RADSAR REPORT
Sharing of competence within search and rescue in a maritime radiological/nuclear scenario

JANUARY 2021
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Sharing of competence within search and rescue in a maritime radiological/nuclear scenario

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Norwegian Radiation and Nuclear Safety Authority

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CONTENTS

The RADSAR project ........................................................................................................... 7
Executive summary ............................................................................................................. 8
Main takeaways from each focus area ............................................................................. 9
Key findings from RADSAR: .......................................................................................... 10
Introduction ..................................................................................................................... 11
Background ....................................................................................................................... 11
Method ............................................................................................................................... 12
Results from the RADSAR questionnaire ....................................................................... 13
1. Responsibilities ........................................................................................................... 13
2. Monitoring capabilities ............................................................................................. 28
3. Monitoring equipment ............................................................................................... 38
4. Education and training on radiation protection ......................................................... 40
5. Exercises .................................................................................................................... 43
6. Experiences ................................................................................................................ 48
Lessons learned from RADEX2019 ............................................................................. 51
Recommendations and way forward .............................................................................. 56
## List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAF</td>
<td>Canadian Air Force</td>
</tr>
<tr>
<td>CBRNE</td>
<td>Chemical, Biological, Radiological, Nuclear, and Explosives</td>
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<td>CMHT</td>
<td>Consequence Management Home Team</td>
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<td>DEMA</td>
<td>Danish Emergency Management Agency</td>
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<td>DHS</td>
<td>Department of Homeland Security</td>
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<td>DMI</td>
<td>Danish Metrological Institute</td>
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<td>DOD</td>
<td>Department of Defense</td>
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<td>DOE</td>
<td>Department of Energy</td>
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<td>DOS</td>
<td>Department of State</td>
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<td>DSA</td>
<td>Norwegian Radiation and Nuclear Safety Authority</td>
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<td>EG</td>
<td>Expert Group</td>
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<td>ENAC</td>
<td>Early Notification of a Nuclear Accident</td>
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<td>EPA</td>
<td>Environmental Protection Agency</td>
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<td>EPPR</td>
<td>Emergency Prevention Preparedness and Response</td>
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<td>EPREV</td>
<td>International Emergency Preparedness Review</td>
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<td>FERMS</td>
<td>Federal Emergency Response Management System</td>
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<td>FERP</td>
<td>Federal Emergency Response Plan</td>
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<td>FIOP</td>
<td>Response and Recovery Federal Interagency Operations Plan</td>
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<td>FNEP</td>
<td>Federal Nuclear Emergency Plan</td>
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<td>FPEM</td>
<td>Federal Policy on Emergency Management</td>
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<td>FRMAC</td>
<td>Federal Radiological Monitoring and Assessment Center</td>
</tr>
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<td>HHS</td>
<td>Department of Health and Human Services</td>
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<td>IAEA</td>
<td>International Atomic Energy Agency’s</td>
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<td>IAMSAR</td>
<td>International Aeronautical and Maritime Search and Rescue Manual</td>
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<td>ICG</td>
<td>Icelandic Coast Guard</td>
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<td>IMAAC</td>
<td>Interagency Modeling and Atmospheric Assessment Center</td>
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<td>IRSA</td>
<td>Icelandic Radiation Safety Authority</td>
</tr>
<tr>
<td>JRCC</td>
<td>Joint Rescue Coordination Centre</td>
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<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>MET</td>
<td>Meteorological Institute</td>
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<td>MRSC</td>
<td>Maritime Rescue Sub Centre</td>
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<td>MRSS</td>
<td>Maritime Rescue Coordination Centre</td>
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<td>MSB</td>
<td>Swedish Civil Contingencies Agency</td>
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<tr>
<td>NARAC</td>
<td>National Atmospheric Release Advisory Center</td>
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<tr>
<td>NCRP</td>
<td>National Council on Radiation Protection and Measurements</td>
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<tr>
<td>NERS</td>
<td>National Emergency Response System</td>
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<td>NNSA</td>
<td>National Nuclear Security Administration</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NOST</td>
<td>National Operational Staff</td>
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<td>NPP</td>
<td>Nuclear Power Plant</td>
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<tr>
<td>RAD</td>
<td>Radiation</td>
</tr>
<tr>
<td>RADSAR</td>
<td>Sharing of competence within search and rescue in a maritime radiological/nuclear scenario - project</td>
</tr>
<tr>
<td>RANET</td>
<td>Response and Assistance Network</td>
</tr>
<tr>
<td>RCC</td>
<td>Rescue Coordination Centre</td>
</tr>
<tr>
<td>RN</td>
<td>Radiological and Nuclear</td>
</tr>
<tr>
<td>RPAS</td>
<td>Remotely Piloted Aircraft Systems</td>
</tr>
<tr>
<td>SAR</td>
<td>Search and Rescue</td>
</tr>
<tr>
<td>SOLAS</td>
<td>International Convention for the Safety of Life at Sea</td>
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<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
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<td>SRR</td>
<td>Search and Rescue Region</td>
</tr>
<tr>
<td>SSM</td>
<td>Swedish Radiation Safety Authority</td>
</tr>
<tr>
<td>STUK</td>
<td>Finnish Radiation and Nuclear Safety Authority</td>
</tr>
<tr>
<td>TTX</td>
<td>Table-top Exercise</td>
</tr>
<tr>
<td>USCG</td>
<td>United States Coast Guard</td>
</tr>
</tbody>
</table>
List of Figures

Picture 1. Floating nuclear power station Akademik Lomonosov
(Photo by: Peter Kovalev\TASS via Getty Images) ............................................. 8

Table 1. Responsibilities for information exchange .......................................... 23

(Photo by: Finnish Border Guard) ................................................................... 26

Picture 3. Land-based high volume air sampler in Svanhovd, Norway
(Photo by: DSA) ............................................................................................. 29

Picture 4. KV Svalbard (Copyright: Haakon Kjollmoen) ................................. 32

Table 2. Responsibilities for prognosis of radiation levels at the incident site .. 33

Picture 5. The «total defence» of Norway is trained on chemical, biological,
radiological and nuclear crisis during NATO-exercise Trident Juncture 2018.
(Photo by: Frederik Ringnes/Forsvaret) ......................................................... 36

Table 3. Availability of education and training on radiation protection .......... 41

Picture 6. The «total defence» of Norway is trained on Chemical, biological,
radiological and nuclear crisis during NATO-exercise Trident Juncture 2018.
(Photo by: Frederik Ringnes/Forsvaret) .......................................................... 47

Picture 7. EPPR members gathered for RADEX2019 in Bodø. (Photo: EPPR) .... 51

Picture 8. RADEX2019 scenario. ................................................................. 52
THE RADSAR PROJECT

Ship traffic in the Arctic includes nuclear-powered vessels, ships transporting spent nuclear fuel and high-level radioactive waste, and the operation of a floating nuclear power plant. The need for generating electric power at remote locations may also include new technologies, such as small modular nuclear reactors for surface or submerged use. The presence of radiological and nuclear material in the Arctic poses a risk for serious incidents or accidents. Previous projects and workshops under the Arctic Council Emergency Prevention, Preparedness and Response (EPPR) Working Group have identified a heightened perceived risk among emergency workers and Search and Rescue (SAR) personnel involved in incident response and that the lack of knowledge about these rare incidents may hinder emergency response.

The RADSAR project, “Sharing of competence within search and rescue in a maritime radiological/nuclear scenario”, was an EPPR cross-cutting radiation and SAR project under the EPPR ARCSAFE project umbrella, initiated and led by Norway and funded by the Norwegian Ministry of Climate and Environment and the Norwegian Ministry of Foreign Affairs. The project was approved by EPPR in June 2018. In RADSAR, all the Arctic States shared their expertise and experiences within SAR operations in a radiological or nuclear event at sea. The main goal of the project was to identify possible challenges and further improve national and international emergency preparedness and response related to SAR operations in a radiological hazardous environment in the Arctic. The project focused on international cooperation including notification, information exchange and situational awareness, resource needs and utilization, international assistance, protective measures, and possible harmonization of decisions.
EXECUTIVE SUMMARY

The RADSAR project, “Sharing of competence within search and rescue in a maritime radiological/nuclear scenario”, was an EPPR cross-cutting radiation and SAR project under the EPPR ARCSAFE project umbrella, initiated and led by Norway and funded by the Norwegian Ministry of Climate and Environment and the Norwegian Ministry of Foreign Affairs. The project was approved by EPPR in June 2018. In RADSAR, all the Arctic States shared their expertise and experiences within SAR operations in a radiological or nuclear event at sea. The main goal of the project was to identify possible challenges and further improve national and international emergency preparedness and response related to SAR operations in a radiological hazardous environment in the Arctic. The project focused on international cooperation including notification, information exchange and situational awareness, resource needs and utilization, international assistance, protective measures, and possible harmonization of decisions.

The first part of the report is a capability survey on national systems for maritime SAR operations involving radiological and nuclear (RN) material. The second part of the report presents lessons learned from the RADEX2019 exercise and recommendations for further collaboration. It is important to note that many of the questions in this report concern national regulations, systems, capabilities and resources, and the aim of this report is not to highlight national capability gaps but to mainly share information and find common ground to develop cooperation.

In the first part of the report, main takeaways for each focus area were identified based on the questionnaire responses. Table 1 below summarizes the main takeaways from part 1.

*Picture 1. Floating nuclear power station Akademik Lomonosov (Photo by: Peter Kovalev\TASS via Getty Images)*
MAIN TAKEAWAYS FROM EACH FOCUS AREA

RESPONSIBILITIES

• Responsibilities in each country for SAR and RN well established.

• Supported by international agreements and standards.

• Responsibilities vary between federal, regional or local level in different Arctic states.

• Responsibilities may also vary depending on RN material is fixed (such as a NPP) or under transport.

• The SAR organization and the SAR workers will only be in charge of the SAR related part of the incident and are dependent on advice from RN.

• Limited availability of contingency plans and SOPs for SAR RN scenario. Table 1. Main takeaways from each focus area

MONITORING CAPABILITIES

• Limited knowledge of radiation safety and radiation monitoring within SAR personnel/maritime responders.

• Challenging especially with volunteers.

• Most nations have access to airborne and seagoing assets that can carry monitoring equipment, fixed or installed. Also some drones are available. Most of these assets are primary SAR assets

MONITORING EQUIPMENT

• Limited equipment for SAR personnel/other maritime responders and knowledge on how to use the equipment.

• Primary SAR assets that are military, do often have small, portable monitoring equipment. Civilian SAR assets do normally not have such equipment.

• Airborne SAR assets do not generally carry specific RN protective gear

EDUCATION AND TRAINING

• Courses for SAR personnel and responders on radiation protection and safety are quite limited.

• Military personnel serving on SAR assets normally have general RN training. Specialists operating RN equipment mounted on SAR assets are trained accordingly.

• There is mostly a system for training/educating decision makers and special units.

EXERCISES

• Maritime radiation protection exercises for SAR personnel and other responders are very limited.

• Not much emphasis on maritime SAR scenarios yet, mostly nuclear power plants, and nuclear powered vessels at port.

• Some upcoming exercises focus on the Arctic and northern conditions, but still a fairly new topic within SAR RN field.
• Need for more TTX, simulation and live exercises to train both SAR personnel and the cooperation process between SAR, RN and other relevant authorities.

These takeaways and the identified lessons from the RADEX2019 exercises were used to draft key findings for this report and to find new initiatives and discover further opportunities for collaboration. This report urges all expert groups to follow up on the recommendations from this report and the findings from both the RADSAR and the ARCSAFE projects.

KEY FINDINGS FROM RADSAR:

• Overall, responsibilities in each Arctic State for search and rescue in a scenario involving radiological and nuclear material are already established, dedicated to specific agencies and supported by international agreements (IAEA/IMO) and standards. Responsibilities vary between federal, regional and local level in the Arctic states. The report recommends enhanced cooperation between all expert groups to further understand the processes and procedures between RN, SAR and other agencies on different levels in the Arctic. Exercises such as the RADEX2019 provide good opportunities to identify, evaluate and reconfirm these.

• It is important for emergency preparedness to define and rehearse SAR/RN maritime scenarios, and specify roles and responsibilities within each of these levels, as well as identify point of contacts (POC) and liaison for these kind of incidents. There is a need to look into contingency plans in a risk-based approach and further define what the SOPs are in the Arctic states. Some potential areas of SOPs for all expert groups to examine further were identified in the RADEX2019 findings.

• SAR personnel and other maritime emergency workers may have limited knowledge of relevant equipment, protective gear, monitoring of radiation at the incident site, safety issues, and handling of RN material and may be reliant only on expertise from the RN authorities. It could be beneficial to map gaps and needs for specialized equipment and protective gear for SAR personnel and other emergency workers and helpers in a separate project.

• The radiation protection and safety courses and training for SAR personnel seem to be limited and only few countries have regular training on radiation safety for maritime responders. It might be beneficial to define what kind of courses and training there could be for SAR and other responders, and what the curricula would normally include.

• Maritime radiation protection exercises for SAR personnel and other emergency workers is quite limited. Exercises seem to often concentrate on NPPs and nuclear powered vessels at port but less on maritime SAR scenarios and training at sea. There is a need for more tabletop, simulation and live exercises for SAR organizations, SAR personnel, and other emergency workers and helpers within this field.

