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The following summaries are provided as fulfillment of milestone M4FT-13SN0811031 and represent international collaboration activities in disposal research funded by the US DOE Used Fuel Disposition (UFD) Campaign during Fiscal Year 2013.

*UFD funded international interactions in the Czech Republic*

**Deep Borehole Disposal (DBD):**

A scientific visit on Crystalline Rock Repository Development was held in the Czech Republic on September 24-27, 2012. The proceedings were documented in FY13 and can be found at <http://energy.sandia.gov/?page_id=12406> The visit was hosted by the Czech Radioactive Waste Repository Authority (RAWRA), co-hosted by Sandia National Laboratories (SNL), and supported by the International Atomic Energy Agency (IAEA). The purpose of the visit was to promote technical information exchange between participants from countries engaged in the investigation and exploration of crystalline rock for the eventual construction of nuclear waste repositories. The visit was designed especially for participants of countries that have recently commenced (or recommenced) national repository programmes in crystalline host rock formations. Discussion topics included repository programme development, site screening and selection, site characterization, disposal concepts in crystalline host rock, regulatory frameworks, and safety assessment methodology. Interest was surveyed in establishing a “club,” the mission of which would be to identify and address the various technical challenges that confront the disposal of radioactive waste in crystalline rock environments.

Paul Mariner (SNL) conducts regular correspondence with Tomáš Pačes of the CZ Geological Services. He is a proponent of DBD. Jan Švancara, a professor at the Masaryk University in Brno has teamed with Tomáš and they are planning to write proposals to secure funding to study various aspects of DBD in CZ. Bill Arnold (SNL) and Paul Mariner have gathered data and performed some quick calculations to provide a ballpark idea of how many boreholes would be needed for the CZ inventory. Here is what Bill reported to Tomáš:

“I took a closer look at the question of how many boreholes would be required for the Czech waste and made some rough estimates.

I evaluated two cases: (1) with rod consolidation, and (2) disposal of intact fuel assemblies.

There are a number of assumptions and approximations associated with my estimates, starting with the inventory.  I used the numbers from the slide you sent, Paul, for spent fuel from the two existing power plants operating for 40 years.  That inventory is 1940 tons from the VVER-440 reactors at Dukovany and 1790 tons from the VVER-1000 reactors at Temelin, for a total of 3730 tons.  I am assuming that these values are mass of uranium.

I assumed a DBD system from the reference design of Arnold et al. (2011), with 2,000 m disposal zone, 5 m canisters [400 canisters per borehole], and 600 kg U/canister for the consolidated fuel rods.  The VVER fuel rods are smaller diameter than the U.S. PWR fuel rods, so a somewhat greater mass might fit in each canister.

Here are the results:

* Case 1: 6,220 canisters, 16 boreholes [3730t/0.6t/400]
* Case 2: 20,282 canisters, 51 boreholes [1940t/0.12t/400 + 1790t/0.435t/400]

The very large difference in the number of required boreholes for Case 2 is due primarily to the smaller diameter of the VVER-440 fuel assemblies.  Each VVER-440 fuel assembly contains only 120 kg U, versus 435 kg U for the VVER-1000, (versus 600 kg U for consolidated fuel rods).  I could not easily find the diameter of the VVER-440 fuel assemblies, but I think it would easily fit in our reference design canister or smaller canister, based on the significantly smaller number of fuel rods in each assembly.  In fact, DBD of intact VVER-440 fuel assemblies might be possible in a smaller diameter borehole than our 17 inch reference design.  On the other hand, the VVER-1000 fuel assemblies would require an internal diameter for the canister that is about 2.6 inches larger than our reference design and would probably require a 20 inch borehole for disposal of intact fuel assemblies.

Paul Mariner is also working with Tomáš to secure funding from a US-CZ program, the KONTAKT-II program. Sandia's role would primarily be as an advisor on technical aspects of DBD. Sandia would need its own funding. The proposal deadline is Sept 6, 2013. Tomáš. would lead the proposal and Sandia would seek DOE’s approval for collaboration on the project. The first draft of the proposal from Tomáš is expected by the third week in August, 2013.

