Summaries awarded research proposals

OPERA-Second call

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Contents

Introduction

In July 2011, OPERA started with a public invitation for submission of research proposals for tasks selected from the OPERA Research Plan. In this document, the research summaries of the awarded research proposals in the Second Call from the respective organisations and contact persons are listed.

Work package 1

In work package 1, Safety case context, six tasks are defined. In this work package, the principles and boundary conditions for the safety case are determined. In the second call, a research proposal for one task could be submitted.

Title of Proposal : Retrievability and staged closure (RESTAC)

- *Consortium Leader:*
  Energy Research Centre of the Netherlands (Hamid Mozzafarian)
- *Consortium Member 1: Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Adriaan Slob)*
- *Consortium Member 2: Nuclear Research and consultancy Group (Thomas Schröder)*
- *Subcontractors: StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Jantine Schröder) and Universiteit Antwerpen (Anne Bergmans)*
  In order to minimize administrative burden, SCK CEN and UA have been conceived as sub-contractors for accounting objectives.

Task 1.2.3 Retrievability and staged closure

Research summary

The retrievability of radioactive waste is an integral part of the Dutch policy on radioactive waste management since 1993. Whereas the objective of retrievability has been discussed and worked out in more detail by other countries, currently in the Netherlands no explicit legislation, guidelines or technical/strategical visions with regard to the exact technical content of the term 'retrievability' are developed. The *RESTAC* project covers Task 1.2.3, '*Retrievability and staged closure*' as defined in the 2nd Call for Work Package 1.2 '*Political requirements and societal expectations*' of the *OPERA Research plan*. In this task, the different facets of 'retrievability' and 'staged closure' will be worked out by a multidisciplinary team in a way that allows to elaborate potentials options and relevant determinants that can be attributed to this topic. Both, technical and socio-political aspects will be addressed, and potentially conflicting views will be analysed and presented. In the contribution of *RESTAC* to Task 1.2.3, a review of current international concepts on 'retrievability' and 'staged closure' will be performed, and a first outlook will be given on the aspects that may apply to the Dutch national context. Then the role of monitoring in the staged closure will be elaborated in more detail. The use of monitoring result in decision making faces several questions that need to be addressed to be able to keep future options for retrieval of the waste open and to define a robust disposal process at the same time. Recent experiences being acquired in analogue processes in the area of CO_2 storage will contribute to the definition of set-up of monitoring activity. In the next step, based on the achieved results a first initial definition and analysis of a staged closure process that may potentially be applied in the Netherlands will be elaborated, and relevant options and determinants will be discussed. Long-term scenarios and decision/societal development pathways developed within the *ENGAGED* project will be integrated. Different options of reversibility, retrievability, staged closure, and the role of monitoring will be analysed in each scenario, and important decisions for these options will be identified. Specific recommendations will be developed from this analysis about the mechanisms (regulatory, economical, participative) to accompany the technological options. The outcome of the study will be discussed with a stakeholder community developed within this project, in close cooperation with the *ENGAGED* project. Finally, an outline for a potential implementation of a disposal process that allows the retrieval of waste during operational, pre- and post-closure phase will be designed. The outline will address all stages, the decision (and their underlying evidence) involved, the role of monitoring, will elaborate the role of stakeholders in the different steps, and will contain recommendations for the institutional control of the prolonged retrievability of the waste, consistent with Dutch policy.

Work package 2

In work package 2, Safety Case, three tasks are defined. This work package constitutes the framework of the research within OPERA. In the second call, a research proposal for one task could be submitted.

