NKS-478
ISBN 978-87-7893-573-1

RNSARCARDS, Nordic Action Cards for Maritime RNSAR

Øyvind Aas-Hansen[1], Oscar Mork[1]
Inger Margrethe H. Eikelmann[1]
Emmi Ikonen[2], Marielle Baklund[2]
Mikel Dominguez Cainzos[2]
Charlotte Alfast Espensen[3], Agnieszka Hac-Heimburg[3]
Per Horsholm[4]
Kjartan Guðnason[5], Gisli Jonsson[5]
Snorre Greil[6], Snorri Hrafnkelsson[6]
Minna Valtavaara[7]
Natalia Andreassen[8], Rune Elvegård[8]

[1]Norwegian Radiation and Nuclear Safety Authority (DSA)
[2]Joint Rescue Coordination Centre Norway (JRCC-NN)
[3]Danish Emergency Management Agency (DEMA)
[4]Joint Rescue Coordination Centre (JRCC) Denmark
[5]Icelandic Radiation Safety Authority (IRSA)
[6]Icelandic Coast Guard (ICG)
[7]Finnish Border Guard (FBG)
[8]Nord University

August 2023

Abstract

The RNSARCARDS action cards are meant to be used for coordinating search and rescue in a maritime radiological / nuclear emergency. The aim is to establish a common operational picture between the on duty RAD authority and the Search and Rescue Mission Coordinator (SMC) as quickly as possible to conduct an effective rescue operation. The action cards give operational guidance for the SMC and provide a checklist of the most relevant RN specific questions in order to conduct risk assessment and start appropriate actions.

RNSARCARDS are created based on the standard operating procedures described in the Nordic handbook for search and rescue in a maritime radiological / nuclear emergency (RNSARBOOK). RNSARCARDS are aimed to be used as a template for creating national procedures.

Key words

maritime search and rescue, radiological and nuclear emergency, emergency response, Nordic, action cards, guidelines, standard operational procedure

NKS-478
ISBN 978-87-7893-573-1
Electronic report, August 2023
NKS Secretariat
P.O. Box 49
DK - 4000 Roskilde, Denmark
Phone +45 4677 4041
www.nks.org
e-mail nks@nks.org

RNSARCARDS

ACTION CARDS FOR MARITIME RNSAR

RNSARCARDS

DSA

GEISLAVARNIR RÍKISINS
ICELANDIC RADIATION SAFETY AUTHORITY

NORD University

These action cards are meant to be used for coordinating search and rescue in a maritime radiological / nuclear emergency. The aim is to establish a common operational picture between the on duty RAD authority and the Search and Rescue Mission Coordinator (SMC) as quickly as possible to conduct an effective rescue operation. The action cards give operational guidance for the SMC and provide a checklist of the most relevant RN specific questions in order to conduct risk assessment and start appropriate actions.

RNSARCARDS are created based on the standard operating procedures described in the Nordic handbook for search and rescue in a maritime radiological / nuclear emergency (RNSARBOOK). RNSARCARDS are aimed to be used as a template for creating national procedures.

List of contributors

Norwegian Radiation and Nuclear Safety Authority (DSA)	Øyvind Aas-Hansen
	Oscar Mork
	Inger Margrethe H. Eikelmann
Joint Rescue Coordination Centre Norway (JRCC Norway)	Emmi Ikonen
	Marielle Bakklund
	Mikel Dominguez Cainzos
Danish Emergency Management Agency (DEMA)	Agnieszka Hac-Heimburg
	Charlotte Alfast Espensen
JRCC Denmark	Per Horsholm
Icelandic Radiation Safety Authority (IRSA)	Kjartan Guðnason
	Gisli Jonsson
Icelandic Coast Guard (ICG)	Snorre Greil
	Snorri Hrafnkelsson
Finnish Border Guard (FBG)	Minna Valtavaara
Nord University	Natalia Andreassen
	Rune Elvegård

We are grateful for additional contributions by:

Joint Rescue Coordination Centre Norway (JRCC Norway) — Johan Mannsåker, Thor Eirik Torkildsen, Ørjan Delbekk, Tomas Ringen, Rune Danielsen

