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DELIVERABLE 4:

**Networking – a way for maintaining and enhancing
radioecological competences in Europe**

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Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]





The objective of the FUTURAE project is to evaluate the potential for establishing deeper and sustainable collaboration in radioecology in Europe possibly in the form of Network(s) of Excellence.

The project started in October 2006 and is to end by September 2008.

Project Coordinator: Institute for Radiological Protection and Nuclear Safety

Contractors:

Institute for Radiological Protection and Nuclear Safety	IRSN
Swedish Radiation Protection Authority	SSI
Centre for Ecology and Hydrology	CEH
Belgian Nuclear Research Centre	SCK·CEN
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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



Executive Summary

Taking advantage of the work performed in the previous deliverables (D1, D2 and D3), the present report was able to identify that there is a necessity to maintain and enhance radioecology competence in Europe.

During the last decades, research in the field of radioecology has led to a widely recognized expertise in Europe. There are clear signs that key elements of this expertise are now declining, although requirements for it remain. In particular, it is of prime importance to maintain a high level of expertise in the field of the assessment of the impact of radioactivity on man and the environment to be able (1) to provide an appropriate response in terms of assessment and management of an accidental situation and 2) to reliably assess the impact of authorized discharges from nuclear facilities. Moreover, as the perception of the public concerning the impact of human activities on the environment and health is evolving, more dialogue with the public and stakeholders is needed which requires high quality scientific input. Globally, due to the current renewal of interest in nuclear power, it can be expected that within a decade there will be a growing worldwide need for radioecological expertise. Maintaining a high level of expertise would improve the competitiveness in the field of nuclear industry and support the potential to export European radioecological knowledge.

Deliverable 3 has shown that important research issues, related to the assessment of the impact of different types of past, present and future nuclear facilities (waste repositories, new build, legacy sites...) remain and that an important research effort still has to be performed. This will be best achieved through an enhancement of the research capacity at the European scale.

Due to the limited available resources in terms of human resources and infrastructures, as identified in D1, the only realistic way to maintain and enhance competences in radioecology at the European level appears to be a better integration of scientific activities. As a first step, a NoE funded by the Commission, networking human resources, infrastructures and projects in radioecological sciences would be an important signal in the objective of maintaining and enhancing competences in the long-term. The NoE, which should constitute the basis for the development of a sustainable network, should have the following objectives :

- to reduce the fragmentation of the radioecological community;
- to optimize the research programmes and utilization of infrastructure;
- to maintain and strengthen European excellence;
- to adequately support the needs expressed by all end-users;
- to improve mobility between the member organizations;
- to put mechanisms in place to involve the wider European radioecological community;
- to attract young researchers (as the average age of European radioecologists is increasing); and
- to liaise with European and worldwide networks and international bodies.

Obviously, the feasibility of a NoE in the field of radioecology is dependent on the existence of a pool of organisations with good infrastructure, excellent scientific output and fit for purpose resources. Analysis conducted in D3 has shown that the EU contains enough such organizations and hence that a NoE is practically feasible.

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

Previous experience in EURATOM and other EC-programmes has shown that the main difficulty when establishing a NoE is in moving towards a sustainable integration. Reaching this objective will be dependent on the willingness of the partners to integrate their activities (research, infrastructures, training, knowledge management) and not only to coordinate them. Therefore, prior to any action that would aim to establish a NoE in radioecology, an active involvement at a high-management level of the organizations should be a key precondition to start the process of integrating radioecological research at the European level. This would demonstrate that important potential contributors to the process are supportive of the principles and objectives of a NoE including the need for durable integration.

In the eventuality of the implementation of a NoE, the characteristics of the present situation of radioecological research in EU would require a specific organizational structure. Firstly to meet the objective of moving towards a sustainable integration, a NoE in radioecology should comprise a limited number of partners ('beneficiaries') who would adequately cover the required range of radioecological competence. However, many small research groups possess specific skills and competences that have a high added value at the European level. Therefore, specific mechanisms that would enable these groups to interact with the NoE will need to be considered.

The organisation of the NoE should also ensure: (1) scientific excellence and; (2) relevance provided through appropriate responses to the needs expressed by the end-users through adequate research programmes. Therefore, it is suggested that the NoE members should establish an "Advisory Committee" made up of a limited number of both scientific experts and end-users that would help to identify, characterize and prioritize research requirements. End-user members of the "Advisory Committee" could comprise representatives of industry, regulatory authorities, national bodies, and NGOs.

To conclude, the FUTURAE consortium considers that there is a justified need for coordination of radioecology in Europe and that this requirement would be appropriately addressed by a Network of Excellence under the EURATOM programme.

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



Table of contents

Executive Summary.....	4
1. Introduction.....	7
2. Rationalising European radioecological capacity with requirements.....	8
2.1 Overview of Deliverable 3.....	8
3. Critical assessment of the benefits of a NoE in Europe.....	10
4. Practical propositions for the implementation of a Network of Excellence.....	17
5. Conclusions.....	20
ANNEX 1.....	24
Special event: A future for radioecology in Europe.....	24
Participants.....	24
Summary of plenary discussions.....	24
Radiation Protection Activities: Future Role of Radioecology.....	24
Main results of the FUTURAE project.....	25
Towards a Network of Excellence in radioecology: an end-user's view.....	25
ANNEX 2:.....	28
Participants to the Special Event.....	28

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

6/30



1. Introduction

The overall objective of the FUTURAE Coordination Action (CA) is to evaluate the feasibility of a Network of Excellence (NoE) in radioecology within the 7th Euratom Framework Programme (FP7). Radioecology is a multidisciplinary branch of environmental sciences which provides the underpinning science, databases, models and expertise required to support legislation, regulators and industry relative to environmental radiological issues. Within the context of this deliverable radioecology is taken to encompass the study of the behaviour of anthropogenic and natural radionuclides in terrestrial, freshwater, marine and urban ecosystems. FUTURAE aims to evaluate, in the field of the assessment and management of the impact of natural and artificial sources of radiation on man and the environment, the potential of a Network of Excellence (NoE) or other similar mechanisms for:

- Maintaining and enhancing competence through the achievement of critical mass;
- Better exploiting existing human and other resources including infrastructures;
- Establishing deeper and sustainable integration;
- Establishing better collaboration with the broader area of ecology.

