NET.EXCEL – A European Thematic Network for suggesting and prioritising future joint R&D projects

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Abstract

The NET.EXCEL project concerns the forming of a network of European end users for analysing the present status and future needs in Research, Technical development and Demonstration (RTD) for the disposal of highly radioactive waste in the three classical rock media: salt, clay/clay sediments and crystalline rock. The aim is to generate values additional to that gained by the individual participants: Svensk Kaernbraenslehantering AB (Sweden), Posiva Oy (Finland), Empresa Nacional de Resíduos Radioactivos SA (Spain), Gesellschaft fuer Anlagen- und Reaktorsicherheit mbH (Germany), Agence nationale pour la gestion des déchets radioactifs (France), Nationale Genossenschaft fuer die Lagerung radioaktiver Abfaelle (Swizerland), Organisme National des Déchets Radioactifs et des Matières Fissiles Enrichies (Belgium) and United Kingdom Nirex Limited (UK).

The practical way to carry out the needed RTD-activities and the principles behind the process to establish priorities for the necessary RTD-work is quite similar among the participants. Common ground has been analysed for the role/responsibilities of the participating organisations, for the establishment of priorities for the RTD work and for the modus operandi of the organisations to carry out the RTD. The issue of prioritising the potential RTD activities and the factors taken into account by the participating organisations have been summarised and analysed with respect to the common denominator in the project.

A number of RTD areas for high-level and long-lived waste were selected and each organisation presented its high-priority issues within these areas. The issues were compiled into the so called “100 list”, which was taken as the basis for testing two ranking approaches, one with expression of interest in the topic with priority numbers by each participant, and the other by selection of high-priority issues in plenum by experts from each of the participants. The two ways resulted in many similarities, and a merging of the high-priority issues provided a list of primarily “thematic areas”, were different issues with small differences but main similarities were collected under one heading. These “thematic areas”, however, contain quite diverse activities and need to be analysed and specified in detail in order to provide a basis for broad and sustainable European co-operation.

The experiences gained from performing the activities in the project are discussed and components of a future systematic procedure for ranking RTD issues and specifying multinational joint RTD projects are suggested based on these experiences.
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1. INTRODUCTION

A future efficient use of European resources in research and development of safe methods for final disposal of radioactive waste is assumed to benefit from close interaction between European end users in planning of national programmes as well as in development of international projects. Good experience exist from multinational co-operation on technical issus, and this brought up the idea of establishing the NET.EXCEL project for a broad and unprejudiced feasibility study on the possibilities for sustainable co-operation in Europe, and on what issues, by forming a network of end users and analysing the present status and the future requirements, and identify areas for joint projects in Research, Technical development and Demonstration (RTD) for the three rock media: salt, clay/clay sediments and crystalline rock. One key component of such joint projects must be a possibility to generate values additional to that gained by the individual participants: Svensk Kaernbraenslehantering AB (Sweden), Posiva Oy (Finland), Empresa Nacional de Resíduos Radiactivos SA (Spain), Gesellschaft fuer Anlagen- und Reaktorsicherheit mbH (Germany), Agence Nationale pour la gestion des déchets radioactifs (France), Nationale Genossenschaft fuer die Lagerung radioaktiver Abfaelle (Swizerland), Organisme National des Déchets Radioactifs et des Matières Fissiles Enrichies (Belgium) and United Kingdom Nirex Limited (UK).

2. SCOPE OF WORK

The project has been progressing in stages in complience with the guiding document, the Project Work Plan /SKB, 2002/. The first issue was to organise and get the network active with the initial task of compiling information on status and plans for RTD in each of the participants home country. This task included methodology and criteria for prioritisation of RTD issues. Eventually the national information was summarised per rock media and later in a synthesis addressing all three rock media and the issues that were in common among the project participants.