Cover photo: *Raymond Engmark, Exercise Arctic REIHN 2023*

Financed by: *Nordic Nuclear Safety Research (NKS)*

INDEX

INTENTIONALLY BLANK

AWARENESS STAGE

Initial communication

Questions for initial assessment	• Name and call sign (or ship station identity) • Position (lat/long) • Nature of the emergency? • Type of assistance needed? • What type of vessel (nuclear propelled/cargo)? → Further information gathering for NPV -> page 4 → Further information gathering for cargo -> page 5 • How many people on board? • Is there a danger of radioactive/nuclear material or reactor being compromised? • Is there a danger of losing propulsion? • Weather conditions? Will they affect the RN situation? • Do you have any equipment on board to deal with the emergency?

In case of MAYDAY and risk of radiation, include maritime safety information or restricted area for vessels in the MAYDAY RELAY.

The common measuring unit of radiation is Sievert (Sv). Note down the unit and dose rate and communicate it to the RAD authority.

Sievert per hour (Sv/h)	MilliSievert per hour (mSv/h)	MicroSievert per hour (µSv/h)
1 Sv/h	= 1000 mSv/h	= 1'000'000 µSv/h

Other units that may be mentioned:

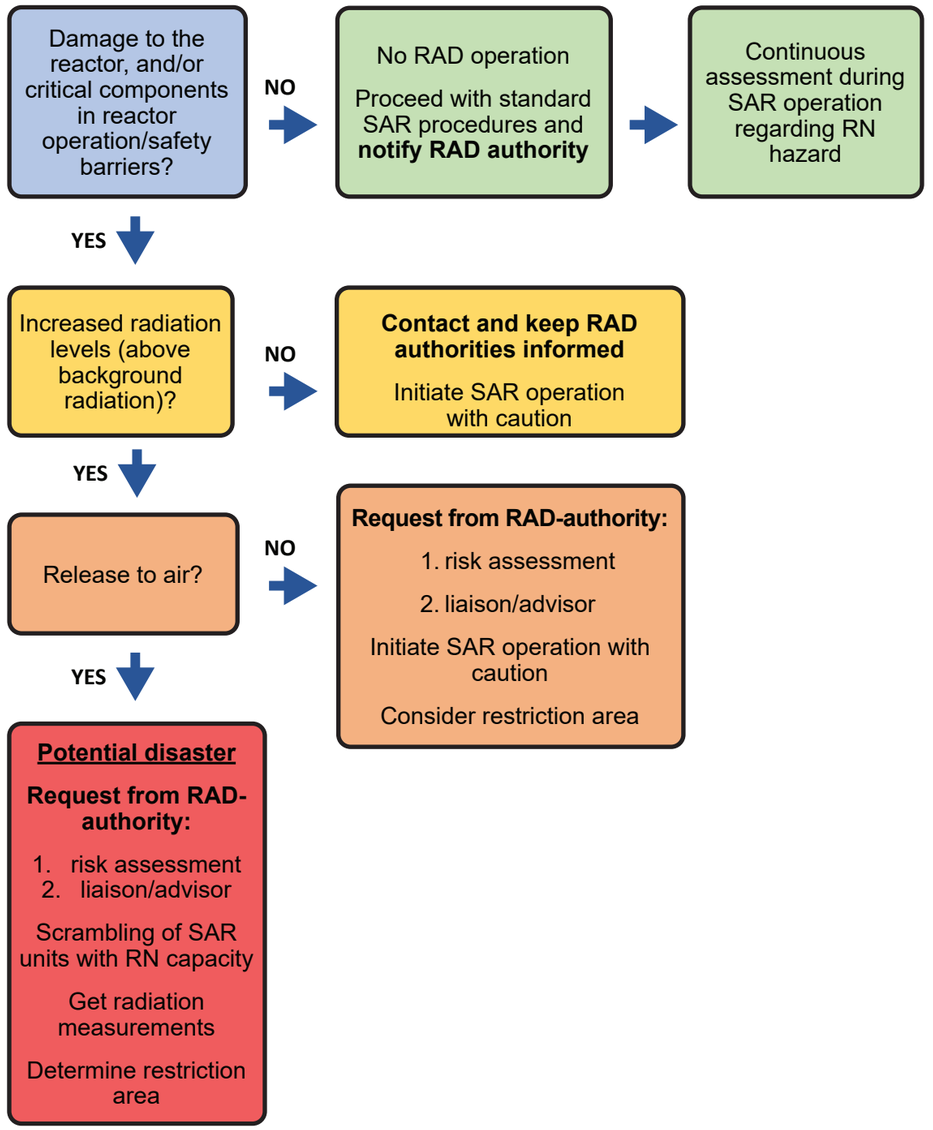
SI unit	US equivalent
1 Sievert (***Sv***)	100 Röntgen equivalent man (***rem***)
1 Gray (***Gy***)	1 000 rad (***rad***)
1 Becquerel (***Bq***)	2,703 x 10^{-11} Curie (***Ci***)