• There is very limited capacity for response in the vast Arctic areas. Dedicated SAR assets permanently based or close to the Arctic region are scarce, especially with equipment and gear for RN. Most populated areas in the Arctic are small communities with limited capacity to receive people affected by RN. EPPR RAD EG is currently working on a risk assessment project to define the risk potential for emergencies due to nuclear/radiological material and activities that pose a threat in the Arctic. The further work should be therefore based on this risk assessment report carried out by RAD EG.
INTRODUCTION

The RADSAR project aims at sharing competence within SAR operations in radiological or nuclear events at sea in the Arctic region. The main goal is to share information about the organizational structures, knowledge, expertise, equipment, routines and plans that the Arctic nations have for rescue operations at sea involving radiological or nuclear material (RN), and to disseminate best practices to the EPPR member states, relevant organizations and the public. The RADSAR report was constructed in two parts; the first part describing key capabilities and common challenges based on questionnaire responses received from the Arctic Council member states (Canada, Finland, Iceland, Kingdom of Denmark, Norway, Russian Federation, and United Stated) and the second concentrating on summarizing recommendations for further cooperation and lessons learned from the RADEX 2019 exercise.

BACKGROUND

Maritime operations in the Arctic includes increasing traffic of nuclear icebreakers and transports of radioactive materials, posing a risk for incidents and/or accidents. These incidents are low-probability but high-consequence events, meaning that the authorities and responders may not have first-hand experience with such events yet, however the risk for exposure to RN for both people and the environment is high. The SAR responders involved in a maritime incident where there might be a RN risk will have to consider the risk for exposure, while planning and executing their primary operations (saving lives). The information flow between SAR organizations and RN specialists is vital when planning for a SAR operation in a RN environment. Plans and procedures have to be established and exercised between relevant stakeholders.

When discussing Arctic SAR and RN in a maritime scenario, it is important to recognize the varying levels of maritime activity, as well as the main risk factors in different parts of the Arctic search and rescue region. Arctic waters will have different types of vessels and maritime operations depending on the possibilities of each economic zone and resources that each nation is concentrating on. Although challenges and capabilities vary between Arctic countries, the main idea of this report and the RADSAR project is to find common ground when it comes to challenges and best practices, and to examine potential areas and initiatives for international cooperation.

This project is a sub project of the EPPR’s ARCSAFE project (EPPR cross country cooperation network to improve emergency prevention, response and the safety of rescue workers in case of a maritime accident involving a potential release of radioactive substances in the Arctic). At the EPPR-I 2017 ARCSAFE Technical Workshop in Vologda, Russia, it was stated, among other things, that in the event of an accident with such vessels, there is a danger that a rescue operation will not be carried out due to lack of knowledge, competence and measuring equipment. Key findings from the ARCSAFE project provide a starting point for the RADSAR project:

- The organization of emergency response in case of a radiological accident at sea differs considerably from country to country. Response to such scenarios may be very complex and challenging, and require close
cooperation between several authorities.

• Depending on type of response unit, there may be a lack of training and necessary protective gear and radiological measuring equipment. Deployment of special response units that normally operate on land may require special arrangements, for example, transport and communications that need to be exercised.

• There is a risk that emergency response may be compromised due to lack of knowledge and a heightened perceived risk among emergency workers and emergency helpers.

• There is a need for joint exercises and trust building between RN experts and emergency workers / emergency helpers.

• Regarding the transport and deployment of floating nuclear power plants in the Arctic, there is a need for detailed technical information, hazard assessment(s) and development of detailed technical guidance for proper emergency prevention and response, including security and specific features of the area.

In relation to the ARCSAFE and RADSAR projects, a tabletop exercise RADEX 2019, was held in June 3, 2019, as part of EPPR-I WG meeting in Bodø, Norway. The exercise scenario covered a maritime radiological/nuclear event including search and rescue (SAR) operations and the handling of a ship in distress in radiologically hazardous conditions. Lessons learned from the RADEX 2019 exercise, in addition to key findings from the ARCSAFE project will be included and taken into consideration in this report.

METHOD

As this first part of the report describes responsibilities and the overall capabilities of the Arctic nations within search and rescue in a maritime radiological/nuclear scenario, a questionnaire was sent out to the EPPR members, and was asked to be circulated to the SAR and RAD expert groups, to map the national systems in the Arctic countries. The questionnaire was also sent to all EPPR Observers. All eight Arctic nations: Canada, Finland, Iceland, Kingdom of Denmark including Greenland and Faroe Islands, Norway, Russian Federation, and United Stated, responded to the questionnaire.

Six focus areas for the questionnaire were found based on the key findings from the ARCSAFE project:

• Responsibilities

• Monitoring capabilities

• Monitoring equipment

• Education and training

• Emergency exercises and training

• Lessons learnt and best practice

Each focus area had specified questions to better define what kind of capabilities, equipment and training do each country have for a combined SAR and RN operation. The first part compiles the answers to the questionnaire from each nation.

From the responses, the report draws some key findings and identifies common challenges, which were used as a framework for developing the second part of the report. Each finding will have a recommendations based on the RADEX2019 tabletop exercise and discussions had at the joint EPPR meetings. Ideas for new possible initiatives developing collaboration are also suggested within the recommendations chapter.
RESULTS FROM THE RADSAR QUESTIONNAIRE

1. RESPONSIBILITIES

The questionnaire respondents were asked to provide a brief overview of responsibilities in a RN maritime SAR scenario. In this section, the report describes the relevant organizations responsible for coordination, cooperation and response for the Arctic region in their respective countries, responsibilities for notification, information exchange, contingency planning and capacities for special response units.

KEY ORGANIZATIONS

Canada

Responsible organizations

The responsibility for emergency management in Canada is shared by federal, provincial and territorial government and their partners. Within Canada’s constitutional framework, the provincial and territorial governments and local authorities are responsible for first response to the vast majority of emergencies – the exception being incidents that fall within federal jurisdiction.

If an emergency threatens to overwhelm the resources of any individual province/territory, the federal government may intervene, but only at the specific request of the province/territory.

1. The Federal response to emergencies, including support to provinces and territories, would be coordinated by Public Safety Canada in accordance with the Federal Emergency Response Plan (FERP).

2. Federal technical support for a radiological or nuclear emergency would be coordinated through the Federal Nuclear Emergency Plan (FNEP), which is an event specific annex to the FERP.

3. The FNEP is led by Health Canada. The FNEP coordinates the radiological capability of a range of federal organisations including Health Canada, Canadian Nuclear Safety Commission, National Defence, Natural Resources Canada and Environment and Climate Change Canada.

4. In Canada, for events involving nuclear power vessels, the Department of National Defence will also play an important role.
Lead agency
In the event of a nuclear emergency, the applicable consequence management provisions of the FERP and the emergency support functions will be coordinated by Public Safety Canada.

For incidents involving nuclear powered vessels from foreign armed forces in Canadian ports, the Department of National Defence/Canadian Armed Forces will act as the Canadian on-site authority.

Existing agreements between different agencies
Existing plans at the federal level include the Federal Emergency Response Plan and Federal Nuclear Emergency Plan.

Other related:
• Canada-United States Civil Assistance Plan
• Emergency Management Framework for Canada – foundational F/P/T EM policy endorsed by F/P/T Ministers Responsible for EM.
• National Emergency Response System (NERS) – provides for the harmonization of joint federal, provincial and territorial response to emergencies. Endorsed by F/P/T Ministers Responsible for EM.
• Federal Emergency Response Management System (FERMS) – integrated within the FERP, is a comprehensive management system which integrates the GC's response to emergencies.
• Federal Policy on Emergency Management (FPEM) - promotes an integrated and resilient GC approach to EM planning.

Agreements on international support
Canada is a signatory to the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency. Health Canada is the National Competent Authority for this convention.

Canada participates in the International Atomic Energy Agency's (IAEA) Response and Assistance Network (RANET).

Health Canada and the National Nuclear Security Administration in the United States have signed a Statement of Intent covering areas of mutual cooperation in the areas of nuclear emergency preparedness and response.

Finland

Responsible organizations
According to the Maritime SAR Act (1145/2001):

1. The Finnish Border Guard (Lead Agency)

2. Other agencies: the Emergency Centers (“112”), the Finnish Meteorological Institute, the regional fire and rescue department, the Finnish Transport Safety Agency, the Finnish Transport Agency, the Police, the Finnish Defence Forces, Radiation and Nuclear Safety Authority – STUK, social welfare and health care authorities, Finnish Customs and environmental authorities, the air traffic service provider, all state authorities, enterprises and agencies, voluntary service.

Lead agency
The Border Guard shall be the leading maritime search and rescue authority and responsible for the provision of maritime search and rescue services. In this purpose it shall:

1. See to the planning, development and supervision of maritime search and rescue services as well as the harmonization of the activities of authorities and volunteers participating in maritime search and rescue;
2. Lead and conduct search and rescue operations;

3. Be responsible for emergency phase-related radiocommunications and the provision of Telemedical Assistance Services for vessels;

4. Participate in emergency phase prevention;

5. Be in charge of the Maritime Assistance Services;

6. Be responsible for receiving distress alerts sent within the COSPAS-SARSAT

7. Provide coordination and management training related to maritime search and rescue services and, where necessary, also other training and public education related to maritime search and rescue.

**Existing agreements between different agencies**

National Administrative MRO/MMA Plan:

- To support the management and administration in all responsible sectors of society
- To clarify the roles of SAR actors in MROs and MMAs
- To create a more specific foundation for administration and operational planning
- To improve the interoperability in Maritime Search and Rescue

**Agreements on international support**

The legal framework covering the maritime search and rescue service can be divided into international agreements and national legislation.

The three most important international conventions governing maritime SAR are:

1. UN Convention on the Law of the Sea

2. International Convention on Maritime Search and Rescue (the Hamburg Convention) and

3. International Convention for the Safety of Life at Sea (SOLAS)

Finland has concluded bilateral agreements on maritime and aviation search and rescue with Russia, Estonia and Sweden, including arrangements for SAR regions in the Baltic Sea.

The IAEA Conventions on Notification and Assistance in the case of a Nuclear Accident or Radiological Emergency and the IAEA Response and Assistance Network (RANET), STUK being the National Competent Authority. Also:


6. CBSS Agreement on the exchange of radiation monitoring data, 2002 (Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Poland, Russia, Sweden)

7. ECURIE and EURDEP arrangements

8. Nordic agreement on mutual assistance in radiation emergencies (1963)

9. Bilateral agreements on notification and information exchange on Nuclear accidents with Sweden, Russia, Ukraine, Germany, Norway and Denmark.
Iceland

**Responsible organizations**

1. Icelandic Coast Guard (ICG) overall responsible (Operates JRCC, VTS, MAS, Coastal Radio, helicopters, OPVs).

2. Other agencies include National Police Civil Protection Department (Responsible for national contingency planning and operates the National Emergency Coordination Centre), local police, Environment Agency, Icelandic Association of Search and Rescue ICESAR (volunteer organization with rescue boats), Icelandic Radiation Safety Authority (IRSA) in case of SAR incident which includes radiation, Red Cross, National Hospital staff, Transport Authority (Icetra), Capital City Fire and Rescue Brigade.

**Lead agency**

Icelandic Coast Guard is lead agency in all maritime incidents.

**Existing agreements between different agencies**

- ICESAR agreements with Ministry of Justice regarding cooperation with ICG and police authorities.
- Icetra, ICG, and Environment Agency regarding pollution at sea.
- ICG and Icelandic Radiation Safety Authority (IRSA)
- Regulation regarding maritime and aeronautical incidents, which appoints ICG JRCC as lead authority.

**Agreements on international support**

- ICG and Danish Arctic Command
- ICG and Norwegian Joint Headquarters
- Arctic SAR Agreement
- MOSPA Agreement
- Arctic Coast Guard Forum
- IRSA
- The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (IAEA treaty)
- Registration to the Response and Assistance Network (RANET)
- Iceland is party to The Convention on Early Notification of a Nuclear Accident (ENAC).

Kingdom of Denmark

**Responsible organizations**

**Greenland:**
The Danish Emergency Management Agency (DEMA) is the competent authority for nuclear emergency preparedness in Greenland with respect to monitoring, prognoses and decision support. Other emergency preparedness matters in connection with a nuclear emergency are a matter for Greenlandic authorities as the emergency management area is an area where jurisdiction has been taken over.

Maritime search and rescue (SAR)-operations are carried out by the Greenlandic Police and the Joint Rescue Coordination Centre (JRCC) Greenland which is a unit in the Artic Command, the Danish Defence.

The specific responsibilities are determined based on the location and severity of the emergency.

The national framework for nuclear emergency management (covering Denmark and Greenland (partly)) is based
on the Emergency Management Act (amended in 2018), which establishes the principle of “sector responsibility” besides the provisions concerning the planning obligations of the civil sector. The sector responsibility principle assigns the authority responsible for a day-to-day function with the same responsibility in emergencies.

The Greenlandic Ministry of Health holds the overall responsibility for ionising radiation, cf. Inatsisartutlov no. 33, December 9, 2015.

**Faroe Islands:**
The responsibility for maritime SAR operations in the Faroe Islands belongs to the Maritime Rescue Coordination Centre (MRCC) Tórshavn, which is a unit in the Ministry of Fisheries, the Faroese National Government.

The Faroe Islands Police are responsible for coordination of SAR incidents on land and within local waters. The MRCC Tórshavn will lead and coordinate the activities regarding maritime SAR operations within the SRR of the Faroe Islands. In case of a major accident the Administration Management Board for MRCC Tórshavn will provide linkage between MRCC Tórshavn and the Government via the Ministers.

Emergency preparedness is a matter for the Faroe Islands authorities as the emergency management area is an area where jurisdiction has been taken over. The national framework is based on the Emergency Management Act no. 61 (amended in 2012), which establishes the principle of “sector responsibility”: The authority responsible for a day-to-day function has the same responsibility in emergencies. In case of a nuclear emergency, DEMA may to a specified extent additionally provide personnel and equipment to the Faroe Islands upon request.

**Lead agency Greenland:**
The SAR responsibility in Greenland is divided between the Joint Rescue Coordination Centre (JRCC) Greenland and the Greenlandic Police.

