European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery

NERIS statement – August 2015

NERIS is a European Platform on preparedness for nuclear and radiological emergency response and recovery, founded in June 2010. The mission of the NERIS Platform is to establish a forum for dialogue and methodological development between all European organisations and associations taking part in decision making of protective actions in nuclear and radiological emergencies and recovery in Europe. 55 institutions are currently member of the NERIS platform from which 28 supporting organizations.

An integral part of the mission of NERIS is to identify gaps and needs for further research and developments and addressing new and emerging challenges in the field of preparedness for nuclear or radiological emergency response and recovery. The Strategic Research Agenda (SRA) of NERIS, coordinated by the NERIS R&D Committee, identifies these research needs.

In the context of future EU research calls, NERIS has identified current research priorities which can serve as input for defining call topics. The definition of the research priorities proposed here is based on the following elements:

- The priorities identified in the current SRA of NERIS: http://www.eu-neris.net/;
- The input from the members of the NERIS R&D Committee;
- The recently organized NERIS workshop (Milano, April 2015) and especially the conclusions from the session rapporteurs;
- A consultation of all NERIS members related to the identified priorities (July 2015);
- The Operra survey;
- The realizations in past and current EU funded projects and especially from the Fukushima experience.

Research and development in the field of emergency management and recovery at the European level calls for co-operation between authorities, emergency centres, research organisations and the academic community in different countries, as well as interactions with key concerned stakeholders with the goal to enhance adequate and coherent response throughout Europe in case of a nuclear and or a radiological event. To reach this goal, apart from advances in the development of models, research improving the decision-making processes is crucial (NERIS SRA key topic 5). Four out of the six priority subjects proposed here are falling within this key-topic and include uncertainty handling in emergency response and recovery, robust decision making, countermeasure preparedness strategy and monitoring strategies. This research requires a highly multidisciplinary approach and should

include societal and ethical aspects. The identified priority research needs related to advances in modelling are in the domain of atmospheric dispersion modelling and local radio-ecological modelling. Based on the exchange of ideas with other radiation protection platforms (MELODI, ALLIANCE, EURADOS) a link with potential common research priorities was identified.

A short description of the current ranked research priorities identified by NERIS are given below. A more detailed description can be found in the annex.

1. **Assessment of and communication of uncertainties**. Investigation of data uncertainties (model or monitoring results) and how they can be communicated, e.g. in model results and in Decision Support Systems (DSS) to help decision-makers to understand the radiological situation. This includes also work on model sensitivity, validity of model results and inter-comparisons of models and measurements.
2. **Robust decision-making.** Structuring the decision processes and the protective strategies at national, regional and local levels with the help of formal decision aid tools, such as multi-criteria analysis and on the basis of feedback from stakeholder processes. Development of guidance on the use of DSS in the various phases of an event based on feedback from stakeholder processes and from Fukushima experience in emergency response and recovery.
3. **Countermeasure strategy preparedness.** Development of sustainable preparedness strategy at Local, National and European level, based on the analysis of countermeasures for relevant accident scenarios. Ensuring that parameters governing the radiological consequences can be identified in time to enable optimized remediation and contribute to the elaboration of robust recovery strategies.
4. **Atmospheric dispersion modelling.** To make more reliable forecasts of atmospheric dispersion, including data assimilation and improved inverse modelling (to determine source term and/or source location) in different environments (e.g. urban areas) and/or at different spatial scales (near range to global scale).
5. **Local radio-ecological models.** Development and integration in general DSS of local radio-ecological models interlinked with monitoring information and the more global and food chain dose models. Investigate the capability of such models to be operated by local stakeholders as farmers or local communities. Link with ALLIANCE.
6. **Monitoring strategies.** Optimised use of monitoring resources, including mobile units and trans-border issues. Integration of new monitoring technologies (e.g.; drones). Development of processes and tools for integrating the monitoring results from experts and lay people into a common operational picture (monitoring crowdsourcing). Information fusion (radiological and non-radiological). Link with EURADOS but focus on strategy and integration, less on the improvement or development of new measurement methods/techniques.

