improvement that the scenario revealed.

The findings are presented below.

4.1. ACTIVATION

All Arctic States indicated that they would activate their emergency operations centers fully once the notification of the fire/blackout was received. This was specifically due to the presence of a nuclear reactor onboard a vessel involved in a fire.

Best Practice – In Norway, the DSA and the national Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response will be notified and activated quickly, as well as affected ministries and counties/municipalities. This ensures competent authorities and responsible agencies are available to respond to public concerns as quickly and effectively as possible.

Best Practice – A request for information regarding the vessel from the owner nation would be one of the first actions taken. This assumes that the stricken vessel had notified their host nation of the initiating incident.

Best Practice – JRCC will act immediately to establish contact with the vessel in distress and responding ships. The activation of 330 Squadron for SAR only requires 15 min notice to move. Due to information on reactor driven vessel the DSA would be notified immediately to provide decision making support. JRCC will also inform Chief of Police and Fire Brigade MIRG Team. The JRCC will investigate potential vessel cargo through the vessel monitoring system.

Best Practice – DSA activates the Crisis Committee, which takes a proactive “Worst Case” approach. DSA will inform relevant ministries. DSA will start prognosing possible nuclear releases and establish contact with the Norwegian Meteorological Institute (met.no) for detailed wind and water predictions.

International notification is a priority for the Crisis Committee. The IAEA would be notified on the potential nuclear incident early in the initial response and if international assistance is required this is one method of engaging said assistance. Other bilateral agreements would be enacted, and information shared with neighbouring countries regarding the event.
4.2. URGENT PROTECTIVE ACTIONS

Participants noted that communication with the Commanding Officer (CO) of the stricken vessel through the coastal radio is key to obtaining information regarding the status of the onboard reactor and the potential for a radiological release. Cooperation of the CO, especially following a mayday, is expected to be forthcoming and all efforts to assist the vessel in mitigating a potential reactor issue should be carefully considered.

Opportunity for improvement: DSA may wish to produce a list of questions that the JRCC could pass to the CO to understand the developing situation onboard the vessel. JRCC should have relevant questions to ask of the vessel to that accurate and timely information is provided to the DSA.

Opportunity for improvement: The role of a liaison officer between DSA and JRCC requires definition of roles and responsibilities, including mutual expectations. There was a recommendation to use civilian-military liaison agreements with the Norwegian Joint Headquarters as a template for this liaison officer agreement.

Opportunity for improvement: It was noted by several participants that it is important to deploy governmental expertise to the scene to prove that the authorities take responsibility and that the threat is manageable.

Opportunity for improvement: Additional questions that require resolution include:

- Who should brief JRCC response crews and how will this be done?
- How is the voluntary status of the crews ensured?
- How are dose levels for rescue workers (1 mSv to 50 mSv) monitored and controlled?
- Is there personal protective equipment available for the use of the crew in the event of a radiological release (including equipment for communication with mask worn)?
- How is this process documented?

Best practice: The Norwegian Coastal Administration will issue Notice to Mariners and Notice to Airmen to inform marine and air traffic to avoid the hazard area.

Best practice: From the initial assessment, and as more information becomes available, the DSA will conduct continuous dose rate projection prognosis to increase accuracy of its models.

Opportunity for improvement: The evacuation of non-essential crew from the stricken vessel should be a priority, potentially before a release has started. For those essential crew who remain onboard, a procedure for supporting the rotation of the crew on/off the stricken vessel should be considered to minimize the accumulated dose and allow for rest and recovery. Unless the vessel is completely abandoned, there will be a requirement for engineering personnel to maintain the systems that cool, control, and contain the damaged reactor and any fission products released from the reactor core.

4.3. PROTECTION OF EMERGENCY WORKERS AND EMERGENCY HELPERS

Best practice: The JRCC is prepared to provide guidance to responding vessels and to direct them to specific ports where radiation detection and decontamination is prepared and provided to crew members and evacuees from the stricken vessel.

Opportunity for improvement: A procedure for monitoring dose and ensuring continual care for emergency workers and emergency helpers is required. This means that emergency workers or emergency helpers would be able to report their accumulated dose and, if they were approaching a predefined limit, could be rotated with fresh personnel until the available personnel were exhausted. This allows the dose load to be distributed across
multiple individuals without risking a large dose to a single or a few persons.

