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Nordic sharing of experience from radiation emergency preparedness exercises

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Abstract

The Nordic countries have for a long time had close cooperation in the field of radiological and nuclear emergency preparedness. In recent years there has been more emphasis on cooperating with other authorities, not only first responders but also e.g. those responsible for law enforcement (police). With exercises becoming more realistic and complex, they require more resources and everything cannot be tested. This is where Nordic cooperation can be useful, cooperating in developing and conducting exercises and sharing results from national exercises, especially where some specific issues of relevance for the other Nordic countries have been tested.

This report describes results from the NKS NordEx-12 activity, to cooperate and share experience from Nordic radiological and nuclear emergency resonse exercises. Summary descriptions of exercises shared are given, various details were presented at meetings of the Nordic radiation safety authorities contact group on emergency preparedness, the so called NEP group. The NEP group later took over the organisistion of sharing lessons learned from exercises and developing exercise cooperation further. The planning and lessons learned from such exercises often need to be confidential in part and thus not suitable for NKS reporting. With this work taken over by the Nordic authorities themselves within the NEP framework, the NKS NordEx-12 had served its purpose and was not needed anymore.

The other main factor in the NordEx-12/EmSem work was to prepare the Nordic participation in the Swedish REFOX-12 exercise, to facilitate cooperation between the countries and arrange a seminar to discuss the results, lessons learned and possible development of new NKS activities. The EmSem seminar was held in Stockholm in August 2013 with generous support from Swedish Radiation Safety Authority. The Swedish Radiation Safety Authority will be publishing its own report on the exercise and the part of the seminar directly associated with it. This report focusses therefore on presentations and lessons learned that are not directly connected to the REFOX exercise.

Key words

Radioactivity, exercise, nuclear, radiological

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Final report from the NKS-B activities NordEx-12 and EmSem (Contracts AFT/B(11)2, AFT(12)2 and AFT/B(13))

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1 Introduction

The Nordic countries have for a long time had close cooperation in the field of radiological and nuclear emergency preparedness. In previous years this has involved joint Nordic exercises (such as Odin and Nora) and participation in each others' exercises. In recent years there has been more emphasis on cooperating with other authorities, not only first responders but also e.g. those responsible for law enforcement (police). With exercises becoming more realistic and complex, they require more resources and everything cannot be tested. This is where Nordic cooperation can be useful, cooperating in developing and conducting exercises and sharing results from national exercises, especially where some specific issues of relevance for the other Nordic countries have been tested.

This was the basis for the start of the NordEx-12 activity, to cooperate and share experience from Nordic radiological and nuclear emergency resonse exercises, to assist the Nordic authorities in co-operating and sharing lessons learned from radiation exercises, drills and training as well as aiding the authorities in developing new ones. A special opportunity arose when it became clear that Sweden would be holding a major exercise called REFOX (**R**adiological **E**mergency – **F**ield **O** perative **Exercise**) in 2012. There have been previously large exercises in Sweden with broad Nordic participation, such as the Barents Rescue in 2001 and DemoEx in 2006. Some of the other Nordic teams used considerable resources in the exercises (e.g. the teams involved in mobile measurements) and considerable coordination was required. Many of the Nordic (non-Swedish) participants in DemoEx missed that there was no venue for a follow-up after the exercise, where the participants could share experiences and exchange views. This was not a responsibility of the local hosts, as this was a Swedish exercise. So for the later REFOX in 2012, the NordEx-12 activity could help to organise a platform for such a dialogue. It became clear that organising a good follow-up seminar would require more resources than NordEx-12 could provide, it was therefore decided to apply for extra funding for preparing and conducting a seminar in cooperation with the Swedish Radiation Safety Authority (SSM). The aim of this seminar would be to discuss the Nordic experience gained at the REFOX exercise, experience from other exercises and experimental work and how this could be used on the way forward, e.g. in the form of NKS proposals. The EmSem seminar was held in Stockholm in August 2013 with generous support from SSM. Although it is the responsibility of the authorities to plan and conduct exercises, NKS can play an important role in the development phase and as a catalyst for cooperation. The organisers of REFOX 2012 wished to be able to use the NKS-B NordEx-12 not only for the Nordic co-ordination and follow-up of REFOX 2012, but also to assist in assessing the technical and scientific aspects of threat analysis, detection and protection in radiological and nuclear emergencies.

The NKS has supported this work through contracts AFT/B(11)2 Nordic Exercises 2012, AFT(12)2 Nordic Exercises 2012 and AFT/B(13)1 EmSem: Seminar – Practical and operational emergency preparedness – Status and future developments

The accident at the Fukushima nuclear power plant greatly affected the work of all the Nordic radiation safety authorities in 2011 and meant that limited resources became available for exercises. For awhile it was considered to include some of the lessons learned and practical experience after the accident (e.g. concerning measurements) in the NordEx work, but plans for this were dropped when it became clear that the NKS would hold a special seminar on the lessons learned after Fukushima in January 2013.

The focus of the work in 2011 was thus on sharing the experience of exercises and encouraging the joint development of new ones, this is described in chapters 2 and 3 of this report. In 2012 the main focus was on joint Nordic preparations for the REFOX exercise, one aspect was coordination with the NKS-B MOMS activity on mobile measurments, encouraging harmonisation in use of data formats before the REFOX exercise, e.g. at the MOMS seminar in May 2012. The focus of work in 2013 was on the EmSem seminar in August and encouraging participants to take the experience gained further into new NKS work. The work on REFOX and the EmSem seminar is discussed in chapter 4.

The progress of work was regularily presented and discussed at meetings of the NEP group, a contact group of representatives from the Nordic Radiation Safety Authorities dealing with emergency preparedness.

2 NordEx-12 – Cooperation and sharing experience

The following exercises have been presented to the other competent authorities through the NEP group as a part of the planned sharing of the lessons learned from national exercises. In many cases additional material was distributed so it would be easier for other authorities to adapt an exercise for their own use.