Priority 1	**Assessment of and communication on uncertainties**
Priority description	Important advances have been made in the last decades in the development of models and monitoring methods for evaluating the impact of nuclear/radiological events or assist in the recovery phase after such an accident. Examples are the validation of food chain and hydrological models, validation of the RODOS model for the Hanford scenario, use of models & monitoring methods in the aftermath of the Fukushima accident. However, uncertainty in these assessments has never been addressed in detail. Both, uncertainty arising from limited information, especially in the early phase of an accident, as well as inherent model or monitoring uncertainties have to be addressed and communicated properly. The research needs identified are: - The investigation of data uncertainties on model or monitoring results and how to propagate uncertainty through simulation models; - How to communicate uncertainty to decision-makers. Key research questions are: - Identify the need of decision makers: how to include uncertain information from simulation and modelling in their decision making process, helping them to avoid rigid schemes with the likely difficulties for implementation and social acceptance? - Define the level of uncertainty for the key simulation areas of a DSS; - How to include/visualise uncertainty in the results of simulations & measurements and how to propagate them between simulations (e.g. source term – dispersion – dose assessment)? - Is there a methodology for uncertainty handling and sensitivity analysis applicable for all? - How to communicate uncertainty – legal, social and ethical aspects?
European relevance	The topic is part of the NERIS Strategic Research Agenda (Key Topic 5, sub-topic 5.1). Especially in European context, in which accidents have a high probability to have cross border consequences, having better insight in the uncertainty of evaluations based on models or monitoring and how to communicate and visualize these uncertainties is of key importance to come to common European decisions on protective actions and for the harmonization of intervention levels across Europe.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	Uncertainty handling is crucial in all aspects of radiation protection and of importance in several disciplines: apart from assessments in nuclear emergency response and recovery it is of importance e.g. in radio-ecological modelling (ALLIANCE), dosimetry (EURADOS) and studying dose-effect relationships (MELODI).
Impact: decreased uncertainty	Better understanding and quantification of the sources of uncertainty will result in efforts to reduce the main sources of uncertainty.
Impact: increased radiation protection	Taking into account the uncertainty of model calculations and monitoring results makes it possible to elaborate better scientifically sound decisions, as well as more acceptable from the social and ethical points of view.
Impact: increased acceptability	One of the main challenges of communication of uncertainties is to improve the decision-making processes (DMP).
Feasibility	The propagation of the uncertainty between simulations is a scientific challenge. However, model developers are the key scientists to address this topic. Estimation of the budget: 1-2 M€, duration 3 years.
Other justifications	The topic has a high scientific relevance because by identification of the uncertainties new research priorities will be identified. In addition, it has a very societal relevance by addressing uncertainties to improve DMP and favour the communication with the public.

Priority 2	**Robust decision-making**
Priority description	Further developments in decision-making are currently required to clearly address i) the structure of the different levels of decision-making and the needs of different tools and ii) how to make best use of existing Decision Support Systems (DSS). The work proposed entails: • Structuring the decision processes and the protective strategies at national, regional and local levels with the help of formal decision aid tools, such as multi-criteria analysis and on the basis of feedback from stakeholder processes. • Development of guidance on the use of DSS in the various phases of an event based on feedback from stakeholder processes and from Fukushima experience in emergency response and recovery. The work proposed will investigate: how are DSS used today and if this complies with their existing structure and robustness; the potential added value of using formal decision-aiding tools in the decision-making process; the adequacy of decision support tools at different levels of decision-making, including all possible stakeholder groups; stakeholder involvement in the preparedness phase: the use of predefined strategies in emergency and recovery management and inclusion of social resources (crowd sourcing, stakeholder participation,…) in the Decision-Making Processes (DMP).
European relevance	The topic is part of the NERIS Strategic Research Agenda (Key Topic 5, sub-topic 5.3). Moreover, the work proposed will help evaluating if pre-defined protective strategies are sufficient to manage the early phase of an emergency and if yes, how to define and use them in an emergency. It is thus relevant to the implementation of the BSS, namely recommendations regarding emergency planning and recovery strategies. Finally, the work is grounded on strong stakeholder involvement and will entail establishing legal, social and ethical guidelines; it will thus require input from social sciences and humanities and contribution from stakeholder engagement processes in Europe.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	The topic is highly relevant at European level, since it will lead to the identification of criteria for the “optimal” use of European DSS and the development of additional guidance material to support their usage. The topic is related to the priorities described in the SRA of European platforms: - NERIS: Key Topic 5, sub-topic 5.3 -ALLIANCE: Challenge 3
Impact: decreased uncertainty	By helping to develop appropriate tools to support the decision-making process at the various levels, the topic will contribute to decreased uncertainty concerning the efficiency of the protection and thus to the health effects for people in emergency and recovery situations.
Impact: increased radiation protection	By contributing to an improved decision-making process on protective actions in case of a nuclear or radiological accident, it will contribute to better protection of workers, people living in affected area and the general public in emergency and recovery situations.
Impact: increased acceptability	A better structured and more efficient decision-making process will bring increased transparency and grounds for justification of protective actions in case of an emergency and recovery situations. It will thus also contribute to increased social participation in the DMP and thus improve efficiency of protection and favour reassurance.
Feasibility	The scientific/technological competences needed for this topic are available in Europe. Estimation of the budget: 1-2 M€, duration 3 years.
Other justifications	The topic has a high societal relevance since it aims at a better protection of the population in case of a nuclear or radiological situation.