Title of Proposal : OPERA Salt Safety Case (OSSC)

- *Consortium Leader: Nuclear Research and consultancy Group (Jaap Hart)*
- *Consortium Member 1:*
  Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Leslie Kramers)
- *Consortium Member 2:*
  Gesellschaft für Anlagen und Reaktorsicherheit mbH (Dirk-Alexander Becker)

Task 2.2.1 Evaluation of current knowledge for building the Safety Case

Research summary

The development of geological disposal facilities for radioactive waste is a complex process that can comprise decades of efforts. At various stages in the lifecycle of such facilities decisions are needed to proceed through the subsequent stages of the disposal process. These decisions are supported by a Safety Case. A Safety Case is a collection of arguments in support of the long-term safety of the repository. A Safety Case comprises the outcomes of a safety assessment and a statement of confidence in these findings. The Safety Case should acknowledge areas of uncertainty and unresolved issues and provide guidance to resolve these issues in future development stages of the repository. The development of the Safety Case methodology is also a powerful tool for structuring and conducting research programmes for the disposal of radioactive waste and this tool will be applied in the present study.

The structure of a generic Safety Case of a disposal facility in Boom Clay in the Netherlands will be developed in the framework of Task 2.1 of the OPERA programme, i.e. the OSCAR project. The OPERA Safety Case (OSC) will be based on the evaluation of the scope, structure and argumentation of existing international Safety Cases, safety reports and license applications, and will identify the best suited elements for the Dutch programme. Although the OPERA research programme is primarily focused on the disposal concept in Boom Clay, part of the management strategy in the Netherlands is also to develop and maintain the knowledge on the disposal of radioactive waste in rock salt.

The OPERA Salt Safety Case (OSSC) project aims 1) to assess the current knowledge base concerning the safety and feasibility of the geologic disposal of radioactive waste in a rock salt formation in the Netherlands, 2) to process the current knowledge according to the methodology of the Safety Case for deep geological disposal, (3) to identify knowledge gaps in the Dutch Salt Safety Case, and (4) to provide recommendations for further development of the Safety Case for rock salt in the Dutch context. International experiences on relevant feasibility studies and the waste disposal in rock salt will be accounted for.

The overview of the state-of-the-art will be compiled on the basis of an analysis of the existing national and international information concerning the disposal of radioactive waste in rock salt. It is recognized that Germany and USA have the most developed programmes on the geological disposal of radioactive waste in rock salt. The necessary information from those countries is brought into the OSSC consortium by the German partner in the project, through the documentation provided by the American partner in the OSCAR project, and through participation in the OECD/NEA hosted Salt Club.

The results of our research will be recorded in two documents, one on the review of the current status of knowledge concerning the Salt Safety Case and another on the evaluation of gaps in the Salt Safety Case which need further development within the Dutch context.

Together these will from the OPERA salt safety case (OSSC) that will be presented to and discussed with the OPERA Safety Case Group.

Work package 4

In work package 4, Geology and geohydrology, four tasks are defined. Possible evolutions of relevant geological and geohydrological properties in the host formation (Boom Clay) and aquifers surrounding the host formation are described. Also geological, geomechanical and geohydrological boundary conditions for the use of Boom Clay for hosting radioactive waste are described. In the second call, research proposals for two tasks, namely 4.1.2 and 4.2.2, could be submitted. Two research proposals have been awarded.

Title of Proposal 1:
Future evolution of the geological and geohydrological properties of the geosphere

- *Consortium Leader:*
  Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Johan ten Veen)
- *Consortium Member 1:*
  StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Mieke De Craen)
- *Consortium Member 2: Nuclear Research and consultancy Group (Thomas Schröder)*

Research summary

Main aim of this research is to describe how geological and geohydrological properties of the geosphere are controlled by earth's processes over a time span of 1 million year, and in particular how this might affect the long-term safety assessment of radioactive waste disposal facilities in the Boom Clay in the Netherlands. This study will focus on the three main driving forces, i.e. tectonics, climate and human activity, and describe their future evolution by assessing the complex interaction of changing conditions and processes that result from them. Key in this assessment is the question whether or not these changing conditions and processes are relevant with respect to the Boom clay's safety functions 'isolation', 'dilution and dispersion' and 'transport and retention'. The multidisciplinary study proposed here, will evaluate and present well-documented (state-of-the-art), though conceptual, scenarios both through workshops, literature studies and predictive modeling of climatic evolution. This should result in a summary of all possible future scenarios (qualitative) with clear indication of possible ranges (semi-quantitative) that should serve as the basis for defining boundary conditions for geohydrological modeling exercises and test-scenarios for radioactive waste storage.