The NEP group took over in 2012 the task of developing joint exercises and organising sharing information from exercises. This is a positive development, since recent years have seen more cooperation between the Nordic radiation safety authorities and law enforcement agencies. The planning and lessons learned from such exercises often needs to be confidential in part and thus not suitable for NKS reporting. With this work taken over by the Nordic authorities themselves within the NEP framework, the NKS NordEx-12 had served its purpose. The reporting on sharing experience from exercises therefore focusses here on the work in 2011.

2.1 Norway

2.1.1 Mobile measurement exercise - search of hidden radioactive materials in a container harbour

On the 23rd of May 2011, NRPA took part in a source search exercise arranged by the Oslo Home Guard District 02. NRPAs participation consisted of one car-based measurement team. In addition to NRPA, people from the Norwegian Army and the police participated. The scenario of the exercise was an attempt of smuggling of radioactive materials. It was known that the materials were somewhere in a container harbour, but the precise location of the materials was unknown. The exercise was a useful experience and showed clearly a number of challenges both related to measurements and to communication between different actors.



Fig. 1. Survey of containers at the Home Guard District 02 mobile measurement exercise on 23rd of May 2011.

2.1.2 Marine Safety Operation (MSO) exercise - fire involving radioactive materials at sea

On the 25th - 26th of May 2011, NRPA took part in a joint emergency preparedness exercise, coordinated by the Chief of Police in Troms county, Norway. The scenario exercised was a fire aboard a container ship transporting radioactive waste, and included in situ measurements, measurement strategies, communication strategies and fire fighting at sea. Together with the police and NRPA, the Norwegian Royal Navy participated in the exercise. A communications and operations centre was located on board the Norwegian frigate KNM Helge Ingstad. NRPA participated with a small measurement team, equipped with an air filter station and handheld detectors, and also provided counselling with regard to safety and measurement strategies.



Fig. 2. Deployment of air filtering station onboard the frigate KNM Helge Ingstad during the Marine Safety Operation (MSO) exercise 25th-26th of May 2011.

2.1.3 Civilian-military cooperation table-top exercise - situation management during entry of a transport ship with SNF into Norwegian waters

On 3rd of May 2011, the NRPA arranged a nuclear and radiological emergency preparedness and response seminar together with the National Joint Headquarters. As part of this seminar, a table top exercise was conducted in order to discuss common issues and the relationship between several civilian and military authorities during an emergency. Besides the National Joint Headquarters and NRPA, the Joint Rescue Coordination Centre of Northern Norway, the Civil Defense District of Nordland county and the Norwegian Defense CBRN school participated. The scenario of the exercise was an entry of a transport ship with spent nuclear fuel (SNF) in distress into Norwegian waters.

2.1.4 Summary

Norway has had several exercises in 2011 related to nuclear or radiological emergency. The exercises above have all been related to transportation of radioactive material (legal or illegal).

The NRPA wishes to focus more on situation management during emergencies at sea, civilmilitary cooperation and cooperation with emergency services (police, fire departments, health services). Similar activities could also be done in a Nordic context. Nordic information exchange and Nordic assistance are important assets in crisis management, but may be further developed. Seminars or exercises that touch on a Nordic context will be of value.

2.2 Finland

2.2.1 Olkiluoto exercise on Aug 31, 2011 in Finland

Full-scale exercises are organised with both nuclear sites in Finland every third year. This year the exercise was held during summer season and thus providing opportunities to test and challenge emergency response also on topics directly connected to time of year.

As a new feature in the exercise was to test response during a scenario which was simultaneously related in both safety and security issues of a nuclear power plant. During the exercise cooperation with rescue services and police organisation was tested.

About 30 organisations including authorities on governmental, regional and local level and representation of private sector took part in the exercise. Also journalists were invited to exercise crisis communication during safety and security related event.

2.3 Denmark

Lessons learned from exercises in Denmark were presented and discussed at NEP meetings, even though the details are not included in this report.

2.4 Sweden

2.4.1 SAMÖ-KKÖ2011

SAMÖ-KKÖ 2011 was a large national crisis management exercise based on two tried and tested concepts – the cooperation exercise (SAMÖ) and the nuclear power exercise (KKÖ), which have been combined into one exercise. SAMÖ-KKÖ 2011 is to enhance capacities for the management of both the short-term and long-term consequences of a nuclear power emergency, which has affected large parts of society.

A report on the planning of the exercise is available from MSB:

https://www.msb.se/RibData/Filer/pdf/25552.pdf

as well as the evaluation report:

https://www.msb.se/RibData/Filer/pdf/26065.pdf



Fig. 3. Groups of experts surveying a contaminated field during the Lärmät-11 exercise, Sweden, October 2011.

2.4.2 Lärmät-2011

The Lärmät exercises in Sweden are a part of the national Swedish training programme for first responders and experts having to be able to deal with radiation emergencies. The Lärmät exercise held 3 - 6 October included components (assessment of contaminated fields, working with the police and assessing possible contamination in a confined space) which were later included in the much larger REFOX exercise, where the other Nordic countries participated. The coordinator of NordEx-12 was therefore invited to observe and participate in the exercise.

2.5 Iceland

2.5.1 Northern Viking 2011

This exercise was carried out on June 9th 2011 by IRSA in cooperation with the Icelandic Coast Guard and the National Commissioner's of Police Counter-Terror Intervention Team. The Danish and the Norwegian Coast Guards also took part. The exercise involved gamma spectrometric detection from a helicopter of a radioactive source onboard a container ship. This was subsequently followed-up with a hostile takeover of the ship and a search for radioactive sources, which were then taken away by the police as evidence and analysed. Spectrum of a suspect sample was sent to the US NNSA's TRIAGE system for verification. The other Nordic countries were informed about the exercise in advance and details of the exercise have subsequently been presented and discussed with Nordic experts.



Fig. 4. Two images from the state TV's coverage of the exercise (filmed from a Coast Guard vessel). These two stills from the graphic sequence of the members of the special squad of the police fast-roping down to the ship were used by the State TV for months afterwards as a part of the count-down sequence prior to the main news. The media was only allowed to observe the exercise from a distance, but the coverage was positive.



