Arctic REIHN

Final Evaluation Report

About this document

The Final Evaluation Report is developed by the Evaluation Syndicate on behalf of Project Arctic REIHN. The Grant Agreement underlines the premises for this report, describes the deliverables, and provide the content guideline for which this report is developed from. All the Arctic REINH partners are represented in the evaluation syndicate.

1 Executive summary

Inter-organizational exercises provide a valuable opportunity to exercise how authorities can improve management of accidents, crises, and disasters. Collaboration and coordination between emergency services are important during societal crises, as proven in many previous incidents and crises. Besides providing insight in improvements in management of crisis, the Arctic REIHN exercise has been valuable for participating organizations and provided increased interaction between actors and lead to discussions on structures and improved coordination. The planning period of the exercise has also contributed to increased knowledge about incidents that involve Radiological and Nuclear challenges.

Key findings are:

Comprehensive RN resource database

- There is a need to systemize the knowledge of national resources available that are specialized or trained in the radiological and nuclear field (RN). Additionally, this requires a new focus on common training and exercises on RN scenarios.

Training and awareness programs

- The well-known activities combined with relatively unknown and untrained scenarios have shown the need for further collaboration to strengthen all levels' understanding of the Norwegian preparedness and response actors and their responsibilities regarding radiological incidents.

Collaboration platforms

- National stakeholders must improve knowledge on regional and local mechanisms in relation to implementation and coordination of decided measures.

- The Norwegian Crisis Committee for Radiological and Nuclear Emergency preparedness and response had the ability and implementation power to ensure the timely protection of health and environment.

Standardized protocols and guidelines

- Although some agreements are in place between actors, there is a need to improve operationalization of them. This to ensure common understanding, coordination, and communication between cooperating agencies.

Evaluation and continuous improvement

- Overall, the exercise has been executed in a satisfactory way. The many participating organizations have gained a good understanding of their individual roles and responsibility, as well as the cooperation needed between actors in the crisis management of a sector-overlapping incident.

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2 Introduction

2.1 Project Arctic REIHN 2023 – Quick overview

Project title: “Arctic Radiation Exercise in High North 2023”

Starting date: 01/01/2020 **End date:** 31/12/2023

Coordinator:

- Norwegian Directorate for Civil Protection (DSB)

Partners:

- Norwegian Directorate for Civil Protection (DSB)
- Norwegian Radiation and Nuclear Safety Authority (DSA)
- Norwegian Coastal Administration (NCA)
- Joint Rescue Coordination Centre – Northern Norway (JRCC NN)
- Danish Emergency Management Agency (DEMA) - Denmark
- Icelandic Radiation Safety Authority (IRSA) - Iceland
- Swedish Civil Contingencies Agency (MSB) – Sweden
- National Authority for Emergencies and Civil Protection (ANECP) – Portugal

2.2 Arctic REIHN – A brief history

The Norwegian Radiation and Nuclear Safety Authority (DSA) and the Norwegian Directorate for Civil Protection (DSB) formed a partnership to plan and conduct a major nuclear radiation exercise in Northern Norway. The exercise was originally planned to be conducted in the autumn of 2021, but, due to Covid-19 restrictions and the war in Ukraine, the exercise was postponed to the spring of 2023.

A proposal was submitted to the European Commission for co-funding of the exercise under the UCPM-2019-EX-AG call. The project was given the acronym “Arctic REIHN 2021” (Arctic Radiation Exercise in High North 2021). The "call for proposals" from the Commission opened on 27 February 2019, with a deadline of 15 May 2019. The proposal was successful, and a Grant Agreement with the European Commission was signed in November 2019, with a project duration from the 1st of January 2020 to 31 December 2021 (duration 24 months), and the exercise was planned for the autumn of 2021.

Due to Covid-19 restrictions, the start of the planning process was delayed, and the exercise was consequently postponed to the spring of 2022. An amendment to the Grant Agreement was filed with the European Commission in the autumn of 2020. This amendment included a new timeline for the project, an extension of the project until 31 December 2022, and a revised acronym "Arctic REIHN 2022". The amendment to the Grant Agreement was signed by the Commission on 20 November 2020.

Due to the war in Ukraine and the geopolitical situation in Europe, the exercise was, once more, postponed to the spring of 2023.

2.3 Background

In Northern Norway, as in the Arctic in general, rescue and response resources are few and far apart. In some cases, the nearest responders and resources could be located across a border, in a neighbouring country. Yet, the risk of Radiological and Nuclear (RN) accidents is increasing in this area. Climate change and melting of the polar ice cap, as well as the political climate, has led to increased maritime activity, in this part of the world, involving both merchant shipping, commercial passenger ships and military. Many ships in this area (both military and civilian) have nuclear powered propulsion or carry cargo that includes radiological materials, which makes this region especially vulnerable to accidents involving these kinds of vessels.

The scenario was selected to be a marine accident with consequences on both sea and land. Verification and testing of mechanisms for alerting nationally, other nations and the international community was identified to be an important objective. The nature of the accident was considered to require local, regional, and national response, as well as the need for international assistance, both in the field and in the form of assessments and advice from foreign experts. It was deemed appropriate that Norway would request assistance from the EU Emergency Response Coordination Centre (ERCC) through Common Emergency Communication and Information System (CECIS) and planned that Denmark, Iceland, Portugal, and Sweden would respond. Assistance would also be requested from Sweden and Finland through IAEA RANET. Other important objectives were identified as being to receive and utilize international assistance in an effective manner and to facilitate cooperation with national assets, Host Nation Support (HNS).

In addition, the scenario was very relevant for coastal states in Europe, those bordering the Arctic or having economic/industrial interests in this region. Despite this, there have been few large-scale exercises involving maritime nuclear accidents in Europe. It was expected that "Arctic REIHN" would fill this void, and provide lessons learned and much needed experience that will be valuable to enhance emergency preparedness development in the region and in Europe as a whole.

2.4 Purpose

The evaluation of cross-border risks in the event of severe nuclear/radiological accidents requires strong cooperation between EU Member States as well as between EU and non-EU countries. Between international organisations on the assessment associated with vulnerabilities to accidents to nuclear power plants of on early warning, and on training and exercises.

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Cooperation is also vital between international organisations on the assessment associated with vulnerabilities to nuclear accidents.

A large and complex accident like the scenario in "Arctic REIHN" was designed to challenge the limited response resources available in Norway and amongst the participating countries. It was instigated to trigger the need for rescue services, cooperation, and management of radioactive releases to sea and land. It was envisaged that available EU services and resources would be called upon. At the European level it involved three early warning mechanisms: CECIS, SafeSeaNet, and The European Community Urgent Radiological Information Exchange (ECURIE). The USIE warning system within the IAEA would also be involved. Mechanisms for European and international assistance would be triggered, such as the EU Civil Protection Mechanism (UCPM), the EU Emergency Response Coordination Centre (ERCC), The European Maritime Safety Agency (EMSA) and the International Atomic Energy Agency - Response and Assistance Network (IAEA RANET).

The interaction between these systems is rarely exercised, yet the scenario was highly relevant for all coastal countries in Europe, in particular those bordering the Arctic or having economic/industrial interests in this region.

2.5 Aim and objectives

The *aim* of exercise Arctic REIHN 2023 was to test, verify and further develop emergency preparedness and response in the event of a nuclear or radiological accident in the Arctic, including mechanisms for alerting other nations, and for rendering and receiving international assistance. It was hoped that preparations for the exercise and experiences gained from it would be valuable in the ongoing work on improving national and international emergency preparedness.

The *objectives* for Arctic REIHN 2023 were:

- Effective and timely notification and information exchange of a nuclear emergency according to national and international agreements and conventions. This included, *inter alia*, the European Commission Decision 87/600/EURATOM using ECURIE, the International Convention on Early Notification of a Nuclear Accident, EU ship reporting system SafeSeaNet and (Directive 2002/59/EC), as well as bilateral agreements between Norway and its neighbouring countries.

- Effective and timely conduct of a rescue operation during a nuclear emergency in accordance with the newly revised agreement on cooperation and coordinated response between the Norwegian Rescue Services and the Norwegian nuclear emergency response organisation.

- Effective and timely management of a nuclear emergency on a national, regional, and local level in accordance with the Royal Decree of 23 August 2013 on nuclear emergency preparedness and response and national nuclear emergency response plans, including deciding on and implementing protective measures with the purpose of mitigating impact on health, the environment, as well as national and international public interests.

- Expedient management of the damaged vessel in accordance with national and international maritime law and obligations.

- Rendering and receiving international assistance and providing Host Nation Support (HNS) in accordance with European Union Civil Protection mechanisms, the International Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, and bilateral agreements between Norway and its neighbouring countries.

- Harmonisation of decisions on protective measures and public communication between Nordic countries in accordance with Nordic guidelines and recommendations on Protective Measures in Early and Intermediate Phases of a Nuclear or Radiological Emergency (also known as “The Nordic Flag Book”), and use of the liaison exchange mechanisms between the Nordic nuclear safety and radiation protection authorities during nuclear emergencies provided in the same guidelines.

- Justified and coordinated decisions on protective measures for public health, the environment, and public interests, in the late phase of the accident, involving national and international stakeholders in accordance with international recommendations and experiences from past accidents such as the Chernobyl accident in 1986, the Fukushima accident in 2011, and ongoing international research and development on stakeholder involvement.

- Comprehensive, timely and coordinated communication with media and the public as part of the management of the emergency in all its phases, in accordance with existing communication strategies, emergency response plans and international recommendations.

2.6 Expected results

Arctic REIHN 2023 was anticipated to be an important contribution to the overall improvement of the civil protection preparedness and response to a nuclear disaster in the Arctic region and beyond.

International shipping and tourism are increasing in this vulnerable area, as well as military activity with submarines and surface vessels. Nuclear reactors power many of these vessels. A marine accident in the Arctic will pose more challenges than in European waters, as the distance to rescue services may be further, the resources more limited and climate conditions harsher.

The Commission Staff document from 2017[1] indicates that 23 of the 34 UCPM Participating States focus on nuclear/radiological accidents as one of 11 main disaster risks in their National Risk Assessment. Even countries with no nuclear facilities assess the risk of a nuclear/radiological accident to be high, due to the cross-border dimension.

It was evaluated that the impacts of this scenario could be devastating for people, the environment, agriculture, seafood industry and societal interests in Norway, but also in neighbouring countries in Europe. Radioactive contamination of foodstuffs could negatively affect food production and trade in all European countries even if the accident is not pan-European. Consumers in other parts of the world could well refrain from purchasing European goods due to a fear of radiation risk.

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[1] *"Overview of Natural and Man-made Disaster Risks the European may face"* SWD(2017) 176 final, 23.5.2017

Although there have been international exercises in the past involving nuclear/radiological accident scenarios, few, if any, have involved a maritime scenario with impact on both sea and land. An accident with a nuclear-powered vessel can happen anywhere along the coast or in open waters, where emergency response plans might be lacking or insufficient to deal with the situation. It could also occur in more remote areas where resources are scarce and climatic conditions would add to the challenges.

It was anticipated that Arctic REIHN 2023 would contribute to, and provide valuable inputs and possible follow-ups for:

- EU HNS guidelines
- Places of refuge - EU operational guidelines
- EU action plan to enhance preparedness against chemical, biological, radiological and nuclear security risks
- The Sendai Framework (priority 1 and 3)
- Further development of the EU Macro Strategy for the Baltic Sea Region
- Improving the response capacity, in particular regarding cross-border expert support and reach back[2]

An extensive observer programme was established to ensure that other European countries had the opportunity to learn from the exercise and improve their national plans for dealing with maritime accidents that involve radioactive releases and could trigger requests for assistance from UCPM, IAEA RANET and EMSA.

2.7 The project organization

A Project Management Team (PMT), led by DSB, managed project activities. The PMT was responsible for the progress of the planning process and followed up on financial aspects and project management. This involved a process to steer and oversee the project from start to finish.

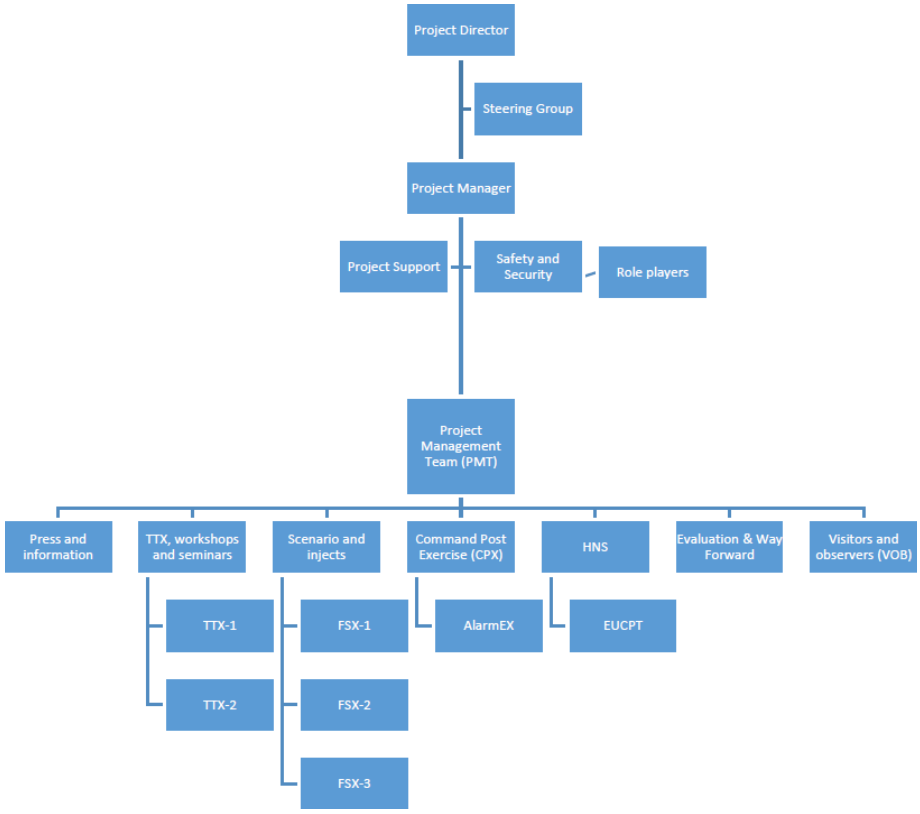
The Planning Group (PG) consisted of the PMT augmented by representatives from all partners as well as syndicate leaders. The PG met as required between the major planning conferences and many tasks were planned in this format, such as scenario development and injects, logistics, visitors and observers' program, evaluation etc.

The DSB was responsible for day-to day management of the project. This included handling of expenses and financial accountability throughout the project.

The Steering Group maintained strategic oversight and a holistic perspective to the progress of the project. The Steering Group consisted of one representative from DSB and each of the partners (ABs) in this project. DSB's Director General was the Project Director and chaired meetings in the Steering Group. The Steering Group provided direction and guidance to the PMT as necessary throughout the project.

[2] "After-action Analysis of the Magic Maggiore Workshop on Expert Support and Reachback" ERNCIP Thematic Group Radiological and Nuclear Threats to Critical Infrastructure. JRC Science Hub https://ec.europa.eu/jrc JRC 108920. ISBN 978-92-79-75339-8

2.8 The Arctic REIHN project organization



2.9 Budget

It was planned that EU funding would cover 85 % of budgeted costs for the project. Budget administration for the project was handled by DSB with assistance from DSB's internal accounting department. All expenses and personnel costs were registered in the DSB accounting system (Agresso), and then transferred to the financial statement for the project.

As a rule, every participating organization/agency was expected to cover their own costs for participation in the planning, conduct and evaluation of the exercise. EU funding was allocated to cover common expenses and costs that did not naturally fall on any participant, such as preparation of exercise site(s), transportation of assets, equipment etc.

Project partners in the Grant Agreement (GA) were entitled to have expenses related to travel and subsistence for the exercise covered or reimbursed by the exercise budget and were provided Host Nation Support (HNS) in accordance with the EU Host Nation Support Guidelines.

DSB as coordinator took the overall responsibility for financial control of the project. No funds were transferred to partners in the form of advance payment for expected costs. Funds were reimbursed by DSB to partners (85 %), based on invoices for expenses and travel, or timesheets received. Thus, DSB retained full control of expenditure and budget status at all times, and it was planned that there would be only one financial statement for the project.

3 Prior to conducting Arctic REIHN 2023

The planning process for Arctic REIHN was extended due to the Covid-19 pandemic, followed by the invasion of Ukraine. This resulted in postponement of the exercise planned in 2021 and 2022. National Health Exercise 2022 was planned as part of exercise AR2022. Although AR was postponed to 2023, Health Exercise 2022 was conducted in 2022. Despite the long planning period, almost all key planners from the various Norwegian authorities were able to follow the planning process from 2020 to 2023. The fact that the planning group was very consistent, is considered as a huge contributing factor to the success of planning.

The extensive planning resulted in a lot of learning for the personnel involved. Working together for such a long time led to increased knowledge and experience in planning and exercises, but most of all on emergency preparedness, response plans and courses of action in the different agencies. The planning process led to pre-exercise improvements in preparedness plans and routines in several agencies in the planning group.

In advance of the exercise, several activities for competence building were initiated. In line with the Grant Agreement for Arctic REIHN, Danish Emergency Management Agency (DEMA) organized an international competence webinar on the 21st of October 2021.

Furthermore, several of the partners in AR23 have participated in competence building activities organized by Bodø Municipality and Nordland County Governor.

Activities include:

- 22nd of September 2021 – Bodø Municipality organized a competence day for Salten Municipalities. DSA, as the national authority on radiation and nuclear safety participated with senior advisors.
- 14th and 27th of October 2021 – Nordland County Governor organized a workshop and competence day for local actors in Bodø.

4 Conducting Arctic REIHN

4.1 Scenario

The following scenario was developed:

A foreign, nuclear-powered icebreaker is on route southwards outside the coastline of Northern Norway. The icebreaker is carrying tourists on a cruise towards Antarctica, after a visit to the North Pole. At sea, off the coast from the city of Bodø, located north of the polar circle, the vessel suffers a small explosion and an emerging fire on-board. The crew works to get control of the fire, but the safety of the nuclear reactors on board is compromised, and the icebreaker loses its propulsion. The crew works relentlessly to maintain reactor safety, but there is an increasing risk for a release of radioactivity from the reactors.

Several of the crewmembers are injured. The captain of the ship asks for assistance from Norwegian authorities, including medical evacuation of the injured crewmembers. During the exercise, a rescue helicopter is dispatched from the Joint Rescue Coordination Centre, to retrieve the injured crewmembers from what is now a nuclear and radiological hazardous area. The injured crewmembers are then received and handled by civil protection and health authorities on land. To ensure their safety and to improve conditions for managing the nuclear emergency on board, the captain later requests assistance in evacuating the passengers from the vessel.

As the situation evolves, and the icebreaker drifts closer to shore, Norwegian authorities notify other countries, and start to prepare local communities in the area. There is a need to cordon off vulnerable areas on land, evacuating a limited number of people, and possibly implementing or preparing other protective measures. During these operations, radiation safety for personnel should be in place, and the affected public should be properly taken care of.

In the meantime, a request for assistance goes out from Norway to other countries, and field assistance teams from several countries are dispatched to assist Norway. During the exercise, the international field assistance teams are working together with national resources to measure and monitor contamination from the vessel at sea and on land, and to assist in decontamination of the local public. Based on monitoring data and assessments of the situation, Norwegian authorities together with international counterparts need to decide on how to best handle the emergency and how to best manage the situation in the long term, together with stakeholders and the affected public.

4.2 Exercise conduct timeline

All activities are in 2023:

- **25-26 April** Table Top 1 (TTX-1)
- **27 April** AlarmEX
- **3 - 4 May** Command Post Exercise (CPX)
- **8 - 12 May** FSX-week
- **24 - 25 May** Table Top 2 (TTX-2)

4.3 Tabletop 1 (TTX-1)

4.3.1 Scenario

The scenario for TTX-1 was developed to be in line with the overall AR22 scenario, involving a nuclear-powered vessel accident. However, TTX-1 focussed exclusively on handling of the damaged nuclear-powered vessel with risk of radioactive contamination, not addressing early warning (covered in ALARM-EX) and rescue operations (covered in FSX-1) or other aspects that may or may not be covered by other parts of AR22.

4.3.2 Objective

The main objective was "*Effective and timely handling of the damaged vessel with risk of oil spill and radioactive contamination according to the agreement between the NCA and DSA, in accordance with EU Operational Guidelines on Places of Refuge, and in accordance with national and international maritime law and obligation".*

- Improve understanding of roles and responsibilities nationally and internationally
    - Understand the organization, roles, and responsibilities handling a nuclear-powered vessel in both normal and complex situations.
    - Understand the organization, roles, and collaboration between responsible authorities handling a nuclear-powered vessel in a complex situation.
- Improve understanding of how to handle a reactor-powered vessel in distress.
    - Understand how a nuclear-powered vessel will be handled in an uncertain and complex situation outside and inside 12 nm.
    - Understand the legal basis outside and inside 12 nm for handling a nuclear-powered vessel.
    - Understand how the authorities will handle a situation with an accidental release of radionuclides.

4.3.3 Conduct

Tabletop exercise Arctic REIHN TTX-1 was conducted on 26 April 2023, at the Oslo Congress Center in Norway, with a total of 41 persons present at the meeting. The exercise was organized by the Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Nord University, Danish Emergency Management Agency, Swedish Civil Contingencies Agency, and Icelandic Radiation Safety Authority.

The Arctic REIHN tabletop exercise (TTX-1) was designed as a discussion-based exercise.

Training audience

During the exercise, the main focus was on the Norwegian authorities' handling of the vessel. The main training audience was the key Norwegian organizations normally involved in handling vessels in distress in the described situation.

The organizations from Norway were represented by the Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Norwegian Coastguard, and the Crisis Committee, with their representatives from the Norwegian Radiation and Nuclear Safety Authority, Norwegian Coastal Administration, Food Safety Authority, and Police Directorate.

Throughout the exercise, additional contributions from Sweden and Denmark were planned after every presentation to discuss how emergency management might differ if this occurred in their waters. Participants from Sweden and Denmark, with similar responsibilities, were asked to explain how they would handle a similar situation in their country.

The radiation safety authorities were the Civil Contingencies Agency (MSB) from Sweden and Danish Emergency Management (DEMA) from Denmark.

The training audience received an information folder with background information in advance to prepare for the discussions. During the exercise, the moderator presented a situation, an inject, and key questions. Additional materials, such as maps and drift prognoses, were distributed to the training audience during the presentation of each inject. The training audience took part in the discussion during the exercise, provided their reflections in the hot wash up, and submitted their individual evaluation forms.

Observers on site

The exercise was observed by representatives from the European Commission, UK Secretary of State's Representative to the International Maritime Organization (IMO), the Norwegian Ministry of Trade, Ministry of Health and Care Services, and Ministry of Climate and Environment.

Observers on site were present in the exercise room. They received brief information in advance about the timeframe of the day, vessel information, and injects with questions. They were invited to comment on the hot wash up[3] and complete the evaluation form after the exercise.

Observers on streaming

In addition to on-site observers, there were international observers who followed the exercise via streaming. These included the Ministry of Trade and Fisheries, International Atomic Energy Agency, Health Canada Radiation Protection Bureau, Icelandic Radiation Safety Authority, Finnish Radiation and Nuclear Safety Authority, Icelandic Coast Guard, Finnish Border Guard, US Coast Guard, Canadian Coast Guard, Ministry of Foreign Affairs, Norwegian Directorate for Civil Protection, British Embassy, Barents Watch, Nordland Police District, Danish Emergency Management Agency, Danish Armed Forces, County Governor Nordland, University of Oslo, European Commission, and Maritime Incident Response Group (MIRG) from the Netherlands.

4.3.4 Findings

All agencies considered that not only had the exercise itself provided significant educational value, but that the planning and preparation process had been very useful, *per se*. Most of the participants identified the need to review their own routines, plans and current legislation with regard to how to manage such incidents. In addition, it was deemed important that decision-making authorities carry out regular exercises, both internally within their own organization and against other relevant actors.

The exercise has shown how complex the handling of a nuclear-powered vessel becomes when problems arise with the reactor part. It is difficult to get sufficient and relevant information in an early phase. Such accidents are different from other accidents, and it is essential to take advantage of the opportunities available at an early stage. The actors must be quick, proactive and carry out thorough situational assessments before the incident develops into a crisis.

The experience from the Norwegian actors was well appreciated by other nations and organisations with less preparedness for such incidents. Several of the participants thinks that the routines the Danish authorities have for running forecasts for emissions in advance from passing vessels based on

[3] The primary purpose of the hot wash-up is to provide an arena for discussions about what went well and make recommendations on matters that can be improved. The Hot wash-up should be conducted as quickly as possible after the end of the exercise.

sailing routes and weather forecasts are a good approach in this respect. It is also very important to bring the flag state/shipping company into the process as soon as possible.