*UFD funded international interactions in Germany*

Sandia is a contributing partner to the U.S./German joint effort entitled “Comparison of current constitutive models and simulation procedures on the basis of model calculations of the thermo-mechanical behavior and healing of rock salt”. In FY13, SNL continued with the evaluation of modeling capabilities, constitutive models, and validation against benchmark tests initiated in FY12. A report on the collaborative benchmark studies will be issued at the end of FY13.

Also in FY13, SNL obtained core from WIPP to support collaboration with the Germans. The Germans have proposed to extend their current joint project to include benchmark calculations against Room B&D experiments, which were conducted in the north experimental area. They would like to run additional tests on bedded salt to characterize temperature dependence, dilatancy and damage evolution. This work will add to our understanding of generic salt phenomenology across the range of salt types and characteristics—hence will reduce uncertainty while adding to salt database.

A tentative matrix comprises well over 100 tests, which would be conducted at no expense to the US salt programs. Sandia acquired the core from the WIPP site in FY13, ensured its QA pedigree, and shipped it to Germany.

*UFD funded international interactions in Japan*

**Japan Atomic Energy Agency (JAEA):**

A new international collaboration is being developed with Japan Atomic Energy Agency (JAEA) regarding the disposal performance of used fuel. The Performance Assessment Research Group within the Geological Isolation Research and Development Directorate of the JAEA is beginning a mulit-year plan to develop models for used fuel degradation performance and execute experimental work to further the technical basis for the fundamental understanding of these processes and to improve the technical bases of the performance assessments. Given the parallels to the work covering used fuel degradation within the UFDC, scope and schedule of collaboration is being developed currently. In general the UFDC would supply reports on the modeling advances made within this program relevant to that described in the JAEA program to both accelerate the modeling program and facilitate planning experimental work. In return, the JAEA program would provide UFDC access to help define experimental conditions and early access to results of the JAEA experimental program on used fuel degradation.

*UFD funded international interactions in the Republic of Korea*

**Deep Borehole Disposal (DBD):**

The Korea Atomic Energy Research Institute (KAERI) has initiated a program to evaluate the potential implementation of deep borehole disposal of used nuclear fuel or high-level radioactive waste in South Korea. KAERI initiated contact with UFD campaign staff on the topic of deep borehole disposal, based on publications and reports produced by Sandia National Laboratories and the UFD deep borehole project. After an initial teleconference between KAERI and DOE in May, 2013 to discuss potential collaboration, Bill Arnold traveled to the KAERI offices in Daejeon, South Korea in July, 2013 for a series of meetings on the topic of deep borehole disposal. Meetings in South Korea included presentations and discussion of the deep borehole disposal concept, relevant geological conditions in Korea, disposal system design alternatives, numerical modeling of coupled processes, and performance assessment modeling. Bill Arnold also toured the on-site KAERI Underground Research Tunnel (KURT) and discussed potential collaborative experiments, including the potential for drilling a borehole from the surface above the KURT, conducting experiments such as heater tests and borehole seals testing in the borehole, and monitoring the tests from a KURT research alcove. A tour of the Pohan Enhanced Geothermal System (EGS) drill site also occurred, including discussions on potential collaboration on data collected from this borehole. The Pohan EGS borehole is at a depth of 3.5 km in granodiorite and is planned to be completed at a depth of 5.0 km. Sampling of deep fluids upon completion of this borehole could provide information on groundwater age and history, which would be of value to both the KAERI and UFD deep borehole disposal projects. Senior staff with the private company NEXGEO, Inc. on the Pohan EGS drilling project agreed to support deep fluid sampling.

Statements by management at KAERI suggest that an ongoing project on deep borehole disposal likely will be implemented following the initial evaluation project. KAERI has particular interest in pursuing research on waste canister design and the engineered barrier system in the deep borehole disposal system, which are topics that complement the UFD project research well. Further evaluation of collaboration on experiments in KURT and fluid sampling in the Pohan EGS borehole will be conducted by UFD staff and pursued, if determined to be worthwhile.