Title of Proposal 2: Definition of the boundary conditions for the near-field model

- *Consortium Leader:*
  Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Erik Simmelink)
- *Consortium Member 1:*
  StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Mieke De Craen)
- *Consortium Member 2: Deltares (Johan Valstar)*
- *Consortium Member 3: Nuclear Research and consultancy Group (Jacques Grupa)*

Research summary

There is not much knowledge on the distribution of geohydrological properties and geohydrological behaviour in and above the Boom Clay in the Netherlands. Based on the (hydro) geological characterization of the Boom Clay at present (task 4.1.1) and in future geological evolution scenarios for the next 1 Myrs (task 4.1.2) this research will conceptualize the regional geohydrological flow conditions at present day and for the future scenario's at large scale (supra-regional), taking into account the state of the art knowledge on large scale groundwater flow on different spatial and geological time scales. Subsequently, these scenarios will be translated into regional scale conceptual models for selected areas in the Netherlands. The scenario concepts will be modelled using basin modelling techniques at regional scale, telescoping towards more local scale. The results will provide quantified altered properties and boundary conditions, necessary to assess the role of advective transport processes and their possible ranges, that will be used in the subsequent test scenarios for radioactive waste storage within this Programme.

Work package 5

In work package 5, Geochemistry and geomechanics, eight tasks are defined. All aspects related to the natural evolution of the host rock Boom Clay and potential interactions of this host rock with the materials introduced to it are investigated. In the second call, research proposals for seven tasks could be submitted. Five research proposal have been awarded.

Title of Proposal 1 for task 5.1.1: HLW waste matrix corrosion processes

- *Consortium Leader: Innovatief met Bouwmaterialen en Reststoffen (Robert Wiegers)*
- *Consortium Member: Brenk Systemplanung GmbH (Guido Deissmann)*

Research summary

The required long-term isolation of radioactive wastes from the biosphere can be achieved by a multiple barrier system, consisting of a combination of a man-made engineered barrier system (EBS) with a suitable geological barrier, the repository host rock. The first barrier against the release of safety-relevant radionuclides from the disposed high-level radioactive wastes (HLW) is the waste matrix (waste form), which should exhibit sufficiently low radionuclide release rates over time. The understanding of the corrosion behaviour of and the consequent radionuclide release from the disposed HLW forms thus an integral part of a safety assessment for a geological repository.

The aim of this project task is to provide a coherent picture of the corrosion of and the radionuclide release from vitrified HLW and spent fuel from research reactors in a generic repository in Boom Clay in the Netherlands. Based on existing data and information obtained from the literature, and underpinned by geochemical modelling, relevant corrosion processes under the expected conditions in the repository will be investigated to increase the understanding of waste form evolution (i.e. leaching and dissolution behaviour) with time. In addition the subsequent fate of leached radionuclides in the immediate near field, such as radionuclide retardation, for example, by incorporation in alteration phases, sorption on or incorporation into cement minerals or cement degradation products, and/or sorption to steel container corrosion products will be addressed. The results of the project will comprise data and ranges for corrosion rates of vitrified HLW and spent research reactor fuels under repository conditions and the associated release rates of safety relevant radionuclides that can be used in performance assessments for a geological repository in the Netherlands.

Title of Proposal 2 for task 5.1.2: LILW degradation processes and products
- *Consortium Leader: Innovatief met Bouwmaterialen en Reststoffen (Robert Wiegers)*
- *Consortium Member: Brenk Systemplanung GmbH (André Filby)*

Research summary
The required long-term isolation of radioactive waste from the biosphere can be achieved by a multiple barrier system, consisting of a combination of a man-made engineered barrier system (EBS) with a suitable geological barrier, the repository host rock.