Priority 3	**Countermeasure strategy preparedness**
Priority description	Several European projects in past Framework Programmes have addressed the multiple dimensions (radiological effectiveness, technical feasibility, stakeholder involvement, economic impact, legal issues, etc.) of management options for agricultural and urban areas in the aftermath of a nuclear accident (FARMING, SAGE, EURANOS, NERIS TP, PREPARE (on-going project)). The accident in Fukushima highlighted however, the need for further work in the area of emergency and recovery preparedness and response as regards the development of countermeasure and recovery strategies, by: ▪ Drawing the lessons on the applicability, efficiency and sustainability of countermeasures strategies from the emergency and recovery responses following the Fukushima accident; ▪ Improving the adequacy of existing decision-making processes and tools at national/regional/local levels to favour the preparedness of efficient countermeasure and recovery strategies; ▪ Achieving sustainable engagement of local stakeholders in emergency and recovery preparedness and response. The work proposed under this topic entails: • The development of sustainable preparedness strategy at Local, National and European level, based on the analysis of countermeasures for relevant accident scenarios and recovery strategies; • Ensuring that parameters governing the radiological consequences can be identified in time to enable optimized remediation; • Ensuring that countermeasures preserve territorial resilience.
European relevance	The topic is part of the NERIS Strategic Research Agenda (Key Topic 5, sub-topic 5.7). Inputs from social sciences and humanities are required concerning the social and ethical dimensions of countermeasure and recovery strategies.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	The accidents in Chernobyl and Fukushima demonstrated that consequences of nuclear accidents exceed by far national boundaries and last over several decades. The topic proposed will contribute to improved preparedness and response to nuclear and radiological emergency and recovery situations. It is highly relevant at European level, since it entails the development of sustainable preparedness strategies at both local and European level and will allow to draw the lessons from the long-term management of the consequences of the Fukushima accident. The topic is related to the priorities described in the SRA of European platforms: NERIS: Key Topic 5, sub-topic 5.7 & ALLIANCE: Challenge 1.
Impact: decreased uncertainty	Optimized remediation contributes to decreasing uncertainty concerning the effects on people and the environment in emergency and recovery situations and to improve the stakeholder engagement in the strategies.
Impact: increased radiation protection	By developing sustainable countermeasure and recovery strategies and ensuring that parameters governing the radiological consequences are identified in time to enable optimized remediation, the topic contributes to improved protection of the population in emergency and recovery situations.
Impact: increased acceptability	Stakeholder involvement at different levels of preparedness and response will reinforce the efficiency of decisions taken in case of emergency and recovery situations and will lead to increased acceptability of countermeasures strategies. It will also increase the capability of resilience in case of an accident.
Feasibility	The scientific / technological competences needed for this topic are available in Europe. Estimation of the budget: 0.7-1.5 M€, duration 3 years.
Other justifications	The topic has a high societal relevance since it aims at a better protection of the population in case of a nuclear or radiological situation. It will also allow to draw the lessons from the management of the consequences of the Fukushima accident.

