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## **The NKS-B Programme for Nordic cooperation on nuclear and radiological emergency preparedness, including measurement strategies, radioecology and waste management**

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This is the third of three articles covering NKS and NKS activities. The previous two articles, on the overall NKS Programme and its Nuclear Safety Programme, were published in respectively Radiation Regulator volume 1, number 1 and 2.

### **Abstract**

The NKS platform for Nordic cooperation and competence maintenance in nuclear and radiological safety comprises two parallel programmes: the NKS-R programme on nuclear reactor safety and the NKS-B programme on emergency preparedness. This paper introduces the NKS-B programme and its current activities.

### **General introduction to the NKS-B programme**

Nordic collaboration on issues related to environmental radioactivity was essentially initiated in the second half of the 1950's, when anthropogenic radionuclides from nuclear weapons tests had been detected as fallout in Nordic areas. This prompted the organisation of a number of Nordic meetings to discuss the possible radiological implications of the environmental radioactive contamination. Particularly, there was concern that Finnish and Norwegian Laplanders could be at risk, since an important dietary component for these populations was reindeer meat, which was enriched in radionuclides through the lichen foodchain. The concern increased in the early 1960's when the second nuclear weapons test period started, and from 1962 to 1969 a series of larger Nordic meetings were held to discuss these issues. Also the two superpowers of the time (USA and USSR) participated in some of these meetings. By the early 1970's, when anthropogenic radioactivity concentrations in the Nordic environments had declined by decades, several Nordic nuclear power reactors were in operation, and concern was now expressed in relation to the consequences of possible environmental releases. This was the background for inclusion of radioecological studies in the very first research activity programme that NKS launched in 1977. Today, 36 years later, radioecology is an important integrated pillar in the NKS-B programme.

In connection with the Chernobyl accident, it had also become apparent that decision makers in nuclear emergency situations could be faced with a considerable complexity of different questions, and systematic decision guidance including specialised prognostic tools would be valuable in optimising emergency response

through different time phases. Operational emergency preparedness became an official priority area for NKS in the early 1990's. Much decision support material has been produced by NKS activities, for early accident response and management of contaminated areas of different types. Some of the reports produced have been trendsetters for later developments of European decision support materials. In general, there has been considerable synergetic effects between NKS-B activities and European (e.g., EURATOM, SECURITY) R&D projects.

Over the years, NKS has endeavoured to address emerging nuclear and radiological challenges, and for instance already about 10 years ago NKS ran activities to investigate the potential health impacts of radiological dispersal device deployment and other malicious uses of radioactive sources. Also consequences of possible environmental releases from special types of nuclear installations, including nuclear propelled sea vessels and floating nuclear power reactors, have been addressed in recent NKS-B activities.

Although NKS has continuously strived to facilitate a common Nordic view on nuclear and radiation safety, Nordic emergency preparedness systems have in the past been developed more or less independently, and some of their differences could complicate Nordic cooperation and mutual assistance in emergency situations. Therefore, NKS activities have been conducted with a view to harmonisation of procedures and techniques among the Nordic countries. A recent example is the MOMS (Mobile Measurement Systems) activity, which gathered representatives of the major Nordic preparedness organisations for a two-day seminar in Oslo in 2012, where possibilities for harmonisation of issues like calibration techniques, data formats, information exchange and measurements strategies were discussed in the context of mobile measurement systems, and a number of agreements were made. This was followed up later in the year through collaborative participation in the large Swedish REFOX radiological field measurement exercise, and the outcome was reported in August 2013 at the NKS EMSEM emergency preparedness seminar in Stockholm.

Good measurement strategies and analysis methodologies are essential to operational emergency preparedness, as well as in handling a number of other problems involving radioactivity in the environment, which are also dealt with under the NKS-B programme (e.g., decommissioning waste, and naturally occurring radioactive materials – NORM). For determination of alpha or beta emitter concentrations in samples, chemical separation techniques are generally needed, and NKS work has in recent years been carried out to develop such techniques for new relevant material matrixes, while also increasing the measurement accuracy, and reducing time consumption and other analysis cost elements. Laboratory practice sessions have also been part of recent NKS activities, where knowledge has been disseminated to young scientists through tutored 'hands-on' practice. Such sessions are important in securing the maintenance of specific key competences.