**Korea Atomic Energy Research Underground Research Tunnel (KURT)**

Korea Atomic Energy Research Institute (KAERI) was engaged, on behalf of the Sandia National Laboratories (SNL), to conduct three tasks, which are sharing KURT site characterization data, technique development for in-situ borehole characterization and streaming potential (SP) testing, to support the study of high-level nuclear waste disposal in crystalline geologic media. SNL received the first set of KURT site characterization data, which include fracture and hydrologic data from the deep borehole DB-1 (500m), DB-2 (1,000m), YS-1 (500m) and YS-6 (500m) and hydrochemical data from the deep borehole DB-1 and YS-1 around the KURT (Table 1).

Table 1. Data list for the task of sharing KURT site characterization data

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Data** | **Detail** | **Format** |  |
|  | Background information about KURT | MS Word |  |
| **Geology** | General geology | Geological description | MS Word |  |
| Lineaments (local)  | Orientation, Length | Excel | A1 |
| Topography | Digital elevation map | Cad | A2 |
| Deep borehole dataDB-1 : 500m (length)DB-2 : 1,000m (length)YS-1 : 500m (Core, fracture) onlyYS-6 : 500m | Core data | Core mapping | Cad/PDF | A3 |
| Logging data　 | Image by Acoustic televiewer | PDF and Excel | A4 |
| Image by BIPS | PDF | A4 |
| Geophysical logging data　 | Natural gamma | Excel | A5 |
| Full-wave sonic | Excel | A5 |
| SP  | Excel | A5 |
| Electronic conductivity | Excel | A5 |
| Temp | Excel | A6 |
| Fracture | Deterministic fracture zones  | Orientation, Width, Length | Excel | A7 |
| Background faults/large fractures  | Frequency | Excel | A8 |
| Fracture set | Fracture set | Excel | A9 |
| **Hydrogeology** | Hydrogeological properties | Permeability | K | Excel | A10 |
| T | Excel | A10 |
| Storage | S | Excel | A10 |
| Effective porosity | n | Excel | A10 |
| **Geochemistry** | Geochemical properties.DB-1 : 500mYS-1 : 500m　 | Major ion | Cation, Anion | Excel | A11 |
| Minor ion | trace element | Excel | A11 |
| In-situ data | pH, DO, EC, Temp | Excel | A11 |
| Rock/Fracture minerals | Chemistry, mineralogy | Excel | A12 |

**Joint Fuel Cycle Studies, Fuel Cycle Alternative Working Group (FCAWG)**

**March 10 – 12, 2013:** A meeting of the FCAWG Used Fuel Disposition and Systems Evaluation sub-groups was held in Daejeon, ROK. Discussions between UFD and ROK resulted in recognition that the collaborations are still providing value to both sides. The next FCAWG meetings are tentatively scheduled for late April or early May, 2014 and have been proposed to be held at DOE facilities in Las Vegas, NV.

***Disposition Subgroup meetings:***

***Task #1*** “Evaluation tools for repository decisions” Dr. Yifeng Wang (SNL) presented the most recent results of R&D in this task including the UFD latest strategic directions for the next generation of performance assessment (PA) tools based on High Performance Computing platforms and open source codes. He emphasized the importance of choosing the right PA models for site selection or characterization.

Haeryong Jung (KRMC) presented the ROK discussion. ROK counterparts expressed interest in developing more advanced PA models, similar to the direction being undertaken by UFD at SNL.

***Task #2*** “Engineered and Natural Barrier Systems databases”. Dr. Yifeng Wang (SNL) presented thermodynamic modeling of clay hydration (used in backfill in a granitic repository) and SNL/UFD cement degradation work. UFD Using CANTERA coupled with DAKOTA to extract thermodynamic parameters from experimental measurements was discussed.

Jongtae Jeong (KAERI) presented the KAERI database containing thermodynamic parameters. Approximately 90% of the data is OECD/NEA data with the remaining 10% being data collected and added by KAERI.