The momentum gained through the preparations must be maintained. This particularly applies to the dialogue and cooperation between DSA and NCA. NCA and DSA should carry out exercises at least every two years (along with a review of the agreement). It is anticipated that these be both simple and more complicated exercises.

It is important that DSA and NCA continue a review of existing Point of Refuge (PoR). The exercise also showed the need to send liaisons at several levels when dealing with such incidents.

The experiences from the exercise show assessments that must be made around nuclear-powered vessels are probably also relevant for handling other types of vessels (Battery/ ammonia/ hydrogen/ gas/ chemicals). In relation to the use of PoR, it is possible that the actors should think differently about this type of accident as opposed to just thinking that they are entering into a PoR. Considerations could be made to towing the vessel out to open wate. An effort has been made to adapt the EU Guidelines for PoR, but they do not cover how agencies should assess and decide a course of action involving a nuclear-powered vessel, or vessel carrying radioactive cargo.

It is important, at an early stage, to assess what measures the crew on board can take, to facilitate any subsequent work with casualties before they are evacuated from the vessel.

It must be clarified which restrictions will apply to emergency personnel (Coastguard/ETV). These must be known to the personnel on board who may encounter a similar accident. Included in these assessments, we must clarify and describe what is practicable close to such an accident.

It is desirable that the results from TTX-1 will be presented in the EMSA working group on PoR.

More details regarding findings from TTX-1 are provided in *Appendix 1*.

4.4 Tabletop 2 (TTX-2)

TTX-2 was a tabletop exercise on “Normalisation and stakeholder involvement”. The exercise was part of Arctic REIHN work package 7 (Tabletops, workshops & seminars). In accordance with IAEA terminology, “normalisation” refers to the processes occurring during the transition phase to prepare for a new normal situation in an affected area (i.e., existing exposure situation). The transition phase is the period after the emergency response phase when the situation is under control, detailed characterization of the radiological situation has been carried out and activities are planned and implemented to enable the emergency to be declared terminated.

4.4.1 Scenario

TTX-2 was based on the scenario used in the Command post exercise (CPX) – involving a hypothetical accident onboard a nuclear-powered icebreaker on 3 May 2023. During the release, the vessel was anchored ca. 2 nautical miles from the mainland west of Bodø (7 km from Bodø centre). There were consequences to both sea and land areas from the accident – including cross-border contamination.

The exercise was assumed to take place about 6 weeks after the accident. Main events occurring during the period 3 May – 15 June 2023 were therefore communicated to the participants – including protective actions and other response actions initiated, adapted, and lifted. The radiological situation at the start of TTX-2 was also described. More details can be found in *Appendix 2* attached in Final Evaluation Report for Arctic REIHN.

4.4.2 Objective

TTX-2 dealt with the following three topics, based on wishes and needs from the partners of Arctic REIHN and Norwegian food and health authorities:

Topic A – Lifting and adapting emergency actions with particular emphasis on the return of evacuees and relocated people.

Topic B – Health-related follow-up, including mental health and psychosocial support.

Topic C – Long-term food production with emphasis on marine fish.

The involvement of stakeholders in decision-making in relation to these topics (who, when, how, etc.), and the exchange of experiences and views between participating countries and national/international organisations were also fundamental parts of the exercise.

4.4.3 Conduct

TTX-2 was divided into presentations and group discussions. The presentations included clarification of concepts and provided the basic fundament for the group discussions. Due to the broad scope of the exercise, parallel sessions were organised for the group discussions – with one group focussing on the "health issues" (topics A and B), and the other on the "food issues" (topic C). Parts of the exercise were also open to virtual participation.

There were 25 participants present from several countries – including authorities/decision-makers from Norway and within the EU region, international organisations, and selected stakeholders. Participating organisations were as follows:

- Bodø Municipality, Norway
- CBRNE Centre, Norway
- CEPN, France
- Danish Emergency Management Agency (DEMA)
- Danish Veterinary and Food Administration (DVFA)
- Icelandic Radiation Safety Authority (IRSA)
- Nordland Police District, Norway
- The Norwegian Fishermen's Sales Organization
- Northern Norway Regional Health Authority
- Norwegian Directorate of Health
- Norwegian Food Safety Authority (NFSA)
- Norwegian Radiation and Nuclear Safety Authority (DSA)

- Norwegian Seafood Council
- Norwegian University of Life Sciences (NMBU)
- Radiation and Nuclear Safety Authority of Finland (STUK)
- Swedish Radiation Safety Authority (SSM)

In addition, ca. 30 people attended virtually. About half of these were from DSA, NFSA, NMBU, and DEMA. However, there were also participants from:

- Portuguese Environment Agency
- Swedish Civil Contingencies Agency
- Norwegian Directorate for Civil Protection (DSB)
- Norwegian Ministry of Health and Care Services (HOD)
- Norwegian Ministry of Agriculture and Food (LMD)
- County Governor of Nordland, Norway.
- Norwegian Fishermen's Association
- Institute of Marine Research, Norway.

More details on the conduct – including detailed agenda of the exercise – are provided in Appendix 2.

4.4.4 Findings

The exercise successfully gathered key actors and fostered networking and exchange of experience, information, and ideas. Although the groups discussed different topics, common themes included the importance of communication, information, and dialogue, as well as learning from other experiences (e.g., covid, natural disasters). The complexity of the situation was recognised, including the importance of non-radiological and socioeconomic aspects. The importance of putting both health risks and food contamination in perspective with other risks was also noted. Regarding health issues, it was recognised that plans for data registration and follow-up of affected populations should be further developed in Norway – and that psychosocial support should be included in these plans. Regarding food production, the need to prepare criteria for prioritization of measurements and changing or lifting maximum permitted levels was highlighted – as well as the need to be prepared to deal with communication challenges and demands of the export market.

More details regarding findings from TTX-2 are provided in *Appendix 2.*

4.5 ALARMEX

The ALARMEX generally fulfilled the exercise goals in a satisfactory manner. Participating organisations seemingly have well defined procedures for notifications nationally and internationally. Requests for assistance were executed adequately.

4.5.1 Scenario

The scenario for the national ALARMEX is coherent with the overall scenario for exercise Arctic REIHN. A foreign nuclear-propelled vessel is on route southwards outside the coastline of northern Norway. The icebreaker is carrying passengers on a cruise towards Antarctica, after a visit to the North Pole. At sea, outside the city of Bodø, the vessel suffers a small explosion, and a fire emerges on board. Despite the crew`s efforts to control the fire, the safety of the nuclear reactors on board is compromised. Consequently, the icebreaker loses control of its propulsion. There is also an increasing risk for the release of radioactivate substances from the reactors. Due to the serious situation, the captain of the vessel alerts the Joint Rescue Coordination Centre (JRCC) via the Coastal Radio, which initiates necessary notifications and actions according to standard procedures for notification and early warning.

4.5.2 Objective

The ALARMEX is a test of notification and early warning channels where the respective Contact Points (CPs) send out early warnings of the event through relevant national and international channels.

On the European level the exercise involved three notification systems: ECURIE, SafeSeaNet and CECIS. IAEA USIE was also utilized.

The master of the vessel alerted according to the global GMDSS and IAMSAR guideline to predefined terrestrial and national CPs. A distress alert received by a Coastal Radio station is always immediately forwarded to a RCC nearby the distress position. This JRCC then initiates a SAR operation (on sea, in air and land) and notifies authorities on national, regional and local level. Reference regulations for SAR operation globally through IMO and ICAO and the national Royal Decree on SAR service.

4.5.3 Conduct

The ALARMEX was conducted on April 27, 2023.

The national notification exercise was held in the morning and the international part started at 0800 CET. The national part of the exercise was finished at 1000 CET. Notifications were given as per routine for each organization. Some by telephone, some by email and some in the crisis management system (CIM).

The main training audience of the ALARMEX was defined to be relevant Norwegian national and regional authorities.

A total of approximately 49 organizations were notified nationally during the ALARMEX. Some were notified by more than one the main training authorities as would happen in any real accident og incident involving radioactive/nuclear substances.

4.5.4 Findings

The overall impression from participating agencies was that the notification exercise was successful. Participating organizations perceived the information exchange as timely, precise, and effective. The execution of the exercise met the common objectives in an adequate way.

Response management

Within one hour, all the expected notifications were finalized. The JRCC, DSA, NCA and DSB have procedures for national and international contacts points for notification and the officer on duty in each participating agency carried out notification accordingly. In the exercise there was not a predefined expected timeframe for notification, as the existing practise was to execute further notifications immediately after receiving an initial notification. This was observed in all the participating agencies in the ALARMEX.

Emergency information exchange

Vardø VTS activated Barents Watch during the exercise. The Duty Team in JRCC and NCA were invited to join. This is a good tool in terms of key stakeholders to receive updated information and provides a good foundation for common situational awareness.

Participating organizations primarily use CIM (Crisis Information Management) for information exchange. During the ALARMEX this was the primary tool of information exchange between participating organizations. Pre-developed distribution lists are used for unanticipated events. Organizations and agencies that use CIM should strive to only use organizational emails, and not personal ones, when distributing information and notifications to ensure that messages are received.

International assistance

For participating organizations that have international/ European contact points, a request for international assistance is possible. International contact points used in this exercise consisted of ECURIE, USIE, SafeSeaNet, and CECIS. It should be noted that SafeSeaNet is not intended for use in international assistance but is instead an information portal for alerting national authorities. The NCA forwarded a SITREP in SafeSeaNet to Denmark, Sweden, Iceland, and Finland.

There was, however, some deviation in terms of accessibility and execution. For some of the participating organizations, the predeveloped forms are not flexible enough or did not include options that were suited for this specific incident. Some participants, therefore, had some issues filling out the form in a somewhat less than satisfactory way. This was the case for the ECURIE forms, which have predefined categories for reporting incidents. The categories consist of nuclear incidents at stationary nuclear facilities and not nuclear-powered vessels. The forms should therefore be adapted to scenarios where incidents are occurring at non-stationary installations. Although an officer on duty at ECURIE provided guidance when filling out the forms, efforts should be made to revise the forms so that they are more flexible.

Although the officer on duty at DSA experienced some challenges with the registration forms, the request for assistance was performed adequately.

Other authorities were alerted promptly, however, because radiological and nuclear incidents are not common, they need to be trained more often to make participants better prepared and increase their level of knowledge.

4.6 Command Post Exercise (CPX)

CPX generally shows that the Crisis Committee had the ability and implementation power to ensure that the population was protected in time and given adequate information.

4.6.1 Scenario

The scenario for the CPX was a nuclear-powered vessel with cruise passengers on board, transiting southbound after a cruise in the Svalbard and Jan Mayen area. The flag state was "Atlantistan", and the vessel followed the traffic separation system (TSS) in the Norwegian Exclusive Economic Zone (EEZ). The vessel reported to Norwegian authorities that they experienced serious technical problems, with the need for repair before reaching the end destination in southern Europe. Norwegian authorities received a request for transiting to the city of Bodø for repair. The vessel was by Norwegian authorities allowed to transit closer to shore in the Bodø area, but with several constraints imposed and under no circumstances allowed to go close to populated areas or to berth in Bodø. The vessel was appointed a specific anchoring area, where repair should be conducted.

When approaching the appointed area, the captain deviated from the approvals given and continued sailing closer to Bodø and the populated area. Radio communication was also becoming unclear, and partly non-existent. The captain's intentions were not clear until the vessel anchored only 7 kilometres west of Bodø harbour, where he intended to take on board spare parts and service personnel. Soon after, in this location, an explosion and fire on board occurred, which later led to the loss of control of the reactor.

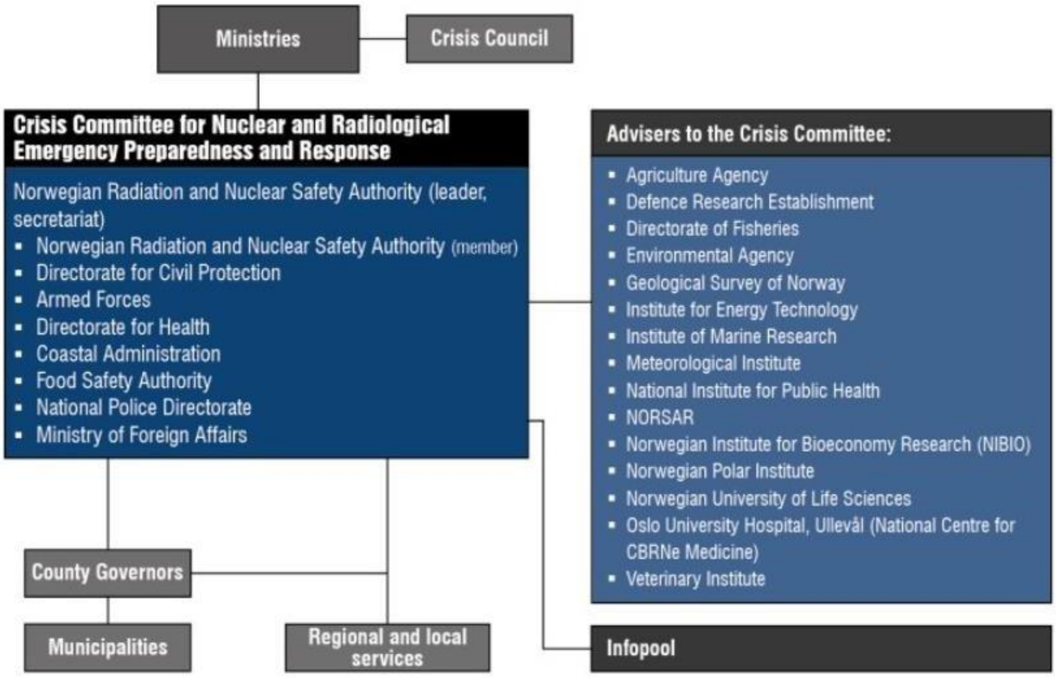
4.6.2 Objective

Based on the common objective for the CPX, a list of ten more detailed objectives was developed by the CPX syndicate. The training audience of the CPX was selected to be relevant Norwegian national and regional authorities, especially focusing on the Norwegian Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response, relevant ministries, the Joint Rescue Coordination Centre (JRCC) North Norway, the County Governor of Nordland and relevant ministries. The latter participated to varying degrees, from active play to being a response cell.

The objectives of the CPX were:

- Before and during the rescue operation, information exchange between the Joint Rescue Coordination Centre and DSA must ensure a common understanding of the situation.
- The Norwegian Crisis Committee for Nuclear and Radiological Emergency Preparedness and Response (CC) must have an updated situational picture and forecasts that enable proactive decision-making.
- CC must have a unified understanding of roles, responsibilities, and decision-making authority in the acute phase of a nuclear incident.
- CC shall without delay take the necessary decisions on preventive and impact mitigating measures.
- Measures shall be harmonized with the Nordic countries as far as is appropriate.
- The implementation of measures must be coordinated, and quality assured regionally and nationally.
- CC shall contribute to the coordination of international assistance resources for handling the nuclear incident.

- Communication to the population about the rescue operation and the nuclear incident must be coordinated, timely and comprehensive.



Organisational chart for the Norwegian Nuclear and Radiological Emergency Preparedness and Response Organisation

All organisations participated in the CPX from their everyday locations. However, the Crisis Committee consist of representatives from multiple organisations, and met physically in The Norwegian Radiation and Nuclear Safety Authority's main office in South Norway. Furthermore, in this incident the Joint Rescue Coordination Centre (JRCC) North Norway established the rescue leadership group under command of the Chief Police of Nordland Police District. This group consist of representatives from multiple organizations that met physically at the JRCC location in Bodø.

The CPX was the main arena for media play during Arctic REIHN exercise and was an integrated part of the injects presented to participants by the Exercise Control staff. The media play contributed to enhanced realism of the CPX; it presented a dynamic to the players that could give a sense of urgency, and it could be seen as one of the driving forces in the progression of the exercise.

The Crisis Committees and its representatives' responsibilities, roles, and decision-making authority are described in the Plan for the Crisis Committee for Nuclear Preparedness, which ensures the committee's ability to quickly and effectively handle any nuclear incidents that may arise in an acute phase of an incident. The Crisis Committee's authority and mandate are established in §16 of the Radiation Protection Act and written out in a royal decree of 23 August 2013.

The king's authority according to Section 16 of the Radiation Protection Act is delegated to the Crisis Committee. In the acute phase of a nuclear accident or other incidents that may involve ionizing radiation or the spread of radioactivity, without hindrance from the allocation of authority in other laws, the Crisis Committee can order state and municipal bodies to carry out decided measures. It is the Crisis Committees' task to decide and implement certain predefines urgent measures to limit the extent of damage from an incident/accident. The predefined measures that can be ordered are: cordoning of areas, evacuation, decontamination of affected people and restrictions in food production. The Crisis Committee can also advise the public on sheltering indoors (up to 2 days) and taking iodine tablets, give dietary advice or advice on other mitigating measures. Other decisions than the predefined ones listed here, are not taken by the Crisis Committee, but by the sector ministry or the government.

The Crisis Committee shall, if time permits, inform, and discuss decided measures with the responsible ministry before implementation.

4.6.3 Conduct

The CPX was conducted a few days after the AlarmEX notification exercise, wherein national and international notification procedures were tested. The notification phase was therefore not given priority in the CPX, where only notification procedures necessary for the course of events were played out. The CPX was organized to run over two days, starting on the 3rd of May 2023:

- Day 1 (3rd of May): The scenario started with the JRCCs notification to the DSA, who soon after convened the initial meeting of the Crisis Committee. The first day was focused on the decision-making processes, to ensure preventive and mitigating measures were taken in the acute phase.

- Day 2 (4th of May) There was a small jump in time (24 h) in the evolution of the accident scenario, facilitating exercise on regional and national coordination and quality control of the measures to be implemented.

The Crisis Committee had the first meeting digitally, while later meetings were physically in the premises of DSA. The JRCC and the County governor of Nordland participated digitally in the CC meetings.

4.6.4 Findings

The execution of the CPX was successful and generally shows that the Crisis Committee was able to decide and implement necessary protective actions for health and the environment in a timely manner. The following are presented as findings of significance:

- DSA and JRCC established contact early in the process, enabling a common understanding of the situation.
- The Norwegian Radiological and Nuclear Preparedness Organisation was swiftly notified about the situation, including relevant ministries and the Office of the Prime Minister.
- The Crisis Committee was provided with satisfactory situational briefings to strengthen decision-making.

- The members of the Crisis Committee demonstrated a good understanding of their roles and mandate on behalf of their respective agencies.
- The leader of the Crisis Committee established contact early on with the Ministry of Health and Care Services, Ministry of Justice and Public Security, and Ministry of Climate and the Environment.
- The CC leader asked for a meeting early on with the lead ministry (Ministry of Justice and Public Security) to present different scenarios, including the possible worst-case scenario, to prepare the government for the potential implementation of protective measures.
- Digital start-up meetings were executed well, and, as the meetings progressed, a more nuanced understanding of the developing situation was acquired. The participation of the JRCC and County Governor of Nordland in the meetings was perceived as valuable for improved information exchange and a common situational understanding.
- The meetings in the Crisis Committee provided sensible discussions on relevant measures, as well as obtained useful communication between relevant actors who contributed to the quality assurance of measures regionally and nationally.
- The member agencies in the Crisis Committees' communication units upheld a good dialogue throughout the exercise.
- Decisions were taken in consensus and seemingly in time to protect the public and the environment.

Some points were identified for further development and strengthening of the Norwegian nuclear preparedness organization:

- The meeting structure of the Crisis Committees meeting could benefit from being more stringent to relieve more time to information exchange and swifter effectuation of decided measures,
- More use of digital visualisation and less technical language in the situational reports would improve a swift common situational awareness and understanding.

Emergency information exchange

JRCC and DSA established a common situational understanding of the incident. The contact between JRCC and DSA was established in an efficient manner and in line with the existing agreement. The existing agreement between DSA and JRCC would, regardless of the positive findings, benefit from operationalizing the agreement that describes, among others, the liaison arrangement.

The secretariat, comprising of DSA staff, prepares situational briefings for the Crisis Committee. The situational briefing is based on the current situation and is compiled from reports from various agencies such as the DSB and the County Governor. The brief may include a prognosis of the dispersion of radioactivity in the atmosphere, an overview of resources and consequences as well as recommended mitigating measures for the Crisis Committee to consider. The 15 advisor organisations to the Crisis Committee are also contributing to a various degree depending on the scenario at hand.

In general, participants in the exercise found the situational briefings to be satisfactory. Some of the feedback on the situational briefs was that the structure could be better adapted to events that develop rapidly over time. The data shows that the briefs are better suited, in their current form, to events that develop slowly; the secretariat did, at times, find it challenging to present the latest up to date information for decision-making, when the scenario was developing all the time. Furthermore, the briefs could benefit from more use of visual tools and more focus on impact assessments that are comprehensible for the Crisis Committee.

General feedback from most respondents was that the meeting structure in the Crisis Committee, although well-known and exercised before, still has room for improvement. In its current meeting structure, the national report with the situation updates, decided measures and prognosis for the development is distributed at the end of the meetings. This entails that when meetings exceed the expected length or are prolonged due to the nature of the event (as it was in this exercise), the national report will be distributed somewhat late to the rest of the Nuclear and Radiological Organisation. This can present a risk due to the fact that when information is distributed it is not completely up to date. It should be noted though, that important changes in the situation will be distributed without delay to the Nuclear and Radiological Organisation, independently of the meetings in the CC. There is a continuous information exchange with the RN organisation, the public and the media in addition to the formal national report.

In the early phase of incidents, the Crisis Committee shall involve the ministries to inform and discuss the implementation of measures, if time allows. During the exercise, the ministries participated to varying degrees and in different ways. The Ministry of Health and Care Services was, from the start, an observer in the meetings. DSA and the Directorate of Health also reported frequently to the ministry as underlying organisational advisors. The Ministry of Justice and Public Security was the lead ministry during this event and was more reserved in its participation in the meetings and in dialogue with the Crisis Committee and its member staff. The ministry received national reports, in line with the other ministries and the Office of the Prime Minister and participated as an observer at the third meeting.

During one of the meetings in the Crisis Committee, it was proposed by the DSB representative to conduct a 'Samvirkekonferanse' (coordination conference) with relevant actors not involved in the Norwegian Nuclear and Radiological Preparedness and Response Organisation. In this particular exercise, the proposal was not played out (for technical reasons) but since DSB is a member of the Crisis Committee it should be easy to coordinate such conferences in a real incident. It could be beneficial to assess whether the interface between the Crisis Committee and DSBs coordination role should be described more explicitly. Related to this it is important to emphasize that the "Samvirkekonferanse" must not interfere with the more acute crisis management that is undertaken by the Crisis Committee.

Cooperation and harmonization with Nordic partners were done through a Teams meeting and by informing the Nordic partners throughout the incident. A meeting was held the first day of the exercise before the CC had decided any measures. A second meeting was scheduled in again in the afternoon. However, this was not carried out as the other Nordic countries indicated that they were well enough informed. Throughout the exercise the Nordic partners received protocols from CC meetings, press releases and messages to the nuclear preparedness organization was translated into English and disseminated to the Nordics. It is recommended that use of liaison exchange and the practical alignment of this, which was not played out in the exercise, should be discussed. With the evermore available technology, it might be beneficial to review the use of physical exchange of liaison. **Assessment and prognosis**

In general, the members of the Crisis Committee reported that the situation update given to the Crisis Committee was satisfactory in the way that decisions to protect people and the environment was taken in due time. The prognoses for radioactive fallout were swiftly provided. Improvements identified are greater attention to possible further consequences and corrective actions. These should be presented clearly without the use of too many technical terms.

The JRCC and the County Governor of Nordland participated as observers in the Crisis Committee meetings. This provided real-time insight into the discussions in the meeting and ensured that questions could be answered on an ongoing basis as well as timely information sharing about the situation. As such this interaction is seen as valuable for information sharing that contributes to the assessment of the situation and establishing a common situational understanding.

During the Crisis Committees meetings, member agencies provided valuable input from their sectors to the overall situational understanding. A remaining challenge, however, is time for members to exchange information with their own organizations often enough. This was largely due to prolonged sessions and a short time between meetings (resulting from the compressed timeline chosen for the exercise). This could in some cases delay swift information exchange, and a more stringent meeting structure combined with the use of back-benchers and new technical means should be further explored.

The JRCC had a central role in the exercise and provided important premises and information during the meetings in the crisis committee. JRCC underlines sufficient radiation expertise and subsequent risk assessment as crucial to ensure the safety of the crew carrying out rescue operations. The JRCC is not a member of the Nuclear Preparedness Organization. It could be beneficial to reassess the formal connection between the JRCC and the nuclear preparedness organization.