Previous FUTURAE deliverables have assessed the: (i) current levels of research capacity, human resources, infrastructure, research programmes and funding of radioecology in Europe (Vandenhove *et al.* 2007a, D1), (ii) present and future needs of end-users of radioecological research (Moberg *et al.* 2007b, D2), and (iii) way of rationalising the radioecological capacity across the EU with the requirements of end users (Beresford *et al.*, 2008, D3).

Based on the outputs of the three previous deliverables we herein make proposals on possible mechanisms to maintain and enhance competences in radioecology at the European level. In particular, we explore the feasibility of establishing a Network of Excellence in radioecology in Europe. To address this aim, we first perform a critical assessment of the benefits of a NoE and then we make practical propositions for the implementation of such an instrument.

The main results of the FUTURAE project, and in particular a draft version of the present document (D4), were publicly presented during a special session organized during the International Conference on Environmental Radioactivity that was held in Bergen (Norway) in June 2008. More than 80 persons from 23 countries attended to this meeting and fruitful discussions followed the presentations (see Annexes 1 and 2). Additionally, a draft version of D4 was sent for comments to the FUTURAE end-users group in June 2008. The many comments or suggestions made either during the special session of the Bergen conference or by the end-users were taken into account in the present report.

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

2. Rationalising European radioecological capacity with requirements

2.1 Overview of Deliverable 3

Deliverable report D1 assessed the current levels of research capacity, human resources, infrastructure, research programmes and funding of radioecology in Europe. Deliverable report D2 assessed present and future needs of end-users of radioecological research. In deliverable report D3, these two outputs were brought together and it was considered how to rationalise the radioecological capacity across the EU with the requirements of end users.

Taken at face value, deliverable D1 of the FUTURAE project (based on responses to a questionnaire) implied that there is a wide range of radioecological expertise, sufficient funding and approximately 1000 active radioecologists in Europe. However, some questionnaire inputs were thought to be inaccurate and therefore a re-evaluation of the reported number of radioecologists, publications output and facilities was carried out. It was concluded that responses to the initial questionnaire responses overestimated the number of active radioecologists by approximately two-fold.

Information on requirements for radioecology was identified initially through the D1 questionnaire and from a consultation with a range of end-users in the deliverable report D2 of the FUTURAE project. The broad categories identified from this process were supplemented by a further review in the D3 deliverable of a number of recently reported or on-going initiatives which have important implications in determining the requirements for radioecology in the forthcoming years. These included: recently revised recommendations of the ICRP, OSPAR, the IAEA EMRAS programme, on-going EURATOM projects, and IUR Task Groups. The user defined requirements clearly fit into the context of European wide issues, some of which are source driven (radioactive waste, nuclear power generation; legacy issues; emergency preparedness) and others cross-cutting (protection of the environment and climate change).

The deliverable report D3 demonstrated that there are justifiable, and increasing, requirements for radioecological research within Europe for the foreseeable future. These requirements are common across member states. A SWOT (**S**trengths, **W**eaknesses, **O**pportunities and **T**hreats) analysis highlighted issues for radioecology in Europe (TABLE 2.1). Whilst Europe retains radioecological expertise in a wide range of disciplines, there are currently ‘threats’ to sustainability as there is considerable fragmentation occurring with the majority of organisations conducting radioecological research having comparatively small budgets and few staff. Similarly, although the deliverable report, D1, indicated an adequate infrastructure, the number of facilities to conduct some key activities (e.g. low level chronic irradiation studies, farm animal transfer studies, large-scale plant uptake studies, interception studies) has declined over the last decade to a critically low level.

The urgent need to train future radioecologists and to transfer knowledge was highlighted by a number of fora (including a FUTURAE workshop held to discuss an early draft of deliverable report D3). This is especially important as there will be an ongoing loss of key (‘Chernobyl generation’) experts over the next decade. Co-operation and integration at the European level would maximise added value and provide radioecological underpinning for those countries where there is significant fragmentation.

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

If a Network of Excellence is to go forward within FP7, there needs to be a detailed consideration of how to obtain sustainable (institutional) integration with a balance of sufficient organisations with good infrastructure, excellent scientific output and 'fit for purpose' resources. An analysis of the questionnaire responses demonstrates that there are a sufficient number of organisations meeting the above criteria who could contribute to a future Network of Excellence within Europe. Obviously, an appropriate balance between resources, facilities, areas of expertise and scientific output would be required for a successful Network of Excellence.

TABLE 2.1: SWOT analyses – radioecology in Europe (taken from Beresford *et al.*, 2008).

Strengths	<p>Europe retains radioecological expertise in a wide range of disciplines in most EU member states.</p> <p>There remains an adequate infrastructure to conduct most radioecological studies.</p> <p>There is a good track record of collaboration (funded by EURATOM) between European researchers successfully contributing to addressing radiological issues.</p>
Weaknesses	<p>Fragmentation - more than one third of organisations conducting radioecological research have less than five radioecologists (these are predominantly universities) – loss of key staff in these institutes may lead to cessation of radioecological activities within them.</p> <p>Less than 50 % of organisations who responded to questionnaire presented in Deliverable 1 have a budget in excess of €100k.</p> <p>The number of key specialist facilities is declining.</p> <p>Deliverable 1 indicated that a significant proportion of radioecological funding came from the respondents own organisation – this proportion of their budget was that which respondents were least positive about increasing/being maintained in the future.</p>
Opportunities	<p>Renewed need for radioecology.</p> <p>Europe faces many common radioecological questions driven by the need to:</p> <ul style="list-style-type: none"> ➤ resolve legacy issues including the construction of waste repositories ➤ assess the contribution of nuclear power to future energy supplies ➤ respond to changing international recommendations (e.g. environmental protection) ➤ maintain emergency preparedness (including for malevolent acts). <p>Europe maintains the highest competence in radioecology and there is the potential to 'export' this expertise to help address issues world-wide.</p>
Threats	<p>European radioecology has previously benefited greatly from the cofunding of co-ordinated programmes by EURATOM. A lack of European support in the future would lead to:</p> <ul style="list-style-type: none"> ➤ further fragmentation of research ➤ potential complete loss of expertise in some countries ➤ further loss of specialist facilities ➤ duplication of effort ➤ loss of added value ➤ lower cost effectiveness. <p>The average age of European radioecologists is increasing with many key scientists likely to retire within the next 10 years. There is a need, identified in a number of fora, to ensure knowledge transfer and motivate young scientists into the field.</p>

3. Critical assessment of the benefits of a NoE in Europe

What is the purpose of a NoE?