Fig. 5. A member of the Police Counter-Terror Intervention Team contacting the control centre via a TETRA portable radio and reporting having localised a hard-to-find radioactive source in a container only 10 minutes after fast-roping down to the ship from a helicopter (he is holding one of the small CsI-based detectors used by the team).



Fig. 6. After the team had found another source in the blue container and mapped the radiation levels on the outside, a radiation expert (here doing measurments from a ladder) was lowered from a helicopter to give advice before the container was opened.

Working with the Coast Guard and Police Counter-Terror Intervention Team out at sea with limited control and lack of time proved to be educational for all parties. Many of the issues that came up are similar as came up later in REFOX and the Swedish Lärmät-11 exercise, where radiation experts assisted the police in raiding and securing a makeshift laboratory at a farm. One challenge is obtaining the best balance when applying radiation protection principles in a (potentially) very dangerous environment (where people have to watch out for booby traps, explosive devices and risk being shot at). What advice should a radiation expert give beforehand and if appropriate, during the operation and what should be his role? Another challenge also highlighted in REFOX/Lärmät-2011 is how far should radiation experts go in radiological cleaning of a suspected crime scene (and possibly destroying vital evidence). Developing routines of cooperation between the team securing the scene and forensic and radiation experts is important, so all parties can work constructively together. This issue has subsequently been taken up in the draft IAEA Nuclear Safety Series report, Radiological Crime Scene Management.

3 Suggestions for exercises

3.1 Sea transport of radioactive materials – table top exericse

The proposed NKS exercises for competent authorities on Sea Transports comprise three table top exercises with relevance to currently occurring transports along Nordic coasts. The following preliminary plan has been developed, taking into account experience of the Nordic group dealing with transport of radioactive substances. All exercises are proposed to follow the general exercise design below, including an outline of the recommended media handling:

EXERCISE DESIGN

- 1. Competent authority receives initial message from national vessel traffic /search and rescue services/emergency management agency, [team receives limited/inadequate information]
- 2. Initial assessment of situation [teams ability to assess the situation depends on the amount of information team can get/whom to contact?
- 3. Immediate response to organisation providing first response.
- 4. Further safety assessment for responders and the public
- 5. Identify relevant organisations and inform [who must be involved?]
- 6. Determine if radiological measurements are needed and if so which and by who.
- 7. Consider recommendations in press release.

SUGGESETED SCENARIOS

3.1.1 Capsized UF6-transport Situation:

UF6-transporting vessel capsized during storm. During calm weather conditions inspection confirms no breaches of UF6 transport containers. However, containers confirmed floating or stranded and one found in coastal salmon farm. Late stage material rescue recommendations for personnel are needed.

Additional questions:

- 1. Must on board responders take radiological countermeasures?
- 2. Should coastal team consider radiological countermeasures?
- 3. Recommendations in press release should include: ?
- 4. Chemical vs. radiological risks: co-ordination ?

3.1.2 Grounding of possible INF transport Situation:

INF-classified vessel experience engine power failure. Wind and currents cause vessel to approach Nordic coastal waters. Mayday stress signal and call for nearby vessel to provide help against drift towards coast. Unconfirmed information from other Nordic Competent Authority claims INF onboard.

Additional questions/considerations:

- Nearest conventional vessel: Oslo-Copenhagen ferry: Queen of Scandinavia or Ocean Cruise Ship.
- INF is later confirmed to be onboard by selected foreign authority.

- Media: An environmental group questions container capabilities (water depths more than design basis criteria for INF packages 200 m water pressure).
- Recommendations in press release should include: ?

3.1.3 Fire onboard vessel carrying Co-60 sources for industrial irradiators Situation:

Developing fire onboard Co-60 carrying vessel occurs immediately outside major Nordic harbour. Rescue operation at harbour. Landward smoke plume is developing.

Additional questions/considerations

- Can smoke divers be deployed in vessels holds/compartments?
- Is harbour to be cordoned off?
- Recommendations in press release should include: ?

3.2 Assessment of an accident in a nuclear powered vessel, using results from the NKS-B *MareNuc* and *Cosema* activities

There has been increased interest in being able to assess the possible consequences of an accident in a nuclear powered vessel. The **MareNuc** seminar was held 25-26 August 2011 in Iceland, see <u>https://www.gr.is/nks-b/marenuc/</u>. A number of presentations were given on possible accidents in nuclear powered vessels and what the consequences could be. The findings are described in the MareNuc final report, NKS-268, *A Nordic Approach to Impact Assessment of Accidents*. This can be used with results from the **Cosema** activity (being concluded at time of writing) on possible spreading of radionuclides in the marine environment.

4 EmSem and the joint Nordic participation in REFOX

The Swedish REFOX exercise was a major undertaking, not only involving the Swedish Radiaton Safety Authority (SSM) which had the coordinating role, but also the Department of Medical Radiation Physics, Lund University (LU) which was responsible for much of the planning and practical work. Other Swedish authorites were also involved as well as voluntary organisations. It was thus very valuable for the other Nordic countries to be able to participate in an exercise of this large magnitude.

4.1 A separate report on the REFOX exercise and lessons learned

At the EmSem seminar in August, it was decided to divide the reporting of the exercise and the seminar so that **SSM and LU would describe the REFOX exercise and the lessons learned in a special report**, since they as planners know the exercise best and for them documenting Nordic lessons learned is part of the outcome they want to get. It was decided that this NKS report should only give a summary description of the seminar and focus mainly on the NKS aspects (which will not be covered in the SSM/LU report), that is NKS specific presentations related to other exercises and the discussions on how the lessons learned could be utilised for generating new NKS activities.