Opportunity for improvement: Tugboat crews may require additional training for towing a stricken vessel. Current level of training envisions detection of a threat and to leave the area once detected. There is currently no provision in the plans for working within an area of potential continued exposure. However, some Coastguard or Naval vessels are capable of towing in a radiological situation. They are also capable of creating a fog of seawater around the vessel, sometimes called a pre-wet system, that is specifically designed to wash contamination off the vessel in this type of situation. Vessels with these capabilities also have a method of entering the safe interior through an internal decontamination facility.

Opportunity for improvement: DSA's cooperation agreement with JRCC is an excellent process. However, the JRCC may require more interaction with the DSA to conduct further training and exercises to ensure a complete understanding of specific details or advice that each expects from the other in the event of a nuclear emergency at sea, especially when complicated by a SAR component.

Opportunity for improvement: There is an agreement between DSA and the coast guard as well as between DSA and the Norwegian Coastal Administration concerning emergency shelters and ports. There is a need for procedures for use of emergency shelters and ports in RN situations.

### 4.4. MEDICAL CARE

Best practice: Contaminated casualties would be evacuated to the nearest hospital for treatment. Priority is placed on life saving regardless of contamination issues.

Opportunity for improvement: Issues regarding how to retrieve a casualty from a radiologically hazardous area during an emergency/release were noted. Plans for this situation should be drafted and tested in further TTX environments.

Opportunity for improvement: Procedures that can be taken to minimize the cross contamination of transport vessels/vehicles should be investigated and implemented.

Best practice: DSA will prepare radiation detection and mass decontamination at ports for vessels involved in response efforts, as well as preparing to respond to the concerns of the “worried well”, both onboard the responding vessels and from the public ashore.

Best practice: DSA will initiate detection and sampling along the Norwegian shoreline in locations as informed by weather forecasts. The results of the sampling and monitoring program will inform the response as well as the public communication’s strategy.

Best practice: DSA will consider sending radiological measuring expertise to responding vessels before they arrive in port, thus allowing them to confirm if radiological contamination is present.

### 4.5. PUBLIC INFORMATION

Best Practice: Media inquiries regarding the full activation of the DSA, and eventually the Crisis Committee, are expected early in the incident.

Many of the participants noted the extreme interest that would be generated from the worldwide media. In order to maintain public confidence a proactive approach to the media and employing additional resources would be critical to an effective response. In addition, priority on direct contact with stricken vessel’s state should be reflected in the communication.

Best practice: An agreement is in place providing roles and responsibilities for media relations. The JRCC is lead on the rescue operations and the DSA is the lead on radioactive and nuclear challenges. Opportunity for improvement: Immediately following awareness of a nuclear incident the public will be looking for a prediction of the impact on their health. DSA needs to establish procedures for understandable communication of plume
prediction models to share with the public, with careful explanation to allow an understanding of what the predictions mean and what the real dangers are.

### 4.6. ADDITIONAL CONSIDERATION – OIL INSTALLATIONS

Oil installations were not considered in this TTX. However, there are numerous installations off the Norwegian coast that could potentially be affected in this scenario. This type of event could affect the installations directly, the vessels and aircraft moving to and from the rigs, and cause concern within the staff onboard the oil rigs and support craft. Communicating the threat to the rigs staff and senior management should be considered for inclusion in future exercises.
5. CONCLUSION

The scenario presented to RADEX 2019 TTX participants required Arctic States to cooperate fully to achieve the goal of maximizing the opportunity to critically examine their response to the scenario. The TTX presented on June 3rd, 2019 met the objectives of the exercise and was a good first step in improving the emergency preparedness and response of the Arctic States. The TTX scenario created for RADEX 2019:

- Was sufficiently complex to challenge the participants to consider the wide-ranging issues that the scenario brought to light, allowing the participants to identify areas for improvement (11) as well as areas of best practice (13) in the five assessed actions;

- Identified and reinforced national roles and responsibilities by allowing the participants to explain the agreements that they have in place to respond to a similar scenario;

- Reinforced international cooperation by sharing best practices and solutions to the scenario’s challenges;

- Identified available resources, competencies, resource needs and resource utilization in an RN SAR environment, or identified the lack thereof were appropriate;

- Identified support available to non-radiological emergency helpers (i.e. in this case tugboat crew and first responders ashore) so that the response is not compromised due to a lack of knowledge and/or a concern over a heightened perceived risk as demonstrated by a rapid media response to the emergency;

- Challenged the health and safety for emergency responders and emergency helpers and identified the protective measures available (or required) to face these challenges; and

- Identified that the presents of oil installations in the Arctic may need to be considered in future planning and preparedness efforts.