Priority 4	**Atmospheric dispersion modelling**
Priority description	Atmospheric dispersion models are the key tools to study the impact of atmospheric releases of radioactive material to humans and the environment. Although a long history exists in the development of atmospheric dispersion models and recent improvements such as worldwide applicability of the JRODOS system (FP7 project NERIS-TP), the use of higher spatial and temporal resolution meteorological data (FP7 project PREPARE) and source term estimation based on monitoring have been achieved, several improvements are still required. Important steps can still be made to improve reliable forecasts of atmospheric dispersion, including data assimilation and inverse modelling to determine source term and/or source location. Especially in specific environments e.g. urban areas and specific ranges (e.g. the near-range) room for improvement is possible. Specifically highly interesting research questions are: • Model improvements responding to the needs of decision-makers in specific areas: e.g., near-range, urban areas, confined spaces; • Inverse modelling and data assimilation techniques related to dispersion modelling from near-range to global scales; • Multi-scale modelling: how to integrate model calculations from local to global scale to allow coordinated use of ADM; • Better understanding of the complex interplay between time-varying release characteristics and meteorological conditions (e.g. use of ensembles, impact of precipitation, …); • Statistical analysis and graphical representation of multiple model simulations (using different source terms and meteorological analyses), including use of below-threshold data (null measurements); • Model validation, robust uncertainty handling and visualization in ADM.
European relevance	The topic is part of the NERIS Strategic Research Agenda (Key Topic 1). Improved and validated modelling tools will help harmonization of emergency countermeasures across Europe.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	Atmospheric dispersion modelling is of particular interest, apart from assessing the impact of emergency exposures, in the impact analysis of routine emissions in planned exposures (planned exposure situations, …).
Impact: decreased uncertainty	Improved and validated models will reduce the uncertainty in the output generated by the models and in all further assessments of the radiological evaluation and improve advice to the decision-makers.
Impact: increased radiation protection	Improved and validated models for different ranges and environments will contribute to better protection strategies and increase in this way radiation protection.
Impact: increased acceptability	More confidence in model calculations will result in more confidence in protection strategies and increase the acceptability of advised countermeasures.
Feasibility	Atmospheric dispersion modelling is a key research theme within the emergency and NERIS community for many years. Improvements are linked to the access to better meteorological data, increasing computer power and the continuous development of dispersion and transport methodologies (e.g. Computational Fluid Dynamics). Estimation of the budget: 1-2 M€, duration 3 years.
Other justifications	The continuous improvements in meteorological forecasts and calculation methods allow the improvement of dispersion models for specific ranges and environments. Also very specific situations require new, more advanced modelling techniques.