JRCC Greenland is responsible for maritime and aerial SAR operations within the Search and Rescue Region (SRR) of Greenland. The Greenlandic Police are responsible for SAR operations on land and for minor SAR incidents within local waters. A RADSAR incident will be covered by the above division of responsibilities and the Greenlandic Police has the overall coordination responsibility for the responses in case of emergencies cf. Iñatsisartutlov nr. 14, May 26, 2010, §13, stk. 1.

RADSAR incidents are considered as major, and the responsibility of such SAR operations will consequently be placed within JRCC Greenland. In the event of a RADSAR incident, JRCC Greenland will solely have the DEMA nuclear emergency and preparedness plan to relate to. The plan is an appendix to the National Operational Staff (NOST) plan and describes the responsibilities and actions of the agencies and organisations with responsibilities during nuclear emergencies. DEMA is responsible for (some) nuclear matters (monitoring, prognosis and decision support) in case of an emergency in the SRR of Greenland.

In the event of a RADSAR incident, JRCC Greenland will immediately report the incident to the Arctic Command’s management.

**Faroe Islands:**
The maritime SAR responsibility in the Faroe Islands belongs to the Maritime Rescue Coordination Centre (MRCC) Tórshavn. The Faroe Islands Police are responsible for coordination of SAR incidents on land and within local waters. The MRCC Tórshavn will lead and coordinate the activities regarding maritime SAR operations within the SRR of the Faroe Islands. The Ministry of Fisheries in the Faroese National Government is responsible for the nuclear matters in RADSAR operations and DEMA may1 to a specified extent assist if requested by the

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1 According to provision in the Emergency Management Act, § 3, the Minister of Defense may decide that the Danish Emergency Management Agency may, upon request, be deployed in the Faroe Islands, Greenland or abroad in the event of disasters that cause serious damage to or pose an imminent danger to persons, property or the environment.

It is a prerequisite for the deployment of the Danish Emergency Management Agency that this takes place at the request of the competent authorities in the Faroe Islands, in Greenland or abroad.
Faroe Islands.

**Existing agreements between different agencies**

**Greenland:**
The coordination responsibility for SAR operations in Greenland is defined as:

The Artic Command is responsible for the management of the Joint Rescue Coordination Centre (JRCC) Greenland and they consequently hold the responsibility for SAR operations from air and sea. This includes SAR of those in distress from aircrafts and from ships on or below sea level, regardless of whether the help is to be carried out at sea, in the air or on land. The responsibility for SAR operations at sea includes all inland and offshore sea rescues from Cape Farewell to 62N on the East Coast, from the southern headland at the entrance to Kong Oscars Fjord on the East Coast to Siorapaluk on the West Coast, and all other offshore sea rescue in the rest of Greenland. Furthermore, the liability covers all ships registered in the Greenpos system, regardless of whether the ship is inland or offshore.

The Head of the Greenlandic Police is responsible for conducting small-scale SAR operations in local waters, i.e. inland from Siorapaluk to Cape Farewell on the West Coast, inland from 62N to the southern tip at the entrance to Kong Oscars Fjord, and for SAR at land.

If a RADSAR incident occurs in Greenland, it is expected that the Greenlandic Emergency Preparedness Commission and the Greenlandic Emergency Response Staff will be appointed for coordination at both operational and tactical level.

It is expected that National Operational Staff (NOST) in Denmark will be activated, including DEMA: For nuclear emergencies in Greenland, the national nuclear emergency and preparedness plan will come into effect. It is consequently expected that DEMA will play a leading role with the nuclear matters of handling a RADSAR incident in Greenland – regardless of where the incident occurs. As of radiological matters of handling a RADSAR incident in Greenland this is under the jurisdiction of Greenlandic authorities.

**Faroe Islands:**
The coordination responsibility for maritime SAR operations in the Faroe Islands is defined as:

The Maritime Rescue Coordination Centre (MRCC) Tórshavn makes the necessary provisions for leadership and execution of SAR operations within the Faroese area of responsibility.

These provisions contain guidelines for the coordination between, e.g. the Faroe Islands Police, MRCC Aberdeen and Joint Rescue Coordination Centre (JRCC) Iceland as well as the cooperation with other national and international authorities who provide resources for maritime rescue.

To support the SAR Mission Coordinator at MRCC Tórshavn a team will be assembled at the “Liaison Board”. The members of the board are called in depending on the nature and extent of the incident and their background of expertise in relation to the task at hand.

**Agreements on international support**

**Greenland:**
A co-operation between the Nordic countries (Sweden, Denmark/Greenland, Norway, Finland and Iceland) regarding nuclear emergencies have been established and described in the Nordic Manual (NORMAN). It covers co-operation between the Nordic authorities in response to and preparedness for nuclear and radiological emergencies and incidents. Assistance can also be requested directly through this cooperation.

**Faroe Islands:**
In special circumstances and when SAR missions are carried out at the extremity of the areas covered by any adjacent country in the area, support can be requested from neighbour countries in accordance with International Conventions. A Memorandum of Understanding is in place between Faroe Islands and UK. A SAR agreement is also in place between Maritime Rescue Coordination Centre (MRCC) Tórshavn and the Joint Rescue Coordination Centre (JRCC) Iceland (a part of the Icelandic Coast Guard, the Ministry of Interior). In case of a nuclear and radiological emergency that result in a large SAR-operation in the Faroe Islands, DEMA may to a specified extent also provide assistance on request.
The Kingdom of Denmark (Greenland, Faroe Islands and Denmark):
The Kingdom of Denmark has concluded various bi- and multilateral agreements on international co-operations regarding nuclear emergency matters and participates in the cooperation under International Atomic Energy Agency (IAEA) – including the Response and Assistance Network (RANET). Assistance for nuclear and radiological emergencies can be requested through this network.

Norway

Responsible organizations
1. In Norway, radiological and nuclear emergencies are handled by the National Crisis Committee for Nuclear Preparedness under the Norwegian Nuclear Emergency Response Organisation. The Crisis Committee is lead by the Director General of the Norwegian Radiation and Nuclear Safety Authority (DSA) and consists of lead representatives from Civil Protection, Defence, Health, Coastal Administration, Food Safety Authority, Police, Ministry of Foreign Affairs, and DSA (deputy director general). DSA is also the Secretariat for the Crisis Committee. Advisers to the CC include the Norwegian Meteorological Institute, Norwegian Defence Research Establishment, Norwegian centre for CBRNE medicine and several other research/university/directorate organisations (NRPA, 2013).

2. Norwegian Radiation and Nuclear Safety Authority (DSA) is the national authority and expert body in matters concerning nuclear security, radiation use, natural radiation and radioactive contamination in the environment and the national warning point and competent authority concerning national and international nuclear events.

3. Rescue operations at sea are coordinated by the Joint Rescue Coordination Centre (JRCC). Their available assets include Norwegian Coast Guard (providing coast guard vessels), Norwegian Joint Operational Headquarter (providing other necessary military resources if needed), Norwegian Coastal Administration/ Vessel Traffic Service (providing necessary tug-capacities/-environmental equipment), Governor of Svalbard ( providing land based shelter etc. if needed - Law enforcement), Norwegian Health Authorities (providing Medical personnel and Equipment). The DSA may provide expert personnel/advisory Board if needed. Other organisations will also support if needed.

4. Rescue operations at sea involving a radiological or nuclear scenario involves a coordination between 1) and 2) as described in NRPA 2018. Briefly, the JRCC coordinate all aspects of the rescue operation on-scene, with expert advise from the crisis committee / DSA. Handling and information apart from the rescue operation is coordinated by the crisis committee.

Lead agency
Joint Rescue Coordination Centre - predefined for all kind of rescue operations.

The Crisis Committee for Nuclear Preparedness led by DSA predefined to handle radiological/nuclear emergencies.

For rescue operations at sea involving a radiological or nuclear scenario the JRCC coordinate all aspects of the rescue operation on-scene, with expert advice from the Crisis Committee / DSA, whereas handling and information apart from the rescue operation is coordinated by the Crisis Committee.

Existing agreements between different agencies
• SOLAS - IAMSAR (Norwegian rescue Law -06/2015)

• NRPA 2013 Norwegian Nuclear Emergency Response Organisation (NRPA, 2013 and English version 2017). This includes DSA, the Norwegian Directorate for Civil Protection, the Norwegian Armed Forces, the Norwegian Police Directorate, the Norwegian Directorate of Health, the Norwegian Coastal Administration, the Norwegian Food Safety Authority, the Norwegian Ministry of Foreign Affairs as members, and with the Norwegian county governors (including Svalbard) coordinating preparedness at the regional level.

• NRPA 2018. StrålevernHefte 32 Ansvarsforhold atomberedskap og redningsaksjoner (DSA and JRCC).

• Multiple bilateral agreements between DSA and other agencies (f.ex. Norwegian Coastal Administration)


• Protocol between Norway (DSA) and Russian Federation (Rosatom) on the 1995 bilateral agreement (2015)

• Memorandum of Understanding between JSC Emergency Response Centre of Rosatom (Russian Federation) and DSA (Norway).

• Memorandum of Understanding between US Department of Energy and DSA.

• CBSS Agreement on the exchange of radiation monitoring data, 2002 (Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Poland, Russia, Sweden)

• ECURIE and EURDEP agreements (between EU and non-EU states)

• Nordic agreement on mutual assistance (1963)

**Agreements on international support**

• SOLAS

• IAMSAR

• ARCTIC /NORDRED/BARENTS/ EUR SAR/ - agreements) – (JRCC responsible)

• The IAEA Conventions on Notification and Assistance in the case of a Nuclear Accident or Radiological Emergency and the IAEA Response and Assistance Network (RANET). (DSA being the National Competent Authority).

• MOSPA Agreement (Norwegian Coastal Administration

**Russian Federation**

**Responsible organizations**
The highest level is the Federal level – Russian Unified State System of Emergency Prevention and Response – general management and coordination in case of major emergencies by forces and means of almost all interested and interacting departments.

There are several levels:

• federal

• interregional

• regional

• municipal

• object

Marine Rescue Service is a part of the Federal Agency for Maritime and River Transportation (Rosmorrechflot) of the Ministry of Transport of the Russian Federation. It has in its subordination the Main Marine Rescue Coordination Center, which solves tasks of organizing and coordinating the maritime search and rescue operations in the Russian Federation regions, and 12 branch offices organized on the basis of Basin Emergency and Rescue Departments. This Service provides the full range of sea SAR.

The EMERCOM of Russia;
FSUE Atomflot (a part of Rosatom group) – it maintains the world's only fleet of nuclear–powered icebreakers; Emergency and Rescue Service of the State Corporation «Rosatom».

**Lead agency**
The lead Russian agency for Arctic maritime response is **Marine Rescue Service**.

**Existing agreements between different agencies**
Russian national norms and rules:

«General provisions for ensuring safety of transport and transportable nuclear plants» and «Requirements for planning measures for the actions and protection of employees (human resources) in case of radiological accidents at a ship nuclear plant and (or) other waterborne vehicle».

**Agreements on international support**
International Convention for the Safety of Life at Sea (SOLAS-74).

**Sweden**

**Responsible organizations**
1. In case of a potential nuclear accident at sea the County Administrative Board is responsible in a major accident, with the help of other authorities such as the Swedish Radiation Safety Authority (SSM), the Swedish Coast Guards, the Swedish Civil Contingencies Agency (MSB), the Swedish Food Agency and the Swedish Board of Agriculture, etc.

2. Swedish Radiation Safety Authority; radioactive materials: Monitoring, measuring, emergency center for radioactive release, contamination, fissile accidents, etc. Representatives at IAEA EPReSC and TRANSSC expert groups to establish recommended regulations and guides concerning Transport of radioactive materials (also RASSC; Radiation, WASSC; Waste and NUSSC; Nuclear Standards).

3. Swedish Civil Contingencies Agency (MSB) is the regulator when it comes to preparedness and the supervision of plans.

**Lead agency**
The County administrative boards in case of a nuclear accident, assisted by Swedish Radiation Safety, Swedish Civil Contingencies Agency (MSB) in co-operation with other relevant authorities.

If there is another radiation hazard it depends on where it happens. If it is within a harbor then it is the municipality (the fire brigade) in cooperation with the police and health emergency personal.

If it is at sea, The Swedish Coast Guard in co-operation with the Swedish Maritime Administration assisted of multiple agencies.

**Existing agreements between different agencies**
The national plan for RN emergencies explains the Swedish system, the rolls, and the responsibilities.

Exercised practices between the Swedish Radiation Safety Authority, the Swedish Civil Contingencies Agency and the County Administrative Boards.

**Agreements on international support**
The national plan for RN emergencies explains the different international agreements for emergencies;

- Nordred, NATO EADRCC, Barentsavalet, and Nordic manual (NORMAN); information exchange and arrangements for support with neighbouring Countries.

- IAEA agreement; IAEA RANET (in connection with the Convention on Assistance in the case of a Nuclear Accident or a Radiological Emergency).