Due to time and resource limitations the NET.EXCEL project was focused on long-lived radioactive wastes and deep geological disposal. The needed limitations also restricted the project to consider only work done by the participating organisations. This was not all together satisfactory and an early recommendation was to expand the scope in the future to also cover work on other waste types or repository concepts as well as to work done by other waste management organisations, regulating or supervising organisations.

The final part of the project focused on identifying and ranking projects with common European interest based on methodology and criteria established by the network. The project has consequently resulted in a list of projects which have a high common priority and which are jugded plausible to be developed as joint European projects.

3. DISPOSAL CONCEPTS AND PRESENT STAGE OF NATIONAL DEVELOPMENT

All the participants have in common the preference for disposal in a geological formation. They also share the main basic principles in design and selection of media.

- The repository should be situated in an environment that can be characterized over at least the same time period as the waste has to be isolated from man and his environment.
- The multi-barrier principle should be applied.
- The repository performance should be robust.

The various national concepts have been developed in different media based on these principles. The three media represented in the project have different fundamental characteristics, such as:

- In crystalline (hard) rock may radionuclides migrate along groundwater channels in the fractures of the rock.
- In clay is diffusion the main process controlling the migration of the radionuclides through the saturated media.
- In a salt repository, constructed for the only purpose of waste disposal, is circulating ground water basically absent.

These differences in media characteristics have resulted in somewhat different engineering approaches, and in general, for crystalline rock repositories, a greater safety burden has been allocated to the engineered barrier system than to the natural geologic barrier system (often in order to simplify the site selection). Contrarily, salt repository concepts are strongly utilising the exclusion of the ground-water from the host formation. For the clay repository concepts the safety burden is more equally distributed.

The geological RTD done and planned for in the national programmes are obviously strongly affected by the geologic media available in the respective countries and the materials planned to be used in the repositories.

Although similar issues are addressed in the course of siting, licensing, constructing, operating and sealing a repository the timing for the addressing is dictated by the state-of-progress the respective programme has reached. Table 1 indicates the differences between the participants in the project.

Table 1. State of progress in focus for each country /EC, 2004/

	Planning of programme for repository development	Gen. research on options and alternatives	Strategic choice of policy, media etc	Definition of site requirements	Site investigation	Site decision licensing and pre-construction	Operation phase closure
SKB	**A**	**A**	**A**	**S**	**M**		
Posiva	**A**	**A**	**A**	**A**	**S**	**M**	
Enresa	**A**	**A**	**M**				
GRS	**A**	**S**	**M**	**moratorium**	**moratorium**	**moratorium**	
Andra	**A**	**S**	**M**				
Nagra	**A**	**A**	**S**	**M**	**S**		
ONDRAF/NIRAS	**A**	**A**	**M**				
Nirex	**A**	**S**	**M**				

Marking: **M** *Main focus for present work*

S *Substantial work going on*

A *Areas that have reached an accepted standard*

4. IDENTIFICATION AND PRIORITISATION OF RTD WORK

The methods used by the participants to identify, prioritise and initiate RTD activities show large similarities. Although none of the organisations is claiming currently to utilise a fully quantified and formalised process they all utilise the same basic input and prioritisation factors:

4.1 Input used for the identification of RTD needs

- Results of RTD activities including the normal scientific review of these results, and the follow-up of scientific/technical progress in general.
- Identification of lack of sufficient safety or acceptable support of safety due to:
  - problems encountered in the development of assessment capability and quantification of processes dominating the system/subsystem performance,
  - problems exposed by the performance or safety assessments, and
  - problems encountered in the design or construction/production of barriers.
- Assessment of the uncertainties and the ranking of them with regard to their importance for safety.
- Evaluations and comments given by the regulators in the licensing/approval processes.
- Other stakeholders' concerns and requests (producers, public, local authorities, etc.).

4.2 Factors taken into account when prioritising the potential RTD activities

- Factors given by the political, geologic and technical framework of the country.
  The potential RTD-issues are e.g. evaluated with regard to:
  a) timing in the country specific time-plans and stepwise approach,
  b) relevance to country-specific selection of repository concept and host rock, and
  c) importance for the perceived safety and/or acceptance by important stakeholders and the public.