Although the scenario focused on Norwegian response efforts it is believed that all Arctic States may use the findings of this report to enhance their own response to a nuclear emergency within or near their borders. The best practices identified should be examined by each member state to determine if their own response could be improved by adopting a similar strategy. In addition, the opportunities for improvement should be considered by all Arctic States to determine whether the identified issue should also be addressed within their own national plans.

While the TTX identified some issues, the nature of a four-hour TTX limits its ability to delve deeply into all the
potential issues in such a complex scenario. Ideally, members state would use this report to look for and address the issues raised herein, and conduct further exercises to:

- Demonstrate that the identified issues have been addressed;
- Identify other opportunities for improvement by creating future exercise scenarios that pose uniquely challenging RADSAR response situations; and
- Continue the cycle of exercising existing plans, evaluating the response and identifying issues, updating plans to address deficiencies and maintain best practices, training new plans/procedures and then repeating the process.

When addressing opportunities for improvement, it is typical that a schedule be produced, with an office of primary interest and an expected completion date. If the issue is sufficiently complex, progress updates may be provided to key stakeholders to ensure the issue resolution maintains its priority within the responsible organization.

Finally, the lessons identified herein should be considered in conjunction with RADSAR Report Part One and Part Two, which provide an analysis of the current RADSAR status. Part One addresses responsibilities, monitoring capabilities, monitoring equipment, education and training, and exercise planning. Part Two will detail key findings of Part 1, highlights of recent EPPR EG meetings, and the findings of this report. Both the RADSAR Report Part One and this report have identified areas where RADSAR response capabilities could be improved by updating plans and procedures and through additional education, training, and exercises.
ANNEX A SCENARIO INJECTS

A.1. START STATE

The icebreaker MV NONSUCH is transiting from the North pole to its home port. It is travelling through normal marine traffic corridors along Norway's coast. The ship's complement is 120 crewmen. The vessel's position can be seen in Figure 1.

A.2. INJECT 1 (TTX TIME 1300, 3 JUNE 2019)

1300 – The NONSUCH experiences a severe fire that knocks out ships power (blackout) and damages the main switchboard. This loss of power leads to multiple issues with the control system of the nuclear power plant (One XTV-100 reactor producing 135 MW) and the ship's ability to make way. A mayday is transmitted just before the ship loses all power.

The mayday states:

Mayday, Mayday, Mayday. This is MV NONSUCH.
Mayday, Mayday, Mayday. This is MV NONSUCH.
We are located at 68°50′11.9″N 11°46′03.4″E

We are a nuclear-powered icebreaker, 152 m in length, black superstructure, 20,000-ton displacement and 120 crewmen.

We are currently fighting a fire and have two severely injured crewmen. We are in danger of losing all pow...

Message ends as power onboard fails/fire reaches communications equipment.

1303 – NONSUCH, this is the NoCGV Andenes. Received. We are 200 nm from your position and are responding to your mayday. ETA 10 hours.

1305 – NONSUCH, this is the MV Viking Sky. Received. We are 60 nm from your position and are responding to your mayday. We are preparing to receive your casualties. ETA 6 hours.

1307 – NONSUCH, this is the M/Tr HERMES. Received. We are 40 nm from your position and are responding to your mayday. ETA 4 hours.

Conditional Inject: JRCC NN send helicopter to receive critical casualties from the NONSUCH.

Not immediately passed to participants:

There are 486 passengers onboard the Viking Sky. Passenger nationalities include:

• 126 US citizens;
• 104 Russian citizens;
• 50 Canadian citizens;
• 38 Danish citizens;
• 36 German citizens;
• 26 Spanish citizens;
• 24 Finish citizens;
• 22 French citizens;
• 20 Japanese citizens;
• 20 Norwegian citizens;
• 12 Swedish citizens;
• 8 Icelandic citizens.

1330 – News Inject 1 (See Annex B)

A.3. INJECT 2 (TTX TIME 1700, 3 JUNE 2019)

1705 – The crew of the NONSUCH have restored power to the radio system.