Proactive actions/ other response actions

If time permits, the Crisis Committee shall inform and discuss measures with the responsible ministry before implementation. The Crisis Committee assesses whether the incident and its development allow this and how the contact should be arranged. The leader of the CC asked early on for a meeting with the lead ministry (the Ministry of Justice and Public Security)[4] to inform about the possible scenarios including worst-case predictions for the development of the accident. The discussion included elaboration on different potential measures to be taken before and after a radioactive release, including the possibility that the CC could, in the worst case, advice the government to sink the ship if all other measures failed. The Ministry of Health and Care services also participated in that meeting.

Some feedback that should be further considered is to provide all relevant ministries with sufficient written justification for measures with large societal consequences that are advised by the CC, but

[4] Normally, the leader of the CC would be in contact with the prime minister, but the political level was not participating in the exercise. The Ministry for Climate and the Environment was only participating as a response cell,but would in a real situation have been included in such meetings.

where it is the competent authority or the ministry/government who takes the decision, for instance related to the handling of the distressed vessel.

Information exchange between agencies contributed to increased quality in the implementation of measures regionally and nationally during the exercise. Some measures could have been communicated in greater detail and with less ambiguity to the regional level. Based on this a further review of meeting structure and communication channels for decided measures might contribute to a further improvement of the efficiency for implementing mitigating measures.

During the meetings in the Crisis Committee, the ministry of Health and Care Services participated as an observer. It should be noted that in a real incident, the ministry would not participate (and has not participated in earlier real incidents) in the meetings. During the exercise it was observed that the involvement and the role was perceived as somewhat unclear and unexpected to the members of the Committee. This was due to the ministry's interest or need for regular contact with certain agencies during the meetings and that the ministry suggested to withdraw the Royal Decree and the powers delegated to the Crisis Committee, during the exercise. The involvement can be perceived as a factor that might have contributed to a delay and confusion in the decision-making process. However, the ministry did express that the desire to be involved in the assessments of preventive measures, should not come at the expense of the progress of the decision-making process of the Crisis Committee. According to the mandate and the procedures for the Committee the leader of the Committee will inform the relevant ministries and the Prime Minister's Office and discuss the suggested mitigating measures when time allows. This applies to all responsible sector ministries.

International assistance

International assistance was not a central theme during the CPX. The crisis committee's secretariat sent a request for assistance for measurement resources to the IAEA during the exercises. This was, however, played out in the AlarmEX. DSB sent a request for international assistance through the UCPM mechanism during CPX. It should be considered if it might be beneficial, to further exercise in common the coordination between agencies involved in requesting international assistance.

Public information

Public communication was only partly exercised, with a focus on strategic level. The evaluation data indicated that there was good communication between the communication units in the DSA and other relevant agencies.

4.7 Full-scale exercise (FSX)

4.7.1 The FSX week: a brief overview

An overview of the planned activities for the FSX-week in Arctic REIHN 2023

- Monday 8 May: Travel Day and Icebreaker
- Tuesday 9 May: Preparation Day and competence-building forums
- Wednesday 10 May: FSX-1 day (Rescue OP)
- Wednesday and Thursday: FSX-2 days (Radiation Monitoring Exercise)

- Thursday 11 May: FSX-3 day (Evacuation OP) and Exercise Dinner
- Friday 12 May: Travel Day

Exercise goals:

1. Use a new nuclear contingency plan in handling the incident.
2. Establish and operate the crisis organization according to the contingency plan.
3. Establish, maintain, and disseminate the correct and most up-to-date regional situation picture as possible.
4. Report in the nuclear emergency response lines.
5. Contribute to the implementation of measures and recommendations decided by KU.
6. Convene and conduct a meeting of the regional nuclear preparedness committee.
7. Practice communication with the population in the event of a nuclear incident.
8. Execution of the national plan for measuring radioactivity and use of available capabilities.
9. Effectively collecting and processing a large amount of measuring data to produce situational awareness for national decisions.

4.7.2 FSX-1

4.7.2.1 Scenario

The scenario for FSX1 followed the overarching scenario of the Arctic REIHN exercise. It also created the setting for FSX-2.

The scenario starts with a nuclear-powered vessel sailing southbound along the coast of Northern Norway with crew and passengers when an explosion, followed by fire, occurs on-board. The captain of the ship asks for assistance for firefighting as well as MEDEVAC of the injured crewmembers. After a while the fire spreads, the situation escalates, and the reactor safety is in danger of being compromised with a release to air. To ensure safety of the passengers and crew, the captain later requests assistance in evacuating all passengers and non-essential crew from the vessel.

As the situation evolves, and the icebreaker drifts closer to shore, Norwegian authorities notify other countries, and start to prepare local communities in the area.

4.7.2.2 Objective

FSX-1 was the first part of the field exercises focusing on the search and rescue operation with an emergency on board the distress vessel and evacuation of injured persons and passengers. The passenger ferry MF Landegode from functioned as the distress vessel HYDROATOM.

FSX-1 tested and verified local and national emergency preparedness and response in case of a nuclear or radiological accident, including initial response, cooperation and communication of response organizations, establishing decontamination at the reception site, mechanisms for alerting relevant national agencies and other nations, and rendering and receiving national and international assistance. The purpose was also to test and develop existing plans and procedures for rescue and evacuation in a maritime RN incident.

Each participating organization created their own respective training objectives for the exercise.

4.7.2.3 Conduct

The FSX1 exercise planning was led by the Joint Rescue Coordination Centre Bodø, as the leader for the syndicate and the responsible national authority for search and rescue. Planning was conducted by several working meetings and discussions between the participating organizations, workshops to create injects, as well as reviewing documents and procedures related to RNSAR.

In the FSX-1, different national and international actors worked together in response to the emergency. A search and rescue helicopter transported both Norwegian and Dutch maritime incident response groups to the distress vessel and evacuated injured people from the vessel. The Norwegian Coast Guard vessel Farm acted as the on-scene coordinator and, together with a rescue cutter from the Norwegian Society for Sea Rescue, implemented the SAR operation at sea. The Norwegian Civil Defense, with national and international partners, set up a mobile decontamination unit at the reception centre on land. A portal for screening possible contaminated patients was set up by the DSA and the Norwegian Civil Defence. The portal was used both in the FSX-1 and FSX-3. The regional hospital also received patients. A drone with RN measurement detectors was planned to be dispatched from the Coast Guard vessel to the distress vessel to assist in getting radiation measurements.

4.7.2.4 Findings

Response management

Overall, personnel from participating organizations appeared knowledgeable in using the existing procedures and checklists for a radiological maritime incident. Relevant response measures were implemented accordingly as the situation progressed from MAYDAY to a larger RN incident. In the early stages, agencies were informed that the vessel in distress was a nuclear-propelled vessel. As there was no RN danger in the beginning of the incident, many local assets were scrambled quickly to assist, including a SAR helicopter, a coast guard vessel, a rescue cutter with radiation measuring equipment on board from the civil defense, and the maritime incident response groups to assist with firefighting and search of the vessel. Land-based unified command and a reception center with decontamination capacities to receive evacuees were quickly established according to procedures. The participants involved should, to a larger degree, consider the amount of time it takes for organizations with RN equipment and competent personnel available, to arrive at the scene.

Overall, cooperation and coordination between participating agencies was efficient, however communication and situational awareness was not always shared between the responders at sea and land. There were also some challenges in establishing a common understanding of the level of disaster/incident. Some challenges were also noted with regard to common understanding of the safety and security aspects related to this kind of a scenario.

All organizations got to test their procedures, guidelines, and action plans for this type of a scenario. There is a need to ensure that these guidelines and national plans are harmonized. For example, the military and civilian guidelines could be further examined and harmonized when it comes to safety zones and dose rates in the maritime fora. Evaluating and improving the national RN procedures in SAR operations should be focused upon. The existing procedures for Radiological and Nuclear incidents in Search and Rescue Operations (RNSAR) could also be spread even wider internationally and brought to the IMO level if this is observed as beneficial.

The exercise has also shown that there are improvements to be made in terms of establishing a national overview of what equipment, competence, and training the various response organizations have in order to participate in an RN incident. There is also a need to clarify the role of primary resources in RNSAR scenarios. National resources and the inherent capacities should, therefore, be reviewed as it is of great importance that crews participating in these operations have the right knowledge/prerequisites and are not unnecessarily exposed to risk. However, the exercise and the unique scenario gave an opportunity to test cooperation with agencies that do not normally train with each other. The agencies have a clearer picture of roles and responsibilities for RN scenario.

One of the challenges was to clarify the radiation danger and radiation risk onboard and around the vessel in distress. Such knowledge is important in order for the operations on-scene to be safe and that personnel are not exposed to a high-risk environment without necessary safety precautions.
As the drone with RN detectors was dispatched from the Coast Guard vessel late in the exercise, some of the participating organizations identified a need for further testing with the drone as it is a useful asset for mapping the area in an RN scenario.

The exercise showed that it takes a while for the JRCC to get advice and risk assessments from DSA. In a fast-developing SAR operation, rapid prudent advice from DSA to the JRCC operational level is of great importance. Risk assessment related to the RN source material and potential for incident escalation will greatly influence JRCC decision making and what guidance they communicate to the scrambled SAR assets. Overall, the agreement between the Norwegian nuclear emergency response organizations and the Norwegian Rescue services was exercised and coordination was handled according to the agreement. The exercise however highlighted the need to review some parts of the agreement, for example when it comes to the advisory role of the search and rescue services to the Crisis Committee in a maritime SAR scenario.

In terms of requesting assistance of international teams from the European countries, such as the Dutch MIRG team, it was discussed that it would be good for the strategic level in search and rescue to have an overview of the available EU mechanisms and what they can offer, in order to streamline the formal request for assistance both from the SAR and civil protection lines of communication.

Emergency information exchange

Overall, the interaction and communication between participating organizations was adequate and the communication structure generally functioned well during the exercise. Most of the relevant authorities were contacted according to the procedures. Some practical implications and best practices were found during the exercise, for example in the early phases of the incident, discussions were held whether to send specific maritime safety information or warning for vessels in the vicinity.

The Coast Guard and JRCC appeared to share a common understanding regarding RN-related issues. Barents Watch was used for much of the communication between JRCC and NoCG during the exercise. This platform was found very useful for maintaining a common situational awareness. Many participating organizations however have noted a wish for increased updates of situational reports issued by the JRCC.

In some of the feedback, it was suggested that further focus on worst-case predictions would be beneficial for incidents similar to the present exercise, where the situation is very complex and can worsen rapidly. There is also potential for improvement in the communication structure between tactical, operational, and strategic levels in crisis management, and to clarify what kind of RN advice is given by which organization, on the correct levels. This is to ensure a joint situational awareness and common understanding of the potential risk.

A liaison/advisor was established between the DSA and the Rescue Management Board at the JRCC through Teams. This was found extremely beneficial for emergency information exchange, SAR coordination and risk evaluation. It could be advantageous to have a separate advisor for the operational staff, as this would provide quick responses on proactive or reactive measurements. In a real incident, several organizations would be suitable to obtain a liaison or advice from DSA, either in person or via conference calls. Although this would benefit information exchange and rescue management, there is a challenge in terms of having enough resources for such activity.

Public information

There was no formal media play in FSX1 however before the exercise, communications units from JRCC, the local rescue sub-center from the police, the County Governor, Bodø municipality and Nordland hospital decided to use the FSX1 as an opportunity to exercise their respective communication lines in order to secure coordinated external messages to the public across the entities. Within the JRCC the press releases and statements were coordinated between the strategic and operational levels.

The Rescue Management Board at the JRCC also discussed ideas on how to inform public using sms system for public emergencies.

With regards to exercise planning, it would be beneficial to have a larger focus on the communication aspect towards the public, and coordination of public information between agencies. Few organizations highlighted the need for further training in establishing a press centre, carrying out press conferences, and coordinating press releases between agencies.

4.7.3 FSX-2

4.7.3.1 Scenario

It was planned that FSX-2 would mainly be related to consequence management on land following a radioactive release from the damaged vessel, including monitoring, and measuring radioactive fallout, sampling and control measuring of the environment, drinking water and foodstuffs, implementing protective measures, and other operations in the field. The main training audience for FSX-2 was identified as being national organisations with RN measurement capabilities (DSA, Geological Survey of Norway (NGU), Armed Forces, Civil Defence NCA, 330 squadrons), international field assistance teams from Portugal, Denmark, Sweden, Iceland, and Finland, and international organisations (EU CPT and IAEA RANET).

4.7.3.2 Objective

Radiation survey and monitoring will be conducted when radioactive articles have been deposited on the ground and capabilities are made available. In a real event, this will take place some days after the initial management of the rescue and initial management of the vessel. Due to limited exercise time, this event took place simultaneously with the FSX-1 and FSX-3, however there were no real-time links between these exercise events.
FSX-2 focused on:

- Development of a national plan for measurements of radioactivity
- Execution of the national plan and use of available capabilities
- Providing information to, dialogue and HNS to participating international capabilities.
- Effectively collecting and processing a large amount of data to produce situational awareness for national decisions, through maps with verified contaminated areas.

It should be noted that, during this exercise, the communication between the Monitoring Coordination Centre (MCC) and DSA HQ at Østerås was not part of the exercise.

4.7.3.3 Conduct

The second part of the Full-Scale Field Exercise (FSX-2) was organised to be closely connected with the first part of the field exercise (FSX-1). FSX-2 was planned to be conducted the day after FSX-1. Both parts of the field exercise followed a few days after the notification exercise (AlarmEX) and the command post exercise (CPX). The actions during FSX-2 were pre-scripted and not dependent on decisions taken by the participants during LIVEX or CPX.

4.7.3.4 Findings

Response management

The general impression was that the exercise was well executed and provided good learning for all national and international teams.

The national monitoring plan was provided to all participating actors. The plan was sufficient in the relevant areas of the exercise, such as missions, logistics support and, command and control. Available capability resources were informed punctually and arrived at the operations scene, with relevant equipment in a safe manner. The national monitoring plan would benefit from a review to examine if it would benefit from including details on situation reports, protective measures and reporting to decision makers.

On a general note, some of the feedback suggested that it would have been preferable with more continuous contact with the Monitoring Co-ordination Centre (MCC).

In the exercise, simulated data was provided, and the majority of teams did background measurements. This meant that the teams did not get training in detecting real radioactive sources. For future reference, an exercise might include a few sites with real radioactive sources to test instruments and allow reporting on real values.

The fallout prediction from ARGOS was used to develop the national radiation monitoring plan. Teams were assigned areas for monitoring in order to validate the dissemination prognosis.

During the exercise the MCC received data transmission from a helicopter and the Norwegian Coastal Administration surveillance plane. These are important assets and using airborne monitoring systems for live data is considered to be an effective tool. Nonetheless, this additional resource has potential for improvements as there was occasionally a delay in data transmission.

Another issue identified was related to data handling, mainly in relation to the data upload portal. Some of the monitoring teams received error messages when uploading data, even though some of the data were received in the MCC. This caused some extra work for the data management group in the MCC. Some of the issues were solved between the 10th and the 11th May, but there were still some issues on the 11th May. The data upload portal is a useful asset; however, it is clear that there is a need for further improvement and establishment of resilience in the program in use.

Information exchange

Participating teams were thoroughly briefed before they were sent out on missions. Some of the participants mentioned that communication with MCC on data submission could be improved. Participants would, for instance, have preferred to get a status report (read back) from the MCC to the field teams when submitting data. In this way, the teams would be able to confirm that the measurement reported was duly received and of the correct quality. More focus on information exchange between the field teams and the MCC would be preferable, as this can pose a risk for misunderstanding, for instance, when data is not acknowledged by the MCC.

Furthermore, a lack of communication/feedback can pose a risk in scenarios when the dose rate in some areas is too high and field teams should withdraw. Each team has its own turn-back levels, but this can also be discussed and supported by the MCC. Establishing frequent contact and procedures for data communication between field teams and MCC could improve the coordination of such missions.

The MCC satisfactorily handled incoming data (once the problems with the data upload portal was solved) and provided timely responses when teams submitted questions. The MCC was well organized, and roles were clearly identified. All dose rate data was effectively collected and distributed to the MCC which received, processed, and displayed incoming data as points in the program QGIS. Nuclide data received from field team measurements were not used and displayed. Maps were updated continuously – however, for decision-making, it is necessary to ‘freeze’ the time and produce maps with a time stamp so that protective measures can be decided based on whatever data is available at the time.

Dose rates on the maps could have been indicated and compared to OILs (Operation Intervention Levels, as defined by IAEA) for direct indication of protective measures in those areas.

The MCC should consider regular status meetings during an operation in the future to ensure information exchange between actors and contribute to situational awareness in the field. Teams in the field will not necessarily need the full overview when they are out in the field, but this can be provided when they return to the MCC. Status meetings can also be an arena to review the basis for decision-making, such as maps and measurements, that are sent to decision-makers.

4.7.4 FSX 3

4.7.4.1 Scenario

The scenario was a maritime nuclear incident that required life-saving rescue efforts and evacuation involving a situation where radioactivity was released and had consequences for the rescue operation as well as challenges for crisis management at sea and on land. The incident was planned to involve local, regional, national, and international alerting and handling.

Due to predicted radioactive fallout from a fire/explosion in a damaged atomic ice breaker west of Bodø, the population of Sørvær had to be evacuated. On Wednesday 10 May, Nordland police district was tasked with planning and carrying out the evacuation. This was done in close collaboration with the County Governor of Nordland, Bodø municipality, the emergency services, and the Norwegian Civil Defense.

4.7.4.2 Objective

The FSX-3 was an evacuation exercise and involved training audiences such as the Civil Defence, Nordland Hospital, emergency services, and Nordland County. Participants from 13 different agencies participated in the exercise: Nordland Police District, Bodø municipality, The Norwegian Civil Defence, MSB, Salten Fire and Rescue, Bodø Harbour, Bodø Red Cross, The Norwegian Sea Rescue Society, Nordland Hospital, County Governor of Nordland, DSA, Helse Nord and Norwegian Food Safety Authority.

4.7.4.3 Conduct

A number of permanent residents of 100 people (technically 34 markers) had to be evacuated to Bodø by 12 noon on Thursday 11 May at the latest. Evacuation was carried out using a boat from Bodø harbor and a lifeboat from the Rescue Company. Due to the risk of radioactive contamination of people, equipment, and material from Sørvær, had to be decontaminated on arrival at Bodø harbour. The Norwegian Civil Defense had been given the responsibility of establishing a reception center in Rønvik marina where they could receive the evacuees, and measure radioactivity on people, material, and equipment, as well as decontaminate these before they were sent on to the evacuation and relatives center that Bodø municipality had established at Tusenhjemmet.

Handling of other impact-reducing measures such as iodine tablets, registration, and restrictions in the production of food was also practiced at Sørvær, as well as at Nordsia.

4.7.4.4 Findings

Overall participants were satisfied with the exercise and the exercise goals were met in a satisfactory way. The main findings or areas of improvement from the exercise were:

Early and exact information to the population is crucial in RN events since the public has limited knowledge on consequences of radioactive contamination.

Lack of a sufficient understanding of the measurements such as ambient dose equivalent used during an RN incident was a challenge. This entailed that there was a missed opportunity of being able to provide early and sufficient information to the population to avoid uncertainty and stress.

Competent RN personnel should have been invited into the detailed planning process. There was a lack of adequate knowledge of RN metrics and their short- and long-term consequences.

Communication between those conducting maritime operations and those conducting land operations in the event of coastal incidents must be improved. This is also a learning point from other coastal exercises.

All Norwegian actors participating in such a large international cooperative exercise must be given a clear mandate that they participate as part of a large cooperative and must therefore participate fully in the planning process.

The reception of patients at Nordland Hospital worked well. There is a plan for an RN incident, and the employees were familiar with this and were perceived as motivated to take on the tasks.

The safety of markers was not adequately safeguarded. The transfer of patients from vessel to shore on stretchers was undertaken. However, no security officers were observed on the pier in connection with this process. The risk of hypothermia was not addressed. The safety procedures were generally adequate, but both players and markers in the exercise should have been briefed about these issues.

5 General information

5.1 Safety and security

Everyone involved in Arctic REIHN 2023 had an individual and collective responsibility for making the exercise as safe and secure as possible. There will always be a level of risk related to certain activities, but a conscientious attitude towards risk-taking and the necessary safety rules will minimize risk and secure the conduct of the exercise events.

The responsible Safety Coordinator for exercise Arctic REIHN 2022 had the final word before the start of the exercises was initiated (STARTEX) and was authorized to stop the exercise or halt it at any given time if conditions did not meet the required safety standards, or if a dangerous situation had occurred. A separate Safety Directive for the FSX exercise was developed and published prior to STARTEX. It was the responsibility of every participant to be familiar with the content of the Safety Directive, and to comply strictly with any restrictions or regulations throughout the exercise.

5.2 Exercise staff

The remit of exercise staff included several different functions that are essential to successfully conduct a full-scale exercise (FSX). However, some of these functions were also required for Command Post Exercises (CPX).

EXCON (Exercise Control) was a key function both during the CPX exercise, and the FSX exercises. EXCON had the overall control of the exercise conducted from STARTEX to ENDEX and was responsible for playing different injects in the MIL (Main Inject List) at the appropriate time according to the situation on the ground. For the FSX in Arctic REIHN 2022, the EXCON was located in Bodø city, at the Nord University campus.

The **Controller** function is an integral part of EXCON and represented the "eyes and ears" of EXCON on the ground. The controller observed and reported to EXCON on the progress at the different exercise sites and recommended to EXCON whether any adjustment in "temperature" was required to achieve a sufficient training value.

Evaluators were present at different sites during both CPX and FSX exercises. The role of the Evaluator was to observe and collect information for the evaluation and the process defining the way forward. The evaluation was designed to assess the exercise against the stated exercise objectives and suggest measures to alleviate any shortcomings or discrepancies that were observed during the exercise.

Host Nation Support (HNS) was organised to have personnel in different locations before and during the exercise, to deliver the required (and expected) support for international teams that were participating in the FSX exercise. For Arctic REIHN 2023 the HNS function was delivered DSA with support from DSB.

Role Player Management Arctic REIHN 2023 was set up to have a Role Player Coordinator, and dedicated personnel on the ground to make certain that role players were always safe and secure.

Press and Information Centre (PIC). To promote the Arctic REIHN 2023 exercise and provide insight and visibility to the project, a Press and Information Centre was established to accommodate the media during the exercise. The PIC was situated at Scandic Havet, Bodø during the exercise.

Observers. A Visitors and Observer program (VOB) was developed for the FSX exercise. The visitors and observers were invited by the EU or exercise project management to participate in the VOB program.

Guide(s). Designated guides were provided to look after the well-being of VOB participants and ensure that they remained in designated areas for observers so that their presence would not interfere with the training audience.

Exercise staff (and observers) involved in exercise Arctic REIHN 2022 wore coloured vests when visiting exercise sites in the field. The table below indicates the vest colour worn by observers and different staff functions during this exercise.

Communication during the exercise Kystradio Nord (Norwegian Coastal Radio North) has designed maritime VHF-channel 66 for the exercise.

International participants used NØDNETT radio terminals. Participants received the necessary training in the basic use and information about talk groups, call signs, etc.

Language. The primary language for the exercise Arctic REIHN is English.

5.3 International resources in Arctic Reihn 2023

The purpose of the Syndicate International Resources (IR) was to ensure that international actors would be properly supported during their visit to Norway and participation in Exercise Arctic REIHN. IR served as one single point of contact for Host Nation Support-related subjects for international resources. The IR was supported by the sub-syndicate HNS which was operated by the Norwegian Civil Defence.

Norway planned to provide information, accommodation, meals, transport, and logistical support to international actors according to their reported needs through the IR planning process. It was also agreed that international actors would plan, execute, and pay for their own travel expenses related to Ex Arctic REIHN according to the guidance given in the Grant Agreement. The IR would provide information on simplified customs procedures for the equipment international actors intended to bring across Norwegian borders.

International resources in Arctic REIHN were capabilities from partner organizations from Denmark, Iceland, Portugal, and Sweden. In addition, field teams for radiation detection and monitoring from Finland and Sweden were invited to participate as well as a Dutch MIRG team.

5.4 Host Nation Support

Representatives from DSB and DSA oversaw the Host Nation Support. The Host Nation Support provided customs clearance, rental cars, board and lodging, as well as other needs before and during the exercise in Bodø. The international participants were generally positive to the Host Nation Support. During the Post Exercise Discussion in Bodø on the 7th and 8th of June, a VTC meeting was conducted for the international participants. The participants commented on their experience with Host Nation Support and were generally satisfied.

Information provided by the HNS program entailed the following.

- Customs clearance
- Rental cars
- Accommodation
- Meals
- Any other business

5.5 European Union Civil Protection Team (EUCPT)

Background

As part of Grant Agreement, an EUCPT of three experts and one ERCC LO was selected to the exercise. The team was supported by a Technical Assistance and Support Team (TAST) and a UCPM trained liaison officer from DSB and Norway.