Before assessing the benefits of a NoE in the field of the assessment and management of the impact of natural and artificial sources of radiation on man and the environment, it is helpful to state the purpose of a NoE as noted by the European Commission.

A NoE is designed to **strengthen scientific and technological excellence** on a particular research topic by integrating, at a European level, the critical mass of resources and expertise needed to provide European leadership and to be a world force in that topic.

A NoE is therefore an instrument aimed **at tackling fragmentation** of existing research capacities. It should be implemented provided that :

- research capacity **is fragmented** in the area being considered;
- this fragmentation prevents Europe from being **competitive at international level** in that area;
- the proposed integration of research capacity is likely to lead **to higher scientific excellence and more efficient use of resources.**

A NoE is expected to assemble a **critical mass of resources, infrastructure, activities, and expertise** needed to ensure that they reach their ambitious objective, especially **durable integration** of the participant's capacities in the area considered. This critical mass will differ from field to field, and possibly from topic to topic within a field.

One important point in a NoE is that, at the end of the project, durable (institutional) integration is demonstrated which can only be reached with **a limited number of partners** dedicate to this ambitious goal of the network.

The feasibility of a NoE in the field of radioecology is dependent on the existence of a pool of organisations with good infrastructure, excellent scientific output and fit for purpose resource. These aspects have already been discussed in the D3 report where there was an attempt to determine whether the EU contains enough such organisations on the basis of criteria derived from Deliverable 1 and its underlying questionnaire response database. Table 3.1 which is taken from deliverable report D3 identifies organisations on the basis that they meet at least one of the following criteria (which are based on the three requirements listed above):

- Have 10 or more permanent staff who can be classified as radioecologists;
- Have a refereed journal publication output of 5 or more papers per member of permanent staff over a 5 year period (i.e. >1 paper per member of staff per year);
- Have facilities to conduct controlled transfer studies (terrestrial or aquatic);
- Have facilities to conduct radiation effects studies (terrestrial or aquatic);
- Have accredited radioanalytical laboratories;

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



- Have an annual budget devoted to radioecology in excess of €500k.

The analysis of this table leads to several conclusions :

- Of the 89 organisations responding to the FUTURAE questionnaire, 46 fulfilled at least one of the criteria for inclusion in Table 3.1. Only one organisation met all the criteria for inclusion. **This is a clear demonstration of the fragmentation of the radioecological research in Europe.**
- There are few well-resourced institutes (in terms of staff numbers and budget) and not all of these meet the other criteria. Most of these institutes are either safety authorities or Technical Support Organisations. In these organisations there is a close link between research and expertise, and most of the active researchers are also involved in activities requiring significant expertise.
- From a theoretical point of view, there are a sufficient number of organisations to contribute to a future NoE and it can be expected that the critical mass of resources, infrastructures and expertise will be sufficient to provide a solid basis for durable integration.

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

11/30



Table 3.1: Selected information on resources, outputs and infrastructure of European radioecological research groups, as specified in either the original, or where available revised, inputs into the questionnaire.

Staff	Refereed publications per member of staff over 5 years	Facilities to conduct controlled studies of:				Accredited radioanalytical laboratory (Y/N)	Budget >€500k per year (Y/N)
		transfer to terrestrial organisms	transfer to aquatic organisms	effects of radiation on terrestrial organisms	effects of radiation on aquatic organisms		
36	1.5	Y	N	Y	N	Y	>€500k
35	5.9	Y	Y	Y	Y	Y	>€500k
30	2.7	N	N	Y	Y	Y	>€1000k
30	1.3	Y	Y	N	N	N	N
28	0.8	N	N	N	N	N	>€500k
22	0.2	N	N	N	N	N	N
21	0	Y	Y	N	N	N	N
14	1.6	N	N	N	N	N	N
14	0.1	Y	N	Y	N	N	N
13	4.9	Y	N	Y	N	Y	>€1000k
12	1.3	N	N	N	N	N	N
11	1.9	N	N	N	N	Y	N
11	0.3	N	N	N	N	N	N
10	4.2	N	N	N	N	N	N
10	1.1	N	N	N	N	Y	N
8	5.3	N	N	N	N	Y	>€500k
8	2.1	Y	N	N	N	N	N
7	7.0	Y	N	N	N	N	>€500k
7	2.1	N	N	N	N	Y	N
7	1.0	Y	Y	Y	Y	N	N
6	6.3	Y	Y	Y	Y	Y	N
6	3.0	Y	N	N	N	Y	N
6	1.8	N	N	Y	Y	N	>€500k
6	1.2	N	N	Y	Y	N	>€500k
6	0.8	Y	Y	N	N	N	N
5	3.2	Y	N	N	N	Y	N
5	2.8	Y	Y	Y	Y	N	N
5	1.6	N	N	Y	Y	N	N
4	18.3	Y	Y	N	N	Y	N
4	1.5	Y	Y	Y	Y	N	N
3	7.3	Y	N	Y	N	N	N
3	5.7	N	Y	N	Y	N	N
3	5.3	Y	Y	Y	Y	N	N
3	1.7	Y	Y	Y	Y	N	N
3	0.3	N	N	Y	N	Y	N
2	5.0	N	N	N	N	Y	N
2	5.0	Y	Y	N	N	N	N
2	4.0	Y	N	N	N	N	N
2	3.5	Y	N	N	N	N	N
2	0.5	N	N	N	N	N	>€1000k
1	7.0	N	N	N	N	N	N
1	7.0	N	N	N	N	N	N
1	7.0	N	N	N	N	N	N
1	6.0	N	N	N	N	N	N
1	5.0	N	N	N	N	N	N
1	3.0	Y	Y	Y	Y	Y	N

Bold/italicised text for staff and publication numbers denotes inputs which were confirmed/revised during course of preparation of Deliverable 3; grey shading identifies meeting of criteria outlined in text above.

What would be the benefits from a Network of Excellence in radioecology?

Assessment of the impact of radioactivity on man and the environment is a central issue for nuclear energy: In the European Union, nuclear energy currently produces 35% of the electricity. In the decades ahead, nuclear power is likely to continue to contribute substantially to the energy supply, with the added benefit that it reduces the energy dependency of the European Union on external suppliers, whilst emitting relatively low amounts of greenhouse gas compared with some other energy sources.

