



Joint Nordic nuclear research to strengthen nuclear emergency preparedness after the Fukushima accident



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ABSTRACT

Contrary to most areas of Europe, the Nordic countries (Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands) have for many years shared a regional research and development program on nuclear reactor safety and emergency preparedness - NKS. In spite of its project results having received great recognition and having been integrated in state-of-the-art emergency preparedness tools over the world, NKS as an organization does not seem well known outside the Nordic countries. Although the Fukushima accident had no health impact at all in Nordic areas, it taught a number of lessons of generic nature with respect to new R&D tasks that could further strengthen and secure future maintenance of the Nordic region's capability to effectively respond to such events. For broader inspiration, this paper briefly introduces the Nordic nuclear emergency preparedness co-operation channels and outlines the related NKS R&D project initiatives launched after the Fukushima accident, many of which should be of general interest also far outside the region. The paper is intended as an introduction to NKS with an invitation to explore its results. All project results are available cost-free on the NKS website.

1. Introduction

Specifically in relation to NPP emergency preparedness and recovery of contaminated areas, many lessons were learned from the way that the Fukushima accident was managed off-site. As pointed out by the IAEA comprehensive Fukushima report (IAEA, 2015), 'the arrangements prior to the accident included criteria for sheltering, evacuation and thyroid blocking in terms of projected dose, but not in terms of measurable quantities'. Criteria for relocation had not been determined, and some evacuated persons ended up being relocated a number of times over less than 24 h. Also missing were guidelines for the transition from the emergency phase to the recovery phase, where the authorities in Japan eventually decided to build on the current recommendations of the ICRP (IAEA, 2015).

Measurement strategies to support justification and optimization of practical recovery options were lacking, and the first measured quantities were not in-line with needs with respect to optimizing recovery. Since countermeasures could not be selected and implemented quickly, some potentially important recovery options that need early implementation to be effective (Nisbet et al., 2011) were inapplicable.

This highlighted the general need for expertise and operational guidelines to provide timely help in selecting suitable countermeasures, and readily available equipment and sufficiently skilled personnel to rapidly carry them out. Particularly, topsoil removal operations resulted in extremely large amounts of often not very highly contaminated soil waste, which pose a great disposal problem (IAEA, 2015). This also highlighted the need for optimizing countermeasure implementation in practice through site-specific assessments. Among other lessons learned with respect to off-site consequences should be mentioned the need to deal with multi-unit and multi-site accidents, primary contaminant releases over potentially as long periods as weeks complicating operation using 'traditional' accident phase planning, and source term characteristics that reflected new types of accident processes, and could perhaps in the future to an increasing extent be predicted through probabilistic safety assessments. On top of everything the accident has led to considerable stigmatization and socio-economic repercussions in the contaminated areas (Hasegawa et al., 2015), the nature and extent of which should hardly surprise in the light of, e.g., the Chernobyl and Goiânia cases (Steinhäusler, 2005). Many of these consequences would have been likely to occur at least to some extent also if the accident had

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happened in any other country, and reflect shortcomings of a generic nature that are important to deal with in building a better and more readily operational preparedness for future accidents.

When addressing lessons learned, they need to be considered in the context of existing management systems and cultures. The Nordic countries have a common cultural and historical heritage that stretches many centuries back, and thus a long tradition of working together to solve societal problems. Specifically with respect to nuclear safety (including emergency preparedness), Nordic cooperation goes back to the 1950's, when the nuclear power concept was first foreseen to promise inexpensive energy based on virtually inexhaustible fuel resources. The long-lasting cooperation has resulted in a common Nordic understanding of things like rules, practices and measures, although national differences exist. Through cooperative initiatives, these comparatively small nations have built, and over decades further developed and refined, a nuclear safety network through which they can together tackle existing and emerging problems more efficiently, more consistently and at a lower cost. In this network, the non-profit organization NKS (acronym for 'Nordisk KerneSikkerhedsforskning' – or in English: 'Nordic Nuclear Safety Research'), holds a central position. It emerged from a Nordic wish to together closely follow the planning and development of nuclear energy systems in the region. NKS is funded by the Nordic countries and has since 1977 run joint Nordic research and development activities (with annual open calls for new project proposals) in the fields of nuclear safety and nuclear/radiological emergency preparedness, addressing the region's specific needs, and ensuring that relevant competence and networking is maintained. For more than 40 years NKS has supported and managed collaborative Nordic research and development projects (Marcus, 1997; Bennerstedt, 2011), and alone since the turn of the century this has produced almost 400 final project reports addressing and describing solutions to various problems identified in Nordic areas or internationally (all freely available on the NKS website www.nks.org), as well as countless peer reviewed journal papers. Another important outcome of this collaboration is building and maintenance of vital networks between the region's key people in the field. To secure future continuity, NKS promotes participation of young scientists in the activities, and also has a dedicated budget for travel support for young scientist competence building.