Invitations were sent out two months before the exercise and around 15 applications were received. The team composition of the selected team was:

Teamleader	Austria
Information manager	Lithuania
CBRN expert	Romania
ERCC LO	EU COM

Main events and actions

Capitol level:

The team arrived in Oslo Monday, linked up and started initial teambuilding. As an introduction to key actors at the National level, a dedicated program was developed for the team before entering the exercise in Bodø. The program Monday evening and Tuesday morning comprised of the following meetings and interactions:

- Briefing about DSB and actors involved in Rescue operations in Norway
- Meeting with Ministry of Justice and the Situation Centre
- Meeting with EU delegation to Norway
- Meeting with DSA

Regional level:

On Tuesday afternoon, the team travelled to Bodø and established themselves at Saltstraumen. The scenario started with a mission briefing from ERCC via Teams.
During the exercise, the team met with and interacted with all key actors involved:

- JRCC
- UNN Hospital
- Salten Fire brigade
- NL MIRG team
- DSA
- Bodø municipality
- Sea Rescue vessel
- IAEA
- International team leaders from DK, SE, PT, IS and FI

What went well?

- ➢ The introductions in Oslo were very well received by the team as realistic and fruitful.
- ➢ The flexibility in the exercise with no strict "inject list", but participant-driven injects.
- ➢ The value of the HN liaison officer as a 'door opener' to Norwegian actors
- ➢ The full integration of the TAST members into the team
- ➢ The realism of real actors instead of roleplay
- ➢ The learning opportunity to interact with IAEA in the field.
- ➢ Logistics support provided by HNS and TAST (accommodation, transport. ICT, etc.)

What could be improved?

- ➢ More data and numbers of affected (international) people would have given more effect on consular support and medical support.
- ➢ A Liaison Officer to the European teams would have been beneficial.
- ➢ A Liaison Officer also from DSA (as requesting entity) could have been beneficial.

6 Evaluation, method, and data

6.1 Evaluation and Way Forward

The main purpose of the evaluation of Arctic REIHN 2023 was to assess the exercise and its outcome regarding the exercise aims and objectives. The objective of the evaluation process was to collect and analyse data, observations, and impressions from the exercise, as well as look at different actions and reactions, and evaluate responders, participating agencies, and organizations against the exercise aims and objectives. The exercise was not one single training activity but a series of activities that, in total, form a complete scenario required to successfully prepare, execute, and accomplish the exercise aims and objectives. The evaluation was therefore designed to cover all the events and activities and address them overall.

Evaluation provides opportunities for identifying and assessing lessons learned. To achieve this, the evaluation of the response in exercise Arctic REIHN 2023 was based on exercise objectives. The evaluation was planned to primarily focus on the incident handling and secondarily on the exercise process itself. The scope of the evaluation was organised to be limited to the following activities:

- ALARMEX
- CPX
- FSX-1 FSX-2 FSX-3
- TTX-1 and TTX-2

Evaluators, instructed by the Evaluation Syndicate, were positioned on-site throughout the exercise arena, corresponding with the focus of the evaluation. The aim of the observations was to follow the decision-making process, action patterns and coordination, as well as other relevant factors based on the exercise objectives. It was agreed that the members of the evaluation syndicate would also document their own observations during the exercise. All the dedicated evaluators were requested to submit written reports, which were an important part of the analysis.

The questionnaires were distributed prior to the exercise and the Chief evaluators were responsible for collecting the answers and forwarding the answers to the leader of the syndicate. Interviews could then be used as a supplement to the questionnaires. The interviews could be formal or informal. DSA prepared the interview guidelines.

Feedback from the participants in the hot wash-up process after each activity was an important opportunity to receive information. In addition, interviews were conducted with key personnel. Any documentation produced during the exercise, for example logs from CIM, situational reports, and other relevant documents could be used in the evaluation and form the basis for any analysis. A hot wash-up was conducted after each activity.

The findings and lessons identified presented in this report will form the basis for the Way Forward process. An evaluation and way forward conference was conducted on the 19th and 20th of September in Oslo, were findings and lessons identified were addressed as well as way forward process.

6.2 Methodology

Some changes have been made by the evaluation syndicate that deviates from the Exercise Directive. The questionnaires were not generic, as the syndicate found it more useful to produce and hand out questionnaires that were more adapted to each activity. With this evaluation, it was anticipated that a more in-depth analysis of collected data could be achieved that both facilitates each activity's objectives and aims, as well as producing a thorough evaluation and learning after the exercise. For the exercises, TTX-1 and TTX-2 questionnaires were not used, but rather the data provided were relayed via hot wash-up and reports written by syndicate leaders after the activity had been conducted.

To collect data, various methods have been used. The different methods consisted of five categories, described below. Depending on the exercise, various methods have been used, ranging from two to five categories. The various participating organizations have conducted evaluations concerning their own participation and provided input on the evaluation syndicates' overall evaluation.

Observations

Evaluators have observed the implementation of activities during the exercise. Observations took place in several locations during the different exercises and by various participating organisations.

"Hot wash up"

The hot wash-up provides a showcase of actual performance results compared to objectives wherein participants contribute their opinions and perspectives. They provide their insight, observation, and questions that help reinforce strengths and identify and correct the deficiencies of the completed exercise. The main purpose of the hot wash-up was to provide an arena for discussions about what went well and make recommendations on matters that can be improved. The questions provided in the developed guideline for the exercise were based on the After-Action Review (AAR) method and were intended to be learning-focused.

After each exercise was conducted, the hot wash-up was conducted either internally, in the participating organizations or carried out as a joint effort.

Interviews

For some of the exercises, notably the CPX, interview guides were developed. The interview guide provided an extended understanding of the exercise for the evaluator but also contributes to additional information for this report.

Under some of the evaluation areas, evaluators could find *additional questions* that are developed especially for the specific exercise. Evaluators could choose to answer these upon an assessment of the use of time and the informational value of the answers.

If there were other questions that the evaluator identified as being important, there was an additional observation form at the bottom of the guide document that evaluators could use. Here, they could list other significant observations that they considered important.

Survey

Questionnaires were developed to answer the common objectives of the exercise. Additionally, the questionnaires for each exercise were adapted to the different objectives developed by the responsible syndicate.

A survey has been carried out with questions relating to targets with room for additional comments. The evaluation syndicate has received four completed summary reports from Chief Evaluator activity. When interpreting the results of the survey, it was important to be aware of the low number of respondents.

Document review

Relevant documentation that has been reviewed and assessed in connection with the evaluation includes the participating organizations' evaluations of their own execution, situation reports, meeting minutes, logs, press releases, and crisis plans.

6.3 Data

The data presented in this report are largely generated from submitted hot wash-up summaries, questionnaires, observations, and interviews. Interviews were mainly used in the evaluation of the CPX. It should be noted that there are variations in terms of how many respondents and data material was submitted from each exercise.

The evaluation syndicate does not have sufficient data to evaluate the Arctic REIHN fulfilment of Common Objective 8. This is largely due to that the communication parts of the management of such incidents were not played out to a large extent. As such the syndicate does not have enough grounds to propose recommendations based on findings. One recommendation would, however, be that crisis communication in all its aspects is crucial in the management of any incidents, also in the normalisation phase, and should later be exercised.

Funded by
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Tabletop Exercise 1: Arctic REIHN

Handling of a vessel in distress with risk of radioactive contamination

Exercise Evaluation Report 2023

Authors and contributors

Nord University:

Rune Elvegård

Natalia Andreassen

Norwegian Coastal Administration:

Ole Kristian Bjerkemo

Bjørn Bratfoss

Ståle Sveinungsen

Norwegian Radiation and Nuclear Safety Authority:

Øyvind Aas Hansen

Vibeke Brudevold

Kristine Valberg Nyegaarden

Liv-Åse Hesvik-Lorck

TTX1 WP Leader: Bjørn Bratfoss

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1 Introduction

The Arctic REIHN tabletop exercise 1 (TTX 1) on the effective and timely handling of a damaged vessel with risk of radioactive contamination was conducted 26 April 2023 in Oslo, Norway. This exercise evaluation report describes the exercise conduct, scenario, format, learning outcomes, exercise evaluation, and the way forward.

1.1 About Arctic REIHN

The Arctic Radiation Exercise in the High North (Arctic REIHN) is an EU project funded under the umbrella of the Union Civil Protection Mechanism.

The overall aim of the Arctic REIHN was to test, verify, and further develop emergency preparedness and response in the case of a nuclear or radiological maritime accident in the Arctic.

The Arctic REIHN project involved several sub-exercises:

- ALARMEX
- Command post exercise (CPX)
- Full scale exercise (FSX)
- Tabletop exercises 1 and 2 (TTX1 and TTX2)

In the scenario of the full-scale exercise Arctic REIHN (FSX), a nuclear-driven vessel in coastal waters outside the town of Bodø in Northern Norway is experiencing trouble. The captain reports an accident that will have consequences on both sea and land, as well as cross-border contamination. A massive local, regional, national, and international response is required.

The full-scale exercise with more than 100 rescue workers and experts was conducted on 8–12 May 2023 in Bodø, Norway.

In addition, an international competence building webinar prior to the exercises included briefings on existing cooperation in a nuclear accident, international coordination mechanisms, national and international maritime law and obligations, experiences from previous exercises, and how to tackle possible radiological consequences.

1.2 Aim and learning objectives of Arctic REIHN TTX 1

Aim of the Arctic REIHN TTX 1

The aim of TTX 1 was a discussion of the effective and timely handling of a damaged nuclear-powered vessel with a risk of radioactive contamination, but not including the SAR operations (which was addressed in CPX and FSX).

The purpose of TTX 1 was in accordance with Arctic REIHN objective 4, which is:

Effective and timely handling of a damaged vessel with a risk of radioactive contamination. This should be according to the agreement between the Norwegian Coastal Administration (NCA) and the Norwegian Radiation and Nuclear Safety Authority (DSA), in accordance with EU Operational Guidelines on Places of Refuge and national and international maritime law and obligations.

Figure 1: Arctic REIHN TTX 1 (Photo: Nord University)

Learning objectives of the Arctic REIHN TTX 1

- Improve understanding of roles and responsibilities nationally and internationally
  - Understand the organization, roles, and responsibilities for handling a nuclear-powered vessel in a normal situation
  - Understand the organization, roles, and collaboration between responsible authorities handling a nuclear-powered vessel in a complex situation
- Improve understanding of how to handle a nuclear-powered vessel in distress
  - Understand how a nuclear-powered vessel will be handled in an uncertain and complex situation outside and inside 12 nm
  - Understand the legal basis outside and inside 12 nm for handling a nuclear-powered vessel with a risk of radioactive contamination
  - Understand how the authorities will handle a situation with an accidental release of radionuclides

1.3 Planning process

The planning process for the TTX was very long due to the Covid-19 pandemic, followed by the Russian invasion of Ukraine. This resulted in postponement of the TTXs planned in 2021 and 2022. The decision to run the TTX in April/May 2023 led to a rather hectic final process in winter/spring 2022/2023. Even though the planning was extensive, all the key planners were able to follow the planning process from 2020 to 2023.

The planning was divided into two parts, one with a focus on administrative issues and coordination with international partners. The second one, focused on exercise design, the Norwegian Coastal Administration, the Norwegian Radiation and Nuclear Safety Authority, and University North were the key institutions. The exercise design team included operational, strategic, and administrative competence.

The extensive planning resulted in a lot of learning for the personnel involved. Among other things, this competence was used to improve existing procedures and the cooperation agreement between NCA and DSA and to conduct pre-exercises. The pre-exercises were used to build competence within and between the organizations involved. In addition, it was possible to test draft internal procedures and the cooperation agreement between the key institutions. The planning team involving all key institutions was important for building competence and trust.

1.4 Limitations

The scenario was tailored to focus on specific elements that should trigger certain challenges, such as juridical elements, and focused on the learning objectives.

Before the exercise started, a presentation about state ownership and immunity issues related to nuclear powered vessels was held by legal adviser Kristine Valberg Nyegaarden of the Norwegian Radiation and Nuclear Safety Authority. These issues were not raised during the exercise, but a short presentation was held as an introduction to the exercise. The following questions were addressed:

- What if the vessel was not on a commercial mission and the flag state claimed immunity?
- How would the national authorities handle the situation? What is the legal basis, and who would be involved?

Other issues that might be relevant in the scenario but that were outside the learning objectives were omitted. Some examples that were not discussed are as follows:

- Search and rescue operation (SAR)
- Military vessel handling
- Flag state issues
- Communication issues
- Oil spills

2. Exercise conduct

2.1 Design and scenario

Tabletop exercise Arctic REIHN (TTX 1) was conducted on 26 April 2023 at the Oslo Congress Center in Norway. The exercise was organized by the Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Nord University, Danish Emergency Management Agency, Swedish Civil Contingencies Agency, and Icelandic Radiation Safety Authority.

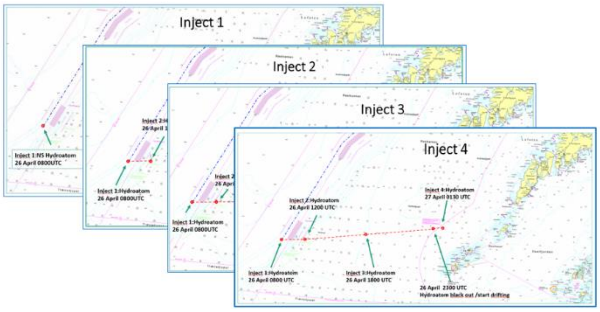
TTX 1 was designed as a discussion-based exercise. The exercise was planned considering the exercise learning staircase and pedagogical–didactical approaches.

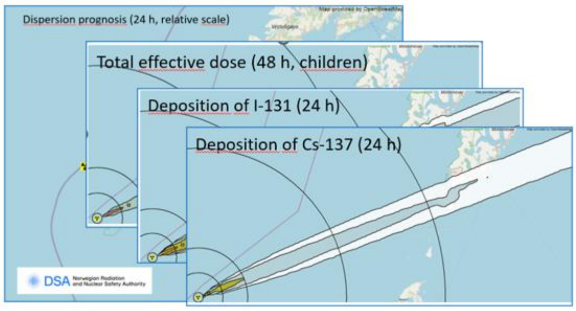
Tabletop exercise design is a well-used tool for enhancing understanding of collaboration. This form of exercise was chosen to achieve a shared understanding of plans, roles, and responsibilities, as well as shared language and terminology between participants.

TTX is also used to discuss possible decisions and solutions in a given scenario and to uncover possible differences in practice.

Figure 2: Oslo Congress Center (Photo: Nord University)

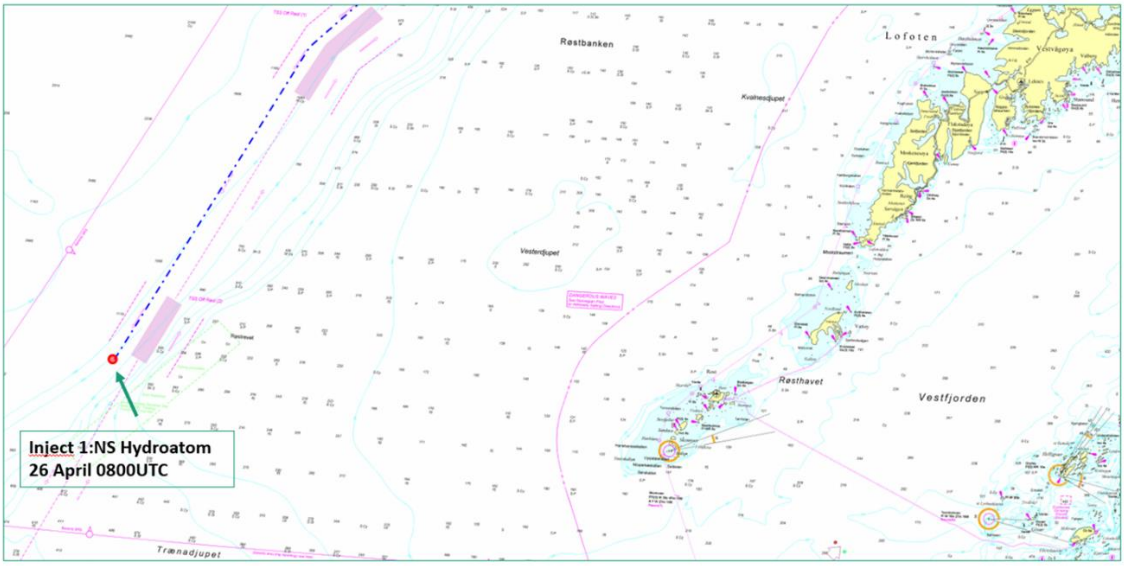
TTX-1 was based on four themes (injects) visualized by text, maps, and figures. Presentations and discussions related to the four injects corresponded to the learning objectives.





The scenario for TTX 1 was a nuclear-powered vessel in distress and with a risk of acute release of radionuclides. The start for the exercise was a civil state-owned nuclear-powered vessel in normal traffic along the Norwegian coast, heading south with passengers. The flag state was “Atlantistan.” The vessel followed the traffic separation system (TSS) in the Norwegian exclusive economic zone (EEZ).

Inject 1 starts on April 26 at 08:00 UTC in the EEZ when the vessel stopped at position N67°33’ E009° 06’ for routine maintenance and drifts. The weather was wind from west-south-west 6–8 m/s.



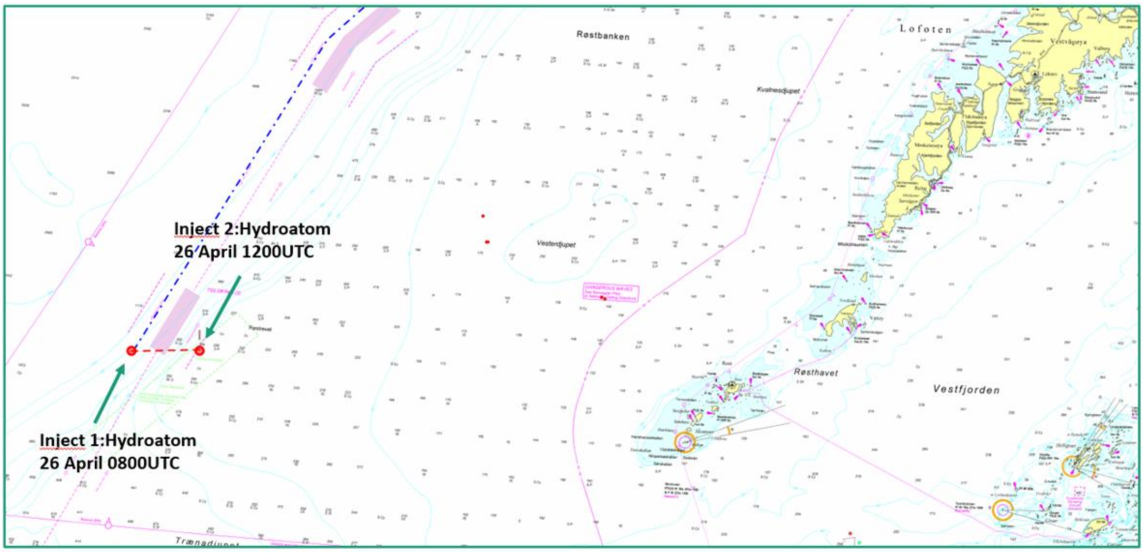
Sub-learning objective for inject 1:

- Understand organization, roles, and responsibilities in handling a nuclear-powered vessel in a normal situation.

Questions presented for discussion in session 1:

- How would the national authorities handle this situation?
  a) civilian reactor-powered vessel in normal traffic, and
  b) when stopped/drifting for routine maintenance.
- Who is involved?
- Notification? If so, from whom to whom?

Inject 2 continued in Norwegian EEZ, April 26 at 12:00 UTC. The captain of the vessel warns that routine maintenance has revealed a need for repairs due to problems with a heat exchanger in the vessel's auxiliary system. The captain asks for shelter for up to 6 hours to carry out the necessary repairs. While awaiting response on shelter position, the vessel starts sailing toward shore using engine with reduced speed (4 kts). The wind has increased to WSW gale 12–15 m/s.



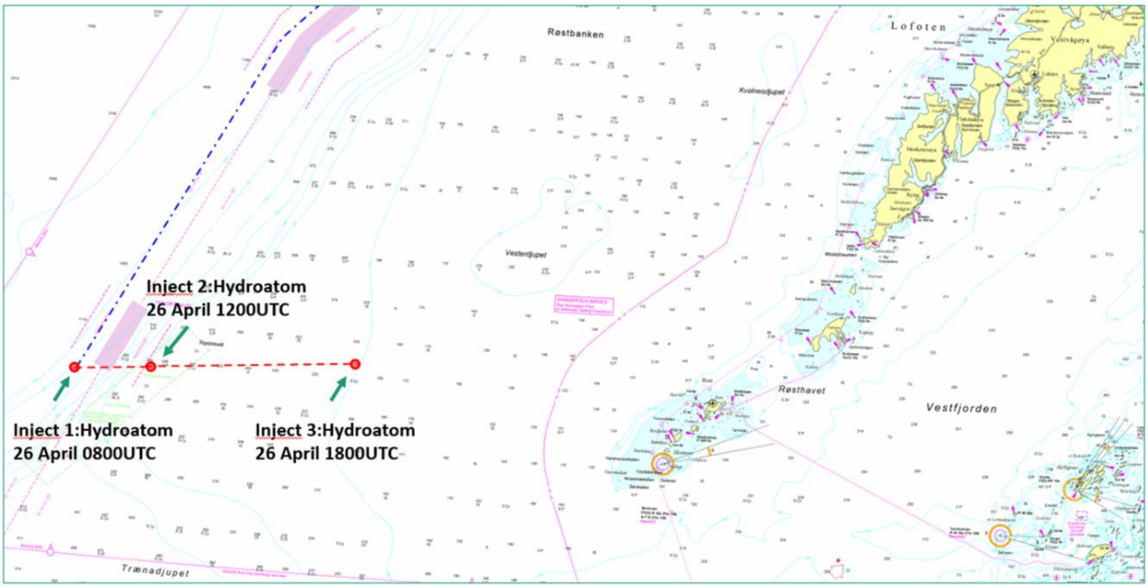
Sub-learning objective for inject 2:

- Understand organization, roles, and collaboration between responsible authorities handling a nuclear-powered vessel in a complex situation

Questions presented for players for discussion in session 2:

- How would the national authorities handle this situation?
  - Who has the overall situational awareness?
  - Which organization has the best understanding of the situation?
- Notification?
- Legal basis for shelter?
- Any international collaboration?

Inject 3 continued in the Norwegian EEZ, but the vessel drifts toward territorial waters on April 26 at 18:00 UTC. The captain informs that the vessel has limited propulsion and requests a place of refuge to carry out the necessary repairs and avoid a worsening of the situation. Wind is still WSW gale 12–15 m/s.



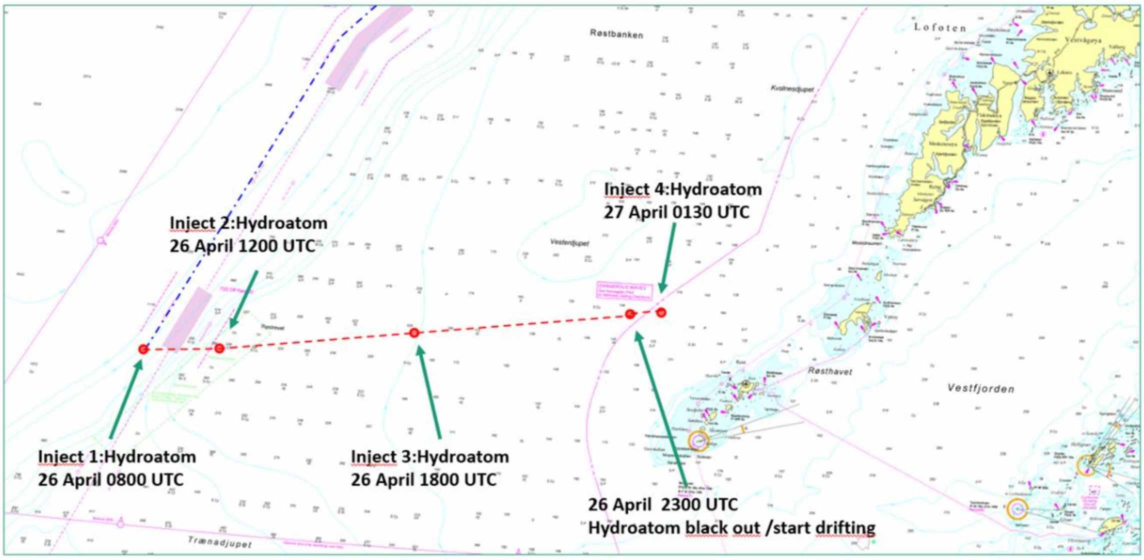
Sub-learning objectives for inject 3:

- Understand how a nuclear-powered vessel will be handled in an uncertain and complex situation outside territorial waters
- Understand the legal basis outside territorial waters for handling a nuclear-powered vessel

Questions presented for discussion in session 3:

- How do the national authorities handle this situation?
- What is the legal basis for place of refuge?
- What other options are considered?