The nuclear industry has now come to maturity and operates nuclear plants with an appropriate level of safety and a satisfactory acceptance by the majority of the public in a range of European countries. The present situation is the result of substantial progress in different fields of nuclear sciences during the last decade, supported by the EURATOM Treaty and co-funding through the EURATOM Framework Programme. This investment, and the response to the Chernobyl accident, has promoted a widely recognized expertise in radioecology in Europe. It is essential to **maintain** this expertise for the following reasons :

- Even as nuclear safety is improving, it is of prime importance to keep a high level of expertise in radioecology to be able to provide an appropriate response in terms of **assessment and management of an accidental situation**. Twenty two years after the Chernobyl accident, there is a real risk of a loss of expertise because the nuclear work force has aged with an inadequate recruitment of young scientists. Such expertise must be maintained in order to effectively deal with severe accident consequences and to support the well maintained modelling and emergency response capabilities within Europe.
- Although authorized discharges of radionuclides related to the nuclear industry are decreasing, **there still exists the need to regularly assess the impact of nuclear facilities on man and the environment**. Due to the continuing and changing demands of recommendations and regulations, a high level of radioecological expertise has to be maintained at the European level to carry this out
- The perception of the public concerning the impact of human activities on the environment and health has considerably evolved over the last decade. With respect to nuclear industry, this has included (1) a continuing concern about the impact of nuclear facilities on health and (2) the emergence of the concept of radiological protection of the environment itself (with imminent inclusion in the International and EC Basic Safety Standards). To address public concerns, **the necessity of a continuous dialogue with the public and the stakeholders** has been a key point to ensure acceptability of nuclear energy and credibility in the experts (as illustrated by the Groupe Radioécologie Nord Cotentin in France, West Cumbria Sites Stakeholder Group in UK, STORA (Study and Consultation Nuclear Waste) and MONA (Consultation Nuclear Waste Mol) in Belgium). This dialogue can only be based on high quality scientific input. A loss of key expertise radioecology would jeopardize the present situation.
- The uncertainty about future energy supplies and their costs is making the combination of nuclear energy and renewable energy increasingly more attractive

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worldwide. Recently, several countries, both with and without nuclear energy, have expressed their interest in building nuclear reactors in the future. Within a decade **there will be a growing, worldwide need for radioecological expertise**. It is widely recognized that high-quality expertise based on high level research programs in radioecology exists in Europe (much of which was established under the EURATOM umbrella). Europe needs to maintain this expertise at a high level to improve the competitiveness in the field of the nuclear industry and to support the potential to export European radioecological knowledge. To face these challenges, **education and training through research programs will be of prime importance to produce future European experts to replace the many prime movers who will retire within a decade**.

As indicated in Deliverable report D3, important issues still remain open in radioecology. At the present time the most important challenges to deal with are the following:

- Human and environmental impact assessments of new facilities;
- Human and environmental impact assessments of legacy sites;
- Evaluation of the impact of nuclear waste repositories on the biosphere;
- Respond to new European and international recommendations in particular in the field of the protection of the environment;
- Respond to new threats such as malevolent acts and the potential contamination of densely populated urban areas.

To cope with these various scientific challenges it will not only be necessary to maintain the present situation but a real **enhancement** of the research effort will be necessary. Most of the EU funded radioecology programs of the last decade have focused on modeling efforts and data summaries. These valuable exercises identified weaknesses that now need to be addressed by targeted, specific research programs. Due to the present situation of radioecological research in Europe which is fragmenting, this enhancement can only be reached through a better integration of the research to co-ordinate available resources both from a human and an infrastructure point of view.

All the elements presented above are cross-boundary issues in the EU. For example, if a major nuclear accident happens, either in Europe or elsewhere affecting Europe, it would require expertise from all the countries directly or indirectly impacted by the event. In another field, recent experiences of stakeholder involvement around nuclear facilities in different EU countries have shown that the participation of foreign experts enhances the credibility of the process by providing independent perspectives. When considering new and continuing challenges (see D2 and D3) and the present situation of radioecological research in Europe presented in D1 and D3, few European countries will be able to address the research needs in isolation, but instead will require collaborative efforts.

Networking of the radioecological community is a necessity. For various reasons, related amongst others to the significant decline in Chernobyl-related research and the associated stagnation of nuclear energy in Europe, radioecological research activity has declined substantially in the past decade and, as a consequence, has become less attractive for young scientists, particularly in European countries. At the same time, the number of key facilities

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which can handle radionuclides has declined while the cost of those remaining has increased due to the enhancement of safety requirements. Furthermore, very few laboratories in Europe now possess the full spectrum of expertise, technical competence and tools at the scale required by the wide variety of technical challenges. Nevertheless, available complementary tools are still present in the various European countries (TABLE 3.1). Efficient use of this expertise needs to be optimized and coordinated with a network structure. Integration, collaboration, coordination are needed; all are central to the concept of a NoE.

Because of its strategic importance, radioecological sciences must be revitalized to become attractive again to young scientists. To maintain and enhance competence in Europe, a pool of scientists and experts for the next generation should be trained. However, currently, there are only a few organisations in Europe that have the appropriate research facilities to support training with an appropriate range of research experience.

To sustain and disseminate radioecological knowledge and expertise, as well as to maintain the appropriate level of research activity in radioecological sciences in Europe, we need Europe-wide networking. Networking will:

- (i) facilitate the coordination, integration and utilization of key remaining facilities for research in radioecological sciences,
- (ii) consolidate and optimise the training and educational possibilities in Europe, and
- (iii) allocate a critical mass of resources and expertise to present challenges through the development of a Joint Programme of Activities (JPA). The JPA would comprise all activities carried out jointly by the participants, with mutual access to infrastructure, equipment, data; exchanges of researchers and technicians. Allocation of resources within the NoE should be structured to increase the output and quality of radioecological research by optimizing the use of the participants' capacities.
- (iv) provide a Centre of Excellence for radioecological research
- (v) Disseminate radioecological knowledge

Though many collaborations are already active, networking will provide the necessary impetus to enliven radioecology in Europe and to strengthen its scientific excellence. By defining shared, ambitious, scientific programmes aimed at maintaining competence and addressing new challenges, a network will be able to reduce the present community fragmentation, in part by offering access to dedicated experimental facilities.