NONSUCH sends:

Mayday, Mayday, Mayday. This is MV NONSUCH.
Mayday, Mayday, Mayday. This is MV NONSUCH.

We are located at 68°50'31.5"N 11°42'23.7"E

We are a nuclear-powered icebreaker, 152 m in length, black superstructure, 20,000-ton displacement and 90 crewmen.

Fire has severely damaged multiple systems onboard, including those of our nuclear reactor. Communications are unreliable. We are dead in the water and cannot make way.

Conditional - We have two severe casualties that require immediate medical attention.

1708 – NONSUCH, this is the NoCGV Andenes. Received. We are 120 nm from your position and are responding to your mayday. ETA 6 hours.

1710 – NONSUCH, this is the MV Viking Sky. Received. We are 20 nm from your position and are responding to your mayday. ETA 2 hours.

Conditional – We are preparing to receive your casualties and have a doctor onboard. Please transmit medical condition of casualties. Doctor will provide instruction to support life until we arrive. ETA 2 hours.

1712 – NONSUCH, this is the M/Tr HERMES. Received. We have you on radar and should have a visual within a few minutes. Please advise on your requirements. We will contact you on channel 3 to arrange assistance.

Conditional inject based on participants recommendation.

1715 – NoCGV Andenes sends onboard helicopter to airlift doctor from the Viking Sky to the NONSUCH in order to provide medical services to the two critical casualties.

1730 – News Inject 2 (See Annex B)
A.4. INJECT 3 (TTX TIME 1900, 3 JUNE 2019)

M/Tr HERMES has been on-scene for two hours and have recovered 33 non-essential crewmen from the NONSUCH. They were unable to help with the casualties.

1900 – MV Viking Sky arrives on scene. They are standing 2nm off the NONSUCH.

Conditional: Viking Sky preparing to receive the two casualties in their onboard medical facility.

1912 – NONSUCH reports to JRCC (Norway) – We are experiencing loss of coolant accident with our nuclear reactor. This has resulted in damage to the reactor’s core fuel elements. We are unable to contain the release of fission products to the environment. They are escaping the NONSUCH and being released into the atmosphere and seawater. In addition, we have an additional critical casualty who is contaminated. He must be evacuated immediately.

Conditional: Two crewmen still require immediate evacuation and medical attention.

1913 – M/Tr HERMES asks JRCC NN for preferred destination of 33 non-essentials. With the potential for a radiological release the CO decides to depart the scene.

1914 – Viking Sky to JRCC NN – Request assistance with the coordination of response efforts given the new information regarding a radiological release to the environment.

1945 – Passengers onboard the Viking Sky have learned of potential radiological contamination from the NONSUCH – They have taken to social media and are demanding information from their respective governments on protective actions they should be taking. Others are demanding immediate repatriation to their home countries.

Simulated radiological readings can be found in Annex A.

1955 – News Inject 3 (See Annex B)

INJECT 4 (TTX TIME 2330, 3 JUNE 2019)

2330 – NoCGV Andenes arrives onsite.

Conditional based on player action: 2235 – JRCC NN informed that the Russian corvette RFS Boikiy, the Swedish corvette HSwMS Härnösand, the Canadian frigate HMCS Charlottetown, and the Danish frigate HDMS Peter Willemoes will be arriving in 12 hours.

2335 – ALP Striker (Norwegian sea going tug) offers assistance to JRCC NN. The Striker can be on site in 24 hours. Looks to the JRCC NN for information on radiological contamination and how to approach the NONSUCH. Asks for assistance from NoCGV Andenes for line handling and assistance with decontamination (should it be required).

Conditional inject based on participant decisions.

2345 – The Viking Sky has departed the scene with 13 non-essential crew (and two casualties) from the NONSUCH onboard. They are proceeding to destination provided by JRCC. Passengers onboard are concerned for their health after learning of a radiological release. They want off the Viking Sky as soon as possible.

Casualties may be flown ashore via helicopter if participants consider this option.

INJECT 5 (TTX TIME 0800, 4 JUNE 2019)

RFS Boikiy, HSwMS Härnösand, HMCS Charlottetown, and HDMS Peter Willemoes have arrived on scene and are prepared to aid the NONSUCH.
The NONSUCH crew has managed to weld the break in the primary loop and re-pressurize the reactor. The release to the environment ends, but there is still hull-shine form the vessel.