Information gathering for nuclear propelled vessel

The RAD authority will need this information to make a risk assessment.

☐	**Reactor integrity/damage** • Is the reactor stable? • Are the reactor cooling systems working properly? • Are the back-up safety systems working properly? ! If there is any damage to the reactor, there is a RISK of reactor meltdown and release of radionuclides to the surrounding environment.
☐	**Is there radioactive release?** **If yes:** • Start and stop time of release (UTC)? • Is the release on-going? • Position of the ship when the release occurred? **If no:** • Is release expected?
☐	**Increased radiation levels? If yes, ask next question.**
☐	**Level of radiation** • Number and unit -> Always spell out the unit of measurement! e.g. 1 microsievert per hour • Time of the measurement (UTC)
☐	**Location of the reactor on board**
☐	**Have you put RN Personal Protective Equipment on?** • How long is it safe for you to stay on board with the equipment you have? • Have you taken any measures to protect persons on board?

For nuclear propelled vessel



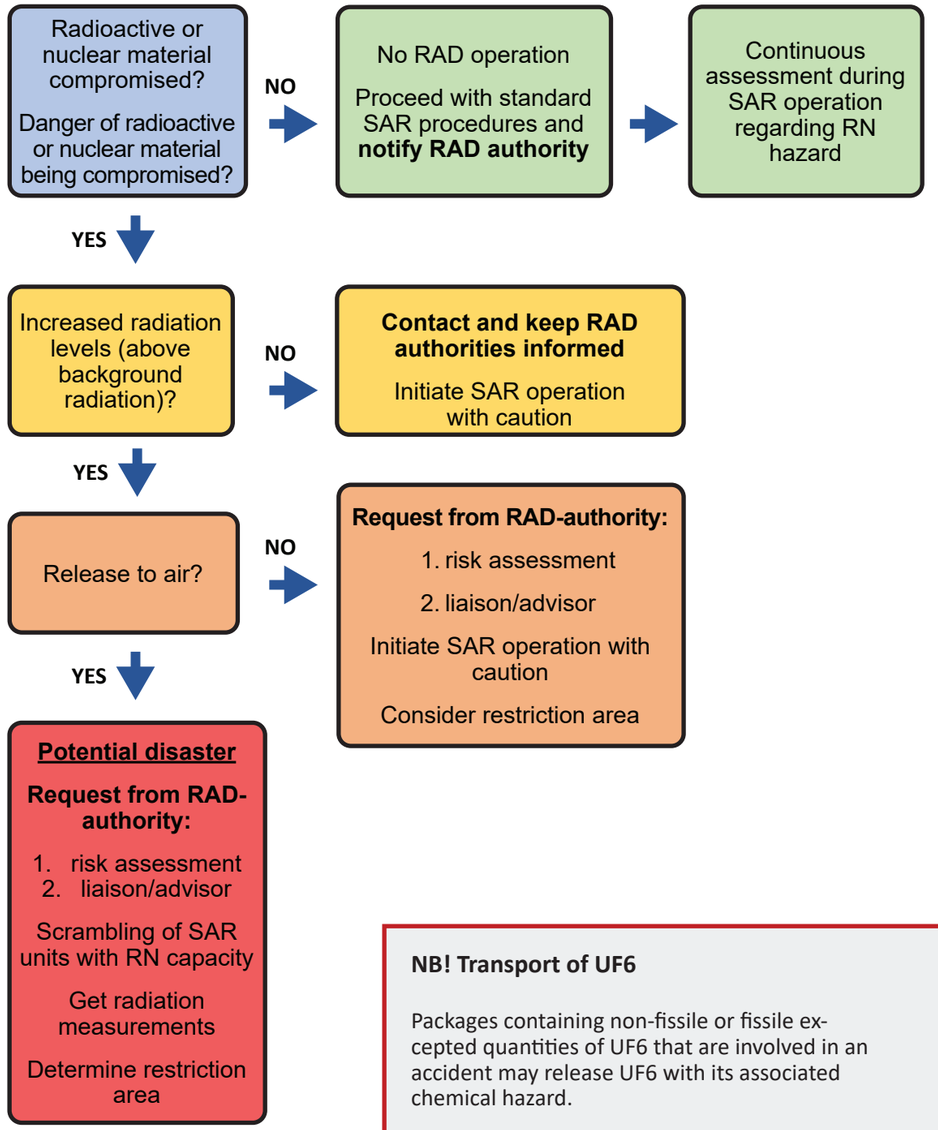
Information gathering for vessels transporting radioactive material

