



**NATURAL
ENVIRONMENT
RESEARCH COUNCIL**

NERC Radioactivity and the Environment (RATE) Programme: Science Plan

Compiled by: RATE Secretariat

Foreword

NERC is commissioning an £8m, five-year research programme - Radioactivity and the Environment (RATE) – focused on capacity-building, with projects planned to run between 2013-14 and 2017-18. It will form part of the NERC contribution to the wider RCUK Energy Programme and falls under NERC's Environment, Pollution and Human Health (EPHH) strategic theme.

NERC established an Expert Group (EG) to help re-scope the RATE action to ensure that the programme develops capacity to secure future UK capability in the field of radioactivity and the environment. The EG included representatives from a number of relevant disciplines including radioecology, environmental radioactivity, hydrochemistry, hydrogeology, radionuclide transport, geology, geophysics, geomicrobiology and radioactive waste disposal.

This Science plan, prepared by the RATE secretariat, is based on the recommendations of that EG, and contains their validated recommendations on the scope and proposed activities to be included in the research programme. The full RATE EG report is available from <http://www.nerc.ac.uk/research/funded/programmes/rate/rate-report.pdf>.

The EG report contains:

- Recommendations about the priority research areas, building on previous scoping work in particular the 2009 Pentreath report and the Phase 3 EPHH Theme Action Plan (TAP)—consideration of radioactivity in the marine environment is also included
- Recommendations about types of activity to include in the research programme to attract researchers with the required and novel expertise, including the potential capacity to be drawn in from related research disciplines
- Recommendations about elements to include in the research programme to deliver the priority areas (e.g. for research, coordination, management, training and impact)
- Recommendations about where capacity will be needed to address identified priority research areas

1 Introduction

There are many important reasons to expand UK research on radioactivity and the environment. For example, in response to tough targets for reduction of greenhouse gas emissions, it is possible that a new generation of nuclear power plants may be commissioned in the UK and elsewhere. The UK faces significant legacy issues associated with radioactive waste and contaminated sites; and there has been a recent change in approach for environmental protection from radiation.

To address this, NERC is commissioning an £8m, five-year research programme - Radioactivity and the Environment (RATE) – focused on capacity-building, with projects planned to run between 2013-14 and 2017-18. It will form part of the NERC contribution to the wider RCUK Energy Programme and falls under NERC's Environment, Pollution and Human Health (EPHH) strategic theme. Financial support for the programme is from NERC (£5M), the Nuclear Decommissioning Authority – Radioactive Waste Management Directorate (NDA-RWMD) (£2M) and the Environment Agency (EA) (£1M).

To ensure that RATE addresses relevant areas of research, which are currently underrepresented in the UK, while building capacity in the field, NERC appointed an Expert Group (EG) to advise on key areas in which the resources available to RATE should be focussed.

2 Background

In recent years NERC has been considering a research programme on this topic and in 2009 commissioned Jan Pentreath to provide advice to them on the UK's research needs over the next 10 years. In September 2010 Roy Harrison, the Theme Leader for EPHH, held a meeting to discuss a potential NERC proposal for an action on Radioactivity and the Environment. This meeting report was used to develop the TAP Action which was recommended by the NERC Science and Innovation Strategy Board (SISB) to NERC Council, with some changes, and subsequently approved as the RATE Research Programme. This defined the boundaries and scope of research discussed at the EG meeting.

NERC invited applications from individuals interested in joining the time-limited EG for RATE. The group was tasked to advise NERC on priority areas for research and ways to build UK research capacity in these areas. The British Geological Survey (BGS) provided the secretariat for the EG.

2.1 EXPERT GROUP MEETING

The EG attended a two day meeting held at BGS Keyworth on 2nd and 3rd May 2012. The format of the meeting, agreed between the secretariat and NERC was designed to elicit a consensus from the EG within the boundaries set by the three bodies which are contributing to the funding of RATE.

A detailed summary of the meeting is provided in the EG Report and membership of the EG is given at Annex A.

2.2 OPPORTUNITY TO COMMENT

Following completion of the EG final draft report it was made available to allow any interested individuals or organisations to comment on the draft recommendations. This was undertaken using a web-based approach accessible from the RATE pages on the NERC website. The comments received were collated into a single document together with suggested revisions to the recommendations to NERC that the RATE Secretariat thought appropriate in the light of the comments. This document was circulated to the EG for their consideration and their comments compiled. The RATE Secretariat has revised the recommendations to NERC taking into consideration the responses received from the EG. These recommendations have been accepted by the funders and form the basis of this Science Plan.

3 Science Priorities

The EG identified a number of science areas and priorities for the NERC RATE Programme. The agreed programme priorities are detailed below. As the EG specifically noted that 'marine' is embedded in all areas, specific topics in this area have not been highlighted as areas of high science priority. Thus 'marine' ecosystems do not have extra emphasis over any other topic, but should be encompassed in the overall scope of projects developed in response to the RATE call.