Priority 5	**Local radio-ecological models**
Priority description	Past and on-going European projects (FUTURAE, EURANOS, NERIS-TP, COMET, PREPARE) have contributed to the development and integration in Decision Support Systems (DSS) of models for the estimation of the radiological spatial-temporal situation in different environments (terrestrial and aquatic) and the impact on population. Such models have been applied for remediation purpose in both emergency and recovery situations. Furthermore, generic regionalisation has been done for different European climatic regions of the radiological parameters and other socio-economic factors. However, there is a need to: ▪ Develop / adapt the radio-ecological models used in DSS for the preparedness and management of the emergency and recovery to the complex local specificity; ▪ Apply the radio-ecological models to establish feasible and efficient site-specific remediation and monitoring strategies; ▪ Improve the operability and the understanding of the dose assessment and countermeasures models by potential users, including non-expert stakeholders. The work proposed under this topic entails: • Development and integration in general DSS of local radio-ecological models interlinked with monitoring information and the more global and food chain dose models; • Estimation of the efficiency and spatial-temporal evolution of the protective /remediation actions in relation to site-specific characteristics; • Investigation of the capability of locally customised models to be operated by local stakeholders as farmers or local communities especially for the recovery situation; • Identification/classification of vulnerable areas in European environments with the implication of stakeholders.
European relevance	The topic is highly relevant at European level since it involved further developments of European DSS, such that they can be used at local level in order to allow enhanced preparedness and optimised response. The topic is part of the NERIS Strategic Research Agenda (Key Topic 5, sub-topic 5.6). Inputs from social sciences and humanities are required concerning stakeholder involvement at local level.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	The topic proposed will contribute to improved preparedness and response to nuclear and radiological emergency and recovery situations. The topic is related to the priorities described in the SRA of European platforms: NERIS: Key Topic 5, sub-topic 5.6 & ALLIANCE: Challenge 1 and Challenge 3.
Impact: decreased uncertainty	Adaptation of generic models to the specificity of the local areas affected by a nuclear or radiological accident will lead to an improvement in the estimation of radiological transfer and impact on population. This in turns leads to decreased uncertainty in the estimation concerning the effects on people and the environment in emergency and recovery situations.
Impact: increased radiation protection	The topic will contribute to optimised decision-support and thus to increased protection of the population in emergency and recovery situations.
Impact: increased acceptability	Empowering local stakeholder and communities with tools adapted to the specificity of the local context will contribute to increased preparedness and higher efficiency and acceptability of countermeasures strategies.
Feasibility	The scientific / technological competences needed for this topic are available in Europe. Estimation of the budget: 0.5 - 1 M€, duration 3 years.
Other justifications	The topic has a high societal relevance since it aims at a better protection of the population and the environment in case of a nuclear or radiological situation.

Priority 6	**Monitoring Strategies**
Priority description	Decisions in the aftermath of or recovery from a nuclear or radiological accident are largely based on monitoring efforts. Although most countries installed monitoring capacity for nuclear and radiological accidents, important challenges still exist, such as: - The optimization of the monitoring strategy in function of the decision support; - The integration of different monitoring techniques in one strategy, including new technologies (drones, measurement by the public, …). Research questions are: • How to optimize the measurement strategy taking into account radiological, societal and ethical factors in case of a nuclear accident, especially addressing accidents with cross border impact; • Evaluation of new technologies and how they can be integrated in nuclear emergency and long term monitoring: e.g., drones, smartphone apps, …; • How to integrate and support monitoring by the public; • How can monitoring be linked with nuclear emergency and recovery reference levels (e.g. related to contaminated goods); • How can monitoring (strategies) be linked with advanced modelling (source term calculations); • How to combine monitoring data, including non-radiological data (data fusion); • How does monitoring uncertainty impact decision support and how to visualize monitoring uncertainty; • How to use monitoring efficiently in optimization recovery countermeasures; • What are the specific differences needed in monitoring in the different phases of an accident.
European relevance	The topic is part of the NERIS Strategic Research Agenda (Key Topic 5, subtopic 5.9). Currently all European countries have developed their own monitoring capacity. A sound scientific basis, taking into account local differences, for developing a robust monitoring methodology, considering technical as well as societal factors is missing.
Multidisciplinarity; Reference to the strategic research agendas (SRA)	Apart from NERIS, monitoring is strongly linked to research related to the European platform for dosimetry (EURADOS). However, it should be noted that this topic doesn't focus on the development or optimization of new measurement techniques, but addresses the integration of existing and new technologies in a robust monitoring strategy to support decision-making. The set-up of monitoring strategies should also include stakeholder involvement.
Impact: decreased uncertainty	A robust monitoring strategy will allow a much faster assessment of the situation. It will also improve the efficiency of countermeasures.
Impact: increased radiation protection	This topic aims at optimizing monitoring strategies, which should result in acquiring a clear picture of the radiological situation in a limited timeframe. In this way better and faster protective actions can be taken.
Impact: increased acceptability	A clear, stable picture of the radiological situation will enhance trust in decisions related to protective actions and consequently increase acceptability of countermeasures. In addition capabilities will be developed for stakeholders.
Feasibility	The main challenges are to connect monitoring experts with radiological emergency and recovery experts (advisors to the decision makers) and integrate societal/ethical aspects. Estimation of the budget: 1-2 M€, duration 3 years.
Other justifications	The Fukushima accident demonstrated that the involvement of the public in measurements is essential. Research in this context should be the basis for any preparedness actions in this respect.