The proposed research deals with the degradation processes and products of low-intermediate level waste (LILW) in a potential Dutch nuclear waste repository situated several hundred meters below the sea level in the geological host rock formation Boom Clay. Besides the LILW, also large amounts of non-radioactive materials are introduced into the host rock (e.g. cement, container, shielding, air). For the estimation of the influence on the host rock structure and engineered barrier system (EBS), it is important that the chemical and physical interactions between the waste components and their degradation products, respectively, with the EBS/host rock (and also their degradation products) are known. This information will then be used to perform a safety assessment for the LILW. Task 5.1.2 interacts closely with Task 1.1.1 (Definition of radionuclide inventory and matrix composition) since the knowledge about the waste matrix composition is paramount for further research about its degradation. Generally, various physical and chemical processes will take place in a nuclear waste repository (e.g. material corrosion/degradation, gas generation, leaching and migration of radionuclides). Focus of the proposed research is to identify these processes and to quantify possible safety-relevant parameters. The possible interaction of LILW degradation products with the host rock and elements of the EBS will be analysed.

Title of Proposal 3:
Geochemical Performance of the EBS: Translation and Orientation of Existing Knowledge towards the Boom Clay in the Netherlands (GePeTO)
- *Project Leader:*
- *StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Frank Druyts)*

Task 5.1.3 Metal corrosion processes
Task 5.1.4 Cementitious material degradation
Task 5.1.5 Microbiological effects on the EBS and Boom Clay

Research summary
WP5.1 will focus on the (long-term) degradation and corrosion of materials present in the waste packages and the EBS. The Supercontainer design has been perceived to offer a high pH environment to the overpack in which the carbon steel containers will be passivated and corrode at a very slow rate. Under these conditions, the overpack lifetime may largely exceed the thermal phase and this could have an impact on the degradation of the waste components, e.g. spent fuel. The purpose of the SCK•CEN proposal is to assess the degradation/corrosion rate of the different components of the EBS (overpack and cement) and to investigate possible interactions between the different components, as well as interactions with the microbial community. The SCK•CEN team offers the advantage of having a large experience and database on EBS component degradation and close collaboration between the different members of the research team. Since we have been working as a team on R&D studies on the long-term behaviour of EBS components in the framework of the Belgian Supercontainer design since 2006, we can offer state-of-the-art knowledge on this topic, by transferring our current database to the OPERA design.

Title of Proposal 4: CorDegChem – Geochemical interactions in Boom Clay

- *Consortium Leader: Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Jasper Griffioen)*
- *Consortium Member: Nuclear Research and consultancy Group (Hans Meeussen)*
- *Subcontractor: Bureau de Recherches Géologiques et Minières (C. Tournassat)*
  In order to minimize administrative burden, BRGM has been conceived as sub-contractor for accounting objectives.

Task 5.2.2 Geochemical interactions in Boom Clay

Research summary

Insight into the geochemical behaviour of the Boom Clay is needed to evaluate its short- and long-term integrity in case of the presence of a radioactive waste disposal. Besides radioactive waste and its matrix and packaging, such a repository consists of elements of engineered barrier system (EBS), made from cement and steel. Heat generation, gas generation and transport of (bio)geochemical reaction products could alter the geochemical properties of the Boom Clay and thereby potentially induce mineral dissolution and precipitation reactions. One well known effect is the appearance of an alkaline plume as result of cement degradation. Although limited in its extent, the effects of such reaction products need to be assessed. In order to evaluate the effects of the OPERA reference concept on the short- and long-term integrity of the Boom Clay, an integrated approach will be followed, based on geochemical and geophysical model calculations