- Factors stemming from the safety assessments or standard engineering practice for optimisation and choice of materials/procedures. These factors can often be used for quantitative ranking of potential RTD-activities e.g. by sensitivity analysis or similar techniques addressing:
  d) importance of the activity for the constructability of the repository system, for achieving an acceptable safety level, or for the proof of them,
  e) need for reduction of uncertainties, quantification or bounding of conservative simplifications,
  f) need for a robust/insensitive system with a flexibility to be able to adjust to new developments in techniques and knowledge,
  g) effect on resources, cost and/or optimisation, and
  h) availability of resources

- Many less quantifiable, factors based mainly on subjective evaluations of potential for success, availability or need for competence, etc will often have a decisive impact on the priorities. Such factors are:
  i) benefits of a reasonably successful outcome of the RTD-activity,
  j) resources needed for getting a reasonable chance of success,
  k) risk/potential for failure/success,
  l) availability of necessary equipment and/or competence, and
  m) necessity to develop and maintain a competence base that is sufficient for the perceived needs of the foreseeable future.

By these means have all the participants developed RTD-programmes and published them for external comments.

4.3 Added value and future joint RTD activities

The primary values (e.g. possibility of cost savings, availability of a broader/better competence base etc.) brought in by undertaking RTD activities in international co-operation have long been recognised, and are the reason for the existing co-operation. Other benefits - like the development and maintenance of joint competence centres and joint utilisation of rare competence - might be increased through an extended co-operation.

The focus of the NET.EXCEL project, to explore the possibilities for a more systematic co-operation, also brings up issues or problems that have to be addressed when discussing an extended co-operation. Such issues might e.g. be due to:

- Different timetables for the repository development in the various countries. Many co-operative efforts presume a willingness to participate also in activities that for some partners might not have their full utility until some years in future. In RTD areas where the knowledge base is well advanced and sufficient for the near term needs this might limit the will for broad participation.

- Different geological media. RTD areas that are very site or design specific can be of low interest for a broader group, however, well suited for international co-operation in a smaller group.

- Different needs for quality assurance in different phases of repository development. However, the joint adherence to ISO 9001 and 14001 makes it simpler to establish rules for joint QA procedures and QA levels.

- Reduced availability of independent groups for second opinion and review. Although the forming of centres of excellence and the joint utilisation of rare and scattered expertise often is beneficial for the competence level of the created group, the availability of competence for second opinions and review might be reduced. It is important to be aware of this mechanism especially when discussing the possibilities for the oversight or regulating organisations to do a good job.

5. NATIONAL RTD ISSUES OF HIGH PRIORITY

5.1 Covered areas in the study

To facilitate the identification of common RTD issues, irrespective of geological media a division was deemed needed and the areas below were selected in the project work. They do not cover all areas in nuclear waste management, but they present areas where a substantial amount of work is in focus in each of the participants´ core programmes.

- Radioactive waste
- Waste package (canister and overpack)
- Buffer
- Backfill
- Plugs and seals
- Geosphere
- Repository construction and operation
- Monitoring
- Performance and Safety Assessment

Focusing on these areas each participant provided a list of highly prioritised issues from each one's national programme. These lists were then merged into one list, which in the project was termed the "100-list", and used for the ranking exercise conducted in the project.

5.2 Procedures to identify joint RTD issues

The selection of joint RTD issues from each one's individual RTD issues was besides the simple comparison of headings intended to take into account the various types of added value that a co-operative effort could provide. Since there can be very different objectives for different types of co-ordinated RTD activities, the added values that are most appreciated in a specific joint activity could also be expected to be different. The objectives of such activities might be:

- comparison of optional approaches, development of joint strategies or development of consensus,
- development or preservation of competence, and
- preservation of information.