- Support from EU via the Swedish Civil Contingencies Agency.
The United States

Responsible organizations
1. Department of Homeland Security (DHS)/US Coast Guard (USCG)
2. Department of Energy/National Nuclear Security Administration (DOE/NNSA)
3. Department of Defense (DOD)
4. Department of State (DOS)
5. National Oceanic and Atmospheric Administration (NOAA)
6. Environmental Protection Agency (EPA)
7. Department of Health and Human Services (HHS)

Lead agency
1. For radioactive materials being transported:
   • By or for the DOD: DOD
   • By or for the DOE: DOE
   • Containing NRC or NRC Agreement State licensed materials: NRC
   • Within the coastal zone for materials that are not licensed or owned by a federal agency or an NRC Agreement State: USCG
   • All others: EPA

Existing agreements between different agencies
• Memorandum of Understanding (MOU) between NNSA and the USCG Regarding Mutual Support Between the Two Agencies (2019)
• Executive Order 12656 of November 18, 1988 as amended
• Presidential Policy Directive 8 – National Preparedness
• Strategic National Risk Assessment
• National Response Framework
• Response and Recovery Federal Interagency Operations Plan (FIOP)
• Nuclear/Radiological Incident Annex to the Response and Recovery FIOPs
• Interagency Domestic Radiological/Nuclear Search Plan, June 2011
• Emergency Support Function 9 – Search and Rescue

Agreements on international support
Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic, 2011
<table>
<thead>
<tr>
<th>Country</th>
<th>Responsibilities for notification and exchange of information</th>
<th>Responsibilities for informing the public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Domestic notifications will follow existing emergency plans and protocols. Domestic information exchange, including notifications and activation, will occur as per provincial and territorial emergency plans, as well as the FERP and FNEP.</td>
<td>Responsibilities for informing the public will occur as per provincial and territorial emergency plans, as well as the FERP and FNEP.</td>
</tr>
<tr>
<td></td>
<td>Canada is a signatory to the Convention on Early Notification of a Nuclear Accident. Health Canada and the Canadian Nuclear Safety Commission are the National Competent Authorities for domestic events for this convention; Health Canada is the National Competent Authority for events abroad.</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>Border Guard (Lead Agency)</td>
<td>Border Guard is the Lead Agency</td>
</tr>
<tr>
<td></td>
<td>STUK for Nuclear Preparedness and Response to radiological or nuclear emergency.</td>
<td>STUK provides information on radiological and nuclear aspects of the emergency</td>
</tr>
<tr>
<td></td>
<td>Ministry of interior guide on national arrangements in radiation or nuclear accident: <a href="http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/74874/Sateilytilanneohje.pdf">http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/74874/Sateilytilanneohje.pdf</a></td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>ICG Operations Centre is a single point of contact for maritime incidents in the Icelandic SRR. Iceland is party to The Convention on Early Notification of a Nuclear Accident (ENAC).</td>
<td>ICG has the main responsibility for informing the public regarding maritime incidents.</td>
</tr>
</tbody>
</table>
**Kingdom of Denmark**

**Greenland:**
Incidents concerning maritime SAR operations are shared between the Arctic Command and the Greenlandic Police, meaning that the responsibility for coordination and for specific tasks is planned between these parts. It is to be expected that the responsibility for notification and exchange of information will take place in the pillar: Joint Rescue Coordination Centre (JRCC) Greenland, Greenlandic Emergency Management Staff (counterpart to DEMA), and the Greenlandic Emergency Preparedness Commission. The Crisis Management Organization will usually be activated quickly. Thereby, the Greenlandic Emergency Management Staff and the Greenlandic Emergency Preparedness Commission will also be activated.

With reference to the abovementioned sector responsibility principle, the organisation of and coordination between various authorities, regardless of the kind or nature of an accident or a catastrophe, will take place in the same single organisational set-up as the day-to-day functions. Thus, notification and exchange of information between authorities will rely on familiar structures and procedures.

**Faroe Islands:**
The Administration Management Board for Maritime Rescue Coordination Centre (MRCC) Tórshavn is the link between the political system and the coordinating authority of MRCC Tórshavn in relation to major maritime disasters or severe accidents. They are responsible for informing the political authority in the Faroe Islands about the circumstances regarding the incident.

**Norway**

| JRCC for the rescue operation. DSA for Nuclear Preparedness and Response for the radiological or nuclear emergency. |

**Russian Federation**

| The Convention on Early Notification of a Nuclear Accident (26 September 1986, Vienna, Austria). |


**Greenland:**
Decisions on and issuance of warnings are handled by the Greenlandic Police, cf. Inatsisartutlov no. 14. The Greenlandic Emergency Preparedness Commission will be the overall responsible for the remaining crisis communication, cf. the Emergency Preparedness Plan for Greenland. In the event of major accidents and disasters, the Greenlandic Emergency Preparedness Commission has so far asked the Greenlandic Police to handle the press on behalf of the Crisis Management Organisation. The Naalakkersuisut, which is supervised by the Greenlandic Emergency Preparedness Commission, can also handle crisis communication.

Communication to the public is additionally based on the “sector responsibility” principle and each authority must consequently provide the public with information within their respective area.

**Faroe Islands:**
Normally, the Faroe Islands Police are responsible for informing the public but it will depend on the specific situation. The Administration Management Board is responsible for providing the political authorities advice on media handling. When a SAR operation is carried out, the Manager of the Maritime Rescue Coordination Centre (MRCC) Tórshavn will act as the media spokesman regarding the progress of the SAR work. The Danish Health Authority informs the public on necessary measures for the protection of health including in nuclear or radiological emergencies.
The United States

1. For radioactive materials being transported:

a. By or for the DOD: **DOD**

b. By or for the DOE: **DOE**

c. Containing NRC or NRC Agreement State licensed materials: **NRC**

d. Within the coastal zone for materials that are not licensed or owned by a federal agency or an NRC Agreement State: **USCG**

e. All others: **EPA**

**SPECIAL RESPONSE UNITS**

The respondents were asked to specify, whether their organization or country have any special response units that can assist in case of radiation leakage into the environment in the Arctic sea areas. The availability of special units is very different from country to country. Some do not have any special units available and most capacities mentioned are generally nation-wide, not Arctic specific. The following examples were mentioned as relevant special response units.

In Norway, there are specially trained response units for rescue operations and fire-fighting on board vessels at sea, but these are not specially trained or equipped for radiological or nuclear incidents. Norway has ground-based and aerial radiation monitoring and survey capabilities, which may be applied for incidents at sea or in coastal areas. Aerial measuring capacities (large NaI detectors) for use with rescue helicopters and airplanes operated by the Armed Forces, Norwegian Coastal administration airplane and Norwegian Geological Survey helicopter, small detectors (NaI, GM and neutron) for one Coast Guard vessel RPAS (quadcopter drone). Small detectors (automess-type) at Coast Guard and Navy vessels. Land-based trained personnel with portable instruments; Norwegian Civil Defence, Norwegian Armed Forces, DSA (also advanced equipment), and others. Triage capability for spectrum analysis and/or technical consultations, plume/deposition modelling, Radiation medicine, dosimetry, isotope identification, assessments, Advisory and assistance support.

Finland has extensive sampling and measuring capabilities including both civil and military resources. Finland also has a volunteer radiation measuring group.

Sweden has extensive measuring capabilities and for sampling. The rescue services and the Swedish civil contingency entities have coordinated RN capability, as well as the emergency organizations at NPPs. Swedish Radiation Safety Authority has the responsibility to maintain the national expertise in this area.

The Greenlandic Police and the Joint Rescue Coordination Centre (JRCC) Greenland do not have special units that can be deployed in the event of radiation leakage into the environment. However, the Greenlandic Police is
together with DEMA part of the measurement preparedness in Greenland. Consequently, the Greenlandic Police is equipped with handheld instruments for detection of radiation, and can assist with the initial measurements in case of a nuclear emergency. The technical management at the scene of the accident is coordinated by the municipal rescue service, cf. Inatsisartutlov no. 14, May 26, 2010. As soon as possible, DEMA will provide trained Field Investigation Teams (FIT) that can identify and map radioactive contamination. Furthermore, DEMA has capacities such as car- and air-borne detection systems that can be used to map radiation leakage of larger scale.

Similarly, the Faroe Islands do currently not have special units that can be deployed in the event of radiation leakage into the environment. If requested by the Faroe Islands, DEMA may to a specified extent provide trained FITs and deploy the same advanced capacities as described above as soon as possible.

The Russian Federation has special response units for assisting in case of radiation leakage into the environment. In particular – as a part of the State Corporation «Rosatom» – the Federal State Unitary Enterprise «Federal Environmental Operator». This is a specialized organization that works professionally with radioactive waste (RW) management all over the country. This organization provides a full range of services concerning RW management, including collection, transportation, reprocessing, conditioning and storage of low and medium level waste, as well as management of spent nuclear fuel and RW, accumulated during Russian Navy activities and generated when disposal of nuclear submarines and surface ships with nuclear power plants.

In Canada, the response units involved will depend on the scenario. For events involving nuclear power vessels at ports, the Department of National Defence has response teams. Furthermore, there are federal response teams that may be deployed under the FNEP. However, the later are focused on events at nuclear power plants, and there are no specific arrangements for an Arctic response.

The United States has several special response units, such as capabilities for radiation monitoring and survey (ground-based and aerial) with USCG having post-release survey equipment. The country also has triage capability for spectrum analysis and/or technical consultations. USCG can conduct reach back with CBP/LSSD-TC. A majority

*Picture 2. International MIRG cooperation exercise in the Baltic Sea. (Photo by: Finnish Border Guard)*
of afloat USCG units also have radiological isotope identification capability. Other special units include plume/depot deposition modelling, radiation medicine consultation and treatment support for individuals with radiation-induced injuries, including retrospective bio dosimetry, and advisory and assistance support. Assessments can also be provided based on monitoring and radioecology information, and advice leading to protective action recommendations based on a host country’s own regulations.

CONTINGENCY PLANNING

The respondents were asked to specify, whether their country or organization has any contingency plans including planning for different scenarios with requirements for rescue capacities. Most countries did not have or did not describe contingency plans for these specific kind of scenarios with RN and SAR. Nevertheless, some examples were found.

In Norway, the JRCCs have plans and standard operating procedures for various types of SAR incidents. The JRCC North Norway is in charge of alerting/deciding the appropriate SAR capacities if a major incident should occur in Norwegian Arctic SRR. The Norwegian Crisis Committee for nuclear preparedness has developed 6 different scenarios for dimensioning the nuclear preparedness capacities (NRPA 2014). There is not a separate scenario on maritime R/N rescue operation, rather, different aspects of a maritime R/N emergency is covered by a mix of 2-3 of the developed scenarios.

In 2016, Norway together with partners from other Nordic countries, in the frame of a Nordic cooperation project NKS COASTEX developed a set of 9 maritime-related scenarios and an exercise guide for design and practice of broad-scale exercises for maritime preparedness and response, and improvement of competences in interested countries (see NKS COASTEX references in the reference list). Norway also referred to IAMSAR / Norwegian rescue Law -06/2015 for documentation on SAR and NRPA 2018 (in Norwegian) Agreement between Rescue organization and crisis committee, NRPA 2013 (in Norwegian plus unofficial English translation), NRPA 2012 (In Norwegian).

Iceland has various contingency plans for mass casualties at sea depending on where around Iceland the incident will take place. National Police Civil Protection Department is responsible for making and maintaining plans. As an example, Iceland has a contingency plan for the Vestman Island Ferry and other passenger ships (in Icelandic).

The MRCC/MRSC in Finland use Mission Management Guidance that includes typical SAR scenarios, however does not have a specific contingency plan for RN specific incidents.

Sweden has planned scenarios around the NPPs for nuclear emergencies. For reference, see SSM 2017:27e - Review of Swedish Planning zones and distances.

For Greenland, there are no planning assumptions/planning scenarios or rescue capacity requirements at present. A rescue capacity will be decided/composed within the framework of the Greenlandic Emergency Preparedness Commission and the Greenlandic Emergency Management Staff. The health authorities and the emergency services are part of the Greenlandic Emergency Management Staff. In addition, it may be possible to receive expert knowledge support from DEMA. For reference in Greenland, see: Inatsisartutlov no. 14, May 26, 2010; SAR Greenland; Emergency Management; Plan for Greenland; DEMA Nuclear Emergency Management Plan.

Similarly, for Faroe Islands there are no planning assumptions/planning scenarios or rescue capacity requirements at present. A rescue capacity will be decided/composed within the framework of the Maritime Rescue Coordination Centre (MRCC) Tórshavn. It is expected that expert knowledge support from DEMA will be requested for assistance on nuclear matters. For reference for Faroe Islands, see: SAR Faroe Islands; Agreement on cooperation on aeronautical and maritime search and rescue in the arctic; Agreement between the Danish Defence and the Faroese Ministry of Fisheries; Agreement between DEMA and Tilhúvgingarstovnur Føroya on nuclear emergency management; Letter of Agreement between JRCC Iceland and MRCC Torshavn; Emergency Management Plan for the Faroe Islands; Agreement between the Faroe Islands and the United Kingdom of Great Britain and Northern Ireland for Cooperation in Search and Rescue Operations.
2. MONITORING CAPABILITIES

This part of the chapter examines national and regional capabilities to identify and monitor any possible release of radiation into the environment in an emergency situation but also regularly in the Arctic areas. The respondents were asked to provide their national strategies, guidelines and tools for emergency monitoring of radiation and also to identify decision support systems and other relevant capacities.

REGULAR MONITORING OF RADIOACTIVITY IN ARCTIC AREAS

Based on the questionnaire responses, many of the Arctic countries do regular monitoring of radioactivity in the Arctic areas.

For radiation surveillance monitoring in Norway, there are land-based high volume air samplers in Skibotn, Svanhovd, Viksjafjell and Longyearbyen, all of which are in near-coastal areas in Arctic Norway. In addition, there is land-based online radiation monitoring network (RADNET; automatic stations) distributed all over mainland Norway and in Longyearbyen. The civil defence do regular field background measurements of radiation all over mainland Norway including in the north (hand-held instrument). As part of the environmental surveillance programme, various samples are collected in Arctic terrestrial and marine areas (RAME programme).

Finland has an airborne and dose rate monitoring network with stations above the Arctic Circle as well as regular monitoring of radioactivity in the environment.

In Iceland, regular monitoring of seawater is done with sampling and analysis at lab. There are stations near sea for continuous monitoring of total gamma.

As for Greenland, there are three permanent measurement stations in Greenland at Nuuk, Qarqatoc and Asiaat. These continuously measure dose rates in the air and collects gamma spectra regularly; i.e. every tenth minute 24/7. The data from these monitoring stations enter the European Radiological Data Exchange Platform (EURDEP). No general systems have been incorporated for regular measurements of radioactivity in water.