A Network of Excellence in radioecology will help establishing a sustainable network at the European level. Networking of human resources, infrastructures and projects in radioecological sciences should not be seen as a short term action. Due to the expected development of nuclear energy in Europe and around the world within the next 15 years, expertise at the highest level based on the development of focused research programs will be necessary to cope with the needs. Within this context, a Network of Excellence within the 7th EURATOM Framework Programme, would constitute the basis of the development of a sustainable network with the following objectives :

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

- *to reduce the fragmentation of the radioecological research community by bringing together a critical mass of resources and expertise on shared challenges so that Europe maintains and enhances its position as a world leader in this field;*
- *to optimise the research programmes and infrastructure utilisation via appropriate Network of Excellence management procedures. In particular, the organisation of the Joint Programme of Activities (JPA) to stimulate the development of knowledge and skills in basic research topics, keeping in mind both their impact on applied issues of importance and their importance in the training of experts in radioecology;*
- *to strengthen European excellence through an internal selection process of joint programme proposals (in relation with Joint Research Programme);*
- *to adequately support the needs expressed by all end-users including the public;*
- *to significantly improve accessibility of the remaining key facilities to the European radioecological community;*
- *to improve mobility between the Network of Excellence member institutions and the broader European radioecological community;*
- *to put mechanisms in place to involve the wider European radioecological community (including access to facilities, fellowships) and to disseminate knowledge;*
- *to attract young researchers who will gradually become the future experts in the radioecological field at a time when most of the key radioecologists will soon retire;*
- *To disseminate radioecological knowledge;*
- *to liaise with other European networks (e.g. BIOPROTA), the broader international radioecological network (IUR) and other international bodies (e.g. IAEA, NATO).*

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

4. Practical propositions for the implementation of a Network of Excellence

To reach the objectives presented above, and taking into account the characteristics of the radioecological community, a specific organisational structure should be adopted when implementing a Network of Excellence in radioecology. In this section, after summarising the requirements related to the implementation of a NoE, practical propositions are given on both the structure and the organisation of a NoE.

What are the requirements when implementing a NoE?

Due to the very demanding nature of the requirement for durable integration, it is important to point out that a NoE requires, from the very start, an active involvement and support at a strategic level of senior personnel in the participating institutions. These institutions have to be actively represented in the management structure that is expected to oversee the progress towards durable integration.

According to the European Commission, the “optimum size” of the partnership to ensure maximum efficiency is between 3 and 7 organisations. A key reason for this limited number is that the important objective of “durable, institutional integration” will only be reachable if the Network involves a limited number of partners committed to the activities of the network.

Any legal entity can participate in a Network of Excellence. However, in practice, participants in NoE should primarily be organisations active in the research field such as: research centres, universities, research and technology organisations.

What structure for a Network of Excellence?

A structure that anticipates a sustainable network.

The central objective of the NoE will be to produce and maintain the necessary knowledge, skills, and tools in radioecological science such that current and future issues in radioecology can be adequately met.

The initial objective of the NoE is to launch and develop a sustainable network. This is a unique opportunity to achieve the necessary integration to maintain critical mass and excellence.

The structure of the NoE should anticipate the future sustainable operation of the network. It should reflect the objective of integrating and optimising the network’s resources, with the objective to move towards sustainable operation at the end of the European funding. The final objective of a NoE should be to move towards a “virtual centre of excellence” in radioecology in Europe.

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

The main organisational issues to be tackled in the field of radioecology are related to the fact that :

- the scientific community is scattered in Europe;
- access of the scientific community to remaining key facilities needs to be facilitated;
- the attractiveness of the field for students and young researchers should be improved;
- the needs of end users (Authorities, Industry,...) should be better taken into account.

Stakeholders should be more involved through consultation processes to increase transparency in the definition of research topics

The contribution of each of the NoE members to the Joint Programme of Activity should be defined with the goal of integrating and optimising the use of the networks resources. This goal will notably be accomplished through sharing of research facilities and tools, joint training and education programmes, and exchanges of researchers and staff mobility.

Previous experiences in EURATOM and elsewhere have shown that the main difficulty when establishing a NoE is in moving towards a sustainable integration. The structure proposed for a NoE in radioecology should anticipate this difficulty as it is doubtful that durable integration can be achieved with the participation of too many institutions. Therefore, as a first step, we suggest to establish a NoE with a limited number of organisations. This constraint, which does not exclude specific mechanisms to involve more research groups thereafter, appears to be the only way to guarantee, over the long term, that a sustainable integration at the European level will be reached.

Prior to any call that would aim to establish a NoE in radioecology, an active involvement at a high-management level of several organisations would be a key condition to start the process of integrating radioecological research at the European level. This is because it would demonstrate that important potential contributors to the process, at a senior management level in each organisation, are supportive of the principles and objectives of a network including the need for durable integration. To maximize the chances of reaching integration within the time of life of the NoE, a “Joint Program of Integration” (JPI) will have to be established and agreed among all the partners. This JPI will detail all the steps towards the integration of all the components of the NoE namely research, infrastructures, training and education and knowledge management. We suggest that there is a need to establish specific mechanisms to monitor the progresses in the integration process. Regular review of this process by independent experts (coming from a field where a successful experience of integration has been achieved) could be introduced.

Deliverable D3 has already indicated that there are sufficient organisations who could contribute to a future NoE within Europe. Obviously, an appropriate balance between resources, facilities, areas of expertise and scientific output will be required for a successful NoE. In Europe, radioecological research is conducted within several types of organisations:

- National regulatory bodies (safety and/or radioprotection authorities);
- Technical support organisations which support, from a technical point of view, the regulatory bodies;
- National research institutes;
- Universities;

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

- Industry.

The NoE members should include a variety of organisations with complementary expertise and infrastructure which then have the capacity to guarantee scientific excellence, relevance and that takes into account end-users needs. Relevant expertise would include access to associated scientific areas such as radiobiology and ecotoxicology.

Whereas a small number of members will be beneficial in facilitating integration of radioecological research in Europe so that it will be sustainable, the organisation of the NoE should ensure that (1) scientific excellence and relevance objectives will be reached, (2) the NoE will provide appropriate responses to the needs expressed by the end-users through adequate research programmes. Therefore, the NoE members should establish an “Advisory Committee” made up of a limited number of both scientific experts and end-users that would help to identify, characterize and prioritize the research fields. End-users members of the “Advisory Committee” would comprise representatives of Industry, Authorities, National bodies, and NGOs. An optimal balance between the different categories of members will be necessary to consider both the short term needs expressed by the end-users and the more fundamental needs (or long term needs) that could be defined by the scientific experts. Representatives of other fields of environmental sciences should also be included in the “Advisory Committee” to provide advice and guidance, and to establish closer links with their fields. In particular, close contacts with the scientific community investigating the environmental impact of chemicals is a necessity.