***Task #3*** “Spent fuel degradation, long term durability over geologic time” Dr. Yifeng Wang’s (SNL) presentation summarized three areas: (1) process model development, (2) experimental study to support process model development and (3) integration of process model into GPAM for granitic repository environments.

Dong-Hak Kook (KAERI) presented status of the similar work in the ROK. ROK remains interested in the work being done by UFD and provided us with a list of topics they would like to remain notified of as the UFD continues this work:

* + Durability and stability of waste form (UO2) influenced by cladding failure
	+ Validation of fission gas release models under repository conditions
	+ Long-term dissolution of waste form and development of dissolution models
	+ Estimation of waste form degradation under granite repository conditions

***Task #4*** “Dry storage material degradation and stress corrosion testing” Brady Hanson (PNNL) presented the most recent results of R&D in this task. Stress corrosion cracking (SCC) for stainless steel (SS) and weld materials was presented. Biggest conclusions thus far are that the higher mass loading of chloride salts, the larger the extent of attack (no surprise

 Sung Soo Kim (KAERI) discussed SCC of austenitic SS. Based on a paper by Angeliue and Was, inter-granular (IG) cracking was accelerated in high purity H2O compared to in Ar. KAERI hypothesized that H2 generation by corrosion is taken up by the SS and accelerates the SCC.

 Metal seal degradation was presented by Wooseok Choi (KAERI). KAERI has designed an experiment to subject metal seal to MgCl2 solutions intermittently to determine the possible effect on corrosion. Hanson asked if the test matrix could be expanded to include boric acid, such as in a PWR spent fuel pool, to look at its effects on metal seal corrosion.

***Task #5*** “Transportability of casks and/or fuel after long term storage” Brady Hanson (PNNL) presented measurement of structural response directly on the fuel assembly and the rods themselves under normal transport mode. Instrumentation INSIDE the package to be installed and compare to finite element models being developed at PNNL, the model intended to be used to predict as long as the model and experimental agree.

 Ki-Seog Seo (KAERI) presented Safety Test of Spent Fuel Transportation. Scale model test completed by mid-2014, license support testing by mid-2016 and prototype testing by 2016.

***Task #6*** “Hydride effects on cladding” was addressed. Brady Hanson (PNNL) addressed concerns including the technical bases to support safe storage, retrieval after extended storage and for transport of high burnup fuel (as well as low burnup fuel) after extended storage. Hanson expressed interest in delayed hydride cracking (DHC) to KAERI…UFD not doing this now, KAERI is. It was agreed to have additional contact between UFD and KAERI to facilitate collaboration on DHC.

 Dr. Dong-Hak Kook (KAERI) presented Hydride Re-orientation Effect Study on Spent Fuel Integrity for Dry Storage. KAERI has been performing crush tests on irradiated grid spacers for the Korean fuel manufacturer, so, unfortunately, the data is proprietary. However, KAERI and UFD will work together to plan additional tests and look for means of collaboration.

***System Evaluation Sub-Group meetings***

Dr. Won Il Ko (KAERI) presented the status of the system analysis of nuclear fuel cycles. The Korean policy for spent fuel management is taking a “wait and see policy” regarding what fuel cycle will ultimately be chosen. A number of different fuel cycles are being evaluated and Nuclear Fuel Cycle System Analysis will become important in informing the decision on which fuel cycle should ultimately be chosen. In particular, by 2020 the JFCS will jointly make a determination about moving forward with pyroprocessing.