Inject 4 starts on April 26 at 23:00 UTC when the captain of the vessel reports a black-out. Severe problems with a heat exchanger result in reduced pressure in the reactor's primary cooling circuit and a failure to cool the reactor. A partial shutdown is carried out, but they lose control of one of the reactors. On April 27 at 01:30 UTC, the vessel is drifting into Norwegian territorial waters. A release to the air is ongoing. Based on drift calculations, the vessel is expected to reach the shorelines within 10 hours and ground at the island of Værøy. Everyone on board is evacuated.



Sub-learning objectives for inject 4:

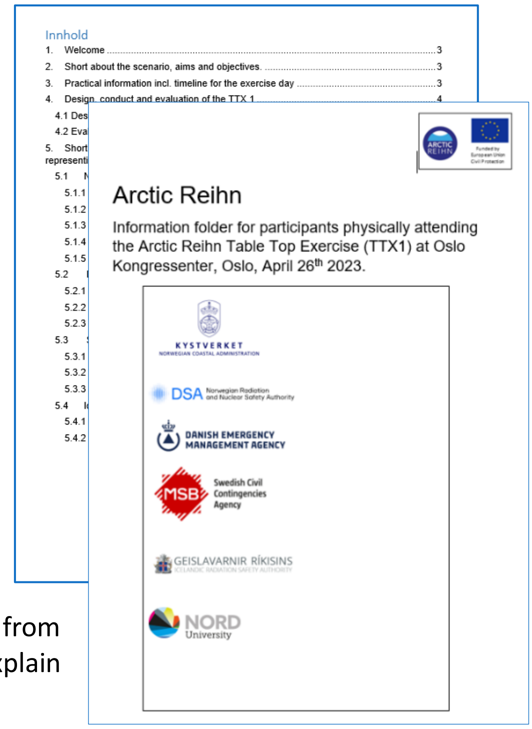
- Understand how a nuclear-powered vessel will be handled in an uncertain and complex situation with limited time for mitigating actions
- inside territorial waters
- Understand the legal basis for handling a nuclear-powered vessel inside territorial waters
- Understand how the authorities will handle a nuclear-powered vessel with a risk of radioactive release

Question presented for discussion in session 4:

- How has the legal basis changed inside territorial waters?
- How do the national authorities handle this situation?
  - Which alternative measures are considered?
  - Which resources will be used?
  - Who will be involved in the discussions and decisions?
  - Who makes the final decisions?

2.2 Participants

The participants were the key authorities in Norway, Sweden, and Denmark that must handle such situations. The TTX exercise audience was divided into training audience, observers on site, and observers on streaming.



Innhold

1. Welcome 3
2. Short about the scenario, aims and objectives. 3
3. Practical information incl. timeline for the exercise day 3
4. Design, conduct and evaluation of the TTX 1 4

Arctic Reihn

Information folder for participants physically attending the Arctic Reihn Table Top Exercise (TTX1) at Oslo Kongressenter, Oslo, April 26th 2023.

Training audience

During the exercise, the main focus was on the Norwegian authorities' handling of the vessel. The main training audience was the key Norwegian organizations normally involved in handling vessels in distress in the described situation.

The organizations from Norway were represented by the Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Norwegian Coastguard, and the Norwegian Radiological and Nuclear Crisis Committee with their representatives from the Norwegian Radiation and Nuclear Safety Authority, Norwegian Coastal Administration, Food Safety Authority, and Police Directorate).

Throughout the exercise, additional contributions from Sweden and Denmark were planned after every inject to discuss how such handling might differ if this occurred in their waters. Participants from Sweden and Denmark with similar responsibilities were asked to explain how they would handle a similar situation in their country.

The authorities were the Civil Contingencies Agency (MSB) from Sweden and Danish Emergency Management (DEMA) from Denmark.

The training audience received an information folder with background information in advance to prepare for the discussions. During the exercise, the moderator presented a situation, an inject, and key questions. Additional materials, such as maps and drift prognoses, were distributed to the training audience during the presentation of each inject. The training audience took part in the discussion during the exercise, provided their reflections in the hot wash up, and submitted the individual evaluation forms.

Figure 3: Crisis Committee with representatives from the Norwegian Radiation and Nuclear Safety Authority, Norwegian Coastal Administration, Food Safety Authority, and Police Directorate (Photo: Nord University)

Figure 4: Participant and observers located in Oslo Congress Center during table top exercise (Photo: Nord University)

Observers on site

The exercise was observed by representatives from the European Commission, UK Secretary of State's Representative to the International maritime organization (IMO), Norwegian Ministry of Trade, Industry and Fisheries (NFD), Norwegian Ministry of Health and Care Services (HOD), and Norwegian Ministry of Climate and Environment (KLD).

Observers on site were present in the exercise room. They received brief information in advance about the timeframe of the day, vessel information, and injects with questions. They were invited to comment in the hot wash up and complete the evaluation form after the exercise.

Observers on streaming

In addition to on-site observers, there were international observers who followed the exercise via streaming. These included the Ministry of Trade and Fisheries, International Atomic Energy Agency, Health Canada Radiation Protection Bureau, Icelandic Radiation Safety Authority, Finnish Radiation and Nuclear Safety Authority, Icelandic Coast Guard, Finnish Border Guard, US Coast Guard, Canadian Coast Guard, Ministry of Foreign Affairs, Norwegian Directorate for Civil Protection, British Embassy, Barents Watch, Nordland Police District, Danish Emergency Management Agency, Danish Armed Forces, County Governor Nordland, University of Oslo, European Commission, and Maritime Incident Response Group from the Netherlands.

Observers on streaming received brief information in advance about the timeframe of the day, the vessel, and the injects with questions. They did not participate in the hot wash up. They were invited to complete an evaluation form.

2.3 Distaff

The exercise was directed by the Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Nord University, Danish Emergency Management Agency, Swedish Civil Contingencies Agency, and Icelandic Radiation Safety Authority.

Project leader for Arctic REIHN TTX 1

- Bjørn Bratfoss (Norwegian Coastal Administration)

Exercise planning, conduct, and evaluation team: Norwegian Coastal Administration, Norwegian Radiation and Nuclear Safety Authority, Nord University

- Ole Kristian Bjerkemo (Norwegian Coastal Administration), Bjørn Bratfoss (Norwegian Coastal Administration), Øyvind Aas-Hansen (Norwegian Radiation and Nuclear Safety Authority), Vibeke Brudevold (Norwegian Radiation and Nuclear Safety Authority), Kristine Valberg Nyegaarden (Norwegian Radiation and Nuclear Safety Authority), Liv-Åse Hesvik-Lorck (Norwegian Radiation and Nuclear Safety Authority), Rune Elvegård (Nord University), Natalia Andreassen (Nord University)

The two moderators were from the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority

- Ole Kristian Bjerkemo (Norwegian Coastal Administration) and Øyvind Aas-Hansen (Norwegian Radiation and Nuclear Safety Authority)

2.4 Presentations from IAEA and EU

IAEA

A pre-recorded presentation was provided by the International Atomic Energy Agency (IAEA). Mr. Florian Baciu gave a speech entitled “IAEA incident and emergency center role in response to nuclear/radiological emergencies: Views on a nuclear-powered vessel scenario.” He touched on the issues of safety standards and categories, mitigation actions and monitoring, and IAEA’s roles and responsibilities during inter-agency responses. He emphasized how different the crisis response and planning would be in an accident with a nuclear-powered vessel.

EU/EEA

A presentation from the EU Maritime Safety Unit European Commission was given by Mr. Jacob Terling. His speech was entitled “EU/EEA Operational Guidelines on Places of Refuge.” He later participated in the TTX exercise as an observer on site and contributed to the hot wash up.

Figure 5 Jakob Terling, representative European Commission

Mr. Terling began his speech by emphasizing the importance of such exercises and meeting physically to learn who does what in such accidents and what changes are needed by people and organizations. He proceeded with an encouraging statement on what is needed: coordination, cooperation, concerned action, commitment, and common understanding (of all involved!).

Mr. Terling addressed the challenges of providing places of refuge to vessels in distress. He reminded participants about several past accidents that became historical before the IMO guidelines were developed in 2003. The fire onboard MSC Flaminia raised concerns about vessels in distress entering coastal areas with potentially hazardous cargo. Similar concerns resulted in a major oil spill in 2002, when the oil tanker Prestige broke in two and sank after governments refused to allow it to dock in their ports.

3 Outcomes

3.1 Summary of learning points

Through discussions during the tabletop exercise, the hot wash up, and the individual feedback through evaluation forms, the participants identified several learning points, presented here in accordance with the learning objectives.

3.1.1 Understanding organization, roles, and responsibilities when handling a nuclear-powered vessel in a normal situation and in a complex situation

- In the case of a maritime incident, authorities will handle different scenarios according to their own legal systems and plans. Exercise participants discussed and became more aware of roles and responsibilities. Norway has experience with handling maritime casualties with the risk of oil pollution, but the risk of radioactive contamination poses different challenges. Thus, developing plans and scenarios, and conducting exercises, is essential to clarify roles and responsibilities between the different organizations. There is a need for detailed procedures, including checklists and action cards. In particular, it is necessary to implement additional routines and procedures for emergency preparedness, especially concerning normal or close-to-normal situations. In addition, it is crucial that the roles of the Norwegian Coastal Authority, the Norwegian Radiation and Nuclear Safety Authority and the Norwegian Radiological and Nuclear Crisis Committee are well defined and understood by other authorities in different countries in such a situation.

- To handle a complex situation more effectively, the roles and responsibilities among authorities seem defined, but a proactive approach from the coastal state is needed. In the case of Norway, the state receives an automatic notification when a vessel begins drifting. Any complexities result in challenges associated with gaining the necessary information to complete a comprehensive situational assessment. In cases involving nuclear-powered vessels, it is important to act promptly where there is a risk of radioactive pollution. Therefore, it is necessary to monitor and assess the risk and contamination prognosis, even during the early stages, before awareness of the possible risk of radiation release in the near future is clear. As such, awareness of the importance of geography is also needed when it comes to both hazard assessments and possible mitigating actions. Nuclear emergency situations differ significantly from other emergencies (such as an oil spill), and the priorities and decisions required to mitigate such an event may also differ greatly. One of the learning points is that there is a need to closely assess the situation and start preparing for a deterioration of the situation from the first notification. It is important to notify relevant authorities and other States according to international agreements.

- Concerning roles and responsibilities in a complex situation involving the risk of radioactive contamination, it is crucial to clearly understand the motives behind the proposed mitigating measures and actions of the different authorities. With different areas of expertise come various considerations; therefore, internal procedures for handling a damaged vessel that poses the risk of radioactive contamination involving all authorities should be coordinated, revised and tested, including who shall do what and when. This should be described for both planning and decision-making.

Sub-conclusions:

➔ Roles and responsibilities between the Norwegian Coastal Administration, the Norwegian Radiation and Nuclear Safety Authority, and the Norwegian Radiological and Nuclear Crisis Committee should be well understood, even for ordinary incidents and near-accidents.

➔ There is a need to establish a proactive approach to risk assessment and early prognosis, as well as to the development of a common situational picture. Capabilities in the different States should be clarified in case neighboring countries need to ask for assistance relating to an accident. Examples of such capabilities could be launch drones for the identification of radiological release.

➔ Internal procedures for handling a damaged vessel posing the risk of radioactive contamination should be revised (e.g., by Vessel Traffic Service [VTS]).

3.1.2 Understanding collaboration among responsible authorities handling a nuclear-powered vessel in a complex situation

- The participants discussed the strong cooperation and early information exchange between involved organizations, particularly the Norwegian Coastal Administration (including VTS) and the Norwegian Radiation and Nuclear Safety Authority. The nuances that call for more discussion and better operationalization include the attainment of a common situational understanding among all involved organizations and a common understanding of similarities and differences to ensure cooperation when handling other incidents at sea.
- There is a need for awareness of counterparts, particularly their competences, capabilities, concerns, and available actions. Given the topics at hand, it has become clear why handling any such situation requires expert input from a nuclear safety preparedness perspective and why special rules for protection take precedence.
- There is a need for a prepared written contact procedure between, e.g., VTS and vessels for different radiological and nuclear situations. Such an action card might specify what to ask and what to convey to a vessel regarding a request for license. Similarly, a prepared contact card to be shared among the coastal state, owner of the vessel, and flag state may be beneficial.
- It is important to implement cooperation plans between the Norwegian Radiation and Nuclear Safety Authority and the Norwegian Coast Guard, as well as to recognize that nuclear events proceed differently from other events and to draw up plans for such.
- Learn from experience using systems such as BarentsWatch, a best practice that should be implemented in the nuclear preparedness organizations.
- Pre-defined places of refuge, which is a best practice, must be considered, specifically in situations presenting the risk of radioactive contamination.
- Implement results from projects such as the Nordic Handbook for Search and Rescue in a Maritime Radiological and Nuclear Emergency (RNSARBOOK) and the Operationalization of Radiological and Search and Rescue Cooperation in Radiological and Nuclear Rescue Operations (RNSARCARDS). Such handbooks, standard operating procedures, and action cards can improve the handling of such a vessel.

Sub-conclusions:

➔ The cooperation agreement outlining the division of roles and responsibilities between the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority should be further elaborated based on the latest developments and learning points.

- ➔ Standard operating procedures for cooperation between the Norwegian Coastal Administration, the Norwegian Radiation and Nuclear Safety Authority, and the Norwegian Radiological and Nuclear Crisis Committee should be further elaborated.

- ➔ General competence can be enhanced and unified using a handbook/action cards for handling vessels in situations presenting a risk of radiological contamination, and VTS will benefit from such procedures.

3.1.3 International aspects

- During discussions and the hot wash up, participants perceived Norway as experienced and relatively well-prepared for such incidents. In a complex scenario, the Norwegian organizational structure with the Crisis Committee, including the Norwegian Radiation and Nuclear Safety Authority, the Norwegian Coastal Administration, the Armed Forces, the Ministry of Foreign Affairs, etc., is possibly an international best practice.
- Roles, responsibilities, and national legislation are organized differently in various Nordic countries, although these countries also have systems and plans for such scenarios. Countries organize differently, but the risks and possible consequences are equally shared. Denmark and Sweden do not have regular visits from nuclear-powered vessels to their national ports, so cooperation between the two is ongoing due to their geographical proximity and marine traffic in the Storebælt strait.
- Denmark performs an atmospheric dispersion modelling every time a nuclear-powered vessel transits through Danish waters, which was identified as a best practice. Meanwhile, Sweden has nuclear power plants ashore and therefore has some contingency plans in place, but the same challenges arise when it comes to handling a maritime accident. Therefore, there is a need to establish guidelines to ensure understanding, a common language, and situational awareness among countries, and new or improved plans must be further developed and trained.
- There is a lack of transnational on-scene guidelines for uncertain situations presenting the possible risk of radiation release, thus necessitating closer cooperation between neighboring coastal states. Further, there is a need to update the International Maritime Organization (IMO) and European Union (EU) guidelines on places of refuge to incorporate radiation. It may be necessary to consider the role of EU Emergency Towing Vessel (ETV) services when facing risk from radioactive and nuclear-powered vessels. Competence, procedures and training would in that case be necessary as part of the contingency planning.

Sub-conclusions:

- ➔ There is a need to develop international procedures and guidelines.

- ➔ There is a need to update EU and IMO guidelines to reflect scenarios with risk of radioactive release from a vessel.

3.1.4 Understanding how a nuclear-powered vessel will be handled in an uncertain and complex situation within and outside 12 nm

- Participants discussed various measures, as well as the importance of their early adoption and coordination with other authorities, and they were reassured that different authorities in Norway have significant knowledge of how to handle such a situation, were it to happen near the coastline. Cross-sectorial cooperation is necessary, including civilian–military.
- Decisions must be made concerning which steps to take in the early stage. Setting up a dialogue between VTS, the Norwegian Radiation and Nuclear Safety Authority, and captain of the vessel may ensure the right questions are asked. Proactive handling of the vessels owner and the captain can contribute to easier salvaging/towing if preparations are made before evacuation. Thus, the actions required of the captain of the vessel prior to evacuation must be discussed.
- It is vital to make preventive decisions early for handling the vessel, before ending up with an abandoned drifting vessel with the potential for radioactive release. The window of opportunity closes fast when there is the risk of a nuclear emergency.
- One of the most important measures identified is the need to consider towing arrangements with ropes early as a preventive measure before evacuating the vessel and before a possible release from the reactor.

Sub-conclusions:

➔ There is a need to discuss the option of towing and ensure a proactive approach to prepare for towage, as well as to ask the vessel to sail towards the high seas.

➔ Early dialogue between VTS, the Norwegian Radiation and Nuclear Safety Authority, and the captain of the vessel should be established.

3.1.5 Understanding the legal basis within and outside 12 nm for handling a nuclear-powered vessel

- Participants reflected that they improved their understanding of the legal basis for a nuclear-powered vessel seeking shelter or a place of refuge. There is a requirement for nuclear-powered vessels to have a license to enter Norwegian internal waters, also if they seek a place of refuge. However, exceptions can be made to the requirement for *written* license for (foreign) vessels that seek a place of refuge; it can be given orally when time requires in extraordinary situations This exception can also be applied preventively - to prevent an emergency situation arising. Licenses are granted by the Ministry of Health and Care services for civilian vessels and by the Ministry of Defense for military vessels.
- The issue of written license may be an urgent concern in terms of the time available for further actions and decision-making. Thus, it is necessary to understand clearly when to deviate from this requirement, if this is not a "normal" situation anymore.

- It is important to have legislation providing adequate jurisdiction for the coastal state to implement measures, in accordance with international law, where there is a risk of radioactive contamination.

Sub-conclusions:

- ➔ There is a need for a procedure describing when to deviate from written license concerning nuclear-powered vessels seeking shelter or place of refuge.
- ➔ The Norwegian Coastal Administration and the Norwegian Radiation Protection Authority will continue the work with a joint evaluation of the existing Places of refuge and routines to take a vessel to such areas.
- ➔ Consider if authority to grant place of refuge should be delegated to the Norwegian Radiation and Nuclear Safety Authority in incidents involving nuclear-powered vessels.

3.1.6 Understanding how authorities will handle the accidental release of radionuclides

- The participants discussed that a release represents a different challenge than a traditional pollution situation and would restrict the possible mitigation options. Knowledge of the specific properties of radiation and radioactive pollution must be enhanced outside the radiation authorities. Understanding and cooperation between responsible actors of the Norwegian authorities in terms of handling such a situation is necessary. One example that was brought up is that one should ask the vessel to sail towards the high seas in cases of radioactive pollution, which is the opposite of what one would want in a traditional oil spill. There is a need to consider all preventive and mitigating operational measures the authorities can take, in case of danger of- or acute radioactive pollution.
- The competent authorities should act proactively and plan for the worst-case scenario. Prepare the vessel for emergency towing and possible sinking, as admitting such a vessel to a place of refuge might not be the best solution. It is important to cooperate with the flag state and owner of the vessel. Towing in case of an accidental release is challenging, as there is concern with the Norwegian Coast Guard's ability to tow in such a situation, highlighting the limitations for responders when working in a radiation environment.
- Responsibility must be determined between the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority for decisions concerning a place of refuge. Careful consideration of radioactive discharge when choosing a place of refuge and different measures is needed.
- The decision of mitigating measures, like place of refuge or sinking of the vessel, are complicated, and may have political aspects. In the end, the decision may be made at the highest political level, and decision-makers should be presented with well justified options. A decision-aiding tool should be developed.

Sub-conclusions:

- ➔ There is a need to consider all preventive and mitigating operational measures the authorities can take, in case of danger of- or acute radioactive pollution. Templates for decisions must be prepared in advance and be available to both agencies in the event of an incident.

- ➔ A proactive approach is needed when asking vessels to sail towards the high seas.

- ➔ When determining whether a request for place of refuge for a nuclear-powered vessel should be granted, and to assess which places of refuge are relevant, there is a need for coordination between the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority.

- ➔ There is a need for more radiation competence building workshops for the Norwegian Coastal Administration and the Norwegian Coast Guard. This may be relevant for the County Governor and municipalities as well.

3.1.7 International aspects

- The participants discussed how geographical location would influence the choice of a place of refuge and mitigating measures. There are shallow waters between Denmark and Sweden, as the Storebælt strait between them is narrow and land with heavily populated areas is much closer, which may lead to consequences for society quickly. Norway has a very long coastline, with the opportunity to tow a vessel to the Atlantic and/or sink it. The case is similar for Iceland.
- Measures and plans are in place but differ somewhat between countries. There is no license requirement in Sweden and Denmark, nor are there specific procedures for nuclear-powered vessels. As such, it is important to raise this concern at the European level, as well.
- Iceland should inform and request assistance from neighboring countries early on, as well as assess proportionate interventions due to the danger of pollution, and cooperation between nations must be considered.

Sub-conclusions:

- ➔ There is a need to develop international procedures and guidelines in case of accidents involving nuclear-powered vessels. The relevant authorities should make an assessment to see if the plans harmonize and should coordinate the procedures if they do not harmonize.

➔ There is a need for international and EU cooperation on procedures for requesting assistance and procedures on mitigating measures in case of an accident involving a nuclear-powered vessel or other floating nuclear-powered installations.

3.2 Summary of conclusions

1 Suggested activities to be performed to enhance the general competence on handling nuclear-powered vessels

a. Seminars on towage preparations.
b. Workshops and seminars with the Norwegian Coastal Administration and the Norwegian Coast Guard.
c. Handbook and action cards to be developed and used at VTS.

2 Proactive approaches

a. Obtain a risk and contamination prognosis early, as well as establish a common situational picture.
b. Prepare to tow the vessel before evacuation.
c. Ask the vessel to sail towards the high seas.
d. Establish an early dialogue between VTS, the Norwegian Radiation and Nuclear Safety Authority, and the captain to ask for the appropriate information.
e. Identify the capabilities and launch drones for radiological release detection.
f. Consider Emergency Towing Vessel (ETV) services for at-risk nuclear-powered vessels.

3 Legal issues

a. Licenses and need for guidance for both applicants and authorities involved.

4 Roles and responsibilities

a. The coordination document between the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority should be updated.
b. There is a need to consider all preventive and mitigating operational measures the authorities can take, in case of danger of- or acute radioactive pollution. Templates must be prepared in advance and be available to both agencies in the event of an incident.

5 Procedures and international guidelines

a. EU and IMO guidelines should be developed or updated to include nuclear-powered vessels.

b. Cooperation procedures between key stakeholders should be updated.

c. Internal procedures (e.g., VTS) to be revised.

4 Exercise evaluation

4.1 Evaluation method

The evaluation of the Arctic REIHN TTX 1 was conducted by gathering information through a survey using the online tool “Nettskjema”, Norway’s securest and most used solution for data collection. The survey included questions associated with the learning objectives of the TTX 1 exercise and the exercise conduct on April 26, 2023. There were three sets of questions: those aimed at participants, those aimed at distaff, and those aimed at observers. The received data were used in the Arctic REIHN TTX 1 report and will be used in the Final Arctic REIHN exercise report. In total, 30 minutes were dedicated to the evaluation at the end of the exercise, and participants received a link and a QR code to provide feedback.

The evaluation team consisted of Nord University, the Norwegian Coastal Administration, and the Norwegian Radiation and Nuclear Safety Authority.

Figure 6 Training audience and observers

Participants in training audience, distaff, and observers

Number of submissions: **46**

Submissions	Count	% of submissions	
Other	14	30.4%	30.4%
KU - The Crisis Committee for Nuclear Preparedness	1	2.2%	2.2%
IRSA - Icelandic Radiation Safety Authority	0	0%	0%
MSB - Swedish Civil Contengencies Agency	2	4.3%	4.3%
DEMA - Danish Emergency Management Agency	2	4.3%	4.3%
NCA - Norwegian Coastal Administration	12	26.1%	26.1%
DSA - Norwegian Radiation and Nuclear Safety Authority	15	32.6%	32.6%

Figure 7 Organizations represented in the exercise

Number of submissions: **46**

Submissions	Count	% of submissions	
Other	4	8.7%	8.7%
Iceland	1	2.2%	2.2%
Sweden	3	6.5%	6.5%
Denmark	3	6.5%	6.5%
Norway	35	76.1%	76.1%

Figure 8 Countries participated in the exercise

4.2 Accomplishment of the learning objectives

Participants assessed the accomplishment of the learning objectives related to roles and responsibilities through injects 1 and 2 and those related to measures and legal issues through injects 3 and 4. Most participants answered “yes, absolutely” and “yes, to an extent.” The participants were also asked about the value of the preparation phase to their learning, to which they answered that preparations for the exercise are highly useful to enhancing competence within organizations. Distaff emphasized that the planning and preparedness phase contributed to the accomplishment of the learning objectives. In addition, the planning and preparation phase was highly useful, both for organizational learning and for learning on a personal level by strengthening the cooperation among organizations.