Also recognising the importance of maintaining and developing competence for analysing complex radionuclide spectra, NKS has in recent years supported a number of exercises in interpretation of various complex spectral information that might be recorded by field measurement teams in connection with accidents at nuclear installations, various types of malicious use of radioactive sources, and mapping of

radioactivity levels and unknown sources from a moving vehicle. The most recent exercise, which was held in 2012, tested participants' ability to discriminate between innocent sources (including industrial, NORM and medical) and illicit nuclear materials, on the basis of data representing realistic in situ measurements.

Considerations of waste management strategies should where applicable generally be integrated in assessments of justification and optimisation of countermeasure strategies for implementation in emergency management. NKS funded efforts have been carried out to examine and describe a range of waste management techniques that might be considered in different types of Nordic environments and under specific Nordic climatic conditions. This has formed part of the background for waste management recommendations in emergency management decision support material that has been developed in more recent NKS-B activities. Also other types of waste management and discharges of radioactive material are dealt with under the NKS-B programme. Examples are as diverse as waste and discharges from decommissioning activities (on which the latest NKS seminar was held in Denmark in 2011), NORM waste from uranium mining and milling, and disposal of radioactive sources.

The NKS-B programme thus comprises the following four formal activity areas:

- *Emergency preparedness*
- *Measurement strategies, technologies and quality assurance*
- *Radioecological assessments*
- *Waste and discharges*

Like its sister programme, NKS-R, the NKS-B programme has produced hundreds of reports, which are all available cost-free on the NKS website ([www.nks.org](http://www.nks.org)), and many of the results of the efforts have also been published in international peer-reviewed journals, through which a larger audience has been informed of the results. Dissemination of results also occurs through activity seminars and workshops, which are announced on the NKS website.

### **NKS-B and the Fukushima accident**

At intervals of some few years, also larger, more generic NKS seminars have been held. The latest of these was the NKS Seminar on the Fukushima Accident and Perspectives for Nordic Reactor Safety and Emergency Preparedness, which was held in January 2013 in Stockholm. The Fukushima accident provided an opportunity for evaluation of the adequacy of specific emergency preparedness routines and an occasion for further scrutiny of the Nordic emergency preparedness system. For instance, it rapidly became clear that even an accident occurring on the other side of the globe, although having no radiological implications for Nordic territories, can be rather highly resource demanding to Nordic authorities and experts, as there was a high demand in the Nordic countries for continuously updated information on the situation, and Nordic citizens in Japan needed advice. If the accident had had a significant radiological impact in Nordic areas, multilateral collaboration and resource sharing would undoubtedly have been very valuable.

There was a discrepancy in the recommendations that the different Nordic national authorities issued to their citizens in Japan concerning iodine prophylaxis. In this situation, with a continuous release and highly uncertain dose prognoses, it could be discussed what would be the most sensible policy, but contradictory intervention strategies for essentially the same areas might be avoided through enhanced preparedness collaboration/harmonisation between countries. However, the distribution of stable iodine tablets to Nordic citizens in Japan worked efficiently, owing to good Nordic collaboration. It is worth noting that very few of the Nordic citizens in Japan actually took the stable iodine tablets they had been recommended to take, possibly because they did not perceive the situation as sufficiently severe. The Fukushima accident also demonstrated that public information on an emergency and its implications will be received through a multitude of different channels, some of which are more trustworthy than others, and recognising the complexity, there may be a scope to revisit Nordic information strategies.

It was discussed at the seminar in Stockholm that there is a need for better and more consistent guidance on environmental monitoring. There is a lack of recent generic international recommendations, but the Fukushima accident also showed that there is a need for more specific measurement strategies, e.g., to guide countermeasure implementation. For instance for the recovery phase, Nordic work has previously demonstrated the importance of recording contaminant distribution profiles prior to removal of contaminated surface layers. Thereby the dose reducing effect can be maximised without generating more waste than necessary. In general the ultimate purpose of measuring in connection with different operations in different phases of an emergency should be clarified, and strategies should be outlined.

As also discussed at the Stockholm NKS seminar, compared with previous major contaminating events (notably the Chernobyl accident), Japanese decision makers were in the Fukushima case faced with a completely new problem: dealing with releases that go on for several weeks. This raises the question of when the accident could be considered to have been contained, and the early emergency phase could be assumed to be over. Further, some effective recovery countermeasures, which must be implemented early to be effective (e.g., removal of contaminated grass cover before the contamination reaches the underlying soil) were here impossible to optimise. Long-term releases can also lead to unusually complex contaminant dispersion scenarios, due to likely greater variation in atmospheric conditions, and challenge existing computerised decision support systems (ARGOS and RODOS are used by Nordic authorities). It would seem prudent to test preparedness plans and tools for use in long-lasting accidental release scenarios.