Dr. Ko described the system analysis activities that have been completed and are underway in KAERI. These activities include:

* Development of equilibrium and dynamic models
* Development of a methodology for integrated analysis and trade-off analysis with the different evaluation criteria for different fuel cycles
* Estimation of life cycle costs of nuclear fuel cycles
* Analysis of environmental impacts of nuclear fuel cycles
* Identification of evaluation criteria and their indicators using a survey of public opinion
* Development of databases on costs and waste arising for various nuclear fuel cycle options

Dr. W. Mark Nutt (ANL) presented the status of used nuclear fuel management in the U.S., focusing primarily on the *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste* released by the U.S. Department of Energy (DOE) in January 2013. Dr. Nutt pointed out that in regard to the spent nuclear fuel that has already been generated in the U.S., the DOE Strategy states:

*“…approximately 98 percent of the total current inventory of commercial used nuclear fuel by mass can proceed to permanent disposal without the need to ensure post-closure recovery for reuse based on consideration of the viability of economic recovery of nuclear materials, research and development (R&D) needs, time frames in which recycling might be deployed, the wide diversity of types of used nuclear fuel from past operations, and possible uses to support national security interests...”*

In regard to advanced fuel cycles, the DOE strategy states that it

*“…will continue to conduct research on advanced fuel cycles to inform decisions on new technologies that may contribute to meeting the nation’s future energy demands while supporting non-proliferation and used nuclear fuel and high-level radioactive waste management objectives…”*

Thus, the current U.S. policy for spent fuel management is direct disposal of spent fuel, in particular for the existing inventory of spent fuel, with continuing research and development on advanced nuclear fuel cycles.

Dr. Nutt presented the two sets of system analysis activities. The first presentation described the screening and evaluation of fuel cycle options that is being performed by the DOE Fuel Cycle Technology (FCT) Program. This effort involves system analysis activities that are very similar to those being performed by KAERI. However, the objective of the KAERI and FCT efforts are different.

* KAERI’s analyses and evaluations are intended to technically support a future decision regarding the fuel cycle that should be pursued in Korea.
* DOE’s analyses and evaluations are intended to identify promising nuclear fuel cycles in order to focus future research and development activities.

While the objectives of the KAERI and FCT efforts differ, there is commonality in approaches. As an example, Dr. Sung Ki Kim presented KAERI’s approach for choosing evaluation criteria for nuclear fuel cycle system evaluation. KAERI’s approach is different than that used in the U.S. to develop evaluation criteria and associated metrics (or indicators), however the evaluation criteria and metrics ultimately chosen by each are quite similar.

Dr. Nutt also presented the logistic-based system analyses that are being conducted to investigate different strategies for managing spent nuclear fuel in a once through fuel cycle. While focused on the U.S. situation, the results of these analyses could provide valuable information to KAERI’s system analysis efforts, in particular to those scenarios that investigate the direct disposal of spent fuel.

Dr. Hyo Jik Lee presented a status of pryroprocessing Modeling and Simulation Activity at KAERI. Dr. Lee’s work intends to develop a “tiered’ simulation method (unit process, operational, and plant models) to analyze an integrated pyroprocessing plant. As the model evolves (e.g., incorporating data obtained from PRIDE experiments), the information and insights provided by that model will likely be of interest to the system evaluation sub-group and to the JFCS’s E-Chem Recycle Working Group (ERWG). As the KAERI model further improves, it would be beneficial for the ROK to present the work at a future JCFS meeting with both the ERWG and the System Evaluation Sub-Group (SESG). The objective of such a joint meeting would both groups of have a good understanding on the capabilities of the model to determine how it would integrate into the ERWG and SESG.

Regarding future collaboration, the System Analysis sub-group of the Fuel Cycle Alternative Working Group is focused on information exchange. This will be accomplished through working group meetings and by the exchange of completed reports that have been cleared for release to the general public. Dr. Nutt will serve as the contact point for providing relevant FCT program reports to KAERI. Dr. Ko will serve as the point of contact for providing relevant KAERI program reports to the FCT program.

Dr. Nutt provided KAERI with the following reports at this working group meeting:

* Projections of spent fuel and high-level waste inventories (mass, volume, decay heat) for different reprocessing techniques
* Conceptual designs for geologic disposal facilities and associated thermal management analyses
* An initial system analysis of different strategies for managing spent nuclear fuel in the U.S.
* An evaluation of how advanced fuel cycles could affect how uncertainties are treated in a deep geologic disposal facility safety assessment
* The final report of the Blue Ribbon Commission for America’s Nuclear Future
* Three reports on the analysis of public perceptions in the U.S.
* DOE’s *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*
* The DOE Office of Nuclear Energy’s research and development roadmap
* Two papers regarding how advanced nuclear fuel cycles affect the performance of deep geologic disposal facilities.