Submissions	No	To a little extent	Unsure	Yes, to an extent	Yes, absolutely	Chart
in a normal situation ?	3	4	0	16	23	
in a complex situation ?	2	1	3	22	18	
nationally	2	2	4	23	15	
internationally in collaboration between responsible authorities	4	3	12	19	8	

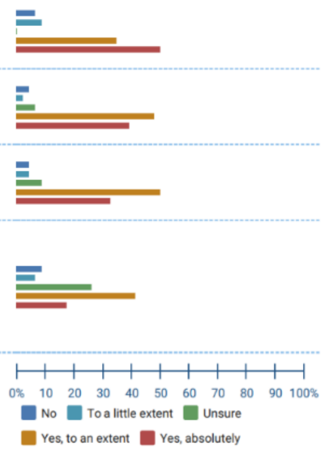


Figure 9. Accomplishment of learning objectives related to roles and responsibilities through injects 1 and 2

Submissions	No	To a little extent	Unsure	Yes, to an extent	Yes, absolutely	Chart
in a complex situation outside territorial waters (outside 12nm)?	1	5	0	27	13	
the legal basis outside territorial waters (outside12 nm)?	4	2	2	30	8	
in a complex situation inside territorial waters (inside 12nm)?	1	4	2	28	11	
the legal basis inside territorial waters (inside 12 nm)?	3	4	5	23	11	
if there is a release of radionuclides ?	3	3	5	24	11	

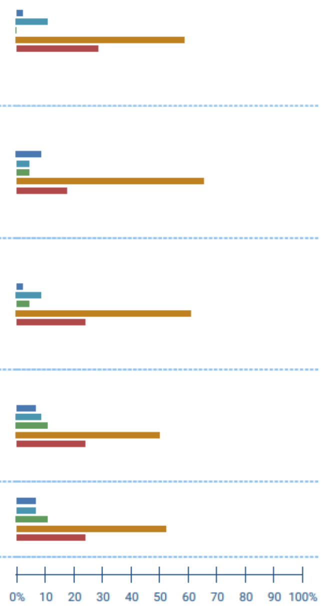


Figure 10. Accomplishment of learning objectives related to measures and legal issues through injects 3 and 4

Number of submissions: **27** Average: **4.41** Median: **5**

Submissions	Count	% of submissions
5	17	63%
4	7	25.9%
3	1	3.7%
2	1	3.7%
1	1	3.7%
0	0	0%

Figure 11. The value of planning and preparation for competence enhancement at one's own organization

4.3 Evaluation of the scenario and exercise

4.3.1 Scenario evaluation

The participants were asked to assess whether the scenario was appropriately complex, realistic, and credible, and they emphasized that such an exercise should be repeated regularly, at all levels, and by all involved. All organizations have new personnel that must be trained as well to understand the complexities of a scenario of handling of a damaged vessel with a risk of radioactive contamination. The participants and the observers perceived the exercise as realistic and credible, as it was structured as an event that could occur, regardless of geographical area or season. Motivation and commitment during the exercise also showed the importance of detailed planning. As one participant concluded:

> "An important exercise across nations; more exercises nationally and between neighboring countries are welcome and needed for better readiness for handling radiation accidents at sea."

Number of submissions: **46** Average: **4.48** Median: **5**

Submissions	Count	% of submissions
5	28	60.9%
4	12	26.1%
3	6	13%
2	0	0%
1	0	0%
0	0	0%

Figure 12. Assessment of the level of complexity of the scenario

Number of submissions: **46** Average: **4.39** Median: **4**

Submissions	Count	% of submissions	
5	22	47.8%	47.8%
4	21	45.7%	45.7%
3	2	4.3%	4.3%
2	1	2.2%	2.2%
1	0	0%	0%
0	0	0%	0%

Figure 13. Assessment of realism and credibility of the scenario

4.3.2 Exercise conduct evaluation

The participants assessed whether it was an appropriate time to discuss the injects. In addition, observers indicated that the technology worked sufficiently when streaming the exercise. Meanwhile, observers commented that the exercise was nicely organized and was interesting to witness. Specifically, the legal scholars emphasized the usefulness of learning about handling emergencies based on the scenarios used in this exercise. In addition, observers responded that it was possible to get much information through streaming.

Number of submissions: **34** Average: **4.35** Median: **4.5**

Submissions	Count	% of submissions	
5	17	50%	50%
4	12	35.3%	35.3%
3	5	14.7%	14.7%
2	0	0%	0%
1	0	0%	0%
0	0	0%	0%

Figure 14. Assessment of appropriate time to spend discussing through the injects

Number of submissions: **12** Average: **3.92** Median: **4.5**

Submissions	Count	% of submissions
5	6	50%
4	1	8.3%
3	3	25%
2	2	16.7%
1	0	0%
0	0	0%

Figure 15. Whether the technology worked sufficiently while streaming the exercise

4.3.3 Overall evaluation

The participants assessed highly the value of the scenario and exercise, and they encouraged the work to be continued between the Norwegian Radiation and Nuclear Safety Authority and the Norwegian Coastal Administration, particularly the lessons learnt during preparation, e.g., as if not, we will return to square one. This topic is of interest to other relevant organizations involved in crisis response and consequence reduction, and the exercise offers a basis for effective collaboration among different agencies in Nordic countries. The participants appreciated the efficient planning and conducting, having raised many questions and having added a new dimension to existing practices.

Number of submissions: **46** Average: **4.54** Median: **5**

Submissions	Count	% of submissions
5	31	67.4%
4	9	19.6%
3	6	13%
2	0	0%
1	0	0%
0	0	0%

Figure 16: Overall value of the exercise

5 Conclusion and the way forward

As participants indicated in the evaluation, the exercise enabled the achievement of the learning objectives and provided a good arena for learning, trust building, identifying best practices, and raising new questions. The decision-making dilemmas regarding exclusive economic zones, territorial waters, legal issues, and radioactive contamination rendered the discussions dynamic and engaging, and the planning and preparation phase was valued, especially among distaff, as it contributed to learning and trust building between organizations.

The exercise addressed multiple issues and scenarios that's unexplored, and the represents from EU, IMO and IAEA acknowledged the relevance and importance of the work Norwegian authorities has started on. More exercises have been requested by participants among the Nordic countries and across sectors, thus indicating the necessity for a shared understanding and guidelines. This exercise should be repeated regularly and on many different levels, as all authorities have new personnel that must be trained to understand the complexities of such a scenario and to ensure continuity in knowledge building.

Identified needs for changing or making new procedures or guidelines are as follows:

- Plans and guidelines of existing rules must be user-friendly for those involved in applying these.
- Follow-up with smaller exercises and updated guidelines for these kinds of incidents.
- EU/EEA guidelines for places of refuge must be prepared for scenarios with nuclear-powered vessels.
- Update IMO guidelines to include special considerations of nuclear-powered vessels.
- Update IMO regulation on towing arrangement requirements to include special considerations of nuclear-powered vessels.
- Develop checklists and decision-supporting tools for actors involved.
- Update the cooperation agreement and the coordination document between the Norwegian Coastal Administration and the Norwegian Radiation and Nuclear Safety Authority, and revise these at regular interval.
- Ensure that the options for handling a nuclear-powered vessel in distress are included in the plan for the Norwegian Radiological and Nuclear Crisis Committee.
- Further develop and implement procedures for licensing of nuclear-powered vessels seeking place of refuge.
- Further identify and develop procedures for preventive and mitigating operational measures the authorities can take, in case of danger of- or acute radioactive pollution form a vessel. Templates must be prepared in advance and be available to both agencies in the event of an incident.

Identified needs for changing a practice at an organizational level are as follows:

- Relevant organizations should increase focus on updating their relevant radiological and nuclear scenarios.
- The relevant organizations should review or develop emergency procedures related to handling a reactor-powered vessel.
- Initiate the Norwegian Radiation and Nuclear Safety Authority into BarentsWatch.
- NCA, DSA and the coast guard should review relevant guidelines for emergency personnel operating in contaminated maritime areas.
- Operationalize plans and develop and implement action cards.

- Each of the countries should conduct national risk assessments and establish national ability and capability based on the assessments.
- Establish a checklist with defined questions to be asked to the vessel's captain.
- Exercise low-risk, high-impact scenarios regularly and institutionalize learning and share experiences.
- Routinely disperse modelling during ordinary transits, as well as more information from VTS NOR/NCA during transit (e.g., expected arrival times at different locations).
- Establish checklists for a place of refuge procedure for the Norwegian Coastal Administration.
- Build a network and trust among the relevant actors in the Nordic countries.
- Apply for EU funding for future project(s) or exercises with focus on “new” or underexplored scenarios, like Arctic REIHN is a good example of.
- Inform about the exercise across relevant international fora at EU level, at the IAEA and other relevant international fora.
- NORD University should publish academic articles based on findings in the exercise.

Final Report Tabletop 2 (TTX2) –

Normalisation and stakeholder involvement

ARCTIC REIHN 2023

Oslo 24–25 May 2023

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Report authors/contributors:

Håvard Thørring (DSA)
Ingrid Landmark (DSA)
Mari Komperød (DSA)

Deborah Oughton (NMBU)
Yevgeniya Tomkiv (NMBU)

Torild Agnalt Østmo (NFSA)

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1. Introduction

A large-scale nuclear emergency exercise, Arctic REIHN 2023, was held in Norway during April–May 2023 – financed by the EU and involving partners from several countries. The aim of this exercise was to test and verify preparedness and international response in case of a nuclear or radiological accident in the Arctic.

TTX2 was a tabletop exercise on "Normalisation and stakeholder involvement". The exercise was part of Arctic REIHN work package 7 (Tabletops, workshops & seminars).

In accordance with IAEA terminology, "normalisation" refers to the processes occurring during the transition phase to prepare for a new normal situation in an affected area (i.e., existing exposure situation). The transition phase is the period after the emergency response phase when the situation is under control, detailed characterization of the radiological situation has been carried out and activities are planned and implemented to enable the emergency to be declared terminated (see figure 1).

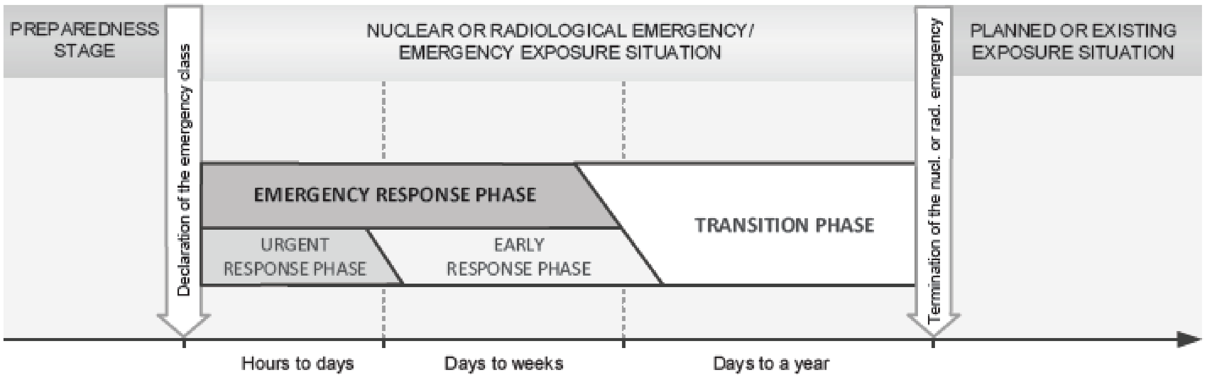


Figure 1: *Temporal sequence of the various phases and exposure situations for a nuclear or radiological emergency (from IAEA GSG 11). For planning purposes not to be used during emergency response.*

Due to the postponement of Arctic REIHN from 2022 to 2023 as a consequence of the war in Ukraine, the objectives / discussion themes of TTX2 were planned in two stages.

The main topics of the exercise were decided at the end of 2021 after meetings and email correspondence between DSA, other Arctic REIHN partners[1], representatives of the Norwegian Food Safety Authority (NFSA), and the Norwegian Directorate of Health:

- **Topic A** – Lifting and adapting emergency actions with particular emphasis on the return of evacuees and relocated people.
- **Topic B** – Health-related follow-up, including mental health and psychosocial support.
- **Topic C** – Long-term food production with emphasis on marine fish.

Involvement of stakeholders in decision making in relation to these topics (who, when, how, etc.), and exchange of experiences and views between participating countries and national / international organisations were also fundamental parts of the exercise.

[1] ANEPC (Portugal), Portuguese Environment Agency, Swedish Civil Contingencies Agency, Icelandic Radiation Safety Authority, Danish Emergency Management Agency (DEMA).

In early 2022, researchers from the Norwegian University of Life Sciences (NMBU) were engaged as facilitators for the discussions. This cooperation continued in the second stage of the planning – starting at end of 2022. NFSA also continued their involvement in the planning process (particularly in topic C) during the second period. From January to May 2023 several planning meetings were held between DSA, NMBU and NFSA.

2. Scenario and timeline of events

TTX2 was based on the scenario from the Arctic REIHN Command post exercise (CPX) involving a hypothetical accident onboard a nuclear-powered icebreaker named HYDROATOM (figure 2).

Figure 2: *The icebreaker HYDRATOM. The vessel has two 171 MW_t reactors using high enriched (90%) U/Zr cladding as fuel. The vessel had 128 cruise passengers and a crew of 140 persons on board from four nationalities: Canada, USA, UK and the fictitious nation of Atlantistan, used as the vessel's nationality in the Arctic REIHN exercise.*

2.1. The emergency situation and accident scenario

Only a short summary will be given here (table 1). During the release, the vessel was anchored ca. 2 nautical miles from the mainland west of Bodø (7 km from Bodø centre) (figure 3).

Table 1: *Overview of main emergency events during 3 May 2023*

Time	Event
08:08	Fire in HYDRATOM reported
11:22	Fire reported to be under control
14:03	Fire flared up again. The situation deteriorated rapidly
15:30	Evacuation of passengers and most of the crew (240 people). Reactor damage reported – cooling was reported to be unstable
16:00	Fire out of control and had spread to the control room
16:30	The rest of the crew was evacuated (28 people)
16:50	Powerful explosion with smoke. Early measurements (with a drone) showed elevated levels of radioactivity
17:00	Ongoing release of radioactivity to air
23:55	HYDROATOM sunk due to damage from the fire – the vessel is at ca. 50-meter depth. The reactor has been cooled by seawater and has stopped. Release to air has also stopped

Figure 3: *Position of the vessel during the accident*

2.2. Weather during the accident

During the radioactive release it was onshore wind from southwest/west. Windspeed in the area was approximately 10 m/s. There were also local rain showers. It was estimated that the release reached Bodø city within minutes and Sweden within 2–3 hours.

2.3. Protective actions and other response actions

There were consequences to both sea and land areas from the accident – including cross-border contamination. Emergency actions initiated, adapted and lifted during the period 3 May to 15 June 2023 are summarised in the following sub-sections.

Evacuation (acute and relocation)

On 3 May (16:00) a safety zone of 3 km radius was established around the vessel. In this area, fairway restrictions were initiated. There were also restrictions on visiting the uninhabited islands within the zone. Except for the 268 crew and passengers on HYDROATOM, no people were evacuated from the safety zone. However, there were self-evacuees from different parts of the surrounding areas (outside safety zone). On 5 May, the safety zone around the vessel was reduced to 1 km (radius). Based on measurements indicating persistently high levels of radioactive contamination in an area north of Bodø centrum (Skivika and Løpsmarka) about 1000 people were relocated[2] on 12 May.

Iodine thyroid blocking (ITB)

On 3 May (15:00) it was given advise to take iodine tablets within a radius of:

- 60 km for all children (< 18 years), pregnant women and nursing mothers
- 20 km for all ages between 18 and 40 years

This included up to eight municipalities: Gildeskål, Beiarn, Bodø, Steigen, Meløy, Sørfold, Saltdal and Fauske. The municipalities were notified that iodine tablets should be distributed to schools and kindergartens. This was implemented by the County Governor of Nordland. In addition, parents were informed that they could obtain iodine tablets for their children from their school if they did not have iodine tablets at home.

Sheltering (staying indoors)

On 3 May (16:30) it was given advise to stay indoors for up to 48 hours (sheltering) within a radius of:

- 60 km for all children (< 18 years), pregnant women and nursing mothers
- 20 km for all adults (≥ 18 years)

This included the same municipalities as for ITB: Gildeskål, Beiarn, Bodø, Steigen, Meløy, Sørfold, Saltdal and Fauske.

For personnel critical to maintaining societal functions, reference was made to the guidelines from the Norwegian Crisis Committee for Nuclear and Radiological Preparedness[3].

The advice on indoor sheltering for adults was lifted from 5 May (16:00). But it was given advice for reduced time outside for children until fallout and radiation levels were mapped for affected areas. In cases where children were outside it was advised to prevent inadvertent ingestion (avoid eating sand, snow, etc.). Sand in sandboxes was replaced in the most affected areas.

[2] Relocation is temporal or permanent moving of people if radiation levels do not decrease at the anticipated rate.
[3] Veiledning til arbeidsgivere og yrkesgrupper med kritiske samfunnsfunksjoner ved råd om innendørsopphold pga.radioaktivt utslipp til luft

Decontamination
Radiation monitoring and decontamination stations were set up by the police, the Civil Defence, prehospital personnel and fire and rescue services – where the evacuees (from the vessel) came ashore (figure 4). It was also recommended self-decontamination for people who were outside during cloud passage within a 60 km radius from the accident site.

Figure 4: *Decontamination station at Bodø harbour with DSA monitoring portals (Photo: Hallfrid Simonsen, DSA).*

Medical care and psychosocial support
The CBRNE-centre was available for guidance during the emergency. The Municipality of Bodø established an evacuation centre and increased staff in emergency room (hospital). Several evacuees were brought in, but none of them had radiation related injuries.

Food and drinking water
Before the release of radioactivity on 3 May it was recommended to take the following preventive actions:

- Sheltering livestock as far as possible – particularly dairy animals, animals ready for slaughter.
- Bring indoors or cover fish hanging to dry.
- Advise private individuals on drinking water – particularly on the use of cistern water.

High priority was also given to get an overview of production in potentially affected areas (incl. overview of waterworks).

Preparation of nuclear emergency regulations for food was initiated. The regulations were ready by 4 May, and included:

- Maximum permitted levels (MPL) for radioactive contamination in food, feed and drinking water to be placed on the market (Table 2). The MPLs applied to the whole country.
- Two agricultural countermeasures were also included: (1) Livestock for milk and meat production must be kept indoors, except sheep and reindeer. (2) Feed must be covered or stored indoors. These restrictions applied to Nordland County.

Regulations were temporary and had to be reviewed within three months. See Appendix 4 for the full regulations (in Norwegian).

It was assumed that no changes were made before mid-June, and that livestock for milk and meat production (except sheep and reindeer) in Nordland County were still inside at the start of TTX2. However, in a real situation it is likely that the restricted area would have been modified according to better overview of the radiological situation 6 weeks after the accident (section 2.4).

Table 2: *Maximum permitted levels for radioactive contamination in food. The maximum permitted levels applied to each isotope group should be treated independently.*

Isotope group	**Activity concentration (Bq/kg)**		
	Infant food[a]	**Dairy produce and liquid food[b]**	**Other food except minor food[c]**
Sum of isotopes of strontium, notably Sr-90	75	125	750
Sum of isotopes of iodine, notably I-131	150	500	2 000
Sum of alpha-emitting isotopes of plutonium and transplutonium elements, notably Pu-239 and Am-241	1	20	80
Sum of all other nuclides of half-life greater than 10 days, notably Cs-134 and Cs-137[d]	400	1 000	1 250

[a] Food intended for the feeding of infants during the first 12 months.
[b] Values are calculated taking into account consumption of tap-water. The same values are applied to drinking water supplies.
[c] Maximum permitted levels for a defined set of minor foods are ten times higher.
[d] Carbon-14, tritium and potassium-40 are not included in this group.

2.4. Radiological situation at start of TTX2

In mid-June the geographical extent and level of fallout of radioactive substances was assumed to be well-characterised by:

- External dose rate measurements at ground level (1 m) and *in situ* gamma spectrometry (HPGe) from various measurement teams.
- External dose rate measurements from the air – using helicopter and aircraft.
- Airborne *in situ* gamma measurements (using NaI detectors)

A deposition map of radioactive caesium is given as an example in figure 5. Additional maps are shown where relevant in the discussion parts (sections 4–6).

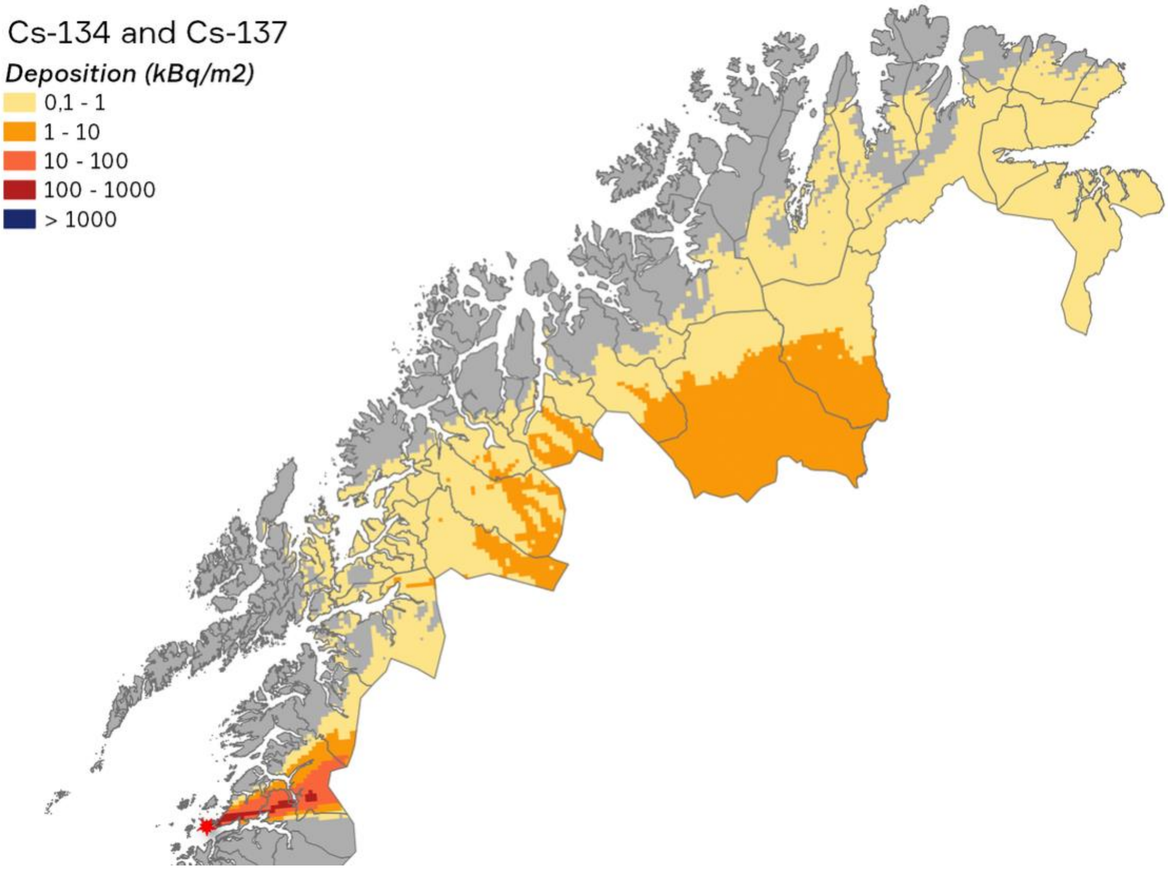


Figure 5: *Deposition of radioactive caesium (Cs-134+137) in Norway (reference date: 5 May 2023). In Sweden and Finland, levels were within the ranges of 0–100 kBq/m^2 and 0–10 kBq/m^2, respectively.*

Note that, implemented protective actions and other response actions described in the previous section (2.3) were based on prognoses and measurements during the first few days (i.e., limited amount of data). Such limitations have, of course, impacted on the decisions made during the emergency response phase.

3. Conduct

The exercise was organized by the Norwegian Radiation and Nuclear Safety Authority (DSA) and took place **in Oslo 24–25 May 2023**, as a lunch-to-lunch meeting. The location of the exercise was hotel Scandic Sjølyst, Sjølyst plass 5, NO-0212 OSLO.