ANNEX B RADIOLOGICAL INFORMATION

B.1. SOURCE TERM

All radiological information for the NONSUCH is based on a naval reactor of a similar size. All readings for the exercise are simulated for training purposes and are not meant to be an accurate model of a realistic event. The source term used for the simulation (Figure 3) represents a severe accident, with an exceptionally low probability of occurrence.

Figure 3: Source Term for NONSUCH
B.2. WIND DIRECTION

For the duration of the TTX the wind will be steady from the northeast (i.e., from 045°), driving the radiological contamination in the atmosphere away from Norway into the open ocean.

B.3. HULL SHINE AND RELEASE PROFILES

The severe accident starts with a release of fission products into the primary loop. On hour later, a LOCA occurs and fission products are released into the atmosphere. Both hull shine and release eventually reach a steady state after a brief period of linear increase.

Figure 4: Hull Shine and Release profile

B.4. DISTANCE FROM EPICENTRE

The points in Figure 5 through Figure 11 are a set distance from the NONSUCH epicentre. Table 2 gives the distance from each point to the epicentre of the release.

Table 2: Distance to Epicentre

<table>
<thead>
<tr>
<th>Map Point</th>
<th>Distance from NON-SUCH (m)</th>
<th>Map Point</th>
<th>Distance from NON-SUCH (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3, 4</td>
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<td>19, 20, 21</td>
<td>1000</td>
</tr>
<tr>
<td>5, 6, 7, 8</td>
<td>200</td>
<td>22, 23, 24</td>
<td>1500</td>
</tr>
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<td>9, 10, 11, 12</td>
<td>300</td>
<td>25, 26, 27</td>
<td>2000</td>
</tr>
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<td>13, 14, 15</td>
<td>400</td>
<td>28, 29, 30</td>
<td>2500</td>
</tr>
<tr>
<td>16, 17, 18</td>
<td>500</td>
<td>31, 32, 33</td>
<td>5000</td>
</tr>
</tbody>
</table>
**B.5. RADIOLOGICAL READINGS**

Figure 6 through Figure 10 represent the radiological readings in the vicinity of the NONSUCH at various times within the scenario. Figure 6 represents readings before the nuclear accident begins, and all readings are background.

*Figure 6: Approximate radiological readings at 1300 and 1700, 3 June*
The readings shown in Figure 7 represent hull-shine only. The hull-shine detectable at scenario start is detectable to approximately 400m. The profile increases the hull-shine as the scenario progresses.

Figure 7: Readings at 1800, 3 June and after 0800, 4 June

By 1900 the hull-shine is at its maximum and the release begins. In Figure 8 the release has not yet reached the points downwind of the NONSUCH.

Figure 8: Readings at 1900, 3 June

Figure 9 shows the progression of the plume downwind towards Norway. Any vessel downwind of the NONSUCH, and within the arc of the release will eventually become contaminated.
**Figure 9: Readings at 2300, 3 June**

![Figure 9: Readings at 2300, 3 June](image1)

**Figure 10: Readings at 0200, 4 June**

![Figure 10: Readings at 0200, 4 June](image2)

Figure 10 provides the readings when four naval vessels arrive on-site to aid the NONSUCH.

**Figure 10: Readings at 0200, 4 June**
B.6. PLUME MODEL

Figure 12 and Figure 13 provide a plume model with dose contours using the exercise source term and the NONSUCH location as the epicentre.
ANNEX C NEWS ARTICLES

Simulated news articles will be used as injects during the TTX. They will reflect the developing situation, fed a great deal by the people onboard the Viking Sky and members of the crew onboard the fishing trawler.

C.1. NEWS INJECT 1 – 1330, 3 JUNE

KNN is tracking reports that the nuclear-powered icebreaker NONSUCH is currently fighting onboard fires and may have casualties as a result of their efforts to limit the spread of the fire. Response efforts may be hampered by a possible loss of power onboard. The NONSUCH issued a mayday at approximately 1300 this afternoon that was picked up by several seagoing vessels in her vicinity.

The NONSUCH appears to be located in the shipping lanes to the west of the Lofoten Islands, approximately 100km from the coastline. It will take some time before aid can arrive but response to the mayday is underway. Vessels in the area of the NONSUCH are apparently responding to aid the vessel as quickly as possible.