KAERI is translating the following reports into English and will provide them when complete:

* Reports describing equilibrium and dynamic fuel cycle model development
* Report describing the methodology for integrated and trade-off analyses of fuel cycles using evaluation criteria
* Summary report of preliminary conceptual design for cost estimating of a pyroprocessing facility.

The System Evaluation Sub-Group of the Fuel Cycle Alternative Working Group believes it would be optimal to hold the next working group meeting after the FCT program has completed its screening and evaluation of fuel cycle options. This is scheduled to be completed in early 2014, so a meeting in the spring of 2014 in the U.S. would be optimal.

**July 10 – 11, 2013:** Storage, Transportation and Disposal representatives from the US and ROK met in Washington, DC to discuss the status of current and future collaborations. Storage and transportation representatives from the US and ROK met separately to discuss current and future collaborations.

Haeryong Jung, Principal researcher, KRMC and Kyungsu Kim, Principal Researcher, KAERI, presented the US with a proposal for prioritizing and identifying current and future collaborations. Collaborations are currently being conducted under the authority of the Joint Fuel Cycle Studies, Fuel Cycle Alternative Working Group. Future collaborations are proposed to be conducted under the same authority.

A quick review of the outcomes from the March 2013 FCAWG meetings in Daejeon, ROK was discussed. The proposal from ROK was reviewed by the US and it was determined that the work being proposed is consistent with work already being (or planned to be) conducted by UFDC. Consequently, the remainder of the meeting was devoted to defining the collaborations as specifically and explicitly as possible, including time frames and deliverables (where possible) for the collaborations and identifying specific points of contact in the US and ROK for each of the collaboration areas. The remainder of this document contains the proposed collaborations between the US and ROK (subject to both US and ROK approval).

A follow up meeting proposed for November, 2013 will be used to confirm the collaborations have been approved by both parties and to make any changes to the proposals as is needed.

*UFD funded international research programs activities*

**DECOVALEX**

Yifeng Wang (SNL) and Payton Gardner (SNL) attended a Development of Coupled Models and their Validation against Experiments in Nuclear Waste Isolation (DECOVALEX) meeting in Lepzig, Germany, from Nov. 6-8, 2012. DECOVALEX is one of three international nuclear waste disposal research programs the DOE-NE is currently participating in. The objective of trip was to ensure that the UFD work be approriately represented at the workshop and the future work planned for DECOVALEX collaboration meet the UFD needs. At the workshop, the problem definition, data needs, experimental testing method, modeling approach, and schedule for each of five tasks were discussed in details. These tasks involve a broad specturm of modeling tools and codes of different maturity levels. Payton presented DOE/SNL team’s approach for modelling Task C2, with the following main aspects: A simple groundwater flow problem? the environmental tracer paradigm, environmental tracers – the basics, the contribution (utilizing Sandia’s computing power to simulate the suite of age tracers, the mean age and the age distribution), high resolution modelling of multiple environmental tracers with sample models and results, calibration of flow and transport model against tracer and head data, numerical dispersion experiment, and conclusion. The discussion following the presentation concerned mainly with different tracers with different travel time, discrete fracture network vs. equivalent continuum approaches, matrix diffusion for discrete fracture approaches, and use of lumped parameter approaches. Potential use of Czech Bedrichov Tunnel Test data for model validation was discussed.

Payton Gardner attended DECOVALEX meeting in Jeju Island, Korea, from April 15-19, 2013. Payton presented DOE/SNL team’s progress for modelling Task C2, with the following main aspects: environmental tracers, “Age” of groundwater and distribution, stable isotope data in collection canal discharge (dispersion model, V3 discharge (dispersion model, V3 discharge exponential model), lumped parameter age modelling (binary age mixture, exponential age mixture, dispersive distribution, linear distribution), modelling matrix diffusion using a Random Walk in Time method, effect of matrix diffusion-using Random Walk in Time, including matrix diffusion for fracture flow lumped parameter models, conclusion. Issues raised after the presentation concerned with sampling of tracers, and possible using Tritium as tracer.