The RAD authority will need this information to make a risk assessment.

☐	**UN number / Package type (see table below for reference)**
☐	**Specifications of RN material:** • Name of RN material? • Activity levels (in Becquerel or Curie)? • Weight?
☐	**Increased radiation levels? If yes, ask next question.**
☐	**Level of radiation** • Number and unit -> Always spell out the unit of measurement! e.g. 1 microsievert per hour • Distance from measurement probe to radiation source? • Time of the measurement (UTC)?
☐	**Is RN material compromised / danger of being compromised?**
☐	**Is there danger of release to air?**
☐	**Location of RN material on board?**
☐	**Have you put RN Personal Protective Equipment on?** • How long is it safe for you to stay on board with the equipment you have? • Have you taken any measures to protect persons on board?

UN number marking	Other/package type	Hazard
2908, 2909, 2910, 2911	None	Non hazardous **Exposure:** Very low **Contamination:** Insignificant
2912, 2913, 3321, 3322, 3324, 3325, 3326	Type IP-1, Type IP-2, LSA, SCO	Possibly hazardous if inhaled or ingested **Exposure:** Very low **Contamination**: Possible
2915, 3327, 3332, 3333	Type A	Possibly hazardous **Exposure:** Medium – High (Type A), High (Type B + C) **Contamination**: Possible
2916, 2917, 3328, 3329	Type B	
3323, 3330	Type C	
2977, 2978	UF6 package	Hazardous – especially if exposed to water **Exposure:** High **Contamination:** Possible

For vessels transporting radioactive material



NB! Transport of UF6

Packages containing non-fissile or fissile ex-cepted quantities of UF6 that are involved in an accident may release UF6 with its associated chemical hazard.

The main hazard of UF6 to persons is when exposed to water. HF will form, which is very corrosive and poisonous.

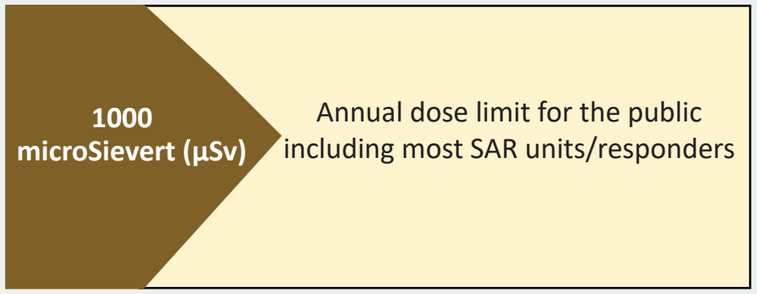
INITIAL ACTION STAGE

Even if risk of release to air, it is possible to start a SAR operation and deploy SAR units for possible evacuation operation in cold zone.