4.2 The EmSem seminar

4.2.1 Stated aims with seminar

The EmSem seminar was announced as "A seminar following up the experiences of the Swedish REFOX exercise (2012) and other recent Nordic exercises - Lessons learned and the way forward. Hotel Park Inn, Solna Centrum, Stockholm, August 27 - 29, 2013". The following description was given:

All the Nordic authorities participated in the large Swedish REFOX exercise in September 2012, lessons learned will be compiled within the NKS NordEx-12 activity. The aim of the EMSEM seminar is not only to provide a forum for the Nordic radiation safety authorities to discuss the lessons learned, but also to discuss the status and challenges in practical and operational radiation emergency preparedness in general. The Fukushima accident highlighted some issues; there has been increased cooperation with other authorities (incl. police); technical developments have offered new possibilities but also created new challenges and demands.

The EMSEM seminar would focus on the current status, challenges and where the Nordic authorities could gain from co-operation (which could be in NKS activities). It would also include aspects of multinational/international assistance (e.g. on the basis of IAEA's RANET) both with regard to giving and receiving assistance as well as the practical challenges of working together in a joint team, including compatibility issues.

Nordic authorities and research institutes within the field of radiation safety, radiation research and emergency preparedness are invited to participate in EmSem. The seminar will discuss and follow up experiences from the Radiological Emergency Field Operative Exercise, REFOX 2012 and other recent exercises in the Nordic countries (project NordEx-12). The objectives of EmSem are:

1. Recapitulate and describe major parts of the REFOX 2012 exercise and encouraging participants to present their experiences, equipment, methods, measurement results and conclusions. The intention is to produce a comprehensive report from the exercise.

- 2. Present and discuss experiences from the NKS-B project NordEx-12.
- 3. Collect ideas and discuss the way forward, thereby identifying needs and ways for future research and development of methods, experimental procedures, exercises, education and training, some of which might lead to future Nordic cooperation and perhaps NKS activities.

It was decided to have one invited lecture by Dr. Matthew J.F Healy from Cranfield University, *A model for CBRN defence*. He had been present at the REFOX exercise at the invitation of the organisers and had been assisting in planning the analysis of the lessons learned. He was also invited to give his impressions of REFOX at the seminar, personal viewpoints and observations rather than a formal analysis.

4.2.2 Value for self evaluation by REFOX participants

The seminar was very valuable for the participants because it gave them a unique opportunity to learn various detail from those who had planned the exercise and been in charge of how it was conducted. This was all the more important, as the exercise was NOT planned to be a test and no evaluation of performance was given. In many cases the participants had thus limited opportunity, before the seminar, to evaluate their own performance and what went well and what not.

4.3 Agenda and participation

The agenda for the seminar was as follows:

Tuesday, August 27

10:00 Arrival and registration. Coffee. 11:00 Seminar introduction by L. Hubbard, S. E. Pálsson, R. Finck 11:30 Invited lecture by Dr. M.J.F. Healy, A model for CBRNdefence. 12:30 Lunch. 13:30 Recap of the REFOX 2012 Exercise. Chair: Robert Finck. Air-borne search of orphan radiation sources (X1,R1, K1). Jonas Nilsson 13:50 Air-borne presentation: H. Johansson 14:15 Air-borne presentation: S. Karlsson 14:35 Questions and discussion 14:50 Recap. Car-borne search of orphan radiation sources (PreEx, S1-9, R2, G1, G2), by Jonas Nilsson and Mikael Hörnlund 15:15 Coffee break 15:45 Car-borne search presentation: Aage 16:00 Car-borne search presentation: Nilssen 16:15 Car-borne search presentation: Watson 16:30 Car-borne search presentation: Behring 16:45 Car-borne search presentation: Söderström 17:00 Car-borne search presentation: Halldórsson Holm 17:15 Questions and discussion 17:30 Recap: Car accident (R3) by Karl Östlund 17:35-17:50 Car accident presentation: Söderström 18:30 Dinner. Wednesday, August, 28 08:30 Impressions of REFOX (Dr. M.J.F. Healy). 09:00 Recaps Illegal laboratory (R4), Children irradiated by RED (R6), Car bomb in street

(R8), Strong radiation sources (K2), by Karl Östlund:

09:10 Recaps: Illegal radioactive waste dump (B2), Suspected dirty bomb area (B3), Radioactive fallout on the ground (B4) by Mikael Hörnlund and Karl Östlund:

09:20 Illegal laboratory presentation (R4): Pálsson

09:30 Illegal laboratory presentation (R4): Gäfvert

09:40 Illegal laboratory presentation (R4): Smolander

09:50 Illegal laboratory presentation (R4): Breddam

10:00 School children irradiated by RED presentation (R6): Gårdestig

10:10 School children irradiated by RED presentation (R6): Holmgren

10:20 School children irradiated by RED presentation (R6): Israelson

10:30 Car bomb in the street presentation (R8): Smolander

10:40 Strong radiation sources in the field presentation (K2): Aage

10:50 Strong radiation sources in the field presentation (K2): Halldórsson Holm

11:00 Coffee break

11:20 Illegal radioactive waste dump presentation (B2): Nilssen

11:30 Suspected dirty bomb test area presentation (B3): Gäfvert

11:40 Suspected dirty bomb test area presentation (B3): Pettersson

11:50 Radioactive fallout on the ground presentation (B4): Gäfvert

12:00 Radioactive fallout on the ground presentation (B4): Nilssen

12:10 Radioactive fallout on the ground presentation (B4): Söderström

12:20 Discussion themes: Pre-exercises. Threats. Opening: Pálsson

12:30 Lunch.

13:30 **Results and discussions around NKS NordEx-12 and MOMS. Chair: Sigurður Emil Pálsson.** Grim, Jönsson, Karlsson, Nilssen, Selnæs, Smolander. Contributions and time schedule as agreed with the chairman (10-12 minutes per presentation).

15:00 The way forward. Chair: Sigurður Emil Pálsson

Reminder: NKS-B call for proposals (Kasper Andersson). Collection of ideas. Suggestions and presentations from participants concerning needs and ways for future research and development of methods, experimental procedures, exercises, education and training. Work groups for development of suggestions are formed on the basis of expressed interest.