A permanent measurement station is currently being established in the Faroe Islands to continuously measure dose rates in the air and collects gamma spectra regularly. The data from the monitoring station is expected to be available in EURDEP. Additionally, a car-borne gamma spectrometric system is also being established. This enables the opportunity to measure the radiation levels and identify specific radionuclides in case of a release. No general systems have been incorporated for regular measurements of radioactivity in water.

Health Canada continuously monitors radioactivity in the air across Canada, including in the Arctic. A map of these monitoring stations is available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/environmental-radiation/fixed-point-surveillance-network/map-fixed-point-surveillance-network.html

In Sweden, regular monitoring of the air is performed in the northern part of Sweden (Kiruna). A number of automatic gamma monitoring stations reporting to the Swedish Radiation Safety Authority every hour. The municipalities are conducting background measurement every 7 months.
NATIONAL STRATEGIES FOR EMERGENCY MONITORING OF RADIATION

Canada

Health Canada maintains a cross-Canada network of land-based environmental radiation monitoring stations, including in the Arctic, and can analyse environmental samples at its labs in Ottawa.

Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radionuclides in an emergency situation:

There are no existing, specific strategies for an Arctic emergency. Existing capabilities for monitoring, modelling and source reconstruction would be adapted as appropriate.

Finland

National Strategy on emergency monitoring is under preparation at Ministry of Interior.

Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radionuclides in an emergency situation:

STUK has an internal monitoring plan for emergency monitoring.

Picture 3. Land-based high volume air sampler in Svanhovd, Norway (Photo by: DSA)
Iceland


Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radionuclides in an emergency situation:

IAEA literature such as Guidelines on the Harmonization of Response and Assistance Capabilities for a Nuclear or Radiological Emergency: https://www-pub.iaea.org/MTCD/Publications/PDF/EPR_HarmonizedAssis_2017_web.pdf

Kingdom of Denmark

Greenland:
DEMA is competent authority for nuclear emergency preparedness in Greenland and thus responsible for detection and monitoring of radiation that may arise from a nuclear incident or accident on a nuclear facility. This involves 24/7 monitoring from three stationary measuring stations in Greenland. In case of increased levels of radiation, the monitoring systems will automatically send alarm.

The Greenlandic Police is part of the measurement preparedness, and can assist with on-site measurements from handheld instruments. The results on radiation levels and radionuclide identification are reported to an emergency staff and reach back capacity in Greenland and/or Denmark.

Faroe Islands:
A monitoring station, similar to the monitoring stations in Greenland, is currently being established on the Faroe Islands. Technical support may to a specified extent be provided by DEMA on request from the Faroe Islands.

Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radionuclides in an emergency situation:

No.

Norway

The Norwegian Radiation and Nuclear Safety Authority is developing a national monitoring strategy for the National Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response. The strategy is expected to be finished during 2020 and will also cover emergency monitoring of radiation for Arctic RN-emergencies at sea.

Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radionuclides in an emergency situation:

Emergency monitoring strategies and SOPs are available for log-in users only in the DSA / Crisis Committee decision support system (CIM-system). There is no specific emergency monitoring strategy for maritime emergencies, but there are some recommendations based on previous table top exercises. In addition, the “Nordic Manual” is being used by all Nordic countries (https://www.dsa.no/dav/56bc06c397.pdf) (Nordic Flagbook, 2014).

Russian Federation

At the national level - Unified State Automated System for Monitoring the Radiation Situation on the Territory of the Russian Federation. This system is for information support of the activities of state authorities and administrations of all levels for radiation safety on the territory of the Russian Federation. It integrates departmental and territorial radiation monitoring systems into a single system. RW measurement data are available here: http://egasmro.ru/ru/

In accordance with the Federal Law of 21.11.1995 «On the Use of Atomic Energy» state monitoring of the radiation situation is one of the activities in the field of the use of atomic energy. Organization and implementation of state
monitoring in areas of atomic energy facilities location are entrusted to the State Corporation «Rosatom». Therefore the State Corporation «Rosatom» has an industry-specific radiation monitoring system, posts of which are located directly at and around atomic energy facilities – Automatic radiation monitoring system. RW measurement data of this system are available here: https://www.russianatom.ru/.

**Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radio-nuclides in an emergency situation:**

Emergency monitoring strategies based on rapidly deployed mobile emergency monitoring systems of RW. It is also possible to use unmanned aerial vehicles, their groups as well as robot workcells.

**Sweden**

In case of nuclear accident, the county is responsible for the emergency monitoring. Otherwise, the municipality is responsible. There is an ongoing, national strategy under development.

**Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radio-nuclides in an emergency situation:**

Yes, the County Administrative Boards and the municipality have their responsibility.

**The United States**


**Other emergency monitoring strategies or standard operational procedures describing monitoring of radiation or radio-nuclides in an emergency situation:**

Manuals and Standard Operating Procedures (SOPs) for the Federal Radiological Monitoring and Assessment Center (FRMAC) are available online at [https://www.nnss.gov/pages/programs/FRMAC/FRMAC_DocumentsManuals.html](https://www.nnss.gov/pages/programs/FRMAC/FRMAC_DocumentsManuals.html).
RESPONSIBILITIES AND TOOLS FOR PROGNOSIS OF RADIATION LEVELS
AT THE INCIDENT SITE

In this section, the respondents were asked to identify responsibilities for radiation monitoring for SAR-personnel, prognosis of radiation levels, source term estimation and reach back capacities. They were also asked to specify the decision support systems, modelling and forecasting tools, and aircraft or remotely piloted systems used to assess the possible exposure for SAR-personnel.

When it comes to the responsibility for radiation monitoring for SAR-personnel in a rescue operation, few countries, such as Norway and Sweden, noted that the health and safety of SAR-personnel must be provided by the respective employer. This is however a challenge when it comes to volunteers. IRSA in Iceland stated that while SAR-personnel have some limited equipment, IRSA can provide support, advice and dose evaluation. In Finland, the SAR personnel either have or should have their own detection gear.

In Greenland, the municipal rescue service has the technical management at the scene of the accident, cf. Inatsisartutlov no. 14, May 26, 2010. In maritime SAR operations, where a nuclear incident is included, the responsibility is not described. Ship managers on Danish Defence ships are responsible for radiation monitoring of own SAR personnel in a rescue operation. In Faroes Islands, for small nuclear incidents, the Working Environment Authority is responsible for radiation monitoring. For maritime RADSAR operations, the responsibility for radiation protection belongs to the Danish Health Authority. Pursuant to Executive Order No. 669 of 01/07/2019 on Ionising Radiation and Radiation Protection § 14: In relation to emergency workers, responsibility for compliance with the provisions of the Radiation Protection Act and of rules laid down pursuant to that Act for the purposes of worker protection rests with the respective employer. This includes personal dose monitoring. Furthermore, radiological monitoring of emergency workers in a specific emergency situation is subject to such (further) requirements the Danish Health Authority might lay down, as necessary, in the specific circumstances.

In Canada, Health Canada can provide personal radiation dosimeters for SAR-personnel on request, however are not responsible for radiation monitoring for SAR personnel. In the United States, the Department of Energy/National Nuclear Security Administration provides response assets, including for radiation monitoring, in support of the lead agency. USCG will support DOE or the lead agency.

*Picture 4. KV Svalbard (Copyright: Haakon Kjollmoen)*
When it comes to prognosis of radiation levels at the incident site and source term estimation, the responsibilities in the Arctic countries are described in the table below.

**Table 2. Responsibilities for prognosis of radiation levels at the incident site**

<table>
<thead>
<tr>
<th>Country</th>
<th>Responsible authority</th>
<th>Responsibility for source term estimation. How is information shared?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canada</strong></td>
<td>In general, this would reside with the operator of source causing the emergency. Under the FNEP, the federal government would also undertake an assessment and prognosis to help inform decision making. CAF may be requested to assist, however, this would lie outside CAF SAR specific duties and would require coordination at the federal level via Public Safety Canada and the CAF Joint Operations Centre.</td>
<td>In general, this would reside with the operator of source causing the emergency. Under the FNEP, the federal government would also undertake an assessment and prognosis to help inform decision making. CAF may be requested to assist, however, this would lie outside CAF SAR specific duties and would require coordination at the federal level via Public Safety Canada and the CAF Joint Operations Centre.</td>
</tr>
<tr>
<td><strong>Finland</strong></td>
<td>Finnish Meteorological Institute is responsible for weather prediction models and atmospheric dispersion models. STUK is responsible for modelling the radiological consequences of an emergency in collaboration with the Finnish Meteorological Institute.</td>
<td>STUK is responsible for estimating the source term. Information is updated and shared at international level according to agreements e.g. through IAEA USIE.</td>
</tr>
<tr>
<td><strong>Iceland</strong></td>
<td>Icelandic Radiation Safety Authority</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Details</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Greenland:</td>
<td>DEMA is responsible for the measurement preparedness and for operating the decision support system, ARGOS. The system is used to calculate prognoses of atmospheric dispersion of airborne radioactive material and radiological consequences in and around Greenland in case of a release. The dose level calculations are based on weather data provided by the Danish Meteorological Institute (DMI). In case of a nuclear emergency that results in a SAR operation, the necessary prognoses will be calculated and delivered to the relevant SAR-authority.</td>
<td></td>
</tr>
<tr>
<td>Faroe Islands:</td>
<td>In case of a nuclear emergency, that can or will affect the Faroe Islands, DEMA may to a specified extent support Faroe authorities, e.g. in the area of prognosis and decision support.</td>
<td></td>
</tr>
<tr>
<td>Norway:</td>
<td>The DSA is responsible for making prognoses in cooperation with the Norwegian Meteorological Institute (MET). The DSA is responsible and uses specialised modelling tools for source term estimation, such as RASTEP. This information will be used in ARGOS/SNAP to improve prognosis on aerial dispersion and deposition. The results from ARGOS are shared with central authorities and the regional County Governors (Fylkesmannen) who will share it with the municipalities.</td>
<td></td>
</tr>
<tr>
<td>Russian Federation:</td>
<td>N/A Predefined and designated technical support centers and research centers for relevant profiles: Nuclear Safety Institute of the Russian Academy of Sciences, All-Russian Research Institute for Nuclear Power Plants Operation, nuclear power plants designers.</td>
<td></td>
</tr>
<tr>
<td>Sweden:</td>
<td>Swedish Radiation Safety Authority’s crisis organization can make dispersion prognosis of radiation levels and have tools for forecasts in co-operation with the Swedish Meteorological and Hydrological Institute. Swedish Radiation Safety Authority has the capability and information is also shared to IAEA IEC.</td>
<td></td>
</tr>
</tbody>
</table>
A combination of field and reachback personnel would work together to determine the source term by a combination of measurements, modelling, and analysis. It would be updated as needed based on new information. Our information is distributed via CMweb.

DECISION SUPPORT SYSTEMS

With regard to decision support systems used in emergency situations, only some countries noted to have decision support systems or modelling tools to assess the possible exposure of SAR-personnel, however most countries will have systems in place for including meteorological information into decision support tools.

Norway use the ARGOS decision support system. ARGOS is a software system to support the emergency organization to make the best possible decisions in case of incidents involving atmospheric dispersion of hazardous CBRN-materials. The system can present monitoring data, which can be used to assess a nuclear emergency. It can, for example calculate consequences of airborne nuclear and radiological releases to the atmosphere. The authorities note that, monitoring data must be fed manually into the system. Work is under way to include data from other monitoring systems. In Norway, there is no modelling tool specific for SAR-personnel. The DSA can assist in calculating or estimating exposure dose rates to SAR-personnel. The ARGOS decision support system is automatically linked to the SNAP model at MET for and can be used as a forecast tool and adjusted according to live measurements. Emergency-scene prognoses of radiation levels for rescue workers may be provided by DSA upon request. ARGOS DSS is automatically linked to the MET SNAP model and new weather prognosis are available every 3 hours. During an emergency, there will be close cooperation between DSA and MET on these issues.

The ARGOS system is also used in Greenland and Faroe Islands, operated by DEMA. In addition to the features mentioned above, the ARGOS system can be used to calculate consequences of air-borne nuclear and radiological releases to the atmosphere and expected effective dose to people in the affected area. This additionally involves calculation of expected equivalent dose to the thyroid and inhalation dose. The prognoses can consequently be used as a tool to predict potential dose delivered to SAR-personnel. National met information is provided by the Danish Metrological Institute (DMI) and automatically included and updated (every forth hour) in ARGOS.

Iceland does not have a specific decision support system or tool to assess radiation exposure for SAR personnel. The authorities will work in close cooperation with agencies that use such systems. The meteorological data is collected on a case-by-case basis. The met office runs trajectory calculations continuously due to hazard from volcanic activity.

Similarly, Finland does not have a specific decision support system to assess radiation exposure for SAR personnel, however STUK operates for example JRodos decision support system, and the Finnish Border Guard have a decision support system for SAR incidents.

Canadian respondents note that decision-making will be based on modelling and monitoring results under the Federal Nuclear Emergency Plan (FNEP). Regional meteorological data in Canada is available automatically. The availability of local measurements depend on the situation.

In Sweden, the Swedish Radiation Safety Authority collects all relevant data and calculates doses. Meteorological data is updated every three hours, with specific assessment and forecasts depending on the situation.