KNN will continue to follow this story and provide updates as they become available.

C.2. NEWS INJECT 2 – 1730, 3 JUNE

KNN has just learned that there may be an issue with the nuclear reactor onboard the NONSUCH. Apparently the recent fire onboard the NONSUCH is causing significant problems for its crew. The latest communication from the NONSUCH says that they may be having issues with their control systems, and a struggling to maintain power to vital equipment.

The NONSUCH has one nuclear reactor onboard, giving it the power needed to smash through the thick northern ice. It recently visited the North Pole with a small number of research scientists, a first for the Fantasian ship. The NONSUCH was returning to its home port in Fantasia when the fire broke out.

One of the responding vessels has been identified as the cruise ship Viking Sky. It was on its was from the fjords of Norway to its last stop in Reykjavik then it answered the NONSUCH’s mayday. Other responding vessels include...
the trawler Hermes, which was fishing within the Vesterålsbankene outside Nordland when it received the mayday, and the coastguard vessel NoCGV Andenes.

KNN News will continue to follow this story and provide updates as they become available.

**C.3. NEWS INJECT 3 – 1955, 3 JUNE**

KNN News has learned that there is an incident involving the nuclear reactor onboard the NONSUCH. The vessel reports that it is releasing radiation into the environment and that there is damage to the nuclear fuel in their reactor.

KNN’s science advisor states that this will create a new risk to any vessel that may have responded to the initial mayday. Dr. Popov states, “There are a lot of unknowns at this point in time. A lot depends on the amount of damage to the NONSUCH reactor and how much of the released fission produces are making it out of the vessel. As long as the responding vessel are cautious and don’t approach the NONSUCH too closely there should be no immediate danger to their crew.”

Passengers onboard the Viking Sky are taking to social media to demand action on their behalf. They want the Captain to leave the scene immediately and many are asking their governments to find a way to get them home. What was an idyllic vacation has turned into a nuclear nightmare for some.

KNN will continue to follow this story and provide updates as they become available.

**C.4. NEWS INJECT 4 – 0015, 4 JUNE**

KNN has learned that four naval vessels are sailing to intercept the NONSUCH at this time. The Russian corvette RFS Boikiy, the Swedish corvette HSwMS Härnösand, the Canadian frigate HMCS Charlottetown, and the Danish frigate HDMS Peter Willemoes should all arrive within the next 12 hours. The Swedish and Danish vessels were taking part in a joint naval exercise when they were ordered to provide assistance to the NONSUCH. The Canadian vessel was traveling to Copenhagen from Reykjavik when it was diverted to respond. The Russian vessel was leaving the Baltic Sea when it told Norwegian authorities that it would be responding to the scene.

The ALP Striker, a seagoing tug capable of towing a vessel the size of the NONSUCH has also offered its assistance to help deal with the current situation.

The addition of these vessels may help with the complex and ongoing situation as the NONSUCH continues to release radiation into the environment. A lot of people are asking questions about what to do now.

Where will these ships go if they are covered with radiation?

How will we ensure the safety of the people ashore once these ships arrive?

Is there a safe place for the NONSUCH?

Public concern is rising, and people are asking the government if it knows what to do.

KNN will continue to follow this story and provide updates as they become available.

**C.5. NEWS INJECT 5 – 0830, 4 JUNE**

KNN has learned that the release of radiation from the Fantasian icebreaker NONSUCH has ended. What remains is a damaged reactor and the need to get the NONSUCH back to Fantasia as quickly as possible.

Naval Vessels from Canada, Russia, Denmark and Sweden remain on scene with the Norwegian coastguard vessel NoCGV Andenes. They are reportedly assisting the NONSUCH in any way they can.
In the meantime, the vessels that responded to the initial mayday are making their way to various port throughout Europe. Each is potentially covered with the radiation that leaked from the NONSUCH. The crew of the vessels may also have been exposed to this radiation and many are expressing concern for their health. Several crew members onboard the Hermes are afraid to go home to their families until they can be reassured that they won’t bring radiation into their homes, thus exposing the family members and children.

For now, the NONSUCH appears to be unable to move under its own power and the ALP Striker, a seagoing tug, is on route to assist with relocating the NONSUCH to its final destination.

KNN will continue to follow this story and provide updates as they become available.