Initial actions:	
☐	**Contact and maintain close liaison with national RAD authority**
☐	**Notify other emergency authorities/stakeholders** • E.g. Health services, fire and rescue services, police, MET office, voluntary organizations, coastal authorities, military, environmental agency, ship owner, etc.
☐	**Find asset that can measure radiation on-scene**
☐	**Inform, alert or dispatch SAR units** ! Saving lives has the highest priority. • Which SAR units have RAD measurement capacities? Check page 15. • If radiation levels are expected to be higher than 1000 microsievert for SAR unit, prepare additional crew.
☐	**Consider establishing restriction area for vessels and aircraft** • Contact VTS and ATS ! Whenever radiation, even if no risk of release to air: → Establish immediate restriction area of 0.1 nautical mile, including NO-FLY zone for all vessels and aircraft • Broadcast maritime safety information to other vessels
☐	**Consider notifying adjacent RCCs or RSCs** • Consider the need for additional SAR resources or RN equipment from other countries, e.g. MIRG teams • If the incident is bordering to or the weather conditions may push release towards neighbouring SAR regions
☐	**Start considering areas for decontamination**

! **Dose rates dictate how long SAR units or other people may stay near the vessel** before total received dose exceeds threshold levels.

→ **For example: if the distress vessel reports measurements of 10 microSievert per hour (µSv/h), one can stay in the area for 100 hours before 1000 microSievert is received.**



! **Avoid exposure of SRU personnel above limits and avoid contamination of helicopter.**

! **Pre-determined safety zones. Need real-time measurements on-scene.**

	Cold zone	Warm zone	Hot zone
Dose rate	0,2 – 0,8 Microsievert per hour (µSv/h)	0,8 – 100 Microsievert per hour (µSv/h)	>100 Microsievert per hour (µSv/h)
Maximum hours of exposure allowed	Unlimited, background radiation	1250 hours (0,8 µSv/h) - 10 hours (100 µSv/h)	Less than 10 hours

INTENTIONALLY BLANK

PLANNING STAGE

	Action points:
!	Planning should be based on actual on-site measurements and prognosis -> set limits for warm and hot zone based on this!
!	SAR units conducting monitoring and measurement tasks must have the appropriate Personal Protective Equipment and have adequate training in measuring radioactivity
☐	**Assess risk, possible rescue procedures, and monitoring plan together with the RAD authority** ○ Request dispersion models ○ Request assessment of worst-case scenario
☐	**Report all values from on-site measurements, including low ones**
☐	**Ask RAD authority to define safety zones** ○ Safe direction to approach, route, and continuous monitoring of the hot zone
☐	**Assess need for evacuation**
☐	**Ask to make the vessel ready for emergency towing**
☐	**Remind SAR units about iodine tablets**
☐	**Continuous contact with other agencies**
☐	**Getting overview of injured/contaminated people, their location on the ship**
☐	**Replacement of personnel, materials, and equipment** ! Consider decontamination of personnel and equipment

Determination of restriction area

1. Determine an immediate restriction area for all vessels and aircraft where access can be granted by SMC/OSC.
2. Inform maritime traffic about the restriction area.
3. Inform relevant authorities of warnings and access to the restriction area.

Pre-planned restriction areas for RN-incidents[1]:

Risk of radiation but no risk of release to air → **Immediate restriction area of 16 nm radius, including NO-FLY zone**

Release to air or risk of release to air → **Immediate restriction area of 16 nm radius, including NO-FLY zone**

4. The immediate restriction area should be adjusted after consulting the RAD – authorities.

1 Based on NATO-standard ATP-45 Edition F Version 2, March 2020, in accordance with IAEA recommendations

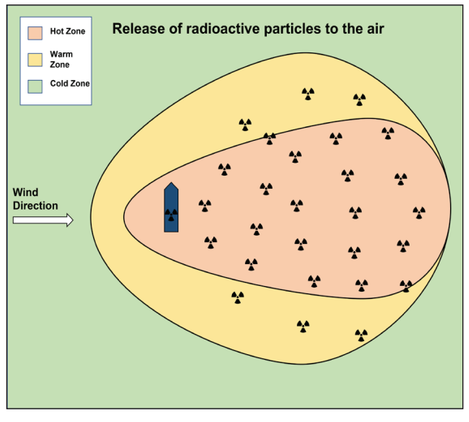
Determining safety zones / area of SAR action