Our modelling approach consists of: 1) defining the corrosion and degradation products out of the EBS, in line with the outcomes of WP5.1; 2) defining the autonomous evolution of the Boom Clay at geological time scale, considering the outcomes of WP4 and the uncertainties in system parameters as well as hydrogeological scenarios; 3) defining a conceptual geochemical model integrating 1) and 2); 4) quantitative prognosis modelling considering the above two aspects as well as the uncertainties in the leachate behaviour of the EBS; 5) relevance of geochemical alteration of Boom Clay for the Safety Case. Geochemical and reactive transport modelling of the near-EBS and host rock scale fluid-rock interactions will be carried out. The results of this project will consist of geochemical predictions of the short- and long-term response of the Boom Clay mineralogy to potential changing fluid composition and heat generation, where the short-term retrievability (100 yrs) will be one topic to be considered. Changing geochemistry could lead to changes in porosity and permeability, which will influence the transport and geomechanical properties of the host rock. Collaboration with task 5.2.3 (geomechanical properties) will be carried out. Discussion with an international expert from France is proposed.

Title of Proposal 5: Geomechanical properties of Boom Clay

- *Project Leader: British Geological Survey (Richard Shaw)*
- *Subcontractor:*
  StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Geert Volckaert)
  In order to minimize administrative burden, SCK CEN has been conceived as sub-contractor for accounting objectives.

Task 5.2.3 Geomechnical properties and thermo-hydromechanical evolution of Boom Clay

Research summary

The disposal of radioactive waste by means of deep geological disposal will result in a change in the Boom Clay. These changes will be in the form of stress changes, temperature, compaction etc and will result in a change in the geomechanical response of the rock-mass. A central component of a safety case is an understanding of the way the rock-mass will deform and the effect construction of an underground repository will have on material behaviour.

The Boom Clay in the Netherlands is a plastic clay that lends itself well to description in terms of critical state soil mechanics (CSSM). We propose a combined desk study and laboratory based experimental programme designed to describe the geomechanical properties of Boom Clay at depth, in terms of the CSSM framework. This information will then be used to undertake scenario analysis to assess the likely behaviour of the Boom Clay during the repository life-cycle. Given the limitation in budget, it is proposed to perform these key experiments under isothermal conditions. If pre-existing data from analogous material describing the likely thermo-mechanical coupling is identified during the literature study, this will be incorporated into the scenario analysis.

Work package 6

In work package 6, Migration of radionuclides, nine tasks are defined. Relevant processes with which the migration of radionuclides can be described from the host formation (Boom Clay) to the geosphere (containing aquifers) and reaching the biosphere via the geosphere are investigated in this work package. In the second call, research proposals for eight tasks, could be submitted. Three research proposals have been awarded. The proposed work for one task, namely 6.1.3, has been awarded for a research proposal containing also proposed work for work package 7.

Title of Proposal 1: Radionuclide migration (RANMIG)

- *Consortium Leader: Nuclear Research and consultancy Group (Thomas Schröder)*
- *Consortium Member 1:*
  StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Norbert Maes)
- *Consortium Member 2:*
  Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Laura Wasch)

Task 6.1.2 Modelling approach for sorption processes
Task 6.1.3 Modelling approach for diffusion processes
Task 6.1.4 Mobility and presence of colloidal particles
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Research summary

For the long-term safety of the OPERA reference concept for radioactive waste in Boom Clay, the migration behaviour of radionuclides in the host rock is the most relevant safety function. To be able to extrapolate experimental data on migration to long time scales and larger spatial scales, it is essential to understand the processes that affect the migration of radionuclides through the Boom Clay. Because the mobility of radionuclides is highly variable and depends strongly on local conditions, it is essential to develop a generic model approach for radionuclide migration that allows to translate empirical, localized data to the conditions that may be present in a future Dutch repository. The major challenge of the RANMIG project is to develop an approach that allows to incorporate current state-of-the-art in process understanding into a generic framework that can be used to calculate the behaviour of radionuclides in Boom Clay on a macroscopic level. The methodology that is followed within the RANMIG project aims to analyse the physical-chemical mobility of radionuclides by assessing the role of underlying fundamental processes, giving most emphasis to the nuclides that are known to be relevant for the long-term safety. However, because the delivery of the necessary input for OPERA WP7 has high priority, a well-balanced approach is followed, which is based on existing data, modelling studies and - if necessary - additional experiments that allow to support the proposed modelling approach and parameter reference values that are one of the main outcomes of this project.