TTX2 was divided into presentations and group discussions, as shown in the agenda below. More details on the conduct of these parts are provided in sections 3.2. and 3.3, respectively. Due to the broad scope of the exercise, parallel sessions were organised after the plenary introduction – with one group focussing on the "health issues" (topics A and B), and the other on the "food issues" (topic C). Note that parts of the exercise were also open to virtual participation (i.e., presentations on 24 May). The agenda is presented below:

Agenda – Tabletop 2 (TTX2)

Normalisation and stakeholder involvement

24 May	12:00		Lunch
	13:00		Registration
	13:15		Introductory plenary talks: Introduction to TTX2*, Håvard Thørring, DSA Experiences with normalization in Fukushima*, Pascal Croüail, CEPN, France Recommendations on nuclear preparedness*, Deborah Oughton, NMBU Scenario and timeline of events*, Håvard Thørring, DSA
	15:00		Parallel sessions:
		A	Discussions topic A: Lifting and adapting emergency actions with particular emphasis on the return of evacuees and relocated people
		C	Consequences for food production after the accident*, Torild A. Østmo, NFSA Communicating about food safety*, Yevgeniya Tomkiv, NMBU Discussions topic C: Long-term food production in general
	17:45		Summary day 1
	18:00		End day 1
	19:30		Dinner
25 May	09:00		Introduction
	09:30		Parallel sessions:
		B	Discussions topic B: Health-related follow-up including mental health and psychosocial support
		C	Discussions topic C: Long-term food production with emphasis on marine fish
	12:00		Summary day 2
	12:15		End of seminar
	12:30		Lunch

*These talks were streamed and open to virtual participation.

3.1. Participants

There were physical participants from several countries (Denmark, France, Finland, Iceland, Sweden, and Norway) – including authorities/decision-makers from Norway and within the EU region, international organisations, and selected stakeholders.

Participating organisation were as follows (see Appendix 1 for list of participants):

- Bodø Municipality, Norway
- CBRNE Centre, Norway
- Nuclear Protection Evaluation Centre (CEPN), France
- Danish Emergency Management Agency (DEMA)
- Danish Veterinary and Food Administration (DVFA)
- Icelandic Radiation Safety Authority (IRSA)
- Nordland Police District, Norway
- The Norwegian Fishermen's Sales Organization
- Northern Norway Regional Health Authority
- Norwegian Directorate of Health
- Norwegian Food Safety Authority (NFSA)
- Norwegian Radiation and Nuclear Safety Authority (DSA)
- Norwegian Seafood Council
- Norwegian University of Life Sciences (NMBU)
- Radiation and Nuclear Safety Authority of Finland (STUK)
- Swedish Radiation Safety Authority (SSM)

In addition, ca. 30 people attended virtually. About half of these were from DSA, NFSA, NMBU and DEMA. However, there were also participants from:

- Portuguese Environment Agency
- Swedish Civil Contingencies Agency
- Norwegian Directorate for Civil Protection (DSB)
- Norwegian Ministry of Health and Care Services (HOD)
- Norwegian Ministry of Agriculture and Food (LMD)
- County Governor of Nordland, Norway.
- Norwegian Fishermen's Association
- Institute of Marine Research, Norway.

3.2. Presentations

The introductory plenary talks were considered relevant for all participants of TTX2. This part of the exercise included clarification of concepts and providing the basic fundament for the group discussions:

- Pascal Croüail (CEPN) presented experiences with normalisation from the Fukushima Daiichi nuclear accident from 2011 to present, with emphasis on (a) return of the population to territories affected by the accident, and (b) fisheries resource management in the Fukushima Prefecture. The presentation demonstrated the complexity of such situations.

- Deborah Oughton (NMBU) talked about social dimensions in nuclear accidents, and lessons learned from Fukushima based on the report series from IAEA (2015) – e.g., socioeconomic consequences, involvement of affected people in decision-making, self-help activities. Recommendations for medical and health surveillance for populations affected by previous and future radiation accidents from the EU Shamisen project were also introduced.

- Håvard Thørring (DSA) described the exercise scenario and the main events during the emergency response phase – e.g., characterization of geographical extent, level of fallout and radiation doses, description of emergency actions in the affected area (Cf. section 2 of the present report).

Additional presentations were given in the parallel session of Topic C:

- Torild A. Østmo (NFSA) gave an overview of food production and waterworks in the affected area. More details on what had happened in various parts of food production were also provided (in addition to examples given under "Scenario and timeline of events"). The presentation was used as a basis for the group discussions, and part of it is presented in section 6.1.

- Yevgeniya Tomkiv (NMBU) gave a presentation on communicating about food safety related to nuclear emergencies. Themes included restoring confidence in food markets, protecting local economies, avoiding undue negative socio-economic impact, and communication during different phases of an accident (cf. Figure 1).

3.3. Organisation of discussions

This part of TTX2 was not streamed to avoid possible negative impact on the discussions. The number of participants in each group was 9–10 (see Appendix 1).

- Deborah Oughton was the facilitator for the "health group" (topics A and B)
- Yevgeniya Tomkiv was the facilitator for the "food group" (topic C)

Ingrid Landmark (DSA) gave short introductory presentations for topics A and B building on "Scenario and timeline of events" - providing additional information on the radiological situation, remedial actions and the number of people affected. This also included brief background information on relocation and health related follow-up. For topic C, the presentations given by Torild A. Østmo (NFSA) and Yevgeniya Tomkiv (NMBU) provided the necessary background for the discussions.

Details on the discussions is provided in sections 4, 5 and 6, for topic A, B and C, respectively.

4. Topic A – Lifting and adapting emergency actions

4.1. Background information

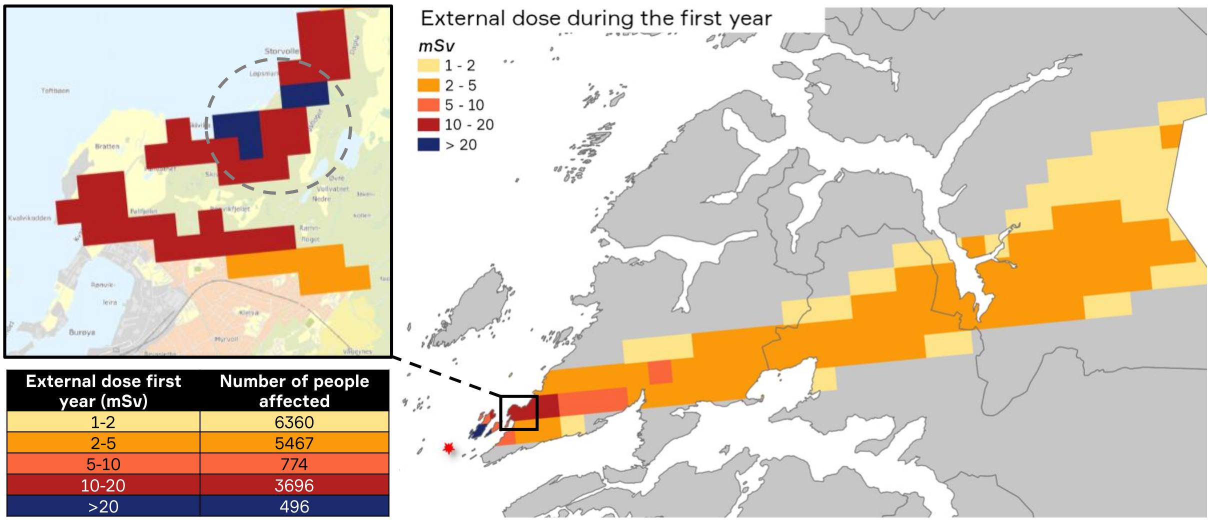
General situation at the start of TTX2:

- → Still relocation in "Løpsmarka area", but more details on the local radiological situation is now available (figure 6).
- → Relocated people (and self-evacuees) – some are in housing set up by Bodø municipality, some live with relatives in Bodø area, some live with relatives elsewhere in Norway.
- → Urban remedial strategies (particularly in the relocated areas) have been debated.
- → Strong need for information about doses and risks

Initial questions to the participants regarding lifting of relocation was:

- → What is needed for people to move back?
- → How do we make this decision?
- → Who makes the decisions?

The discussion was also open for additional discussion points.



External dose first year (mSv)	Number of people affected
1-2	6360
2-5	5467
5-10	774
10-20	3696
>20	496

Figure 6: *External dose during the first year (only areas >1 mSv/y are shown) and number of people affected. IAEA reference level for transitioning to an existing exposure situation: 1-20 mSv/y. Critical infrastructure in the relocated area include: School (300 pupils and 45 employees), kindergarten, football ground, playground, harbour, and hiking areas.*

4.2. Discussion

At the start of the session, the participants were asked by the facilitator to write down keywords they considered to be important for people to move back to the affected (relocated) area (details are provided in Appendix 2). This information – and the initial questions presented above – were used as starting point for the discussion.

The present summary has been structured in four (slightly overlapping) themes:

- Communication, information and dialogue
- Evaluating the current (radiological) situation
- Further measurements and remediation
- Establishing a "new normal"

Communication, information and dialogue

One of the most widely recognised factors that would support the return of the populations to the affected areas was communication. The participants highlighted the importance of dialogue with the affected people and their involvement in the decision-making. The authorities will need to provide information but also support the affected populations and show empathy.

As several levels of authorities will be involved in the emergency management, the information will have to be well coordinated and be given regularly. It is also important that the information is understandable and relevant, and that it responds to peoples' concerns. Communication should be honest and transparent – and acknowledge mistakes and identify how those are being corrected. It will be important to identify the needs of the population – but also of the local and regional authorities.

Participants recognised the need to learn from the successes and failures of other crises (e.g., the covid pandemic). They suggested the use of a common language of crisis communication to increase recognition of the concepts, to use experienced communicators and adjust information for the different groups, as some people might be more affected/vulnerable than others.

While it helps to put radiation risks into perspective with other hazards, it was recognised that this can be tricky. For example, comparison with medical and natural radiation risks can be useful (see example in Appendix 3), whereas comparisons with smoking and driving etc. are more challenging. Finally, to assist coordination of the communication between the different actors involved in emergency management, joint meetings should be organised across the different levels of governance.

Evaluating the current (radiological) situation

The radiological situation in the affected area will be the main factor to consider in the decision to lift the relocation order. As evident from figure 6, the relocated area is quite small, and the contamination levels are not very high (if compared to IAEA reference levels). Some of the participants, therefore, questioned whether other protective actions should have been considered in this situation. The decision to relocate was made under a lot of uncertainty and it could have been better to wait for more precise information on the local dose situation before making this decision. In addition, it was pointed out that dose estimates had not been corrected for sheltering by staying indoors[4], as usually recommended in such cases.

The participants recognised that it is challenging to define what is high and low dose when one needs to balance reference levels with peoples' perceptions of these doses. They argued that there would have to be a solid justification to support the decision to lift the relocation order. In addition, non-radiological factors like availability of critical infrastructure and services will have to be considered – as well as legal requirements to end the emergency.

There will also be a need to consider different groups of affected people – not only those relocated, but also the several thousand people outside of the relocation area likely to receive more than 1 mSv during the first year (figure 6). These different groups might require a different kind of follow up.

Further measurements and remediation

Continued measurements will be crucial to provide information to authorities and affected people, and regular updates of the radiological situations should be given. The group considered the situation near critical infrastructure – such as schools and kindergartens – as being particularly important.

It is important to empower local population and give them some control over their own exposure and the general recovery of the area. Personal dosimeters could be distributed to people in the affected areas to help them understand their exposure better and visualise the risk. Guidelines for decontamination and remedial activities could be developed so that people can clean their own homes and gardens.

However, there are challenges with these types of self-help activities. For instance, the use of private dosimeters implies that people will need help to interpret the dose rates so that they understand what they measure. Involvement of people in decontamination activities directed by the government can lead to challenges regarding the different requirements on protection that apply for the *public* and *workers* – e.g., different dose limits. In addition, it should be recognised that vulnerable groups might not have the same capacity to get involved and participate in these self-help activities. In all cases, communication would be key to the success of the measures.

Establishing a "new normal"

Summing up the general discussion, the participants described the importance of general support for the population to establish a "new normal" in the existing exposure situation (according to IAEA terminology). This means enabling populations to take decisions themselves on whether to return, thus accepting the extra risk in the affected area.

As mentioned above, solid justification will be needed for the return of people to the relocated area – balancing annual doses (cf. reference levels applied) against non-radiological issues and health risks such as depression etc. Individual variations in how people cope with the situation must be anticipated. Parents with small children might have different perceptions and expectation than elderly people. It was suggested that different groups could return at different times: starting with volunteers – then discussing with the rest. This is a common

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[4] Generally, people in Norway stay indoors from 80% to more than 90% of the time (depending on season and region): https://www.ssb.no/a/samfunnsspeilet/utg/201204/06/tab-2012-10-09-04.html. Dose estimates in figure 7 conservatively assume that there is no sheltering from staying indoors.

strategy in relation to evacuation and return of evacuees in various crises. The group also debated whether you could differentiate between age groups – elderly before young. At least some of the participants supported that this could be justified.

Return of evacuees would be linked to the termination of the emergency. Based on the radiological situation, it was suggested that a possible return could be within weeks to months. However, critical infrastructure and legal requirements in relation to termination of the emergency also needs to be in place before the relocation can be lifted. It was e.g., considered high priority to get the children back to school as soon as possible (cf. lessons learned from covid).

The group also discussed responsibilities for lifting the evacuation: It was the Norwegian Crisis Committee for Nuclear and Radiological Preparedness that made the decisions regarding protective actions in the first place, and it is likely that termination of the emergency and return of evacuees would be their responsibility as well (the distribution of responsibilities needs to be clarified). The County Governor will be an important actor on the regional level, and municipalities will cooperate with the County Governor.

Finally, a crisis lasts longer than an emergency, and there will be continuing *long-term* consequences in the "new normal". This is especially the case in connection with food production (see section 6). Challenges in connection with house values and jobs might also be expected.

5. Topic B – Health-related follow-up

5.1. Background information

General situation at the start of TTX2:

- → Radiation monitoring (and decontamination) has been offered to everyone in the area, including the "worried well". Personal data and monitoring results have been recorded.
- → Dose estimation is ongoing.
- → Thyroid monitoring has been offered to relevant groups – particularly children and pregnant women.
- → A health follow-up program is being developed by The Directorate of Health, the CBRNE-centre and DSA:
  - → Relevant groups have been identified.
  - → Inclusion criteria have been discussed.
  - → Dose registry is being established, based on measurements and dose estimates.

Prognosed thyroid doses in different areas are shown in figure 7.

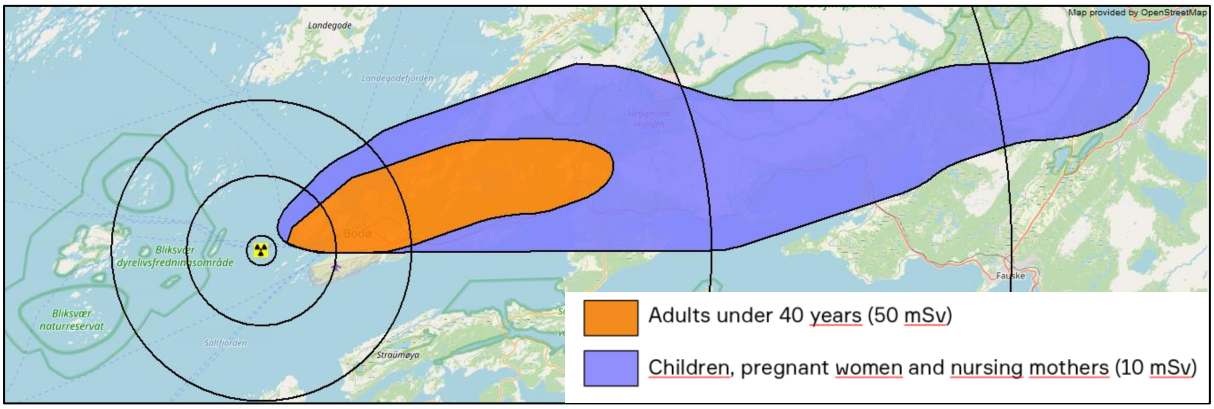

Figure 7: *Prognosed thyroid equivalent doses in different areas (mSv). Areas with need of ITB.*

The following questions were raised regarding health follow-up:

- → What kind of medical follow-up should be offered?
- → Who should be included?
- → What kind of measurements and dosimetry will support this work?

The discussion was also open for additional discussion points.

5.2. Discussion

Monitoring of individuals

Before the start of the discussion, Astrid Liland (DSA) presented an overview of available measurement equipment at DSA and other Norwegian institutes.
For our scenario, monitoring of individuals could be split in three:

- Use of measurement portals or handheld instruments for contamination control during the urgent response (acute measurements).
- Establishing a thyroid monitoring programme.
- Long-term monitoring using whole-body measurements.

Monitoring itself can induce psychosocial stress. There was a discussion on the importance of *neutrality* when contacting people regarding measurements. Participation should be voluntary, and wording should not impose pressure. Some examples from Norway were given indicating that a minor fraction of possibly affected people would want to be monitored (10–25%).

Thyroid monitoring

Following the recommendations from the SHAMISEN project[5], the participants agreed that in the discussed scenario, *thyroid monitoring*[6] would be justified, while thyroid *screening*[7] would not be recommended. It will be very important to communicate this distinction clearly to the population.

It is also important to establish a thyroid monitoring programme as soon as possible (mainly due to the fast physical decay of radioactive iodine). The main priority of this programme should be to identify individuals that will need further medical follow-up (due to significantly increased cancer risk) – i.e., individuals that may have received more than 100 mSv equivalent dose to the thyroid. Secondly, individuals that may have received more than 10 mSv to the thyroid should also be included for the purpose of evaluating future health risk (even though detectable increase in cancer rate is not expected for this group). Children and pregnant women should be given priority when setting up the monitoring programme. Such a programme could also reassure worried individuals that may have been exposed to radioactive iodine in connection with the release.

Besides documenting levels, there are limited possibilities to do anything about the doses from radioactive iodine since it will mainly be due to inhalation (provided that food restrictions in the early phase work properly).

Whole-body monitoring (WBC)

In addition to thyroid monitoring, a whole-body monitoring programme should be established to estimate individual effective doses. The main purpose with this would initially be to check whether food restrictions and information to prevent inadvertent ingestion have worked properly in the affected area. Provided that this is the case, the main use of WBC would be long-term follow-up of radioactive caesium ingestion and monitoring the effectiveness of initiated countermeasures. This enables affected people to take control over their own radiation long-term exposure. It may also answer concerns and be reassuring. A WBC programme can be highly relevant in reducing long-term doses to vulnerable population groups (as e.g., demonstrated by the follow-up of reindeer herders in Nordic countries after the Chernobyl accident).

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[5] https://www.irsn.fr/sites/default/files/documents/actualites_presse/actualites/IRSN_Shamisen-recommendation-guide_201709.pdf

[6] Thyroid monitoring establishes the level of radioactive iodine in the thyroid gland with a subsequent dose estimation.

[7] Thyroid screening is used to look for abnormalities and cancer in the thyroid gland.

Health follow-up

In the introduction to topic B the participants were presented with one of the general recommendations from the Shamisen report on the Fukushima accident: *"To encourage a health surveillance strategy that targets the overall well-being of populations and not only addresses radiation effects, but also psychosocial and socio-economic impacts induced by the consequences of a nuclear accident"*. Health surveillance here is defined as a system used to evaluate whether affected individuals suffer from some health condition because of the accident.

Regardless of the type of action, there is a need to identify the relevant population and the lead organisation or authority when setting up a health follow-up strategy. Expert groups and project groups will have to be established, involving all relevant authorities, also local authorities. There will be a need to identify different interests and perform risk analysis for the whole population. This will have to be performed rapidly, so planning is important, the more we plan for in advance the more prepared we are. Contingency plans should include how things will be done practically, but it is challenging when you don't know where, what, and when.

The participants recognised the risk of over-treatment and overspending in this particular scenario. The individually received doses and the following increase in cancer risk will probably not be high enough to warrant individual medical follow-up. In addition, psychosocial stress will increase with the number of remedial actions.

Psychosocial follow-up

The group debated whether the accident used in this particular exercise would be large enough to generate a need for extensive psychosocial follow-up. However, even as not all crises lead to trauma, one needs to monitor for it. Experience shows that psychosocial support is likely to be very important as people will be frightened by the accident and its radiological aspect.

Even for nuclear events it is possible to use already existing plans, resources and capacities. In Norway, municipalities have health plans that should also handle this kind of situation (at least with regards to psychosocial follow-up). The principle of subsidiary will still apply, and the local authorities (municipalities) will be key actors. They will receive instructions from the Directorate of Health, via the County Governor.

In the Norwegian context, the Directorate of Health would establish project groups with relevant authorities, including local authorities, with both horizontal and vertical dynamics. There would be at least 1 year of follow-up with a pro-active approach, and the municipality would follow up closely. Communication would be in cooperation with DSA. However, restructuring may be necessary, for example for the local psychosocial health teams. These teams would follow clinical guidelines including the three principles of coping, cohesion and hope. Psychosocial follow-up is equal to medical follow up, according to Norwegian law.

Experiences from the aftermath of the 22July mass shooting at Utøya in 2011 showed that peer review groups could be very useful for psychosocial support and follow-up. These groups were created in cooperation with the Red Cross, and funding for these will also be available in the future.

Data registration

All types of follow-ups will generate large amounts of data. Attention to the data registration procedure is important. What is important to register? Why do we register? It is important to understand why you do something in order to do it right.

The participants agreed that there are several purposes to register data:

- → To decide on actions
- → To inform about dose
- → To predict health effects
- → To reassure the public

Dose registries differ from country to country. In Sweden it's done by the public health authority, with assistance from the radiation protection authority. In Finland a system for dose monitoring exists in collaboration with the Red Cross. It's based on QR-codes and do not include personal data, but this could theoretically be linked later. The focus is currently on group level and not individual exposure. In Norway a dose registry has not yet been established although planning has started. Some participants argued that new registries should utilise already existing and well-functioning systems and registries, like health registries. The establishment of such a system should be performed prior to an actual crisis.

Communication, information and dialogue

Information and communication were brought up various times during the discussion of health follow-up and demonstrates the importance of appropriate communication. The participants stressed the need for a unified message and the importance of honest communication in the initial stages, which will define the level of trust in the later stages. The communication should be open about uncertainties, mistakes and limits in the available information. All relevant information should be shared, even when not all the answers are available. The participants suggested that the same type of vocabulary should be used in all crises, for people to better recognise threats and risks and to be able to draw experience from prior events.

Dose levels should be communicated with care. It was suggested to use yearly doses instead of dose rates, for better understanding. These can be compared to national dose limits and other known sources of radiation. Radiation risk should also be compared to other risks we are exposed to every day. There needs to be a balance between promoting worry and reducing concern, and risk perception is highly individual.

Information concerning radiation should be easy to understand and it would be beneficial to prepare the public in advance on issues regarding radiation. This as a preparation for later communication. A lot of information material is already available but reaching out to the public is challenging. DSA has initiated cooperation with schools and other youth bodies when it comes to information and communication.

6. Topic C – Long-term food production

6.1. Background information

General situation at the start of TTX2:

→ Livestock for milk and meat production are still kept indoors – except sheep and reindeer. Low levels of radioactive caesium have been reported in samples of milk (<20 Bq/kg).
→ Many samples of seafood have been measured – from areas close to the wreck, nearby fish farms and areas further away. Focus has been on fish and particularly on salmon.
→ Low levels have been found – particularly for farmed fish (<1–2 Bq/kg). Slightly higher levels have been reported for wild marine fish (3–90 Bq/kg).
→ Countermeasure strategies in food production have also been discussed – including provisional production stop in the most contaminated areas.

If the restrictions are lifted, and cows start grazing contaminated pastures, it is possible that levels in milk might exceed maximum permitted levels (MPLs) in some areas (figure 8a). Lambs are likely to exceed MPLs during autumn slaughter in considerably larger areas (figure 8b). In both cases, the size of the affected area will depend on site-specific transfer from soil to feed plants. Two simple cases are considered here, using a “most likely” transfer and “high” transfer[8].