The involvement of representatives of end-users is also of primary importance in the future sustainability of the network. If networking is successful and if it provides valuable scientific results, end-users that directly benefit from these outputs should be more inclined to contribute to the financing of the network either during the NoE duration or thereafter.

A structure that considers the diversity of research groups in Europe.

As seen above, the essential objective of sustainability makes it necessary to restrict the NoE to a limited number of participants. However, D1 and D3 have shown that small research groups, mainly universities, possesses specific skills and competences that have a high added value at the European level. It is proposed that specific mechanisms should be explored that would enable these groups actively to interact with the members of the NoE and its associated committees. A number of mechanisms to accomplish this interaction will be explored including:

- opening up the infrastructure and capabilities of the network to other organizations;
- setting up joint research activities with other organizations who are funded by end users, using network resources;
- opening some of the research activities in the JPA to competitive calls for all EC research groups who are not members of the NoE (dependent on appropriate additional funding being organised);
- funding PhD studentships where these are beneficial to the JPA.

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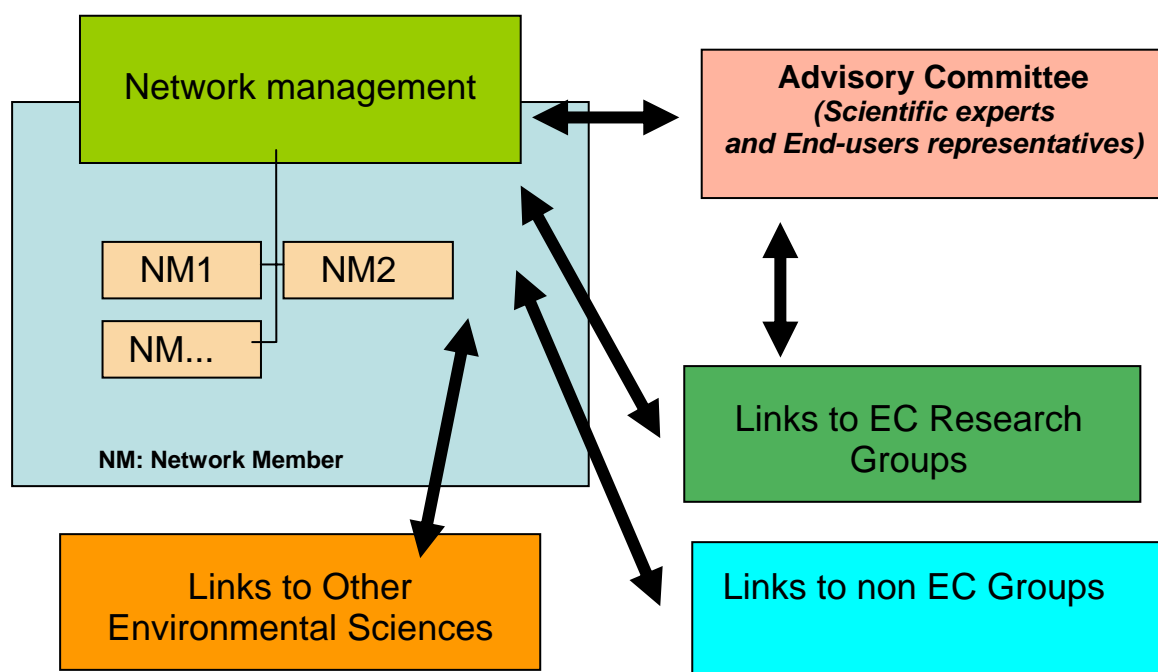


Figure 3.1 : Structure and organisation of a potential Network of Excellence in radioecology.

Figure 3.1 summarizes the management structure of a potential Network of Excellence in radioecology. The main characteristics of this potential NoE are the following :

- A limited number of network members to guarantee the implementation of the JPA;
- An “Advisory Committee” to promote scientific excellence and relevance and to take into account end-users needs and initiate additional funding mechanisms for sustainable integration;
- A link with Associated Research Groups (adapted mechanism of competitive calls to be implemented) that (1) provide added values in specialized research area, (2) establish connections with universities through PhD students, (3) disseminate knowledge.
- A link with international organizations (e.g. USA, Russian, Japan, Canada) which are interested in interacting with the network to mutual benefit.

5. Conclusions

Taking advantage of the work performed in the previous deliverables (D1, D2 and D3), the present report was able to identify that **there is a necessity to maintain and enhance radioecology competence in Europe.**

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During the last decades, research in the field of radioecology has led to a widely recognized expertise in Europe. There are clear signs that key elements of this expertise are now declining, although requirements for it remain. In particular, it is of prime importance to maintain a high level of expertise in the field of the assessment of the impact of radioactivity on man and the environment to be able **(1) to provide an appropriate response in terms of assessment and management of an accidental situation and 2) to reliably assess the impact of authorized discharges from nuclear facilities.** Moreover, as the perception of the public concerning the impact of human activities on the environment and health is evolving, **more dialogue with the public and stakeholders is needed which requires high quality scientific input.** Globally, due to the current renewal of interest in nuclear power, it can be expected that within a decade there will be a growing worldwide need for radioecological expertise. Maintaining a high level of expertise would **improve the competitiveness of EU nuclear industries and help export European radioecological knowledge.**

Deliverable 3 has shown that **important research issues, related to the assessment of the impact of different types of past, present and future nuclear facilities** (waste repositories, new build, legacy sites...) **remain** and that an important research effort still has to be performed. This will be best achieved through an enhancement of the research capacity at the European scale.