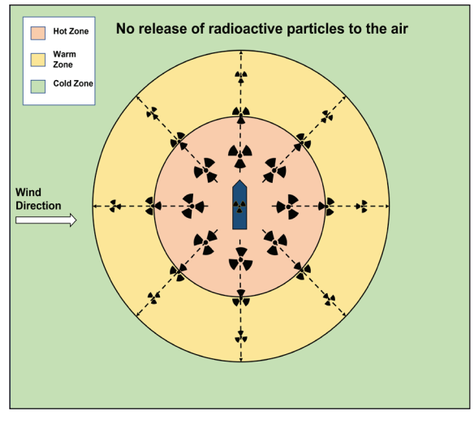
Real-time dose rate measurements must be done on-scene to determine radiation safety zones:

Risk of radiation but no risk of release to air → **All SRUs may safely approach up to 0.1 NM, regardless of PPE and training.**

Release to air or risk of release to air → **Determine zones based on dose-measurements.**

	Cold zone	Warm zone	Hot zone
Dose rate	0,2 – 0,8 Microsievert per hour *(µSv/h)*	0,8 – 100 Micro-sievert per hour *(µSv/h)*	>100 Microsievert per hour *(µSv/h)*
Maximum hours of exposure allowed	Unlimited, background radiation	1250 hours *(0,8 µSv/h)* - 10 hours *(100 µSv/h)*	Less than 10 hours





OPERATIONS STAGE

Resources and SRUs (as reminder)	**Consider and assess the full/limited capabilities of the resources on-site:** • Capacity for RN detection and monitoring • Capacity for decontamination and first aid / emergency medical care • Available personal protective equipment, response equipment • Consider tasks within/outside the restriction area • Limitations for helicopter if contaminated • Ability to monitor and maintain SRU own safety is crucial **Consult SAR units and teams/OSC about:** • Personal protective equipment • Detection and measurement equipment • Decontamination procedures • Onboard plan and tasks
On-scene operations	**Continuous radiation measurements on site** • Keep dialogue with RAD authorities **Consider evacuation to lifeboats in order to get further away from the vessel, upwind if release to air.** **Entry and exit points to warm and hot zone** • Record entry and exit times of SRUs • Remind SRUs of monitoring maximum exposure times and doses **Consider executing emergency towing to avoid plume, shore, hazard, or populated area.**

Planning for decontamination

Decontamination procedures are only to be activated when there is a release to air or risk of release to air.

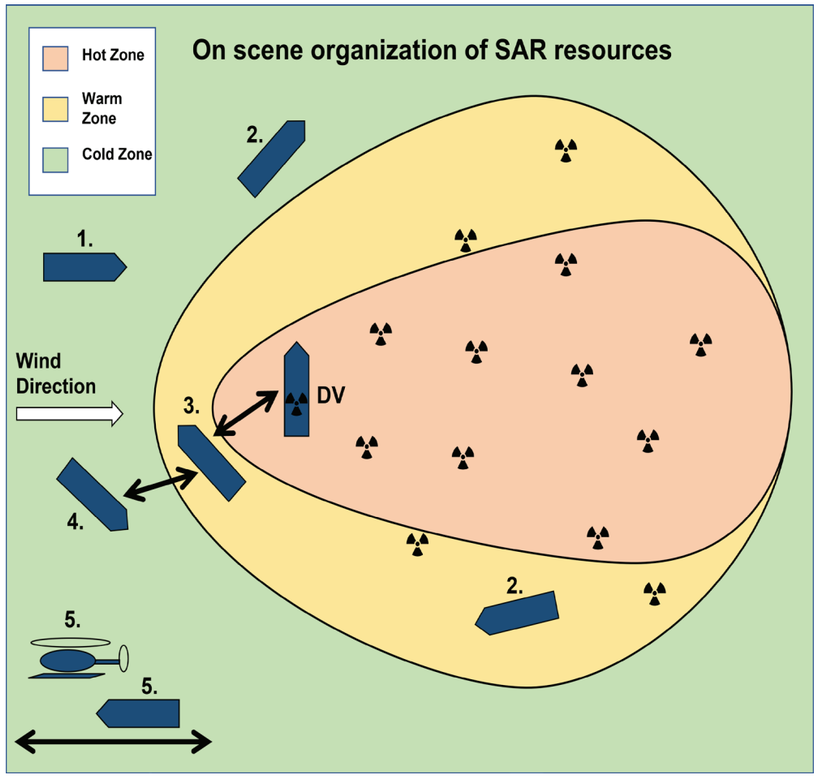
Step 1

Emergency decontamination	! Lifesaving medical measures will have priority over emergency decontamination. Victims can be transported without passing through the emergency decontamination station if the condition of the patient requires expedited measures that only can be provided in another location.
	