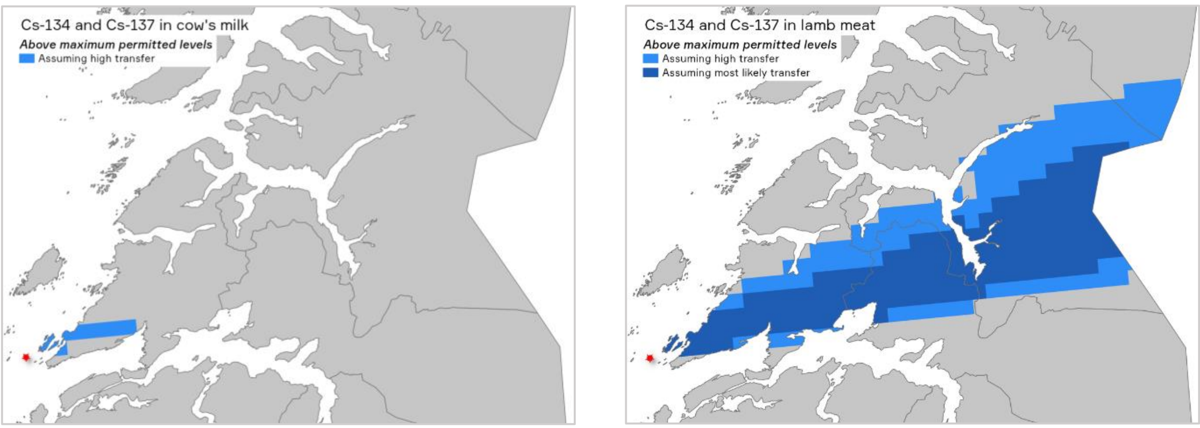

Figure 8: *Areas with (a) cow´s milk and (b) lamb meat predicted to be above maximum permitted levels (MPLs) assuming most likely and high transfer (and no animal migration). Note that most likely transfer to cow`s milk only gives local consequences (not visible on figure 8a).*

For reindeer, the situation is likely to be worse than for lamb, depending on when the animals are assumed to be slaughtered. In figure 9, slaughter during winter has been considered (more conservative than slaughter during autumn)[9]. It will be important here which MPLs is used – 1250 Bq/kg (see table 2) or 3000 Bq/kg (presently used in Norway). If the lower MPL is applied, protective actions might also be required for the major reindeer herding areas in Troms and Finnmark County.

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[8] For cow milk transfer factors of 0.0017 and 0.005 m^2/kg was used for likely and high transfer, respectively. For lamb meat, the respective transfer factors were 0.04 and 0.20 m^2/kg.
[9] For reindeer meat a transfer factor of 0.55 m^2/kg was used based on slaughter during December to January.

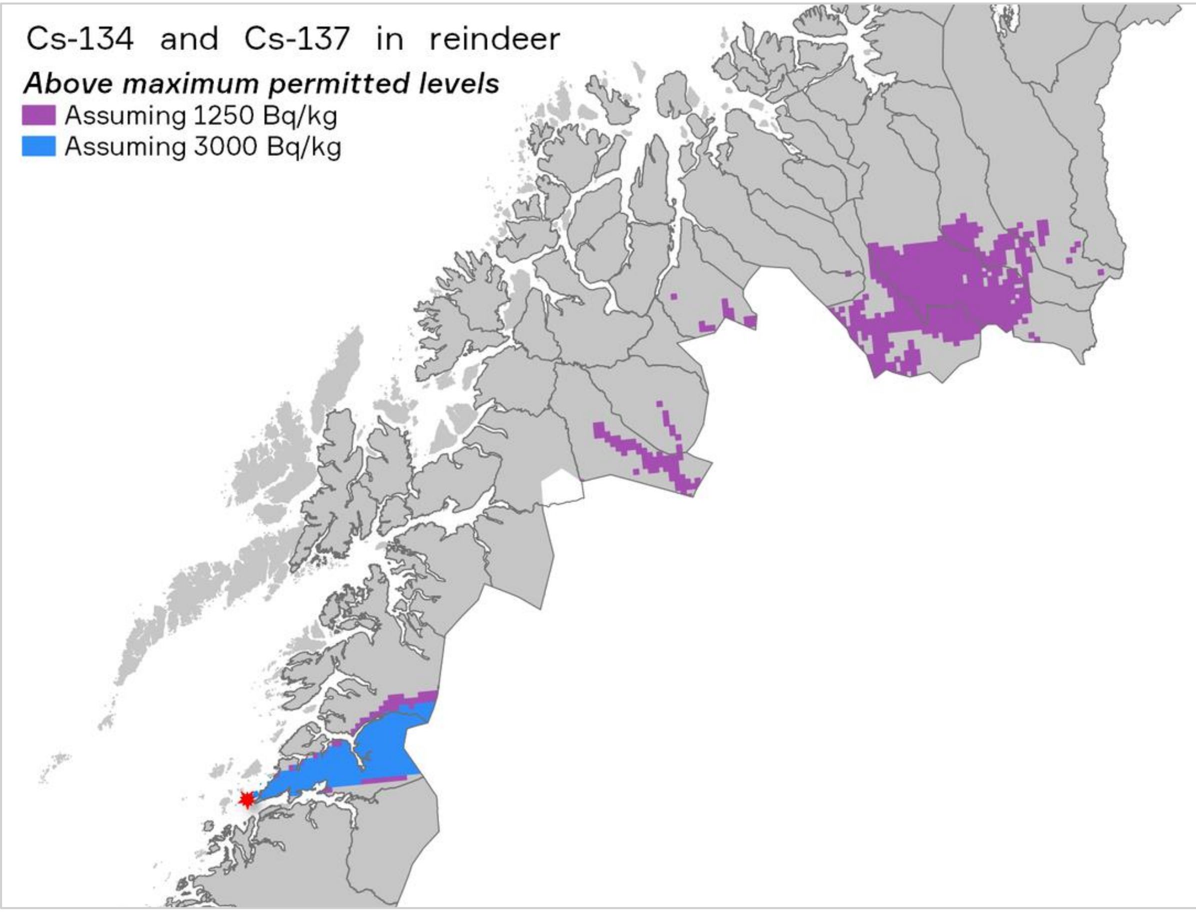


Figure 9: *Areas with reindeer meat predicted to be above maximum permitted levels (MPLs) assuming slaughter in December-January (and no animal migration). Note that two MPLs have been considered. The purple area will include the blue area.*

The discussion on day 1 was structured around the three general challenges:

- The biggest challenges foreseen for the participants' respective organisations at the stage defined in the scenario,
- The most challenging aspects with regard to communication with the public as well as to transitioning towards the *existing exposure situation* stage,
- The organisations' needs to support the communication with the public.

The discussions on day 2 focused on marine fish and issues related to prioritizing measurements and maintaining international trade and consumer confidence. However, since many of the points mentioned on day 1 and day 2 were overlapping, the results of the discussions were grouped into the topics and are reported together.

6.2. Discussion

Measurements

Existing laboratory capacities differ between countries. For instance, Norway has several laboratories set up to measure radioactivity in food due to the country's long-term monitoring and management after the Chornobyl accident. In many other countries, laboratory capacities are more limited and may need to be expanded in order to adequately respond to the issues of food control in the aftermath of an accident. In practice, the available measurement capacities will always be limited, and authorities will need to prioritize between different sample types and regions based on several monitoring objectives:

- The need to control that food entering the market is below MPLs.
- The need to provide documentation for food export industries.
- The need to assess the radiological situation in the affected area and how it develops.
- The need to offer measurements to private citizens who harvest products for personal consumption, e.g., wild foods and garden vegetables.

Prioritization criteria and possible measurement strategies should be developed beforehand to make sure that all relevant factors are taken into account in a radiological emergency. The time aspect needs to be considered in the measurement strategy, as some products reach markets quickly (e.g., milk, fish) and will require more immediate documentation than other products. Detailed measurement plans need to be adapted to the specific situation at hand.

Industries might be able to aid in increasing laboratory capacities by setting up their own measurement equipment. However, given the economic interests of the industry in clearing their own products for the market, the trustworthiness of these measurement results might be questioned. Verification by the authorities will therefore still be required.

Open and accessible databases are increasingly requested by the public as a part of an expectation for transparency. Databases could also be made open for the public to submit their own measurements results, as has been done in Japan in the aftermath of the Fukushima accident. This could help to increase trustworthiness. However, a challenge with controlling the possible false data was also recognised.

Maximum permitted levels

In a radiological emergency, authorities will impose maximum permitted levels (MPLs) to regulate the public's exposure to radioactive contamination in food placed on the market. MPLs will differ between products and may differ between neighbouring countries and change over time as the situation develops. Furthermore, the same country may even use different MPLs on imported food based on the origin country (e.g., the EU has simultaneously used different MPLs for food imported from Japan after the Fukushima accident and food imported from third countries affected by the Chornobyl accident.) Although the optimisation and justification principles justify that different MPLs are being used in different situations, these aspects create challenges for management and communication.

The criteria for when MPLs imposed after an accident should be changed or lifted are not well defined. These criteria should be clearly defined in the preparedness phase and communicated early in the emergency response phase to improve consumer confidence.

Guidelines or recommendation will also be needed to address the public's exposure from food products harvested for personal consumption (e.g., wild foods and garden products). Special attention should be paid to population groups with a substantial intake of products with high concentrations of radioactive contamination. Guidelines aimed specifically at such vulnerable populations may be warranted.

Communication

Various challenges related to communication were highlighted throughout the discussion. The public's tendency to have an exaggerated perception of risk relating to radioactivity was highlighted as an important factor. Examples on how to put the risk into perspective was:

- Explaining the risk in terms of a small increase in risk of cancer over many years, compared with the overall, general risk of cancer.
- Putting the risk into context with everyday risk factors, including natural radiation
- Communicating very clearly “this is safe”, rather than scientific and regulatory details.

The participants expected the risk to be perceived different locally in the affected area (more acceptable) compared to the rest of the country and international markets (less acceptable). It is also important to maintain a balance when communicating, as drawing too much attention to the contamination situation also can serve as a negative reminder and impact the consumer behaviour.

The wide ranges in concentration levels that may be expected between food products may create challenges for communication. Products with higher levels may be considered “unsafe”, even if they are far below MPLs and deemed safe by authorities. One example given during the discussion was that wild fish may get slightly higher levels of radioactive contamination than farmed fish. Even if both products are far below MPLs, this could potentially lead to wild fish being categorized as “not safe”. Participants also pointed out how a single high measurement could create a media response and influence the perception of food safety. Having information on the background levels in food and the environment was recognised as useful as it helps to put new monitoring results into context. Most countries have such ongoing monitoring programmes.

In the discussions relating to seafood export, it was established that concentrations in seafood are expected to be low after a nuclear accident, including the described scenario. Participants recognised, however, that international markets are hard to predict and that the decisions might not be made according to MPLs or international guidance levels. It was suggested that a statement saying that only low levels of radionuclides would be expected in seafood in case of a nuclear accident, could be communicated in advance.

The export industry has experience with solving export problems on their own but would need the support of the authorities in the case of a nuclear accident. Based on the experience from previous contamination events, swift response and documentation from authorities was recognised as incredibly helpful. Clear and consistent information on the websites was also mentioned as helpful. The message should emphasise that the food is safe and managed in accordance with the regulations. Documenting low levels in English will support export industries and organisations to respond to the concerns of the international partners. The documentation requirements for export markets might differ from country to country. It would be beneficial if the level of documentation could be harmonized.

It was recognised that competing markets could use the opportunity to exaggerate problematic issues and spread false information. Conspiracy theories are likely to appear.

It will be important for the authorities to communicate quickly and clearly to reduce the effect of false information. All authorities, organisations and industries should communicate the same message in order to support public confidence.

Use of zones

From the perspective of the seafood export industry, a “zoning approach” would be very useful and ease communication with the international markets. Experience shows that it is easy for importing countries to assume that the whole country is affected, making it therefore important to communicate clearly if the problem is very local. However, if it is possible to set up zones outside of which seafood would be considered “safe” or “not contaminated”, export could proceed immediately for products originating outside this zone. Products originating from within the zone could be measured before entering the market. A similar approach may be relevant for other foods as well.

A challenge with the zoning approach would be how authorities would define a value that would be considered “not contaminated”. It was suggested to develop pre-defined values for different scenarios.

Another challenge with the zoning approach would be to unintendedly create the impression that the food produced *within* the zone is dangerous, even in situations where the concentrations within the “contaminated” zone are low, as would likely be the case with marine fish.

7. Conclusion

The exercise successfully gathered key actors and fostered networking and exchange of experience, information, and ideas. Although the groups discussed different topics, common themes included the importance of communication, information, and dialogue, as well as learning from other experiences (e.g., covid, natural disasters).

The complexity of the situation was recognised, including the importance of non-radiological and socioeconomic aspects. The importance of putting both health risks and food contamination in perspective with other risks was also noted.

Regarding health issues, it was recognised that plans for data registration and follow-up of affected populations should be further developed in Norway – and that psychosocial support should be included in these plans.

Regarding food, authorities should plan for how to make best use of measurement capacity (taking into account different objectives), prepare criteria for when to change or lift MPLs, and plan for how to address communication challenges and demands of the export market.

Appendix 1 – Participant lists

All participants of TTX2:

Name	Organisation
Anne Stemland Olsen	Bodø Municipality, Norway
Oona Dunlop	CBRNE Centre, Norway
Pascal Croüail	Nuclear Protection Evaluation Centre (CEPN), France
Agnieszka Hac-Heimburg	Danish Emergency Management Agency (DEMA)
Charlotte Legind	Danish Veterinary and Food Administration (DVFA)
Kjartan Gudnason	Icelandic Radiation Safety Authority (IRSA)
Arne Hammer	Nordland Police District, Norway
Jonette N. Braathen	The Norwegian Fishermen's Sales Organization
Geir Tollåli	Northern Norway Regional Health Authority
Freja Ulvestad Kärki	Norwegian Directorate of Health
Harald Martin Misje	Norwegian Food Safety Authority (NFSA)
Lars Tore Hestad	Norwegian Food Safety Authority (NFSA)
Torild Agnalt Østmo	Norwegian Food Safety Authority (NFSA)
Anna Nalbandyan-Schwarz	Norwegian Radiation and Nuclear Safety Authority (DSA)
Astrid Liland	Norwegian Radiation and Nuclear Safety Authority (DSA)
Håvard Thørring	Norwegian Radiation and Nuclear Safety Authority (DSA)
Ingrid Landmark	Norwegian Radiation and Nuclear Safety Authority (DSA)
Mari Komperød	Norwegian Radiation and Nuclear Safety Authority (DSA)
Anders Nordøy Snellingen	Norwegian Seafood Council
Deborah Oughton	Norwegian University of Life Sciences (NMBU)
Lindis Skipperud	Norwegian University of Life Sciences (NMBU)
Yevgeniya Tomkiv	Norwegian University of Life Sciences (NMBU)
Aksel Bernhoft	Norwegian Veterinary Institute
Jukka Kupila	Radiation and Nuclear Safety Authority of Finland (STUK)
Peder Kock	Swedish Radiation Safety Authority (SSM)

"Health group" (topics A and B):

Name	Organisation
Agnieszka Hac-Heimburg	Danish Emergency Management Agency (DEMA)
Anne Stemland Olsen	Bodø Municipality, Norway
Arne Hammer	Nordland Police District, Norway
Astrid Liland	Norwegian Radiation and Nuclear Safety Authority (DSA)
Freja Ulvestad Kärki	Norwegian Directorate of Health
Geir Tollåli	Northern Norway Regional Health Authority
Jukka Kupila	Radiation and Nuclear Safety Authority of Finland (STUK)
Lindis Skipperud*	Norwegian University of Life Sciences (NMBU)
Oona Dunlop	CBRNE Centre, Norway
Peder Kock	Swedish Radiation Safety Authority (SSM)

*Only day 1

"Food group" (topic C):

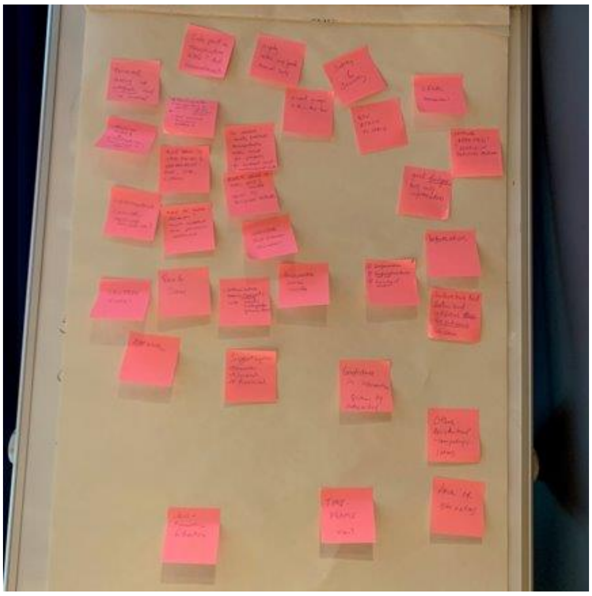
Name	Organisation
Aksel Bernhoft	Norwegian Veterinary Institute
Anders Nordøy Snellingen*	Norwegian Seafood Council
Anna Nalbandyan-Schwarz	Norwegian Radiation and Nuclear Safety Authority (DSA)
Charlotte Legind	Danish Veterinary and Food Administration (DVFA)
Harald Martin Misje	Norwegian Food Safety Authority (NFSA)
Jonette N. Braathen	The Norwegian Fishermen's Sales Organization
Kjartan Gudnason	Icelandic Radiation Safety Authority (IRSA)
Lars Tore Hestad	Norwegian Food Safety Authority (NFSA)
Pascal Croüail	CEPN, France
Torild Agnalt Østmo	Norwegian Food Safety Authority (NFSA)

*Only day 2

Appendix 2 – Key words (topic A)

Initial keywords the participants considered to be important for people to move back to the affected (relocated) area:

People need to feel safe and secure.
Perceived feeling of adequate level of control
Decision making and justification – is it safe to return?
Involve relocated group of people in decision making.
Move back to save houses, environment: food, jobs, schools.
Acceptable risk, and people need to accept and understand risk.
Trust in decision makers
Confidence in information given by authorities.
Socio-economic situation
Timeframe
Expert groups within the law
Legal – prerequisites
Information
Good dialogue, not only information
Authorities that listen and address the citizens' concerns.
Economical support
Someone who answers questions.
Support system: health, social, financial
Network
Use already existing plans.
Infrastructure
Medical help
Take part in remediation work and measurements.
Risk to children
Weather and food
Individual dose estimates
Dosimeters
Acceptable dose levels
Contamination measurements
Cleaning inside schools, kindergartens, and stores



Appendix 3 – Radiation risk vs. dose levels

The figure below illustrates radiation doses received in various exposure situations. Information on documented health risk is also included.

10 000 mSv	100% probability of death from acute radiation effects
4000 mSv	50% probability of death from acute radiaiton effects
2000 mSv	Lowest dose that may cause death from acute radiation effects
1000 mSv	5% increase in risk of cancer death (in excess of normal mortality rate)
100 mSv	Lowest documented correlation between radiation dose and cancer risk
20 mSv	Average annual dose limit for occupational exposure
10 mSv	One CT scan of the abdomen
5 mSv	Mean annual dose to the population in Norway
1 mSv	Annual dose limit to the public from planned exposure
0.02 mSv	One dental X-ray

Appendix 4 – Food regulations

Nuclear emergency regulations for food developed during Arctic REIHN (Command post exercise) (in Norwegian):

Øvelse, øvelse, Øvelse CPX Arctic REIHN

Forskrift om gjeldende midlertidige grenseverdier for radioaktiv forurensning i næringsmidler og fôr som omsettes, og eventuelle andre nødvendige restriksjoner etter matloven, som følge av atomhendelsen på skipet Hydroatom i havet utenfor Bodø i Norge

Fastsatt av Mattilsynet 4. mai 2023 med hjemmel i forskrift 14. september 2022 nr. 1580 om høyeste midlertidige grenseverdier for radioaktiv forurensning i næringsmidler og fôr som omsettes, og eventuelle andre nødvendige restriksjoner etter matloven, som følge av en atomhendelse § 5 jf. lov 19. desember 2003 nr. 124 om matproduksjon og mattrygghet mv. (matloven) § 9, § 12, § 16, § 17 og § 33 jf. delegeringsvedtak 19. desember 2003 nr. 1790.

Kapittel I Formål og virkeområde mv.

§ 1. *Formål*

Formålet med denne forskriften er å beskytte menneskers helse ved å hindre omsetning av næringsmidler og fôr som etter en atomhendelse er forurenset av radioaktive stoffer.

§ 2. *Virkeområde*

Denne forskriften fastsetter gjeldende midlertidige grenseverdier for radioaktiv forurensning i næringsmidler og fôr som omsettes, og eventuelle andre nødvendige restriksjoner etter matloven, etter atomhendelsen på skipet Hydroatom i havet utenfor Bodø i Norge.

Bestemmelsene i kapitlene I, II og IV i forskriften gjelder for norsk land- og sjøterritorium, norske luft- og sjøfartøyer, og innretninger på norsk kontinentalsokkel.

Bestemmelsene i kapittel III i forskriften gjelder bare i Nordland fylke.

§ 3. *Definisjoner*

Definisjonene i forskrift 22. desember 2008 nr. 1620 om allmenne prinsipper og krav i næringsmiddelregelverket (matlovsforskriften) § 1 jf. artiklene 2 og 3 nr. 2 og 8 i forordning (EF) nr. 178/2002 (matlovsforordningen) av begrepene:

a) næringsmidler,
b) fôr og
c) omsetning

gjelder også for bestemmelsene i denne forskriften.

Definisjonene i § 3 annet ledd i forskrift 14. september 2022 nr. 1580 om høyeste midlertidige grenseverdier for radioaktiv forurensning i næringsmidler og fôr som omsettes, og eventuelle andre nødvendige restriksjoner etter matloven, som følge av en atomhendelse av begrepene:

a) mindre viktige næringsmidler og

b) atomhendelse

gjelder også for bestemmelsene i denne forskriften.

Kapittel II Gjeldende midlertidige grenseverdier for radioaktiv forurensning i næringsmidler, mindre viktige næringsmidler og fôr

§ 4. *Gjeldende midlertidige grenseverdier for radioaktiv forurensning i næringsmidler, mindre viktige næringsmidler og fôr*

De høyeste midlertidige grenseverdiene for radioaktiv forurensning i næringsmidler, mindre viktige næringsmidler og fôr som framgår av henholdsvis vedlegg 1, og vedlegg 2 del 2 og vedlegg 3 i forskrift 14. september 2022 nr. 1580 om høyeste midlertidige grenseverdier for radioaktiv forurensing i næringsmidler og fôr som omsettes, og eventuelle andre nødvendige restriksjoner etter matloven, som følge av en atomhendelse, skal gjelde for omsetning av næringsmidler og fôr i Norge.

Kapittel III Andre nødvendige restriksjoner etter matloven

§ 5. *Virkeområde for bestemmelsene i kapittel III*

Bestemmelsene i kapittel III gjelder bare i Nordland fylke.

§ 6. *Definisjon av landdyr*

I bestemmelsene i kapittel III omfattes følgende dyr av begrepet «landdyr»: fugler, landpattedyr, bier og humler.

§ 7. *Hold av matproduserende landdyr*

Landdyr som produserer næringsmidler eller skal bli til næringsmidler, skal holdes innendørs fra ikrafttredelsen av denne forskriften. Påbudet gjelder ikke for sauer som ikke har tilgang til dyrerom, bier og rein.

Mattilsynet kan gi unntak fra påbudet i første ledd for transport av dyr til slakt og andre tilfeller etter en risikovurdering.

§ 8. *Beskyttelse av fôr som skal gis til matproduserende landdyr*

Fôr til landdyr som produserer næringsmidler eller skal bli til næringsmidler, skal tildekkes eller lagres innendørs fra ikrafttredelsen av denne forskriften. Påbudet gjelder ikke for rundballer som er dekket av plast.

§ 9. *Dispensasjon fra bestemmelsene i kapittel III*

Mattilsynet kan i særlige tilfeller dispensere fra bestemmelsene i kapittel III, forutsatt at det ikke vil stride mot Norges internasjonale forpliktelser, herunder EØS-avtalen.

Kapittel IV Diverse bestemmelser

§ 10. *Rangordning mellom ulike bestemmelser*

Ved motstrid går følgende bestemmelser foran bestemmelsene i denne forskriften:

a) bestemmelser som regulerer tilsvarende forhold i forskrifter som gjennomfører Norges forpliktelser etter EØS-avtalen i norsk rett og
b) nasjonale bestemmelser i andre forskrifter som fastsetter høyere grenseverdier for radioaktiv forurensning i bestemte næringsmidler eller fôr.

Bestemmelsene i denne forskriften gjelder foran nasjonale bestemmelser i andre forskrifter som fastsetter lavere grenseverdier for radioaktiv forurensning i næringsmidler eller fôr.

§ 11. *Omsetningsforbud*

Det er forbudt å omsette næringsmidler eller fôr som ikke er i samsvar med de gjeldende midlertidige grenseverdiene for radioaktiv forurensning eller andre krav i denne forskriften.

§ 12. *Tilsyn og vedtak*

Mattilsynet fører tilsyn og kan fatte nødvendige vedtak for gjennomføring av bestemmelsene i denne forskriften, jf. matloven § 23.

§ 13. *Straff*

Overtredelse av bestemmelser gitt i denne forskriften eller enkeltvedtak gitt i medhold av forskriften, er straffbart i henhold til matloven § 28.

§ 14. *Ikrafttredelse*

Denne forskriften trer i kraft straks.