Due to the limited available resources in terms of human resources and infrastructures, as identified in D1, **the only realistic way to maintain and enhance competences in radioecology at the European level appears to be a better integration of scientific activities.** As a first step a NoE, funded by the Commission, networking human resources, infrastructures and projects in radioecological sciences would be an important signal in the objective of maintaining and enhancing competences in the long-term. **The NoE, which should constitute the basis for the development of a sustainable network,** should have the following objectives :

- **to reduce the fragmentation of the European radioecological community;**
- **to optimize the research programmes and utilization of infrastructure;**
- **to maintain and strengthen European excellence in the radiological sciences;**
- **to adequately support the needs expressed by all end-users;**
- **to improve mobility between the member organizations;**
- **to put mechanisms in place to involve the wider European radioecological community;**
- **to attract young researchers (as the average age of European radioecologists is increasing); and**
- **to liaise with European and worldwide networks and international bodies.**

Obviously, the feasibility of a NoE in the field of radioecology is dependent on the existence of a pool of organisations with good infrastructure, excellent scientific output and fit for purpose resources. Analysis conducted in D3 has shown that **the EU contains enough such organizations and hence that a NoE is practically feasible.**

Previous experience in EURATOM and other EC-programmes has shown that the main difficulty when establishing a NoE is in moving towards a sustainable integration. Reaching

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this objective will be dependent on the willingness of the partners to integrate their activities (research, infrastructures, training, knowledge management) and not only to coordinate them. Therefore, prior to any action that would aim to establish a NoE in radioecology, **an active involvement at a high-management level** of the organizations should be a key precondition to start the process of integrating radioecological research at the European level. This would demonstrate that important potential contributors to the process are supportive of the principles and objectives of a NoE including the need for durable integration.

In the eventuality of the implementation of a NoE, the characteristics of the present situation of radioecological research in EU would require a specific organizational structure. Firstly to meet the objective of moving towards a sustainable integration, **a NoE in radioecology should comprise a limited number of partners ('beneficiaries') who would adequately cover the required range of radioecological competence.** However, many small research groups possess specific skills and competences that have a high added value at the European level. Therefore, **specific mechanisms that would enable these groups to interact with the NoE will need to be considered.**

The organisation of the NoE should also ensure: (1) scientific excellence and; (2) relevance provided through appropriate responses to the needs expressed by the end-users through adequate research programmes. Therefore, it is suggested that the NoE members should establish an **"Advisory Committee"** made up of a limited number of **both scientific experts and end-users** that would help to identify, characterize and prioritize research requirements. End-user members of the "Advisory Committee" could comprise representatives of industry, regulatory authorities, national bodies, and NGOs.

To conclude, the FUTURAE consortium considers that there is a justified need for coordination of radioecology in Europe and that this requirement would be appropriately addressed by a Network of Excellence under the EURATOM programme.

[FUTURAE]

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

ANNEX 1

Special event: A future for radioecology in Europe

The FUTURAE Consortium wanted to organise a meeting to reach the wider radioecology community within Europe. The timing of the international conference on radioecology and environmental radioactivity in Bergen enabled the Consortium to present the content of D4 and discuss its content.

Participants

Out of 87 persons who attended the Special event:

- 6 were from FUTURAE EUGorganisations;
- 41 were from organisations at the conference; and
- 10 were from the FUTURAE Consortium organisations

Summary of plenary discussions

Questions were asked following each presentation, so generic comments are reported here in the same order.

Radiation Protection Activities: Future Role of Radioecology

H. von Maravic from the European Commission presented the Network of Excellence (NoE) within FP7.

The question of benefit to the wider community was not clear within a NoE. There is a balance to be struck between the number of active players and the goal of long-term sustainability to be achieved. Links between organisations must therefore be well defined.

A NoE is meant to address fragmentation and not all topics would require to be addressed by this type of instrument. Within the Commission, other instruments exist to address training issues. National funding still remains an avenue for research in radioecology. At present however funding within the Commission will only be possible via a NoE within the radioecology research area.

Discussion on funding streams dominated the plenary and concern raised was more directed at the way FP7 is currently structured. The audience had to be reminded that the purpose of the meeting was not to discuss the Commission's decision to have NoEs as an instrument of the 7th Framework.

People were reminded that questions raised on FP7 can be addressed to their own country's EC representatives and that the list was available. After the event, B Howard indicated that participants of the conference from Germany, Slovenia, France, Portugal and Ireland looked at the list.

[FUTURAE]

D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



Main results of the FUTURAE project

JC Gariel presented the main results from the FUTURAE project, introducing its conclusion set within the deliverable D4.

There is concern that the large institutions within a NoE will define how research is to be developed, and that monopoly may not be good for radioecology. However a NoE is only one of many ways forward to fund research.

Presentations heard already on the first day of the conference indicate that basic research is still needed in radioecology.

The question of whether fragmentation is a disadvantage or an advantage was raised. Different opinions emerged but most people agreed that on a resource-basis fragmentation is a handicap within radioecology. The Consortium acknowledged that it did not research how fragmentation is viewed in other scientific fields.

Towards a Network of Excellence in radioecology: an end-user's view

D Copplestone from the End-User Group (EUG) set within the FUTURAE project gave his views on the draft deliverable D4.

Title

“Towards a Network of Excellence in radioecology: an end-user's view” by D Copplestone from the Environment Agency, England and Wales

Background

Four parts to presentation

Why is a NoE of interest to us as an end user?

What are the advantages to end users of a NoE?

How might we use/be involved with a NoE?

Questions to Futuræ

Why are we interested in a NoE?

Environment Agency is an end user

Wide range of duties

Require a research base to develop evidence based policy and provide operational scientific support

e.g. conducting/reviewing routine assessment of exposure to radioactive substances

e.g. need for (internal and external) credible scientific experts for input into dialogue with stakeholders

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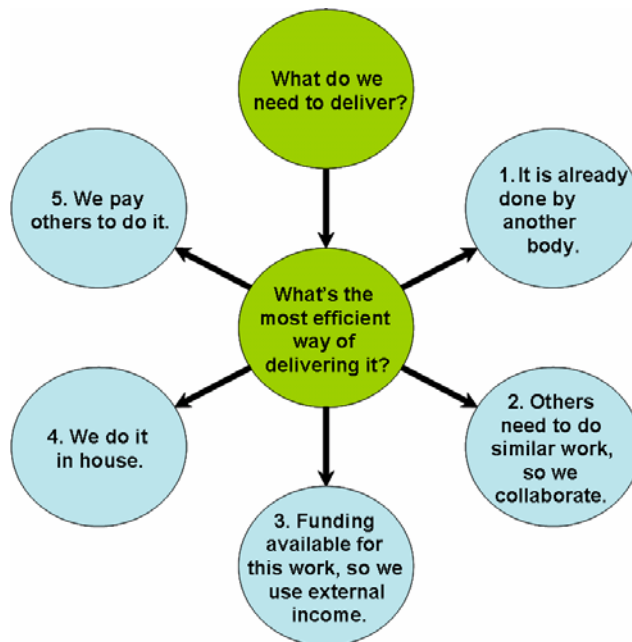
D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

25/30





Problems for us

- Budget constraints
- Limited internal resources
- Wide range of areas to cover (within Radioactive Substances Regulation)
- New challenges:
 - New build
 - Waste management/repository
- Increasingly looking to partnerships or trying to influence others

What are the advantages of a NoE?