15:15 Introduction to subjects for group discussions. Breddam for Group 1, Grim for Group 2, Östlund for Group 3, Finck for Group 4 (3 - 4 min per introduction).

15:30 Coffee

15:45 The way forward. Work-group discussions.

Group 1. Chair: Kresten Breddam

Group 2. Chair: Per Reppenhagen Grim

Group 3. Chair: Kasper G Andersson

Group 4. Chair: Øyvind Gjølme Selnæs

18:30 **Dinner.**

Thursday, August, 29

09:00 Plenary discussion. Presentation and discussions ofwork-group suggestions for future work. Chair: Sigurður Emil Pálsson.

Starting with discussion about the need for pre-exercises. Group chairmen present results from their work-groups, Coffee break when suitable.

12:15 Closure of the seminar.

Robert. Finck, Sigurður Emil Pálsson

12:30 - 13:00 Lunch.

There were 38 registered participants in the EmSem seminar.

4.4 Results from the NKS-B MOMS (<u>MO</u>bile <u>Measurement Systems</u>) activity

The MOMS activity had been concluded and reported¹ by the time of the seminar. But as methods of comparing measurements and sharing data is of core importance in cooperation in exercises and real scenarios, it was considered useful to have a summary presentation by the activity leader, Johannes Nilssen (NRPA), especially with respect to discussions concerning the way forward. The sharing of data was described in three steps, firstly notification, secondly going a bit further by sharing results, e.g. georeferenced results in *shapefiles* and finally by sharing measurement data in a standardized format such as the n42.42. Some progress has been made in this field amongst institutes in the Nordic countries, but there is still much left to improve.

Participants in MOMS had arranged a pre-exercise amongst themselves at REFOX, teams from DEMA and NRPA did produce similar dose rate estimates as a function of location, but neither went the step further to estimate activity levels.

The conclusion was that there was still need to agree upon what to share, doserates, maps, locations of hotspots, dietary advice, travel advice etc. and also, at what time during a real emergency is it realistic for sharing to take place. This needs to be planned well in advance. Practical issues such as file formats and terms-of-use need to be decided as well

4.5 Presentations of exercises and general issues (not directly related to REFOX)

Additionally there were a number of short presentations on topics not related directly to REFOX, either on other exercises or some general issues.

- Johannes Nilssen (NRPA) gave a presentation on "Walk the line Norwegian style". He described an exercise involving a search, where the team was lined up side-by-side for searching a large area and the arrangements for finding, identifying and removing the source and the subsequent decontamination.
- **Per Reppenhagen Grim (DEMA)** gave a presentation on the structural development – Thoughts on future development issues. He discussed the many factors to be considered, e.g. on the operational (staff) level, the strategic (political) level and how the needed tools should be used effectively.
- **Matthias Jönsson (Lund University)** discussed experience gained organizing a course for a mixed group of physicians, nurses and medical physicists on prehospital rescue and initial medical care of a possible contaminated and injured person. The physicist's role (e.g. dosimetry) in this cooperation was emphasized and pitfalls to be avoided (not try to identify radionuclides right away and communicate clearly). The challenge for the physicist is typical for work in mixed environment, to give a simple yes or no answer to the question: Is it safe to work here?
- **Simon Karlsson (SSM)** gave a presentation of a RANET field exercise SSM participated in, which was a great opportunity for testing equipment, methods and strategies in a real fall-out situation and the SSM RANET team work in Japan.
- Øyvind Gjølme Selnæs (NRPA) presented a small field exercise at Sessvollmoen that was a useful preparation for REFOX. The field exercise was arranged in cooperation with the Norwegian Defence CBRN-School (FABCS) and the Institute for Energy Technology (IFE). There were three different tasks: Field search for an orphan source,

¹ See report NKS-275, Mobile Measurement Systems, Final Report from NKS-B MOMS.

container with a radioactive source and survey of a cordoned-off area. Besides teams from NRPA, a team from the Norwegian Defence Research Establishment (FFI) participated in the exercise. Suggestions mentioned for future activities with respect to Nordic cooperation were: invite other countries to observe exercises and/or share lessons learned; exchange experience in exercise planning (e.g. in a workshop); joint work on scenarios, having a scenario database based on previous exercises and real events and scenario based table-top exercises.

- Petri Smolander (STUK) discussed various practical aspects of information sharing, mentioning that NKS-B MOMS had been a good start, helping to highlight the challenge. Searching for a point source may seem a simple procedure, but there is a lot of potentially relevant information, what to share? After having agreed what to share comes the challenge of agreeing on a common format for sharing. Digital maps can also be a challenge, to have maps that can be downloaded and include all drivable roads and have sufficient extra data to be of use. One more challenge is protective clothing, not just for a short time indoors but that can be used for a long time outdoors and possibly under harsh conditions. Other environmental hazards may have to be taken into account as well, heat and chemicals.
- Kasper Andersson (NKS-B programme manager) mentioned a few points from the NKS seminar on the Fukushima Accident: a need was expressed for better and more consistent guidance on environmental monitoring; decision support systems (DSS) and preparedness plans should be tested and updated for use in long-lasting release scenarios; easier access to important data in the event of an emergency would be beneficial, e.g. by creating a Nordic access/exchange platform to share results and secure that modeling experts have access to the needed data; better integration of monitoring data and source term data, and possible improvments of dose calculations in DSS were discussed; it was concluded that Nordic communication with the public needs strengthening.

4.6 Some comments on lessons learned of general relevance mentioned at EmSem

As explained earlier, details from other presentations will not be given here, as the REFOX presentations will be covered in a separate report. There were, however, some comments made on Nordic cooperation which were relevant for the discussion on follow-up and possible generation of proposals. Some of these points were the following.