	• Establish an area on land or designate vessel with the capabilities to conduct decontamination
	  ○ Location: in proximity of the vessel in distress outside the hot zone.
	  ○ Position: Upwind.
	  ○ Facilities: easy access to hot zone, fresh water supply, adequate PPE, capacity to provide clean transition to cold zone
	
	• If this is not possible, other options are to hose people with water, dip in the sea, wrap them in a blanket before transport.

Step 2

Decontamination of SRUs (for information)	• SRUs, including personnel, vehicles and equipment are to be decontaminated as soon as possible. Especially if they need to be used in the operation for a long time or if needed for other missions. • Decontamination procedures should be arranged following the advice of the competent national radiation authority. ! Facilities to handle contaminated materials/equipment must be prepared offshore and onshore asap or before the SRUs return to land.

Possible organization of on-scene operations/decontamination in a situation with a risk of release of radioactive material to air (contamination risk):



Possible tasks for SAR assets while decontaminating

1. On-Scene Coordinator
2. Measurement and monitoring
3. Evacuation of personnel and decontamination first/inner vessel
4. Evacuation of personnel and decontamination second vessel
5. Transportation of evacuees to shore (by vessel or helicopter)

INTENTIONALLY BLANK

Overview of the national agencies and organizations with RN capacity - template

This table is meant as a template for the national SAR and RAD authorities to fill in. Dedicate a responsible authority to update the table annually.

Supporting Radiation Safety Authority	*Insert contact information here*

Organizations with radiation measuring capacity		
Organization	Asset	Contact
Insert list of organizations here	*Insert list of assets here*	*Insert contact information here*

List of organization with the capability and Personal Protective Equipment to respond			
With release		**No release**	
Organization	Capability/PPE	Organization	Capability/PPE
Insert list of organizations here	*Insert which capability/PPE*	*Insert list of organizations here*	*Insert which capability/PPE*

Decontamination support	
Organization	Capability/location
Insert list of organizations here	*Insert which capability/location*

An overview of the health effects of radiation

LOW RADIATION DOSES		4-5 mSv	Annual average dose for the general population (including SRUs) originating from “natural radiation” as ionizing radiation of natural, terrestrial, or cosmic origin	Low radiation doses (under 100 mSv) do not pose an acute danger to living organisms and developing further sickness has a low probability
		1 mSv	Annual dose limit for the general population (including SRUs) **in addition to** natural radiation levels.	
		20 mSv	Annual dose limit for occupationally exposed workers.	
		≥ 50 mSv	Only for informed, voluntary personnel in life saving work and disaster mitigation (applicable in some Nordic countries).	
		≥ 100 mSv	Increased statistical chance for developing cancer as well as heart and lung problems at a later stage. Damage to a fetus can occur. Only for informed, voluntary personnel in life saving work and disaster mitigation (applicable in the EU and some Nordic countries)	
MODERATE RADIATION DOSES		150 mSv	Temporary sterility in men	Moderate doses of radiation (100 mSv – 1 Sv), can have effects at the cellular level. These effects do not cause further sickness necessarily; however, cancer and foster damage can occur.
		500 mSv	Small changes in blood. In exceptional cases a dose ≥ 500 mSv can be allowed. With doses higher than 500 mSv acute radiation symptoms could occur.	
		> 1 Sv	Serious health repercussions	High doses of radiation (> 1–2 Sv) can cause acute life-threatening sickness (starting with acute radiation syndrome). Possible symptoms include nausea, diarrhoea, headache, fever, dizziness, weakness, and hair loss. With very high exposure during a short period, symptoms can develop in a matter of minutes.
HIGH RADIATION DOSES		2 Sv	Lowest acute deadly dose. Nausea, erythema, low blood pressure	
		4 Sv	50% chance of survival	
		10 Sv	Not possible to survive	
Reference: RNSARBOOK				

International alarming procedures for radiation authorities

RAD

It is the responsibility of National Competent Authority (usually under RAD authority) to contact and alert international organizations, neighboring countries and resources related to radiological issues.