Various objectives and the values sought in joint activities are exemplified in Table 2. These differences were kept in mind when ranking the possible activities.

Table 2. Possible added value in joint RTD activities

Objective of an RTD project	Most appreciated added value from international co-operation
To develop a basic understanding	Broad scientific competence and participation, extensive reviews, cost savings
To establish consensus or common strategies	Detailed scrutiny of the issue, thorough mapping of alternatives, extensive reviews, wide dissemination of results
To produce or improve on specific data	High detailed competence, accepted methodologies, high level of QA, joint build-up of competence
To compile or establish joint databases	Shared cost of maintenance and availability, joint and reviewed documentation on data and its quality, longevity
To carry out specific experiments or demonstrations	Shared cost, more or better competence or equipment
To develop/preserve necessary competence or establish joint centres of excellence	Shared cost, better quality, "critical mass of experts"

The wish of the NET.EXCEL participants - to look fully at the possibilities and problems of enhanced co-operation, and the awareness of the various aspects raised by this - evokes a number of questions regarding how such co-ordinated operations should be initiated, organised and managed. Similarly, it is recognised by the participants that a possible future continuation of the activities tested in NET.EXCEL and extension into other areas (e.g. biosphere, near-surface disposal, non-radioactive wastes) or the inclusion of new members might evoke new issues and problem areas to be discussed.

In the NET.EXCEL project two approaches have been tested for the development of ranked lists of activities of high interest as co-operational projects:

1. A ranking of the issues/activities in the "100-list" of the organisations' high priority issues by having each participant mark its interest in participating in each of the listed issues

(0 = none, 1 = low, 2, medium or 3 = high interest) and adding them up to form a ranking number.

2. A selection of issues and areas with potential for co-operation made by the NET.EXCEL project group in plenum. The list was based on the participants' knowledge of their own national interest, their awareness of what could be suitable co-operative projects and a general understanding of the international status of repository development.

6. HIGH PRIORITY AREAS FOR FUTURE CO-OPERATION

The two approaches resulted quite logically in similar results, and a digestion of theses provided a list of future RTD areas that could benefit from European co-operation, shown in Table 3. The nature of this list of suggested RTD issues is "thematic" rather than "detailed", because the secretariat handled the merging in such a way that scopes were broadened in order to accommodate other topics, which have many similarities but would not fit when the definition of each topic was to narrow.

Table 3. List of RTD issues that could benefit from European co-operation

High priority areas	PA	Waste	Repository barriers	Geosphere
Methods and tools in PA/SA	X			
Dissolution of spent fuel and vitrified HLW *High pH radionuclide dissolution and migration*		X		
Buffer saturation and evolution			X	
Backfill materials *Backfill materials and techniques*			X	
Plugs and seals *Plugs and seals strategy*			X	
Radionuclide speciation and migration *Confirmation of diffusion databases*			X	X
Excavation Damaged Zone			X	X
Repository induced perturbations on the geosphere			X	X
Gas migration in tight media *Gas transport capacity of rock*			X	X
Radionuclide migration in the geosphere *Radionuclide retention*				X
Up-scaling of host rock properties				X
Criticality		X		
Gas generation by organics		X		
Long-term stability HMC				X

7. DISCUSSION

7.1 Future RTD needs of high priority as seen today.

A major factor influencing the possibilities to identify the future RTD that is jointly regarded to have a high priority is the level of details in the national lists of RTD needs. In the NET.EXEL effort it was early recognised that the basis provided by the participants was quite uneven with regard to elaboration and details.

In the two approaches used, the ranking with numbers encountered problems in clearly being able to define the primary objectives and delimitations in the suggested RTD issues. This made it difficult to do an early merging. However, the RTD issues were prioritised by the participants and after ranking have highly prioritised issues been merged into areas with a higher level of generality – thematic areas. To be able to identify well framed and internationally consistent projects these areas have to be further analysed. The methodology for this has not been tested. This issue was not encountered in the approach taken in the plenum exercise since the picking of suitable activities was done by the experts with their suitability for international co-operation in mind. The problems encountered here were mainly connected with the traceability of the decision - both for why some activities were chosen and others were not. However, even if the list of high priority areas were developed in different ways, large similarities can be seen.