In Task 6.1.2, the sorption behaviour of radionuclides will be evaluated, based on literature data and the outcomes of Task 6.1.1. In Task 6.1.3, the role of diffusion in the complex, heterogeneous Boom Clay will be analysed on two different manners in order to address the specific features on different scales. Task 6.1.4 will address the potential role of colloids for migration, by merging experimental results with sensitivity exercises, strongly reflecting the outcomes of the previous tasks. As overall outcome, RANMIG will deliver reference databases on nuclide migration properties, and a modelling approach that allows the integration in PA (WP7).

Title of Proposal 2: Critical evaluation of transport properties of Boom Clay and EBS material
- *Project Leader: British Geological Survey (Richard Shaw)*

Task 6.1.5: Non-diffusion related transport processes of solutes in Boom Clay
Task 6.1.6: Gas migration in the EBS and in Boom Clay

Research summary

The disposal of radioactive waste by means of deep geological disposal will result in a change in the THMC properties of Boom Clay. These changes will result in the alteration of stress, porewater pressure profiles, temperature gradients, compaction states etc. As a result, non-diffusive transport may be enhanced or induced within the Boom Clay. For example, changes in temperature and temperature gradient can result in multiple interactions such as thermo-osmosis, thermally induced pore-pressures and thermo-mechanical behaviour. Understanding the evolution of the repository system is further complicated by the complex processes such as the generation of gas, its dispersal within the Boom Clay and the potential generation of over-pressures. The movement of water and gas through Boom Clay is a highly coupled flow phenomena and is dictated by the interplay of stress, temperature, chemistry and potentially biology.
In this research proposal we will critically evaluate the non-diffusive related transport processes in Boom Clay. Additionally, critical evaluation of gas transport in the Boom Clay and Engineered Barrier System will take place, with targeted experiments designed to answer fundamental questions on the underlying physics governing gas movement in clay-rich systems.

Title of proposal 3: Radionculide migration the surrounding rock formations (RAMROCK)
- *Consortium Leader: Deltares (Johan Valstar)*
- *Consortium Member: Nuclear Research and consultancy Group (Thomas Schröder)*

Task 6.2.1 Modelling approach for hydraulic transport processes
Task 6.2.2 Modelling approach for radionuclide migration

Research summary
The research objective of RAMROCK is twofold. The first goal is the formulation of a model approach that can be used for the calculation of the groundwater transport of radionuclides, from the host formation (Boom Clay) to the biosphere. Here, it is important to keep in mind that the radionuclides interacting least with the sediments are the most mobile and are therefore of most interest in terms of risk. The second objective of RAMROCK is to generate information that can be used for the definition of the geohydrological boundary conditions for the near-field model in Task 4.2.1.
In Task 6.2.1, 1D stream tube (or flow path) models are derived from the National Hydrological Model Instrument (NHI), the state-of-the-art groundwater flow model of the Netherlands. The evolution of the geosphere, as described in Task 6.2.1, will be incorporated into the NHI. Additionally, the model parameters of the NHI will be varied, to take into account the effect of their uncertainty on the 1D stream tube models. Via a statistical analysis on all 1D stream tube models obtained, one or more representative, stochastic 1D flow models will be formulated, which will serve as hydrological basis for the calculation of reactive transport of radionuclides in Task 6.2.2 and WP 7.2.
In Task 6.2.2, a model description will be formulated for the reactive transport of radionuclides through the geosphere, that can be used in the PA model. Both a detailed, state-of-the-art model description will be formulated for the reactive transport, as well as an alternative approach in which the reactive behaviour of the radionuclides is reduced to a simple effective retardation. The performance and uncertainties of both approaches will be compared. The geochemical parameterisation of the transport models will be performed via a statistical characterisation of the geological formations, from national geochemical basis. This involves a translation of properties from well-studied geological units to units of which fewer analyses are available. A sensitivity analysis will be performed on the detailed transport model, to determine which processes should be incorporated into the PA model (to be developed in WP 7) and which processes could be neglected.