- Alert IAEA via USIE
- Alert EU via ECURIE
- Request assistance via IAEA RANET mechanism[2]
  - RANET offers assistance with field assistance teams and external based support for radiation survey activities such as: measuring dose rates, fallout prognosis, establishing contamination levels, etc.
  - Assessment and evaluation of radiological consequences of a perceived threat or actual incident or emergency and its possible evolution can be requested through RANET.
- Request assistance via EU Civil Protection Mechanism3
  - Following a request for assistance through the Mechanism, the Emergency Response Coordination Centre (ERCC) mobilises assistance or expertise.
  - The ERCC ensures rapid deployment of emergency support through a direct link with national civil protection authorities.
  - Specialised teams and equipment can be mobilised at short notice for deployments inside and outside of Europe.
  - Can be mobilized within few hours.

2 Source: https://www.iaea.org/services/networks/ranet

3 Source: https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/eu-civil-protection-mechanism_en

Example reporting template for dose rate

Date	Time (UTC)	Latitude	Longitude	Name of location	Dose rate Value	Unit
23-04-2017	09:25	Xx*xx*xx	Xx*xx*xx	Enter name	988	µSV/h

Acknowledgements:
NKS conveys its gratitude to all organizations and persons who by means of financial support or contributions in kind have made the work presented in this report possible.

Disclaimer:
The views expressed in this document remain the responsibility of the author(s) and do not necessarily reflect those of NKS. In particular, neither NKS nor any other organisation or body supporting NKS activities can be held responsible for the material presented in this report.

Bibliographic Data Sheet **NKS-478**

Title	RNSARCARDS, Nordic Action Cards for Maritime RNSAR
Author(s)	Øyvind Aas-Hansen[1] Oscar Mork[1] Inger Margrethe H. Eikelmann[1] Emmi Ikonen[2] Marielle Bakklund[2] Mikel Dominguez Cainzos[2] Charlotte Alfast Espensen[3] Agnieszka Hac-Heimburg[3] Per Horsholm[4] Kjartan Guðnason[5] Gisli Jonsson[5] Snorre Greil[6] Snorri Hrafnkelsson[6] Minna Valtavaara[7] Natalia Andreassen[8] Rune Elvegård[8]
Affiliation(s)	[1]Norwegian Radiation and Nuclear Safety Authority (DSA) [2]Joint Rescue Coordination Centre Norway (JRCC-NN) [3]Danish Emergency Management Agency (DEMA) [4]Joint Rescue Coordination Centre (JRCC) Denmark [5]Icelandic Radiation Safety Authority (IRSA) [6]Icelandic Coast Guard (ICG) [7]Finnish Border Guard (FBG) [8]Nord University
ISBN	978-87-7893-573-1
Date	August 2023
Project	NKS-B / RNSARCARDS
No. of pages	21
No. of tables	6
No. of illustrations	6
No. of references	4

Abstract
max. 2000 characters

The RNSARCARDS action cards are meant to be used for coordinating search and rescue in a maritime radiological / nuclear emergency. The aim is to establish a common operational picture between the on duty RAD authority and the Search and Rescue Mission Coordinator (SMC) as quickly as possible to conduct an effective rescue operation. The action cards give operational guidance for the SMC and provide a checklist of the most relevant RN specific questions in order to conduct risk assessment and start appropriate actions.

RNSARCARDS are created based on the standard operating procedures described in the Nordic handbook for search and rescue in a maritime radiological / nuclear emergency (RNSARBOOK). RNSARCARDS are aimed to be used as a template for creating national procedures.

Key words

maritime search and rescue, radiological and nuclear emergency, emergency response, Nordic, action cards, guidelines, standard operational procedure

Available on request from the NKS Secretariat, P.O.Box 49, DK-4000 Roskilde, Denmark.
Phone (+45) 4677 4041, e-mail nks@nks.org, www.nks.org