Consequently the identification of high priority areas by expert opinion (at large the most often used method for initiating international co-operation up to now) seems to be adequate with respect to selecting RTD issues that are on a high-priority list, but not necessarily the top issues on that list. A more formal and structured ranking process would be needed in order to verify the completeness of the ranking, even if the original activity list, as has been the case in the NET.EXCEL project, has a low and uneven level of details.

7.2 Procedures that might enhance the future systematic co-operation

Such a systematic process, which would aim at resulting in a substantially higher level of co-ordinated RTD in Europe or internationally in the future should preferably have components that are capable of addressing the following questions

The procedure or methodology is:

- able to show that no major areas of higher interest has been missed
- able to define projects in such a way that the merged activities
  - support each other,
  - provide a forum for discussions among the engaged persons on methods, work and interpretation, and
  - give a possibility to an effective co-use of instruments and models.
- able to suggest organisational forms suitable for the added value looked for in the international co-operation.

The deliberations and the results are documented in a traceable way and enable the revisiting of areas without having to redo the work.

The network or group carrying out the work provides a link between the interests of

- the established implementing organisations as well as newly constituted organisations or programmes,
- organisations like the European Commission supporting research, and
- the existing high competence centres in the world.

Assuming that the exploration of possibilities for an enhanced RTD co-ordination is of interest for the participating organisations, the following staged approach for identifying RTD activities, ranking them and defining projects for co-operation is based on the experience gathered in the NET.EXCEL project.

1) The starting point can be a list like the “100-list” that can be compiled from national programmes or needs. This can successively be updated and augmented by ideas from the scientific community, regulators/overseers etc. and expanded to nearby areas as appropriate. At this stage the level of details in the input does not have to be very high.

2) The ideas/activities are categorised with regard to different “thematic areas” and different objectives or added value sought for, and are evaluated by the participants with regard to their interest to participate.

3) For areas that have many suggested activities and also are of high joint interest, groups of specialists are formed to discuss the suggested activities, define them further and merge them into appropriate projects with regard to the needed competence or equipment and the possibilities for spin-off. In this job decision-aiding methods like multiple attribute analysis or expert opinion elicitation could be used for larger areas or in complicated cases. The same specialist groups should also recommend the competence centres that are available to carry out the project.

4) Normal negotiations and adjustments will precede the appointment of lead, definition of scope, financing and contracting. An appropriate organisational structure will be selected for the work.

5) In specific areas, where many activities will be going on over long times, the same specialist groups could be made semi-permanent to review the results for further guidance, revise the mandates or take new initiatives. Such types of co-ordinating groups already exist in international co-operation for safety and performance related activities and within the biosphere area.

The NET.EXCEL experience indicates that the early intentions to try to make the ranking, the grouping of the RTD activities into suitable projects, and detailing the projects were too optimistic. And the option to remedy the lack of definition by develop a very detailed starting list would require much work that would need the specialist input anyway. By the above procedure a reasonable focusing and area-based ranking could be done without too many demands on a detailed definition of the national inputs, and the national specialists could discuss what aspects should be detailed.

The mechanisms used by the participants to identify national RTD activities and evaluate their priorities could be used also for potential co-operative efforts. The added value of doing different types of activities jointly could be further developed by addressing preservation and availability of information, and by discussing also means of fulfilling requirements from quality assurance and quality control.

The establishment of a recommended procedure should not be used to hinder the use of less formal methods in cases when the selections are simple and straightforward. There are further aspects on this procedure that are strongly affected by a possible enlargement of the participating group, by possible extension of the subject areas covered, the umbrella such a group would work under, and the level of formality required to be achieved.

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