Work package 7

In work package 7, Scenario development and Performance Assessment, ten tasks are defined. All methods and instruments that are required for the safety assessments in the Safety Case are defined, developed and documented. For these safety assessments, scenarios need to be identified and represented. In the second call, research proposals for four tasks could be submitted. One research proposal has been awarded.

Title of Proposal: OPERA Performance Assessment Project (OPAP-II)

- *Consortium Leader: Nuclear Research and consultancy Group (Jacques Grupa)*
- *Consortium Member 1:*
  Nederlandse organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Ton Wildenborg)
- *Consortium Member 2:*
  Gesellschaft für Anlagen und Reaktorsicherheit mbH (Dirk-Alexander Becker)
- *Consortium Member 3:*
  StudieCentrum voor Kernenergie Centre d'étude de l'énergie nucléaire (Eef Weetjens)

Task 6.3.1	*Modelling approach for transport & uptake processes*
Task 7.2.2	*PA model for radionuclide migration in the rock formation surrounding the host rock*
Task 7.2.3	*PA model for radionuclide migration and uptake in the biosphere*
Task 7.2.4	*Integrated model for safety assessment*
Task 7.2.5	*Parameterization of PA models*

Research summary

The present research project aims to develop a calculational framework for the transport of radionuclides from a deep geological repository for the final disposal of radioactive waste through the rock formation surrounding the near field of the repository and to the biosphere, as well as the subsequent uptake by the living environment. The proposed project, Opera Performance Assessment Project II, is the follow-up of the OPERA OPAP-I project, and is a cooperation of the organisations which are also involved in OPAP-I.

In OPAP-II, the computer program ORCHESTRA will be used as the tool to build the modelling framework and to perform the radionuclide transport calculations. The open structure of the ORCHESTRA framework, in which all model equations for chemical, physical and user defined processes are given as (object oriented) input, is suitable for incorporating detailed process models (see our proposal for WP 5 and WP 6) as well as building a large scale integrating PA model (for WP 7). In our proposal for WP7, ORCHESTRA enables (1) to define different compartments and interactions and mass transport processes between these compartments, and (2) to couple the dedicated compartments resulting in an integrated model to perform safety assessment calculations.

As part of the presently defined Tasks 7.2.2 and 7.2.3 the PA compartment models will be developed which define dedicated calculation models for nuclide migration through the aquifers in the rock formations surrounding the host rock, the transport path to the biosphere, and the PA compartment model for the biosphere.

In Task 7.2.4 the PA compartment models will be coupled in ORCHESTRA to obtain the PA integrated modelling environment. The coupling includes the data transport from one compartment model to the next. In addition, output will be defined for each of the relevant safety and performance indicators which will be calculated as part of OPERA OPAP-I Task 7.3.3.

The scenarios which will be defined in OPERA OPAP-I Task 7.1.2, will be translated into parameterized model representations for the integrated modelling environment as part of the presently defined Task 7.2.5.

In Task 6.3.1, which is also part of our OPAP-II proposal, a conceptual generic migration and uptake model for radionuclides that enter the biosphere will be established. The model intends to describe all features which are considered relevant for the transport to the biosphere and the subsequent intake in the living environment. Relevant pathways resulting in human exposures will be evaluated, and the uncertainties with regard to the future evolution will be discussed.

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