- **Mixed teams.** It was interesting to note how prominent the use of mixed teams was, e.g. involving cooperation between radiation experts, police and other first responders or e.g. customs officials. This is no doubt a development that should be taken into account when planning future exercises.
- **Communication and documenting.** Many team stressed the need for efficient communication and documentation in the field and with the base station. Various digital alternatives to pen and paper were tested for recording sound and visuals, videos as well as photos, some even transmitted in real time. Sharing this information and using it for fast assessment is one of the current challenges. Given the fast technological developments in this field, many new solutions can be expected.
- Applying protection a graded approach? After the Fukushima accident some of the radiation measurement teams in Japan were faced with the challenging question, how to apply contamination control doing measurements amongst the local population, is it consistent to wear full protective overalls and facial respiratory masks

with stating that the situation is safe. Some teams chose thus to apply as little visible protection as possible (e.g. taping their shoes with clear tape). One team suggested a solution to have a small portable air sampler to confirm that no airborne contamination was present in cases where there was no reason to believe there was some. Another team stated that in real cases they would not use shoe protectors because they could cause slipping hazard on snow and ice, instead shoes should be monitored and decontaminated, if needed. Also, that there was no need for dust proofing if there was no airborne contamination present.

- **Realistic scenarios make it more challenging to clarify what is a part of the exercise.** The organisers did very thorough work in making the exercise as realistic as possible, e.g. by having part of the exercise in an open uncontrolled environment. This was one of the good features of the REFOX exercise, but it can also make it more challenging for participants to determine what should be taken a part of the exercise and what not, e.g. which roads/areas are closed for all (not just the public), what can be assumed about sources and their location etc.
- Impressions from Dr. Matthew J.F Healy. Matthew Healy came with a few observations and questions for thought and generation of discussions.

4.7 The way forward - Group discussions

4.7.1 Suggested topics and results of discussions

On the second day there was an introduction given by Kasper Andersson to the NKS and its framework for supporing activities, including the call for proposals. This was followed by introductions to suggested topics for group discussions:

1. Group 1: Development of tactical one-page operational guidance for different scenarios.

Suggestion / Chair: Kresten Breddam / Catharina Söderström

- 2. Group 2: Development of the tactical measurement platform (team levels, skill levels, instrumentation, education, exercises). Suggestion / Chair: Per Reppenhagen Grim
- 3. Group 3: **Practical testing of decontamination methods for urban and rural areas using short-lived radionuclides as tracers**. Suggestion / Chair: Karl Östlund and Robert Finck / Kasper G Andersson
- 4. Group 4: **Development of education and training procedures for unknown** radiological threat scenarios. Suggestion / Chair: Karl Östlund and Robert Finck / Øyvind Gjølme Selnæs and Matthias Jönsson

The aim with these discussions was to generate ideas, which could later be developed into proposals for NKS activities. The results from each group were presented the following morning, on Thursday August 29th. The slides from these presentations can be found in the appendix to this report. They are included here, as they may contain useful suggestions for future NKS work. It must be stressed, that these slides are not the presentations themselves, they are only illustrations for the presentations and some details discussed may thus be missiong. It must also be pointed out that some of the coordinators had the opportunity to make preparations, including slides, before the group discussion session, whereas others were appointed just before and the slides presented here were simply prepared by the group during the discussions.

4.7.2 Follow-up of group work, development of NKS proposals

Representatives from each group were contacted when the deadline for call for proposals was expiring and asked if any proposal had been developed on the basis of the work within the

group. No proposal had been developed as a direct consequence, but some stated that development work had started and that it simply would take more time to develop mature proposals due to the technical complexity of the propsals, especially because this process needs to be ongoing in organisations in different countries simultaneously. Hopefully REFOX and EmSem will contribute to generating more NKS work in the future, this has to be seen as a long term cultivation task, one should not expect the harvest right away.

Acknowledgements

The participants would like to thank the NKS and its supporting organisations for having generously supported this work, both financially through NKS funding and through allowing participants and all those who participated in one way or another to do so. The support given by the Swedish Radiation Safety Authority (SSM) is highly appreciated, especially for encouraging joint Nordic participation in the REFOX exercise, using considerable resources for integrating the participation from the other Nordic countries in the REFOX and then to support and devote resources to holding a joint seminar with the NKS on the lessons learned of the visiting teams. REFOX and EMSEM required a huge effort by many, but special thanks have to go to Robert Finck (SSM), Karl Östlund and Christer Samuelsson (both from University of Lund) for their hard work and welcoming enthusiasm for the visiting teams, which made the exercise and seminar a model for Nordic cooperation in the best of NKS traditions.

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 authors 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.

Appendix – Presentations slides from group disucssions

It should be noted that some of the coordinators had the opportunity to make preparations, including slides, before the group discussion session, whereas others were appointed just before and the slides presented here were simply prepared by the group during the discussions.

It should also be remembered that the following slides are not *the presentations*, they are merely illustrations for the presentations given.

Presentation from Group 1

Sündhedsstyrelsen



Group I (Action Cards) Development of tactical one-page operational guidance for different scenarios

NKS-B Nordic Seminar on Radiological Emergency Exercises – EmSem Stockholm, August 2013

Sündhedsstyrelsen

Objectives



- Collect ideas and discuss the way forward, thereby identifying needs and ways for future research and development of methods, experimental procedures, exercises, education and training...
- ...some of which might lead to future Nordic cooperation and perhaps NKS activities.

Group I

- Present suggestions and condusions Thursday 29/8.
 - Could Action Cards be beneficial in our line of work or do they fall apart in real situations?
 - Can a "best practice" be defined at all? (method or tool box?)
 - Define target group(s)
 - Discuss contents
 - Way forward
 - NKS-application? and how to make it...

Sündhedsstyrelsen

Action Cards

Reasoning

- REFOX showed a variety of different ways to handle radiological crime scene scenarios
- Some scenarios obviously challenged groups
- Lots of guidance for emergency 1.st responders, but its often not "easy access" guidance
- Lots of guidance for prehospital triage & monitoring and for hospital management
- Focus is on EM rather than crime scene investigation guidance (simultaneously or after the EM)
- No tactical guidance for RPE's characterising a crime scene or guiding responders

Two general objectives

- Action cards providing a Nordic recommended basis for radiological CSI, saving evidence, time and doses
- Action cards for 1.st responders (?)