- Addressing fragmentation
 - Fragmentation reduces no of potential sources of expertise for us
 - Need a critical mass to drive innovation and scientific developments
- Should increase access to academics/researchers
- Opportunity to fund research to meet our needs directly through the NoE (?)
- Maintenance and development of expertise
- Training opportunities – new blood
- Maintenance and development of infrastructure (and improved access to them)
- Funding opportunities may be increased from other sources (national funding sources etc)
- Increased interactions at European and International scale

How might we be involved with a NoE?

- Based on the description of the NoE, potentially
 - Influencing the research programme, through engagement with NoE/Advisory body
 - Participation in research projects of interest to us (as a resource)

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



Using our influence to obtain external research funds from others (e.g. national funding bodies)
Potentially provide external funding for research in areas of interest to us

However

Would not want to see simply an amalgamation of research groups
Stifle innovation
Reduce competition which can increase costs

Questions to Futurae?

Will NoE cover all areas of radioecology or focus on specific areas?
e.g. waste management, new build, human/non-human assessments etc
How will this be linked to the experience/expertise of those joining the NoE? Or will they dictate the research areas of interest?
How will network function?
Calls for research proposals in key topic areas?
End users influence the topic areas? Or the Joint Programme of Activities? Involved in evaluation of proposals?
Funding – short term and long term? Demonstration of benefits of NoE... durable integration

It was pointed out that a NoE would not cover all topics within the field of radioecology.

Experience has shown that “critical mass” is needed to drive research but that individuals can also have a major role to play. It is also agreed that there is no unique mechanism by which to fund research. Therefore the radioecology community should be able to accommodate a range of collaboration and funding opportunities and find ways to engage smaller research groups. If a NoE is the only available mechanism offered by the Commission then the how to be part of it is an important issue that should be explored.

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



ANNEX 2: Participants to the Special Event

FUTURAE EUG members

Name	Organisation	Country
V Berkovskyy	IAEA	-
F Brechignac	IUR	-
I Prlic	IMI	Croatia
J Kovac	IMI	Croatia
D Coplestone	Environment Agency	UK
R Heling	NGR	The Netherlands
C Willrodt	Bfs	Germany

Conference participants

Name	Organisation	Country
T Lazo	NEA	-
L Saracevic	Faculty of veterinary medicine	Bosnia and Herzegovina
R Tsihranski	Kozloduy Nuclear power plant	Bulgaria
S Mihok	CNSC	Canada
C Seymor	McMaster University	Canada
C Mothersill	McMaster University	Canada
N Garisto	SENES	Canada
J Horyna	SUJB	Czech Republic
S Nielsen	Riso	Denmark
S Salminen	University of Helsinki	Finland
K Vaaramaa	University of Helsinki	Finland
T Yves	ANDRA	France
C Boyer	CEA	France
L Tosch	Centrum for radiation protection and radioecology	Germany
S Harb	ZSR	Germany
A Stylianosh	Hellenic Centre of Marine Research	Greece
S Long	RPII	Ireland
L Currvan	RPII	Ireland
H Tsukada	Institute of environmental sciences	Japan
S Yoshida	NIRS	Japan
GC Christensen	Institute of Energy Technology	Norway
HE Heldal	Institute of Marine Research	Norway
B Salbu	UMB	Norway
B Michalik	GIG	Poland
JW Mietelski	IFJ PAN	Poland
MJ Madruga	ITN	Portugal
F Carvalho	ITN	Portugal
D Galeriu	IFIN-HH	Romania
A Melintescu	National Institute for Physics and nuclear engineering	Romania
V Soyfer	RAS	Russia

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

Name	Organisation	Country
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F Javier Guillen	University of Extramadura	Spain
E Gallego	UPM	Spain
C Bradshaw	Stockholm University	Sweden
K Stark	Stockholm University	Sweden
M Brennwald	Nagra	Switzerland
F van Dorp	Radioactivity and Environment Consulting	Switzerland
A Nisbet	HPA-RPD	UK
G Hunter	Scottish Environment Protection Agency	UK
P Dale	Scottish Environment Protection Agency	UK
M Wood	University of Liverpool	UK
S Shaw	University of Nottingham	UK
N Willey	University of West England	UK
J Vives Battle	Westlakes Scientific Consulting	UK
S Watts	Westlakes Scientific Consulting	UK
P Mcdonald	Westlakes Scientific Consulting	UK
P Gleizon	Westlakes Scientific Consulting	UK
S Jones	Westlakes Scientific Consulting	UK
G Lazorenko	NASC	Ukraine
C Yu	Argonne National Laboratory	USA
K Higley	Oregon State University	USA

FUTURAE Consortium partners

Name	Organisation	Country
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B Carlé	SCK-CEN	Belgium
H Vandenhove	SCK-CEN	Belgium
R Blust	University of Antwerp	Belgium
T Ikäheimonen	STUK	Finland
D Solatie	STUK	Finland
M Muikku	STUK	Finland
JC Gariel	IRSN	France
J Garnier-Laplace	IRSN	France
K Beaugelin-Seiller	IRSN	France
JC Barescut	IRSN	France
A de Vismes	IRSN	France
R Gurriaran	IRSN	France
C Mercat	IRSN	France
I Zinger	Facilia (IRSN)	Sweden
A Liland	NRPA	Norway
M Iosjpe	NRPA	Norway
M Dowdall	NRPA	Norway
J Brown	NRPA	Norway
J Gwyn	NRPA	Norway
A Nalbandyan	NRPA	Norway
B Smodis	IJS	Slovenia
M Strok	IJS	Slovenia

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D4: Networking – a way for maintaining and enhancing radioecological competences in Europe

Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]



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L Moberg	SSI	Sweden
B Howard	CEH	UK
C Barnet	CEH	UK
N Beresford	CEH	UK

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Dissemination level: PU

Date of issue of this report: 12/11/08 [FINAL]