3.1 HIGH SCIENCE PRIORITIES

Five science topics have been identified as the focus for the RATE programme:

3.1.1 (Bio)geochemical coupling including deep multiphase transport processes

Areas of research that will be considered as a priority for funding under this theme include:

- Hydro-(bio)geochemical reactions under Geological Disposal Facility (GDF) conditions
- Gas production, consumption, reactions and transport, especially of methane and hydrogen
- Coupled Thermal – Hydro – Mechanical - Chemical (THMC) processes including fluid movement and radionuclide transport including over long timescales
- Microbial ecology and radiation microbiology of a GDF

In particular areas of scientific uncertainty where significant progress could be made using new investigative techniques and tools, these should be explored with a focus on radionuclides of particular concern in the UK context.

3.1.2 Learning from contaminated environments including natural analogues (natural laboratories)

Natural and anthropogenic analogues and studies of radioactively contaminated environments provide a basis for understanding the long term behaviour of radionuclides and the long-term preservation of potential repository materials, such as bentonite clay, copper, etc.

Research in this theme will provide fundamental underpinning of understanding, model testing and parameterisation in real environmental systems. It is applicable to

remediation, waste disposal and nuclear power generation impact assessments. Natural Laboratories include both marine and terrestrial environments and may be the result of accidents, such as Fukushima and Chernobyl; natural contamination such as uranium mineralisation or contamination as a result of normal operation, e.g. Irish Sea etc. Such studies would complement rather than duplicate previous work and in particular could inform understanding of how radionuclides behave in natural environments over longer timescales than laboratory experiments are usually performed over.

3.1.3 Innovative approaches to ecosystem/food chain radionuclide uptake and transport processes for key radionuclides relevant to waste disposal facilities and contaminated land

Assessment models are highly sensitive to reported partition coefficient (K_d) and Chemical Reactivity (CR) values, which exhibit great environmental variability for which there is not yet a fundamental understanding. Research within this theme should aim to reduce uncertainty in transfer parameter values on the basis of key radionuclides and environmental variables (such as soil/sediment type) and incorporate spatial and temporal variability.

3.1.4 Effects of chronic exposure on plants and animals

Research within this theme will contribute to improved understanding of the level of dose causing significant negative impacts on plants and animals. Derivation of suitable benchmark/reference levels would be appropriate. The current scientific basis needs to be strengthened for determining processes of chronic exposure, especially where there are gaps in current knowledge and fundamental data for Reference Animals and Plants (RAPs).

3.1.5 Model building/testing, demonstration of scientific robustness, and quantification of uncertainty

The RATE programme recognises the importance of model building, testing, robustness, and reduction/quantification of uncertainty for successful delivery. Research in this area will be associated with one or more of the science priorities listed above. Associated with this research theme is the need for innovative ways of presenting models to a wide audience (see Section 3.8 on KE strategy).

3.2 TECHNOLOGICAL PRIORITIES

The RATE programme is also interested in supporting technological innovation to deliver the science priorities listed above.

Technological innovation for rock mass characterisation at a range of spatial scales

Areas of research that will be considered as a priority for funding under this theme include:

- Methods, tools and approaches to characterisation at the meso-scale range (i.e. 1-100m) as this is often poorly examined
- Characterisation of the far-field/near-field interface, including fractures and faults
- Technology transfer from other industrial/research sectors, including hydrocarbon sector

This is timely for a UK GDF programme because site investigation to determine suitability will occur in ca. 2015 to 2018. Research is required to deploy scientific advances and modern technologies that have been developed for other applications to the characterisation of site(s) for a UK GDF.

3.3 COMPLEMENTARY AREAS OF INTEREST

The following are NOT of high strategic priority for the RATE programme, but could complement the science priorities listed above, where appropriate.

Climate change

Where relevant, there is a need to capture change in environmental boundary conditions as a result of climate change.

Background radiation

Doses to the public vary widely across the world for a variety of reasons, including variability in natural background and lifestyle. The way the public are exposed and the potential resulting detriment need further study and explaining in terms of comparative risk.

Wildlife dosimetry

Exposure of wildlife has been the subject of recent International Commission on Radiological Protection (ICRP) publications and more work could be undertaken, such as on the sensitivity of organisms during their life-cycle.

3.4 MECHANISMS TO ATTRACT, DEVELOP AND MAINTAIN CAPACITY

A key aim of the RATE programme is to encourage involvement of researchers from other sectors that have not traditionally been associated with this area of research. The RATE programme will encourage interdisciplinary and multidisciplinary projects in the call for proposals to draw different groups together and will support networking activities and summer schools to foster exchange and collaboration both within and outside the field. The ambition is for the RATE community to evolve into a group/network that will have a much greater longevity than the RATE programme itself. It is anticipated that networking will develop rapidly with initiatives already funded by EPSRC (Nuclear Champion and Doctoral Training Centres) and proposed in relevant fields under the STFC Global Challenge Networks call.