In the United States, the National Atmospheric Release Advisory Center (NARAC) provides near real-time assessment of atmospheric releases for rapid decision-making during an emergency. Results are shared with all stakeholders as needed via CMWeb. All monitoring data are logged digitally using tablets and a cloud accessible database. The RadResponder Network is also one of the data management tools in the US. NARAC collects the best met info from all available sources or computes met info itself using the most appropriate models.
AIRCRAFT OR REMOTELY PILOTED SYSTEMS FOR FURTHER ASSESSMENT OF RADIATION AT THE INCIDENT SITE

Aircraft systems or remotely piloted aircraft systems can also be used to further assess the radiation situation at the scene of the emergency. In Norway, the SAR helicopter in Bodø is predefined to carry out the portable large NaI detector. Orion surveillance airplanes are also equipped with large NaI detectors. The Norwegian Coastal Administration together with DSA/Coastguard vessels have made plans for using drones at emergency scenes. The Coastguard has drones on 5 of their vessels of which one vessel is equipped with radiation detectors. Also, the DSA has a small drone system with radiation detectors. Large NaI detectors are equipped onboard one airplane of the Norwegian Coastal Administration. The Norwegian Geological survey has one system for use in a helicopter.

In Iceland, the IRSA relies on support from the Icelandic Coast Guard. In Sweden, two dedicated aircraft are available for air radiation monitoring for large scale emergencies. Finland noted to have drones, but no detection gear for them.

In case of a nuclear emergency that can affect Greenland, a large scale of radiation mapping will be carried out by DEMA. Two air-borne gamma spectrometric systems that can be mounted in a pod on Danish Defence Fennec helicopters will be deployed as soon as possible. In case of a nuclear emergency that can affect the Faroe Islands, assistance from DEMA may to a specified extent be sent upon request from the Faroe Islands, e.g. two air-borne gamma spectrometric systems may be deployed as soon as possible.

Russian Federation also indicated to have unmanned aerial vehicles for monitoring of radiation or radionuclides in an emergency situation.

Natural Resources Canada has aerial surveillance capability. The availability of such systems depends on the

*Picture 5. The «total defence» of Norway is trained on chemical, biological, radiological and nuclear crisis during NATO-exercise Trident Juncture 2018. (Photo by: Frederik Ringnes/Forsvaret)*
CAF SAR has aeronautical assets that could be used for aerial surveillance if the situation warrants and through the appropriate federal request for assistance. It is not a core capability of these aircraft or aircrew and would require coordination within CAF to equip as required.

The respondents from the US indicate that they have aircraft, however the vast distance to the Arctic may be a challenge to the response. People can equipment can be deployed to fly on other departments'/agencies' aircraft (as was i.e. done during the response to Fukushima).

REACH-BACK CAPACITIES AND EXPERT ASSESSMENTS AVAILABLE FOR PERSONNEL MONITORING RADIATION AT THE INCIDENT SITE

Not all Arctic countries have reach-back or expert judgment available for personnel monitoring at the incident site, especially in the Arctic region. For emergencies in Norway, the Norwegian Directorate for Radiation Protection and Nuclear Safety (DSA) has a 24/7 emergency phone. They can provide or further reach for relevant expertise and assist in assessments. Available support include evaluation of the exposure situation, establishing hot zones, evacuation limits and prognosis. They can also assist in interpreting monitored spectrum and other field measurements.

In Iceland, IRSA is able to support and request further support from relevant experts and IAEA. In emergencies in Finland, STUK offers reach-back capacities or remote expert support of field teams. Similarly in Sweden, the authorities and universities are able to provide reach-back capacities and expert assessments.

In Canada, technical support could be provided depending on the scenario under the FNEP.

In the United States, the Consequence Management Home Team (CMHT) provides ongoing analytical support to all NNSA consequence management assets once they are established at the incident location and to the federal, state, and local authorities supporting the event. They also provide analysis and interpretation of the initial release based on early data, map products, coordinates laboratory assets, and coordinates and provides situational awareness of response teams en route to the incident. The REAC/TS provides treatment, evaluation, and medical consultation for injuries resulting from radiation exposure. Focused on home team to provide reach-back capability but includes a small deployable contingent.
3. MONITORING EQUIPMENT

In this section, the respondents were asked to specify in more detail what their national monitoring equipment include, i.e. the different types of radiation detection and radionuclide identification equipment, and protective gear and monitoring equipment available specifically for SAR-personnel. They were also asked to provide information on how radiation dose assessments are performed and what the national standard operating procedures (SOPs) are for collecting and analysing samples. Most Arctic countries reported to have standard operating procedures for collecting and analysing samples but did not provide any specifics.

PORTABLE EQUIPMENT AND MONITORING UNITS

With regard to portable equipment for radionuclide identification, Norway has small detectors (NaI, GM and neutron) for one Coast Guard vessel RPAS (quadcopter drone). Navy and Coast Guard vessels also have small autocess-type detectors. In addition, Norway has land-based trained personnel with portable instruments from Norwegian Civil Defence, Norwegian Armed Forces, DSA (also advanced equipment), and others. For sample collection and analysis, Norway has environmental sample collection and deployable lab analysis systems (alpha, beta, gamma). DSA has several portable Ge-detector for more specific radionuclide identification, as well as carborne Ge detector system in Oslo and Svanhovd, which may also be transported for use e.g. from boat. There are also a number of back-pack and handheld detectors identifying different radionuclides. These are located at Svanhovd, Tromso and Østerås. DSA also has a portable lab (a standard container type) with monitoring equipment that can be transported to an emergency scene and 3 monitoring portals that can be used for scanning vehicles or persons for radioactive contamination.

Iceland has one portable HPGe system for high-resolution on-site spectral analysis. In Sweden, the Swedish Radiation Safety Authority has portable measuring equipment and ability to measure and identify most common nuclides and an expert unit that can evaluate and interpret the data. As a state with NPPs, Sweden has extensive capabilities. The Swedish civil contingencies have some capability for common nuclides but need assistance from SSM for more advanced measurements. Advanced monitoring units are also available and can be transported by road. One portable lab is available through the armed forces.

Finland has various types of equipment, both civil and military, with direct spectrometric measurement capabilities including mobile laboratories, car based spectrometric equipment, backpacks with spectrometric capabilities, hand-held devices, and airborne platforms. Finland also has extensive sampling and lab analysis based nuclide identification capabilities.

DEMA has an electrically cooled HPGe detector that can be transported to any scene within the Kingdom of Denmark and used as a portable lab. Deployment would depend on the specific scenario. In case of a nuclear emergency, the detector will be deployed as soon as possible. In Greenland, the Greenlandic Police has been trained to make measurements using handheld measuring devices. They are equipped with dose rate meters and hand held radionuclide identification NaI instruments. The systems can detect all common gamma emitters.

DEMA is responsible for educating the police officers in the use of the equipment and this is done every second year. DEMA additionally has a portable HPGe detector for even more specific radionuclide identification.

In Faroe Islands, a car-borne gamma spectrometric system is currently being established. This enables the opportunity to measure the radiation levels in case of a release. DEMA may assist in interpretation of the data if requested by the Faroe Islands. The HPGe detector can also be used in the Faroe Islands if necessary and if requested.

For Canada, the Health Canada and Natural Resources Canada maintain a mobile radiation surveillance capability including various detectors and mobile analysis capability and tools. Deployment would depend on the specific scenario.

For emergencies in the United States, the relevant authorities can perform high resolution resolution gammaray in situ measurements. Select USCG teams use post release survey instruments for in situ measurements and ORTEC micro detectives in HX with HPGe Gamma detectors. Other instruments include FLIR R300 and Radseeker
CS RIIDs. For sample collection and analysis, environmental sample collection and deployable lab analysis systems (alpha, beta, gamma) are also available. The authors also provide technical reach back support to interpret data USCG uses CBP/LSSD-TC. Fly Away Lab for minimal alpha, beta, gamma spectrometry can be transported to an emergency scene if needed.

**MONITORING EQUIPMENT AND PROTECTIVE GEAR FOR SAR-PERSONNEL**

Overall, the monitoring equipment and protective gear for SAR personnel seem to be quite limited. Most countries did not have special protective gear for the SAR personnel to protect themselves from radiation but some indicated to have handheld devices and/or personal radiation monitors and dosimeters available for SAR personnel.

In Norway for example there is some monitoring equipment on Coastguard vessels and on some of the emergency tugboats, but other than that the equipment for SAR-personnel is very limited. The fire brigade have protective uniforms, and breathing equipment for smoke conditions. The Civil Defence also has some protective gear, so called RADIAC equipment with masks (land-based).

The Icelandic Coast Guard in Iceland has one radiation survey meter from the IRSA that is kept with ICG aviation department. It is a system of large NaI crystals specially made for airborne monitoring. IRSA also has sets of personal radiation monitors and dosimeters that are available for SAR-personnel.

In Sweden, the portable equipment for SAR-personnel available depend on situation as the equipment will differ depending on the personnel who receive the call. SAR-personnel normally only have means to measure gamma, but some also have the capability to measure beta and alpha and in special cases even neutrons. Some units will also have dosimeters but not all. SAR personnel will be supported by Swedish Radiation Safety Authority and radiological experts and possibly also measuring teams from the Swedish Radiation Safety Authority. The SAR personnel will use their normal protection wear that is sufficient to be used in RN-situation.

Finland has handheld devices available for SAR personnel but the SAR personnel do not have special protective gear to protect themselves from radiation.

The Canadian Air Force noted that operational CAF SAR personnel are not equipped with personal monitoring equipment or special protective gear as part of their SAR standard equipment. The United States Coast Guard personnel on most afloat USCG assets have varying degrees of monitoring equipment and respiratory protection.

**RADIATION DOSE ASSESSMENT**

When it comes to radiation dose assessments, the respondents were asked to define how the radiation dose assessment is performed, based on what data and whether their country has a set dose limit for the rescue personnel in an emergency situation.

In Norway, the DSA will assist if needed, but in principle the employer must provide radiation dose calculations. The calculations will be based on available monitoring/dosimeter data or best estimates. DSA will perform assessments for the public, based on available source term, weather conditions etc. The DSA follows international recommendations and national law and recommendations (f.ex. national CBRNE-guidelines) for dose limits for emergency workers and dose limits for exposed workers. However, most rescue workers are not defined as radiation workers, and therefore it’s the dose limits for the general public that applies. Norway is presently preparing new regulations and guidelines on this.

Similarly, in Sweden the employer is responsible for the radiation dose assessments and assessment of reasonable levels. Dose limits are not applicable in a radiological emergency at present, but dose limits for workers (radiological) shall as far as possible be followed (20 mSv/year) by rescue personnel (according to EU BSS). Helpers from the public may not be given tasks that go above this level.

In Iceland, the assessments are performed by IRSA based on available data. They do note that in case of a nuclear or a radiation emergency, rescue personnel or other personnel may exceed normal dose limits if they are saving lives, preventing harmful radiation, or preventing an emergency. In an emergency situation the radiation dose
should be kept under 100 mSv.

In Finland, the employer is responsible for dose assessment. Dose assessment can be based on dosimeter or monitoring data or estimated. STUK can provide dose estimates in Finland. Similarly to other Arctic countries, Finland also has set dose limits for rescue personnel and other personnel in an emergency situation.

In the preparedness phase in Greenland, dose assessments are based on ARGOS calculations and prognoses. In case of a nuclear emergency, dose assessments will be based on data from the three measurement stations in Greenland and from measurement data from the hand held equipment operated by the Greenlandic Police. Conditions regarding ionising radiation are regulated by Inatsisartutlov no. 33, December 9, 2015.

In case of a nuclear emergency, and on request from the Faroe Islands, DEMA may to a specified extent assist in collecting and assessing dose data. Dose limits and reference levels etc. for emergency occupational exposure have been set by the Danish Health Authority. Pursuant to Executive Order No. 669 of 01/07/2019 on Ionising Radiation and Radiation Protection:

§ 27. Doses to emergency workers must be kept as low as reasonably achievable and should, as far as possible, not exceed the dose limits for occupational exposure.

§ 28. In cases where it is not feasible to remain within the dose limit for the effective dose for occupational exposure, a reference level for the effective dose of 100 mSv applies.

§ 29. In exceptional situations, in order to save life, prevent severe radiation-induced health effects, or prevent the development of catastrophic conditions, the Danish Health Authority may authorise a higher reference level for the effective dose, though not exceeding 500 mSv. (2) In circumstances comprised by (1), emergency workers must be specifically instructed concerning the work and clearly and comprehensively informed of the health risks associated with the entailed actions, the protective measures available, and that their participation in the actions is voluntary.

For Faroe Islands and Denmark, in accordance with the aforementioned executive order, emergency workers are defined as: Any individual having a defined role in an emergency and who might be exposed to radiation as a result of taking action in response to the emergency, including volunteers who have been instructed on their role in advance. Other individuals are regarded as members of the public for which a dose limit of 1 mSv/y apply.

A dose assessment will be performed in Canada under the FNEP based on an understanding of the scenario, source term, monitoring and modelling, etc. The scale and precision depends on the scenario. Dose limits have been set for off-site emergency workers. See the Generic Criteria and Operational Intervention Levels for Nuclear Emergency Planning and Response for more information.

The technical reach-back assets in the US use a dose assessment tool called TurboFRMAC for assessing dose from environmental dispersals. Also, REAC/TS can do dose reconstruction for individuals who are exposed to or contaminated by some specified source term. The US has various federal guidelines that establish dose limits. The National Council on Radiation Protection and Measurements (NCRP) Report No. 179, Guidance for Emergency Response Dosimetry, provides guidance on the accrual and control of radiation dose in the emergency phase of a radiological or nuclear incident. The United States Coast Guard also aligns with non-occupationally exposed dose limits.

4. EDUCATION AND TRAINING ON RADIATION PROTECTION

In this section, the report describes national radiation protection education and training available for SAR-personnel, support personnel and for relevant decision makers. Based on the answers received to this section of the survey, the radiation safety training for SAR personnel within the Arctic countries/region seem to be quite limited and only few countries have regular training on radiation safety for responders. There seems to be however more availability when it comes to regular national inter-agency education and training, as well as training for special units, support personnel and decision-makers.