Sündhedsstyrelsen

Examples: EM action cards

TMT Handbook, 2009

- General (Chapter E; Immediate actions)
- · Control exposure; monitoring to confirm; set up zones & boundaries

ERG-2012

6 scenarios (low, moderate, high, high external, fissile, UF6)

"Uheldsvejledningen"

- 10 specific scenarios (7 transport, 3 fire)
- Tactics; Placards; Background (risk, expected dose, container)

HPA Guidance for public health professionals

- General
- · Emergency Response; Health Protection; Radiation & Health Effects

Sündhedsstyrelsen

Considerations

• Two sets?

- Basic guide for 1.st responders
- Extended guide for RPE CSI

Generic or specific scenarios?

- Generic may be too generic
- Specific may be too specific
- Both? generic with specific examples

Include general section?

- · Radiation an when to suspect it
- Safety distances
- Health effects
- Public safety

Preservation of evidence



Sündhedsstyrelsen

Way forward

Today

- Brain storm
- May Action Cards be useful?
- · Can a "best practice" be defined at all? (Method or tool box?)
- Define target group(s)
- Define contents
- · Ideas on best way to retrieve scenario experiences
- Propose way forward
- Outline & set-up PPT for tomorrow
- Select co-chair to present discussions

After EmSem

- NKS-funding?
- · Working group with a NEP-group responsible
- · Form?: Distribute templates, Collect and merge templates?

Way forward

Brain storm

 Practical size, 1st responders wear gloves, and are too busy to read stuff, logical structure, several 1st responder levels, reach back unit has more time to "read", civil defense measurement unit action cards being developed in Norway (MS); Action cards could form a basis for exercises; feed back from responders needed in developing cards; (embassy action cards / advice), scaling of incident, language

May Action Cards be useful?

Definitely useful for RPE's and a version for 1st. Responders too.

Best practice or tool box?

RPE's (tool box); 1st. Responders (best practice; instructions; orders)

Define target group(s)

RPE's; 1st. responders

Sündhedsstyrelsen

Way forward

Define contents

Generic, procedures can differ, important things to remember ie. Alfa, beta, gamma, neutrons, personal protection,

Ideas on best way to retrieve scenario experiences

Start with Refox-scenarios, real experiences, "not" scenarios, complexity and size of accident

Propose way forward

Scenarios to tackle Write proposal for NKS (KB) Collection of scenarios and available action schemes and plans, lessons leamed. Before end of February. Meeting and merging, prototype (March) Reviewal (April) Follow up (?)

Way forward

Define contents

Generic, procedures can differ, important things to remember ie. Alfa, beta, gamma, neutrons, personal protection,

Ideas on best way to retrieve scenario experiences Start with Refox-scenarios, real experiences, "not" scenarios, complexity and size of accident

Propose way forward

Scenarios to tackle Write proposal for NKS (KB) Collection of scenarios and available action schemes and plans, lessons learned. Before end of February. Meeting and merging, prototype (March) Reviewal (April) Follow up (?)

Sündhedsstyrelsen

Way forward

- After EmSem
 - NKS-funding?
 - Time? Printing;
 - Meeting, travel expenses
 - Working group with a NEP-group responsible
 - Form?: Distribute templates, Collect and merge templates?

Group 2



Chair: Per Reppenhagen Grim

Development of tactical concept

Phases:

- 1. Mapping, gathering information and discussing this
- Developing standards, educational materials and templates
- 3. Testing the standards, materials and templates
- 4. Revision, education, training, categorization and exercises





Development of tactical concept

Step 1 (2014):

Group 2: Development of the tactical measurement platform 4

- Map existing best practices (Nordic countries and IAEA)
- · Map equipment and categorize it (Nordic countries)
- Map experts (level, speciality), their availability and categorize them
- Status on best practices in Nordic countries

2: Development of the tactical rement platform		
Deve	elopment of tactical concept	
	Further steps:	
,	 Defining best practise by scenarios and availability experts/instruments 	of
	Derive learning materials from earlier works	
	Test best practices	
	 Make templates for i.e. "Plan of Action" (consider a charts) 	also flow
	Classify existing teams in Nordic countries	

Let's apply for funding and go to work





Group 2: Development of the tactical measurement platform 5





Group 3: Practical testing of decontamination methods for urban and rural areas using short-lived radionuclides as tracers

Proposed by Karl Östlund and Robert Finck Participants: R. Finck, M. Hörnlund, J. Nilsson, K.G. Andersson

Heading 1: Testing of readily available modern equipment's potential to effectively decontaminate contaminated surfaces

Objective 1: To extend the current knowledge base in the URBHAND and EURANOS handbooks and associated cms datasheets with novel technologies and improved parameterization, while obtaining valuable hands-on experience in field decontamination.

Kasper G. Andersson NKS-B Programme Manager NKS-B EMSEM Stockholm, 27-29/8, 2013



Equipment (subject to extended information search) might include:

- Modern ditchers and farm scrapers (and other gardening machines) for soil
 removal or 'sequential burial' of contaminated topsoil
- Turf harvesters for topsoil removal
- · Possibly novel asphalt scraping/paving techniques, although rarely called for



Kasper G. Andersson NKS-B Programme Manager



Snow removal machines(high Nordic relevance; exceedingly little testing done in the past)



You do NOT remove all contamination that is on the snow surface (rolling/smearing).

Any implemented decontamination technique must achieve the overall objective with respect to, e.g., acceptable residual dose (relevant within a certain dose band; important to quantify achievable DF for different scenarios).

Method development involving snow canons to not only assess effect for contamination deposited on snow, but also contamination with snow.

Kasper G. Andersson NKS-B Programme Manager NKS-B EMSEM Stockholm, 27-29/8, 2013



Not only the decontamination effect should be recorded, but also time and other requirements, as well as specific learning points that could be valuable in planning.

Use of 'common' shortlived radionuclides as tracers was discussed for methods that are indifferent to physicochemical contaminant characteristics.