Funded projects will also be expected to emphasise the potential for young scientists in Britain, where a new important science challenge is arising, for which we need to develop future innovative leaders to work together to address these topics within their careers.

3.5 CAPACITY NEEDS TO DELIVER RATE

To achieve its long term goals capacity building within the RATE programme should include the:

- Geosciences (including geochemistry, geology, geophysics, geomicrobiology, climate), because of strong competition with other industries and under capacity

- Environmental radioactivity and radioecology (including radioanalytical skills, radiochemistry, field radioecology and modelling), because of significant under capacity
- Involvement of PhD studentships in multidisciplinary projects
- Participation in and creation of wide networks, including non-academic organisations

The EG also identified two areas of capacity building that lie outside the remit of the RATE programme, but which the community should note:

- Development of potential long-term career paths
- Sustainability of funding to help retention with the sector

These issues are not specific to the UK but are common across Europe and farther afield.

The RATE programme aims to attract multidisciplinary scientists with experimental knowledge/breadth with both field and laboratory skills, foster cross industry participation, skills transfer and training of people from other fields. Where possible, funding partners will facilitate access to underground research laboratories (URLs), 'active' and other research facilities. Research proposers will be required to negotiate access, comply with appropriate regulations (e.g. on security) and build necessary resources into project proposals.

3.6 MECHANISMS TO DELIVER RATE

The RATE Programme will fund up to three large multidisciplinary consortium projects that should consist of a minimum of three institutes each. Projects will be up to 5 years in duration. Each consortium will be associated with a cohort of PhD studentships, with up to twenty PhD studentships will be funded in total.

In addition a number of other factors are viewed as important to the successful delivery of RATE:

- The studentships must be embedded within the multidisciplinary consortia, although the students could be based at associated institutions
- Students should have regular summer schools/training events that will encourage integration between the consortia and knowledge exchange between participants
- An annual meeting for the whole of RATE should be open to other interested parties
- Co-ordination of RATE should have strong links with COGER (and similar groups) to facilitate good external communication and outreach

Because the funding for the RATE programme is relatively modest, major infrastructure investment will not be an eligible cost within the programme. Instead, it is expected that use of existing national and international facilities should be made as much as possible and where appropriate.

3.7 DATA MANAGEMENT

There are no special requirements for data management (other than NERC requirements). Researchers funded under this programme will be expected to comply with the NERC Data Policy 2011. Full details will be provided in the call for proposals.

3.8 KE STRATEGY

The design of RATE with NDA and EA input is the main route for knowledge transfer within the programme. However, wider dissemination will be achieved through a RATE programme Network.

The audience for the programme will not be limited to the academic and specialist community; there is a need for effective wider communication of the programme and its outcomes to help build public confidence in the UK's research capability in this area. Public engagement is now a vital element in taking forward the UK's legacy and new build programmes. Although it is beyond the scope of RATE to fund specific communication projects/tasks, effective communication will be expected as an integral part of all projects.

Annex A

Membership of the Expert Group

EG membership included representation of the following groups:

- The UK and international academic community;
- Relevant government departments and policy-makers, and;
- End users, including industry and business experts.

Professor Michael Kendall of Bristol University was invited by NERC to chair the EG.

The EG members were:

- Mrs Joanne Brown - Centre for Radiation, Chemical and Environmental Hazards Health Protection Agency (HPA);
- Professor Neil Chapman - MCM International;
- Dr Brenda Howard MBE - Centre for Ecology & Hydrology (CEH), Lancaster Environment Centre;
- Professor Paul Leonard - Corporate Risk Associates Ltd;
- Professor Francis Livens - Dalton Nuclear Institute, University of Manchester;
- Professor Jon Lloyd - School of Earth, Atmospheric and Environmental Sciences, University of Manchester;
- Professor Becky Lunn - Department of Civil & Environmental Engineering, University of Strathclyde;
- Professor Angus MacKenzie - Scottish Universities Environmental Research Centre;
- Professor Marian Scott - School of Mathematics and Statistics, University of Glasgow, and;
- Professor Jim Smith - School of Earth and Environmental Sciences, University of Portsmouth.

Members of the funders who attended and contributed to the EG meeting were:

- Dr Chris Franklin – NERC;
- Dr Caroline Culshaw – NERC;
- Dr Jon Martin – NDA;
- Mr Andy Mayall – EA, and;
- Dr Neil Smart – NDA.

NERC Theme Leader EPHH:

- Professor Roy Harrison.

Observers (OBS) who attended and contributed to the EG meeting were:

- Mr Mike Gooding - DSTL Porton Down.

The Secretariat, from the British Geological Survey (BGS), were:

- Dr Richard Shaw;
- Dr Jenny Bearcock, and;
- Dr Joanna Wragg.