Since 2011, many NKS projects have specifically targeted on learning points from the Fukushima accident. Currently, the projects are run under two separate programs: the NKS-R (reactor safety) and NKS-B (emergency preparedness – B for 'beredskab' in Nordic language), each with its own program manager. In recent years, NKS has annually co-financed projects with a sum of about 1 MEuro. The participating organisations have at least matched the NKS funding with an own contribution, which has often been given as 'in-kind' payment. Although NKS project budgets are obviously smaller than those often offered by, e.g., the European Commission for their EURATOM research projects, the 'lean' annual project application procedures, un-complicated project administration and end-user integration as well as efficient size of work groups under NKS shorten the time from conceptual idea to use of a valuable result. This has over the years in many cases enabled NKS projects to reach the first important results and conclusions in relation to emerging international nuclear safety problems. All NKS-B activities have participation from at least 3 different Nordic countries. Non-Nordic participation in NKS activities is possible, but NKS funding of Non-Nordic organisations is not possible. The project leader must come from a Nordic country (i.e. work for a Nordic organization). The projects run over one year, but may be prolonged subject to approval of a new application in connection with the next annual call for proposals for new projects.

Also other types of nuclear safety activities are run by NKS. Specifically relating to the Fukushima accident and its implications for nuclear safety, NKS has held two seminars in Stockholm respectively in 2013 and 2016 (each with 100–200 attendants). The first of these sought to describe the immediate new perspectives from the Fukushima

learning points for Nordic reactor safety and emergency preparedness. The seminar was opened with a session of key note presentations from Tero Varjoranta (general director of STUK), providing an overview of the Fukushima accident and its early lessons, Abel González (then vice chair of ICRP), relating Fukushima lessons to the ICRP system of radiological protection, Wolfgang Weiss (then chair of UNSCEAR), giving related discussions and conclusions from the UNSCEAR project, and André-Claude Lacoste (then president of ASN), who spoke of lessons in relation to needs for further international harmonization from a regulatory perspective. This was followed by sessions discussing learning points for Nordic emergency response, learning points for reactor safety, the way forward with respect to assessments and communication, and the future for Nordic nuclear reactor safety and emergency preparedness. Many participants were inspired by the discussions, resulting in an all-time record breaking number of applications for the next NKS call for project proposals.

The second seminar, in 2016, followed up on this, and among other things reported on the results of some of the many NKS projects run since then to strengthen the capabilities in the Nordic region. Here key note lectures were given by Lyn Bevington (IAEA), who spoke about the then brand new IAEA Fukushima report and its implications for nuclear safety and emergency preparedness. Other key note speakers were this time Chris Clement (Scientific Secretary of ICRP), addressing ICRP experiences from dialogues with Japanese public, nuclear power industry and government, Ted Lazo (Scientific Secretary of OECD-NEA's Committee on Radiation Protection and Public Health - CRPPH), speaking of consequence management lessons from Fukushima, and Tomi Routamo (Deputy Director, STUK), addressing new reactor safety related progress. The other seminar sessions this time covered a mixture of high profile Nordic speakers selected to highlight various important topics to initiate discussion, and reporting and discussions of selected recently conducted NKS project work related to problems highlighted in connection with the Fukushima accident.

All presentations at the two seminars were video filmed, and the video recordings as well as the presentation slides can be seen on the NKS website (respectively www.nks.org/en/seminars/presentations/nks_fukushima_seminar_videos.htm and www.nks.org/en/seminars/presentations/nks-2016-seminar-videos/). Some particularly important concluding views presented were:

- Communication with the public needs to be improved with more use of efficient social media. There is an urgent need for better access to timely, correct and easily understandable information.
- The ICRP system of radiological protection is robust but several issues needing attention have been identified. This includes recognising the importance of psychological consequences and fostering the sharing of information.
- Justification and optimization are very important when applying countermeasures and remediation. The noble aim of overprotecting the population can backfire and have undesired consequences.
- It could be very difficult for the Nordic countries to cope with a major nuclear accident in Europe.

A third NKS seminar in Stockholm is planned for 2019. This time the scope will be wider, although nuclear emergency preparedness remains a focus topic.

This paper is aimed at providing a contextualised overview of important research and development carried out in the inter-Nordic collaborative program on nuclear emergency management (NKS-B) since the Fukushima accident. For enhanced understanding, the paper also outlines the framework of other pathways of inter-Nordic cooperation in nuclear preparedness.

2. Nordic cooperation channels on emergency preparedness

NKS is as mentioned a key forum for cooperation on emergency

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