Table 3. Availability of education and training on radiation protection
<table>
<thead>
<tr>
<th>Country</th>
<th>SAR personnel</th>
<th>Inter-agency</th>
<th>Assisting special units</th>
<th>Support personnel and decision-makers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>Yes and no</td>
<td>Yes</td>
<td>Health Canada offers training to its nuclear emergency response partners under the FNEP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Health Canada provides training to its partners involved in field-based radiation surveillance operations.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Health Canada offers training to its nuclear emergency response partners under the FNEP. Also, Health Canada provides training on the management of radiation casualties to first receivers (e.g. hospitals).</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STUK conducts regular education and training activities in cooperation with e.g. rescue services, police, health care authorities, municipalities, private sector actors, military and border guard.</td>
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<tr>
<td></td>
<td></td>
<td>Organization specific training is provided.</td>
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<tr>
<td>Iceland</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td></td>
<td>Inter-agency training on an ad-hoc basis. There is co-operation on exercises and workshops of various types among IRSA and some of the response organizations although they are not regular.</td>
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<tr>
<td></td>
<td></td>
<td>There will be (and has been) ad hoc training / briefing on the use of radiation dose meters and basic radiation protection principles at the beginning of exercises, as would be in case of real emergency.</td>
<td></td>
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<tr>
<td>Kingdom of Denmark</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEMA carry out education of the Greenlandic Police in radiation basics and monitoring as Greenlandic Police assist DEMA to a specific extent as of monitoring of radiation levels.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DEMA carries out training of own personnel and of the Danish police in radiation basics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
<td>Yes/No</td>
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</tr>
<tr>
<td>Norway</td>
<td>Yes and no</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>The 330 squadron is training their key personnel however this process is not completed.</td>
<td>Regular inter-agency cooperation as a part of national the nuclear preparedness organization, but no dedicated education scheme. Some central courses available every year but otherwise less regular, f.ex. between DSA/Crisis Committee and JRCC. Shared procedures are available for agencies of the Crisis Committee but not with JRCC/SAR organization.</td>
<td>DSA and civil protection personnel. There are some fire brigades equipped with special equipment to handle chemical spills, and some of them have Automess radiation monitors. In the future inter-municipal oil-spill response units also trained and equipped to handle radiological pollution.</td>
<td>The National Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response holds annual seminars and desk top exercises are held. This is mainly for decision makers. There is systematic radiation protection training for civil protection (Civil Contingencies Agency) support personnel.</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Our educational and methodological training center for rescues «Atomspas» has already trained specialists from other Russian ministries and departments and is also ready to train foreign specialists.</td>
<td>Special units are trained in frame of retraining program for rescuers of the State Corporation «Rosatom» and have subsequent certification as an emergency rescue unit (triennially).</td>
<td>It is obligatorily.</td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>The Swedish Civil Contingencies Agency offer education concerning nuclear accidents for the agencies. MSB train all firefighters in radiation safety and some other agency upon request. Procedures are available in the national emergency plan.</td>
<td>The County administrative board and the municipality are responsibility to keep personnel trained.</td>
<td>The Swedish Civil Contingencies Agency organize training.</td>
<td></td>
</tr>
</tbody>
</table>
United States

The United States Coast Guard personnel receive both pre and post release rad safety training. The USCG also requires semi-annual proficiency drills and annual re-certifications for RIID operators. Curriculum is developed by MLEA/FLETC and DOD.

Yes

Among many others, inter-agency training is conducted at the Radiation Emergency Assistance Center/Training Site (REAC/TS). USCG receives rad/nuc training from DOD. Procedures, Manuals and Standard Operating Procedures (SOPs) for the Federal Radiological Monitoring and Assessment Center (FRMAC) are available at: https://www.nnss.gov/pages/programs/FRMAC/FRMAC_DocumentsManuals.html

Yes

Response units receive extensive training from their home agencies and inter-agency partners.

Yes

5. EXERCISES

The ARCSAFE project identified the need for the Arctic countries to conduct more joint exercises and trust building between RN experts and emergency workers/emergency helpers in order to increase their knowledge on these kinds of incidents and provide a venue to develop competence. The questionnaire asked the respondents to name responsible agencies for both national and international exercises and to inform about their previous and upcoming exercises with a focus on the Arctic areas. The following table summarizes the responses regarding exercises:

NATIONAL AND INTERNATIONAL EXERCISES WITH A FOCUS ON THE ARCTIC REGION

Canada

Responsible agency for exercises involving radiological or nuclear events in the Arctic
The responsibility is dependent on the scale/scope of exercise, the scenario, the objectives, etc.

Responsible agency for international exercises
The responsibility is dependent on the type of exercise. Health Canada and Canadian Nuclear Safety Commission provide the interface for international exercises organised through the International Atomic Energy Agency and OECD Nuclear Energy Agency.

National exercise calendar including radiological or nuclear exercises in the Arctic
Public Safety Canada maintains a national exercise calendar. Health Canada maintains a national calendar for nuclear exercises. No radiological or nuclear exercises in the Arctic have been identified to date on this calendar.

Relevant Arctic related exercises
After action reports for various exercises exists, but these generally have focused on nuclear power plants.
Finland

Responsible agency for exercises involving radiological or nuclear events in the Arctic
There is no specific exercise plan for the Arctic Region. Radiological and nuclear events are included in exercises held by different authorities that involve also arctic regions.

Responsible agency for international exercises
The responsibility depends on the type of exercise.

National exercise calendar including radiological or nuclear exercises in the Arctic
N/A

Relevant Arctic related exercises
N/A

Iceland

Responsible agency for exercises involving radiological or nuclear events in the Arctic
IRSA at the technical level, and as applicable.

Responsible agency for international exercises
IRSA at the technical level, and as applicable.

National exercise calendar including radiological or nuclear exercises in the Arctic
No

Relevant Arctic related exercises
Northern Viking 2011 (NATO)

Kingdom of Denmark

Responsible agency for exercises involving radiological or nuclear events in the Arctic
Greenland:
For SAR-operations in Greenland, it is Arctic Command and the Greenlandic Police who are responsible for exercises.

For nuclear emergencies, DEMA is responsible for exercises.

Faroe Islands:
For SAR-operations in the Faroe Islands, it is the Maritime Rescue Coordination Centre (MRCC) Tórshavn who is responsible for exercises.

For nuclear emergencies, Ministry of Fisheries is responsible for exercises with assistance from DEMA if requested.

Responsible agency for international exercises
Greenland:
The Danish Defence, the Danish Police and DEMA are responsible for international exercises.

Faroe Islands:
The Maritime Rescue Coordination Centre (MRCC) Tórshavn is responsible for international exercises.

National exercise calendar including radiological or nuclear exercises in the Arctic
No

Relevant Arctic related exercises
A nuclear emergency exercise in Greenland was held in December 2019. The exercise was carried out on land and did consequently not include actual SAR-operations. The scenario was an accident with a nuclear propelled
vessel that had a release with consequences in Nuuk (the capital of Greenland).

**Norway**

**Responsible agency for exercises involving radiological or nuclear events in the Arctic**
DSA and the County Governors in Arctic Norway

**Responsible agency for international exercises**
For RN-exercises it is primarily DSA as the national competent authority and lead of the crisis Committee, but this may depend on the type of exercise and the main aims of the exercise.

**National exercise calendar including radiological or nuclear exercises in the Arctic**
Yes

There is a national exercise calendar when it comes to larger exercises on national or regional level. It is not specific to radiological or nuclear events in the Arctic.

**Relevant Arctic related exercises**
RADEX, 2019 (see EPPR report).

Arctic Reihn – most likely moved to spring 2022.

**Russian Federation**

**Responsible agency for exercises involving radiological or nuclear events in the Arctic**
State Corporation «Rosatom» is the competent authority for the use of atomic energy. In the State Corporation «Rosatom» structure there is Northern Sea Route Directorate.

**Responsible agency for international exercises**
N/A

**National exercise calendar including radiological or nuclear exercises in the Arctic**
Yes

Annual large-scale exercises are held (with participation of representatives from International Atomic Energy Agency and foreign observes) with Nuclear Emergency Response Group at one of the Russian nuclear power plants. 3 of 11 Russian nuclear power plants (including the first Russian floating nuclear power station «Akademik Lomonosov») are located in Arctic region.

**Relevant Arctic related exercises**
13-14 July 2011 – Comprehensive emergency response exercise «Arctic-2011» on «Organization of the work of the territorial subsystem of the RSChS of the Arkhangelsk region and the object emergency response system of the Ship Repair Center «Zvezdochka» in case of a radiation emergency»


17 July 2012 – table-top exercise on «Improvement of the radiation monitoring and emergency response system in the Arkhangelsk region» in the Arkhangelsk region «Pomorje-2012» within the framework of the international project Northern Dimension Environmental Partnership (NDEP-008).

International Exercises «Arctic-2014» on the FSUE «Atomflot» (Murmansk, Russia).

17-18 October 2018 – Emergency Exercises on «Organization and development of the State Corporation «Rosatom» and Federal Medical-Biological Agency co-operation in case of radiological accident at the facility on spent nuclear fuel handling» (Murmansk region) – «DOCKING-2018». The exercises was held within the frame of the joint Project of the Norwegian Radiation Protection Authority and the Federal Medical-Biological Agency of Russia.
Sweden

**Responsible agency for exercises involving radiological or nuclear events in the Arctic**
For nuclear events County Administrative Board (Norrbotten County). The municipality for radiological events.

**Responsible agency for international exercises**
Shared responsibilities between authorities, Swedish Radiation Safety Authority, Swedish Civil Contingencies Agency, County Administrative Boards.

**National exercise calendar including radiological or nuclear exercises in the Arctic**
Yes

**Relevant Arctic related exercises**
Sea eagle 2019

The United States

**Responsible agency for exercises involving radiological or nuclear events in the Arctic**
DOE does not plan independent exercises involving radiological or nuclear events in the Arctic.

**Responsible agency for international exercises**
Departments and agencies across the US Government participate in domestic and international exercises, including:

- a) National Security Council
- b) Department of State
- c) US Agency for International Development/Office of US Foreign Disaster Assistance
- d) Department of Defense
- e) Department of Energy/National Nuclear Security Administration
- f) Nuclear Regulatory Commission
- g) Department of Health and Human Services
- h) Department of Homeland Security
- i) Environmental Protection Agency
- j) Department of Agriculture
- k) Department of Commerce/National Oceanic and Atmospheric Administration
- l) Department of Justice/Federal Bureau of Investigation

**National exercise calendar including radiological or nuclear exercises in the Arctic**
N/A

**Relevant Arctic related exercises**
N/A

**EXERCISES AND TRAINING FOR SAR-PERSONNEL ON RADIATION PROTECTION**

Regarding exercises and training for SAR personnel on radiation protection, the respondents were asked whether their agencies simulate accident situations to train SAR-personnel on radiation protection, if there is any international co-operation on exercises and training of SAR-personnel in RADSAR scenarios and whether the agencies have a list of priorities (exercise goals or objectives) when it comes to exercises involving radiological or nuclear events in the Arctic.

Based on the responses, the radiation protection training for SAR personnel especially in the form of exercises is very limited. Some examples were found from the United States and Sweden. The United States indicated that they do simulate radiation accident scenarios for SAR personnel. The Department of Energy and US Coast Guard work together on training and exercises, both national and international, involving technical and operational
coordination for responding to nuclear/radiological incidents. Similarly in Sweden, there have been exercises to train SAR personnel, but mainly within the nuclear emergencies. Regarding international cooperation, SAR personnel has been included, latest with Nordic teams (Finland, Norway, Denmark) and an IAEA team in 2019. SAR personnel are trained to be deployed in different parts of the world and are trained to be a part of selected teams.

Most of the member states have not identified a list of priorities, exercise goals, and objectives when it comes to exercises involving radiological or nuclear events specifically in the Arctic. The Kingdom of Denmark noted that for Greenland and Faroe Islands, the priorities when participating in exercises is especially to ensure that the authorities are properly equipped to handle their respective tasks. In addition, it is important to practice coordination between the authorities involved in such an accident.

*Picture 6. The «total defence» of Norway is trained on Chemical, biological, radiological and nuclear crisis during NATO-exercise Trident Juncture 2018. (Photo by: Frederik Ringnes/Forsvaret)*
6. EXPERIENCES

The respondents were also asked to share their knowledge and lessons learned from emergency situations, other projects and international fora, and identify the key challenges based on their experience with SAR and preparedness for radiological and nuclear scenarios.

When it comes to emergency situation involving radiological and nuclear substances in the Arctic, the most urgent challenges identified relate to capabilities, response capacity, training of SAR personnel, and limited equipment. More specifically, the following points were mentioned as the current key challenges:

• Very limited capacity for response in huge Arctic area.

• The dominating challenges include geographical conditions, since Arctic SAR-personnel to a large extend work in difficult surroundings.

• The authorities are differently equipped to take care of the tasks, since the resources for emergency management normally are dimensioned to daily risks and thereby do not sufficiently reflect the needs in case of a nuclear and radiological emergency at sea.

• A description of the task and the attribution of responsibilities are not well-defined.

• The opening of the north-east route might increase the risk for an incident near some of the Arctic countries.

• Sufficient number of measurement kits for nuclear or radiological events.

• Radiation safety training for SAR personnel.

• TTX or/and live exercises with SAR personnel.

• Planning for nuclear events is typically focussed on nuclear power plants, and nuclear power vessels at port or in domestic waters. Therefore, the most urgent issue is defining scenarios, roles, responsibilities, capabilities and gaps for dealing with such events. However, this should be a risk-based approach.

Based on the respondents’ experiences, a clear understanding of planning scenario, roles, responsibilities, resources and documented and tested arrangements is critical to efficient coordination and success in emergency situations involving RN. In addition, sufficient equipment, safety training and SAR exercises in this field provide crucial capabilities for preparedness and emergency response. One respondent indicated that it all boils down to effective cooperation.