Means for improved integration in computerised decision support systems of monitoring data and case specific release parameters were also discussed at the NKS Fukushima seminar.

On the practical operational side, the Norwegian authorities demonstrated parallel learning points from the tragic terror attacks in Oslo on the 22th of July 2011.

Video films of each of the NKS Fukushima seminar presentations can be viewed on the NKS home page.

## **Current NKS-B activities**

There are currently 9 ongoing NKS-B activities. Three of these are continuations of previous activities having demonstrated high quality and value in earlier phases. The current NKS-B activities are:

### *Emergency Preparedness*

#### **EMSEM**

The scope of the seminar was to provide a forum for Nordic radiation safety authorities to discuss lessons learned from the recent Swedish REFOX exercise, and to discuss issues related to practical and operational radiation emergency preparedness in general. The seminar was held 27-29 August 2013, and documented valuable experiences and learning points. The final report of the activity is expected by the end of the year.

#### **MUD**

The activity addresses assessment of uncertainties of atmospheric dispersion model predictions as well as possibilities for presentation to decision makers. Meteorological scenarios have been defined involving a variety of different atmospheric conditions. An operational meteorological ensemble prediction system has been run for these cases providing input for atmospheric dispersion models. This leads to description of uncertainty assessment methodologies.

#### **PUBPLUME**

The activity gathers experts on emergency response, dispersion modelling and public information to jointly make recommendations on how to produce and present different dispersion products to the public. The group considers issues such as how to present uncertainty in the products, and how the public interpret visualisation of risk.

#### **THYROID**

This activity aims to evaluate the status of thyroid measurements capabilities in the Nordic region. The existence of an established regional network for in-vivo monitoring of internal contamination is a clear advantage and a good starting point. Materials for calibration are currently being circulated among a total of 30 participants registered with an average of 5 detection systems per participant to calibrate.

### *Measurement strategies, technologies and quality assurance*

#### **GAMMATEST**

The aim of the proposed activity is to follow up on previous NKS gamma spectrometry activities and assess the competence improvement. An intercomparison exercise will be conducted, and results as well as lectures on challenging topics will be presented at a seminar to be held in the autumn of 2013.

## NOVE

In this activity a comparison is made between conventional and novel neutron detection technologies. The project started with a neutron detection workshop, where a plan was made for intercomparison measurements, which will be conducted at the Metrology laboratory of the Finnish Radiation and Nuclear Safety Authority (STUK) using well characterised Cf-252 and Am/Be sources.

## RADIOANALYSIS

The objective of this activity is threefold: (i) to provide workshop participants with an overview of updated radioanalytical methods for important radionuclides difficult to measure, (ii) to provide participants with hands-on experience, and (iii) to provide a forum for knowledge exchange. The workshop took place at Risø, Denmark, on the 2<sup>nd</sup> – 6<sup>th</sup> September 2013. It comprised 2 days with presentations, including a number of invited speakers, as well as 3 days in the laboratory with expert tutors. The final report of the activity is expected by the end of the year.

### *Radioecological assessments*

## BERMUDA

This activity aims to survey levels of natural radioisotopes in wild mushrooms and berries relevant to the Nordic Countries and assess the effective doses among Nordic households using forest produce in their diet. The measurement study comprises 12 Nordic sampling sites representing low, normal and elevated natural radioactivity levels in soil as well as two TENORM (technologically enhanced naturally occurring radioactive materials) sites.

## COSEMA

In this activity, consequences of severe radioactive releases to Nordic marine environment are modelled and analysed. Some hypothetical severe reactor accidents source terms to Nordic marine environment are considered as case studies. The outcome will include modelling assessments, validation studies, uncertainty analyses and a summary evaluation of potential consequences.

## Conclusions

The Nordic countries have collaborated on emergency preparedness for more than half a century, and related topics have been on the NKS agenda since the birth of the organisation. The current NKS-B programme has generated a large number of seminars, reports, conference presentations, journal papers and other NKS activity products, and critical external reviews of the results have generally been highly positive.

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