Cs-136 might be produced and used for other tests...

Also leafblowers were discussed (will the contamination be fixed in the leaves...?)



Kasper G. Andersson NKS-B Programme Manager



Heading 2: Testing of lawn mowing and crop cutting techniques for early phase decontamination of contaminated land

Objective 2: To improve the knowledge of the effect of early vegetation removal techniques including waste collection efficiency. Depends to a great extent on early rain (time, intensity, total amount).

Various degrees of rainfall could be synthesised using the Lund U. surface contamination device (method development).

Time function of DF could be assessed for different conditions: when does it make sense to carry out (how much time is available in an emergency situation)? Which DF's should be assumed in prognostic models to assess situations and for training (real weather data could be used)?



NKS-B EMSEM Stockholm, 27-29/8, 2013



Heading 3: Guidelines for measurements to guide decontamination

Objective 3: To carefully determine and describe what is interesting to measure in different type of contamination scenarios

Which measurement strategies would be recommended for different scenarios and for different purposes and different time phases? What to measure? Equipment, collimation?

Recommendations in IAEA Tecdoc 1092 or other existing documents are not sufficiently specific

Fukushima soil waste problem could have been reduced presumably by orders of magnitude by applying a proper measurement strategy.



Kasper G. Andersson NKS-B Programme Manager



Russian army decontaminated 93 settlements in Bryansk Region in 1989: DRF = 1.1 - 1.5.

Main countermeasure: Removal of topsoil layer

Removal depth wasvery inhomogeneous even over small areas and not optimised in relation to measurements of vertical distribution of contaminants.





2500

30.00



0 50

Mean depth [mm] 많 많 흖 흛

300 250

0

500

1000

1500

Activity in sample [Bq]

20 00

Different result - same location and method





Risø/IRH Fieldcampaigns 1995/1997:

DRF: ca. 7

Optimised application !

Kasper G. Andersson NRS-B Programme Manager

NKS-B EMSEM Stockholm, 27-29/8, 2013



Measurement techniques should also be described for things like RDD contamination scenarios.

Here other types of measurement than contamination levels could be required – e.g., in situations involving single pure alpha emitters. Here knowledge of physicochemical form(s) would enable source identification and modelling to determine likely contamination pattern before alpha analyses can (slow ly) be made.

Kasper G. Andersson NKS-B Programme Manager



Other things discussed:

Possibilities for decontamination tests in Fukushima (door opened by RANET, NERIS or other -?).

Measurement techniques should also be described for things like RDD contamination scenarios.

Assessment of practicability and acceptability of known cms. Related information questions. Which of perhaps 85 cms should made operational in Nordic preparednesses?

Possibilities for production of tracer labelled particles representative of NPP accident near zone contaminants or physical frag mentation aerosols from RDD. Application of these in decontamination tests.

Kasper G. Andersson NKS-B Programme Manager

Group 4: Development of education and training procedure for unknown radiological treat scenarios

Objective

- A common Nordic approach to education and training of all levels of emergency personnel from first responders to experts
- NKS project? Common Nordic course or seminar?

Description

- Per definition it is impossible to train for unknown scenarios!
- The next event will not be like anything we have seen before, so do not prepare too specific.
- You can train for the consequences/crises management without knowing the specific scenario.

Description

- Basic training and understanding of radiation and health effects.
- Role awareness and confidence.
- Interaction between first responder and expert
- What shall we train for?
 - General situations from local to international radiological and nuclear events.
 - Norwegian approach 6 scenarios.

Norwegian approach: Six general Scenarios

The next event will probably not be like one of the general event - but hopefully somewhere inbetween.





Scenario I

Large airborne release from foreign facility



Scenario II

Large airborne release from domestic facility



Title	Nordic sharing of experience from radiation emergency preparedness exercises			
Author(s)	Sigurður Emil Pálsson ¹ (ed), Lynn Hubbard ² , Robert Finck ² , Karl Östlund ³ , Øyvind Gjølme Selnæs ⁴ , Hannele Aaltonen ⁵ , Kresten Breddam ⁶ , Per Reppenhagen Grim ⁷ , Morten Helge Hansen ⁷			
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Project	NKS-B NordEx-12 and EmSem			
No. of pages	42			
No. of tables	0			
No. of illustrations	38			
No. of references	1			
Abstract max. 2000 characters	The Nordic countries have for a long time had close cooperation in the field of radiological and nuclear emergency preparedness. In recent years there has been more emphasis on cooperating with other authorities, not only first responders but also e.g. those responsible for law enforcement (police). With exercises becoming more realistic and complex, they require more resources and everything cannot be tested. This is where Nordic cooperation can be useful, cooperating in developing and conducting exercises and sharing results from national exercises, especially where some specific issues of relevance for the other Nordic countries have been tested. This report describes results from the NKS NordEx-12 activity, to cooperate and share experience from Nordic radiological and nuclear emergency resonse exercises. Summary descriptions of exercises shared are given, various details were presented at meetings of the Nordic radiation safety authorities contact group on emergency preparedness, the so called NEP group. The NEP group later took over the organisistion of sharing lessons learned from exercises and developing exercises cooperation further. The planning and lessons learned from such exercises often need to be confidential in part and			

thus not suitable for NKS reporting. With this work taken over by the Nordic authorities themselves within the NEP framework, the NKS NordEx-12 had served its purpose and was not needed anymore.
The other main factor in the NordEx-12/EmSem work was to prepare the Nordic participation in the Swedish REFOX-12 exercise, to facilitate cooperation between the countries and arrange a seminar to discuss the results, lessons learned and possible development of new NKS activities. The EmSem seminar was held in Stockholm in August 2013 with generous support from Swedish Radiation Safety Authority. The Swedish Radiation Safety Authority will be publishing its own report on the exercise and the part of the seminar directly associated with it. This report focusses therefore on presentations and lessons learned that are not directly connected to the REFOX exercise.

Key words Radioactivity, exercise, nuclear, radiological

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