Some respondents noted that the experiences from EPPR projects, meetings and the RADEX table top exercise have been important for sharing experiences, knowledge and improving preparedness and prevention. Norway mentioned that there could be some relevant synergies to RADSAR with the Nordic Nuclear Safety Research reports (NKS NORCOP-COAST, NKS COASTEX, and previous/other NKS reports). A Canadian respondent also mentions that Canada underwent through an international emergency preparedness review (Eprev), organised through the International Atomic Energy Agency, from June 3rd to the 13th 2019. This review focussed on our preparedness arrangements for an emergency at one of our nuclear power plants. The final report is available at https://www.iaea.org/sites/default/files/documents/review-missions/eprev-canada-report.pdf. The respondent suggested that all Arctic Council countries should consider undertaking such a review, which could be focussed on the scenarios being considered here.

KEY FINDINGS

This part of the report aims to summarize the key findings by identifying common challenges and opportunities, capability gaps, requirements and lessons learned from the questionnaire responses. All observations are based on the information given by the member states and EPPR experts, and aim to find common ground for further
development.

It is also important to note that many of the questions and responses concern national regulations, systems, capabilities and resources, and the aim of this report is not to highlight national capability gaps or preparedness and response plans but to mainly share information and find common ground to develop cooperation. It is also worth mentioning that the national capabilities and plans are undoubtedly connected to the specific risks and challenges within each state’s own search and region and will also vary based on the geographical location. Taking this into consideration, the report aims to present the takeaways as general as possible to be further discussed within the EPPR expert groups. The SAR and RAD expert groups in EPPR are in good position to follow up on the key findings from this report.

Main takeaways from each focus area

Responsibilities
Overall, responsibilities in each Arctic State for search and rescue in a scenario involving radiological and nuclear material are already established, dedicated to specific agencies and supported by international agreements (IAEA/IMO) and standards. Responsibilities however vary between federal, regional and local level in the Arctic states. The lead organization in most of the Arctic states is different for SAR efforts and for RN efforts. The SAR organization and the SAR personnel will only be in charge of the SAR related part of the incident and are dependent on advice from RN expert and authority. The lead for coordination and response will also often be different depending on whether the situation is on land or at sea or whether the RN material is fixed (such as a NPP) or under transport.

In most countries, planning for nuclear events is typically focused on nuclear power plants, and nuclear powered vessels at port or in domestic waters. There is somewhat a lack of contingency plans and standard operating procedures (SOPs) for maritime SAR/RN scenarios.

Monitoring capabilities
Monitoring capabilities overall in the Arctic states for RN are extensive based on defined national strategies. Many of the Arctic countries do regular monitoring of radioactivity also in the Arctic areas. For a maritime SAR/RN scenario, most nations have access to airborne and seagoing assets that can carry monitoring equipment, fixed or installed. Also some drones are available. Most of these assets are primary SAR assets (i.e. Coast Guard, rescue helicopters, or other authority vessels and aircraft). There is also a lot of monitoring cooperation internationally and with various MET services providing good access to relevant met information.

There is however limited knowledge of radiation safety and radiation monitoring within SAR personnel. Although, there are good reach-back and expert assessment capabilities available, SAR personnel may have limited knowledge of relevant equipment, protective gear, monitoring, safety issues, and handling of RN material and may be reliant only on expertise from the RN authorities. When it comes to radiation monitoring for SAR-personnel in rescue operations, the health and safety of the SAR-personnel is often the responsibility of the respective employer. This survey and the responses did not specify what kind of SOPs or other safety measures there are available for SAR personnel regarding this. Sometimes SAR personnel are also volunteers without necessary training and equipment. Volunteers are not categorized as “radiation workers/personnel” and dose limits for the public apply.

Monitoring equipment
Emergencies involving radioactive releases (or a possibility for radioactive releases) will require specialized equipment and protective gear that is not always available. The radiation safety authorities have a lot of monitoring equipment available however, the equipment for SAR personnel and knowledge on how to use the equipment may be rather limited. The equipment available will of course depend on national capacities and priorities. The primary SAR assets that are military, do often have small, portable monitoring equipment. Civilian SAR assets do normally not have such equipment. Many airborne SAR assets do not carry specific RN protective gear.

Education and training
The radiation protection and safety courses and training for SAR personnel seem to be quite limited and only few countries have regular training on radiation safety for responders. However, there is good availability for regular national inter-agency education and training, as well as training for special units, support personnel and decision-makers. Some military personnel serving on SAR assets seem to have general RN training.
Exercises

*Maritime radiation protection exercises for SAR personnel is very limited.* Exercises seem to often concentrate on NPPs and nuclear powered vessels at port but less on maritime SAR scenarios and training at sea. There has also not been much emphasis on exercising specifically in Arctic conditions. There are some upcoming exercises scheduled for the coming years with focus on the Arctic and northern conditions, but this is still a fairly new topic within the combined maritime SAR/RN field.

Other observations

*There is very limited capacity for response in the vast Arctic areas.* The number of dedicated SAR assets permanently based or close to the Arctic region are few. The number of these few assets with protective gear, rinsing and/or protective equipment is even smaller. *Most populated areas in the Arctic are small communities with none or very limited capacity to receive people affected by RN.*

CONCLUSION

This part of the RADSAR report aimed at examining and sharing knowledge of the system that each member states have for a SAR incident involving RN, and to highlight areas for further discussion and research. It gave a brief overview of responsibilities, capabilities, equipment, training and coordination when it comes to a SAR operation with a RN scenario. Based on the questionnaire responses and key findings, this report identified that there is **a further need to discuss and define roles, responsibilities, scenarios, specific equipment and safety procedures in more detail, especially when it comes to SAR.**

Referring to the findings of the ARCSAFE project, this report also indicate that the organization of emergency response in case of a radiological accident at sea differs considerably from country to country. Response to such scenarios may be very complex and challenging, and require close cooperation between several authorities within different international, federal, regional and local levels. Emergency preparedness and response for RN incidents is well established in each country however there has not been much focus on maritime SAR scenarios, especially for the Arctic region.

The ARCSAFE project also highlighted that there may be a lack of knowledge among emergency workers on these types of incidents but also there is little training, protective gear and radiological measuring equipment for SAR personnel. The responses to the questionnaire also indicate similar findings however this depends on the country and the priorities in each nation. Previously, the EPPR has also identified the need for joint exercises and training between RN experts and SAR personnel, which is also one of the conclusions from this report.

The next part will present recommendations for increased cooperation and give idea for future collaboration projects. These recommendations were be identified based on the results presented above, the discussion held at the EPPR I Joint Expert Group meeting, and the findings from the RADEX2019 exercise report.
LESSONS LEARNED FROM RADEX2019

This second part of the report draws findings and best practices from the RADEX2019 exercise held in Bodø, 3rd of June 2019, in connection with the biannual EPPR Working Group meeting. RADEX 2019 was an international exercise concentrated on search and rescue (SAR) in radiologically hazardous environment at sea, and with risk for radioactive contamination of people and the Arctic environment. RADEX 2019 was organized as a table top exercise (TTX) with participants from relevant authorities and organizations in the Arctic countries having responsibilities for search and rescue, oil spill response, radioactive contamination, and radiological and nuclear emergency preparedness and response.

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, and to facilitate an exchange of experiences regarding these types of SAR operations. A secondary aim was to further improve national and international emergency prevention, preparedness and response to such events and to find gaps for future work.

*Picture 7. EPPR members gathered for RADEX2019 in Bodø. (Photo: EPPR)*
The scenario was a maritime event involving a reactor accident on board a nuclear-powered icebreaker (“MV NONSUCH”) resulting in SAR operations in a radiologically hazardous environment requiring coordinated response from several response organizations. While the scenario focused on Norwegian response efforts, it also required the Arctic Council member states to collaborate in order to critically examine the response to the scenario. The EPPR and the Arctic Council member states may use the best practices to enhance their own response to a nuclear emergency within or near their borders. This report draws the general best practices and identified opportunities for improvement from the RADEX2019 report that are closely related to the RADSAR project goals. The identified improvement areas also include a note whether it can be further examined either under RAD or SAR EG, or in some cases all expert groups.

*Picture 8. RADEX2019 scenario.*
ACTIVATION:
All Arctic Council members indicated that they would activate their emergency operations centres fully once the notification of the fire/blackout was received. This was specifically due to the presence of a reactor on board a vessel involved in a fire.

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.

Details on stricken vessel obtained rapidly
SAR deployment within 15 minutes
Crisis Committee takes “worst case” approach

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.

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 on board reactor and the potential for a radiological release. Cooperation of the CO, especially following a mayday, is expected be forthcoming and all efforts to assist the vessel in mitigating a potential reactor issue should be carefully considered.

Best Practice
Notice to aircraft and notice to mariners will be issued to avoid area where hazard may be present
Continuous production of dose rate models

Opportunity for improvement
Prepared questions for the CO of a stricken vessel to obtain critical information quickly (RAD EG Issue)
Define role of RAD authority (DSA)/JRCC Liaison Officer (Issue for RAD and SAR EGs)
Prepare for deployment of expertise to scene (RAD EG Issue)
Prioritize evacuation or non-essential crew from a stricken vessel (SAR Issue)
PROTECTION OF EMERGENCY WORKERS AND EMERGENCY HELPERS:

**Best Practice**

JRCC prepared to guide stricken vessels to appropriate safe harbours

**Opportunity for improvement**

Dose monitoring capability for responders is required (Issue for all EGs)

Prepare training for tugboat crews (Issue for all EGs)

RAD authority (DSA)/JRCC expectations for each other require definition (Issue for both)

Define procedures of shelter/port use in RN emergency (RAD EG Issue)

MEDICAL CARE:

**Best Practice**

Lifesaving is prioritized above contamination concerns

RAD authority (DSA) prepared to detect and decontaminate evacuees and to respond to concerns of worried-well

DSA will monitor shoreline for contamination and change strategy as required

DSA may send expertise to stricken vessel to gather information critical to planning response

**Opportunity for improvement**

Retrieving casualties for a contaminated zone requires procedures (RAD EG Issue)

Procedures to minimize cross-contamination are required (RAD EG Issue)

PUBLIC INFORMATION:

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. Establishing procedures for understandable communication of plume prediction models to the public, with careful explanation in order to create an understanding of what the predictions mean and what the real dangers are.

**Best Practice**

Media response activated quickly

Media roles and responsibilities are predefined
Opportunity for improvement

Media lines addressing public concern can be pre-scripted (RAD EG Issue)

The RADEX2019 report recommends the Member States and all EPPR EGs to consider these above mentioned TTX findings when examining plans and procedures, sharing experiences, and planning for further work in EPPR.
RECOMMENDATIONS AND WAY FORWARD

This part summarizes findings from part 1 of the report and the RADEX2019 exercise. The focus of the report was rather wide and it was not possible to dive deeper into each focus area. This part recommends further research and mapping into few topical areas in order to better understand the challenges that we face and what the best practices are within these fields. This report urges all expert groups to follow up on the recommendations from this report and the findings from both the RADSAR and the ARCSAFE projects.

COOPERATION PROCESSES AND PLANS

In most countries, planning for nuclear events is typically focused on nuclear power plants, and nuclear powered vessels at port or in domestic waters. There is somewhat a lack of contingency plans and standard operating procedures (SOPs) for maritime SAR/RN scenarios.

- There is a need to look into contingency plans in a risk-based approach and further define what the SOPs are in the Arctic states.

- It was discussed in the September 20202 EPR I Joint Expert Group meeting that a handbook for maritime SAR/RN incidents could be beneficial in collect existing material to develop harmonized guidelines and recommended procedures for coordination and handling of maritime RN-emergencies. Such handbook could provide further understanding of RN and its terminology to SAR and other emergency preparedness and response agencies.

- A SAR scenario like this will involve coordination between many agencies at international, federal, regional and local level levels and therefore it is important for preparedness to define and rehearse SAR/RN maritime scenarios, and specify roles and responsibilities within each of these levels.

- Would be beneficial to identify POCs and liaison for SAR RN scenario.

- Need for more exercises such as the RADEX2019 to identify, evaluate and reconfirm processes and procedures between RN, SAR and other relevant agencies on the various levels in different Arctic countries. Some potential areas for all EGs to examine further were identified in the RADEX2019 findings.
EQUIPMENT AND CAPACITIES IN THE ARCTIC

The radiation safety authorities have a lot of monitoring equipment available, however, the equipment for SAR personnel and other emergency workers and knowledge on how to use the equipment may be rather limited.

- This report recommends mapping gaps and needs for specialized equipment, dose monitoring capability, and protective gear for SAR personnel and other emergency workers and helpers in a separate project (covering all EGs).

Overall, there is very limited capacity for response in the vast Arctic areas.

- There is a need to do further research and work to define what the gaps, challenges and risks are for a scenario like this, also when it comes to Arctic communities. EPPR RAD EG is currently working on a risk assessment project to define the risk potential for emergencies due to nuclear/radiological material and activities that pose a threat in the Arctic.

EXERCISES AND TRAINING

The radiation protection and safety courses and training for SAR personnel and maritime responders seem to be quite limited and only few countries have regular training on radiation safety for responders.

- The report recommends further defining what kind of courses and training there are or should be for SAR and other responders, and what the curricula would normally include.

Maritime radiation protection exercises for SAR personnel and emergency workers are very limited. Live exercises seem to often concentrate on NPPs and nuclear powered vessels at port but less on maritime SAR scenarios and training at sea.

- There is a need for more tabletop, simulation and live exercises for SAR personnel, emergency workers and SAR organizations within this topic. This can also be beneficial for streamlining processes and procedures, identifying opportunities for improvement by creating future exercise scenarios that pose uniquely challenging RADSAR response situations, and providing evaluation for further work.