**Mt. Terri URL**

The goal of the cement interaction (CI) activity at Mt. Terri underground research laboratory (URL), Switzerland, is to study the interactions of cementitious materials on Opalinus clay. The interactions between cement and clay rock are important to the sealing performance of liners and plugs in the engineered barrier system (EBS).  Moreover, the potential for fluid-cement interactions could result in the formation of alkaline plumes that could enhance transport in the natural barrier domain.  This experiment consists on emplacing concrete composed of ordinary Portland cement (OPC) into two boreholes (see Fig.) It should be noted that other barrier materials such as bentonite clay and other cement types were also emplaced at specific segments of the boreholes.  Upon emplacement, core sampling activities are planned at 2, 4, 8, 16 years to study the evolution on this interactions with time.  The coring is done using high-quality core stabilization techniques to maximize core integrity and sample preservation during recovery.

The current phase of the CI experiment is focused on sample collection and solid phase analysis.  Some of the analytical approaches considered in this phase encompass compositional and structural characterization of secondary phases resulting from clay-cement interactions that include µ-XRD / (µ-XAS) synchrotron methods, XRD, electron microscopy (SEM, TEM, EMPA), and XRF among others.  To complement these material characterization activities, the UFD campaign will conduct small-angle neutron scattering (SANS) analysis of the clay-cement interface in a mixed OPC- opalinus clay sample.  SANS can provide information relevant to the material transport properties such as surface area and pore size distribution which important to the evaluation of reactive transport during seal degradation. SANS is particularly suitable to study materials with very small pores and porosities such as clay and reaction zones that occur at the clay-cement interface. It also has the advantage of performing this analysis at specific locations in actual specimens without destroying the sample.  The comprehensive characterization of these reaction zones is key to the evaluation of sealing performance of excavated disturbed zones in boreholes and tunnels for disposal galleries.  The SANS study will be performed by Dr. Mei Ding at the LANCSE facility in Los Alamos National Laboratory (LANL).  The core sample was provided to Sandia National Laboratories (SNL) and LANL by Dr. Urs Maeder from the University of Bern who also leads the CI experiment.  Another aspect of the CI activity is to collaborate on modeling of the clay-cement interactions including reactive-transport. The modeling aspect of this activity has not begun yet given the focus on sample characterization but some ideas have been discussed in terms of geochemical modeling.  It is anticipated that SNL will engage in the modeling aspects of clay-cement interactions by providing expertise on thermodynamic database development, thermodynamic modeling of complex systems, and reactive transport.

**Fast / Instant Release of Safety Relevant Radionuclides from Spent Nuclear Fuel (*FIRST-Nuclides*)**

Within the used fuel degradation and radionuclide mobilization activities under the Generic Engineered Barrier System evaluations work package, international collaboration with the European Commission 3-year collaborative project (CP) on the Fast / Instant Release of Safety Relevant Radionuclides from Spent Nuclear Fuel (*FIRST-Nuclides*) is in its second year. D. Sassani is representing UFD and DOE NE as an associated group. The *FIRST-Nuclides* proceedings document from the 1st workshop (held in Budapest, Hungary in October 2012) was distributed and contains technical information on sample selection, experimental setup and characterization. Because the 1st workshop (after the Kickoff meeting in February 2012) was held only 10 months into the project, this document contains little to no results from the experimental work at this point. This report provides a comprehensive overview of the work planned and extensive information regarding experimental design and modeling tools being used within this CP, and large amounts of information regarding existing data for Used Fuel, especially at higher burn up values. Materials from the kickoff meeting in Feb 2012 are also provided towards the end of the report, including the materials that were presented on the UFD campaign. We are planning on attending the next (2nd) workshop at the beginning of November as this will contain presentation of initial results of that program.