DISPOSAL-RELATED INTEGRATED SPENT NUCLEAR FUEL REGULATORY ACTIVITIES—IDENTIFICATION AND ANALYSIS OF KEY REGULATORY AND TECHNICAL ISSUES FOR DISPOSAL OF SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE

MID-YEAR SUMMARY REPORT AND TABLE SUMMARY OF DOCUMENTARY DELIVERABLES AND INFORMATION ITEMS FROM FISCAL YEAR 2012 THROUGH 2014

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QUALITY OF DATA, ANALYSES, AND CODE DEVELOPMENT

DATA: No data are contained in this report, which contains only summaries of technical results

ANALYSES AND CODES: No scientific or engineering software was used in the analyses contained in this report.

1 INTRODUCTION

The Center for Nuclear Waste Regulatory Analyses (CNWRA®) continues to provide technical support to the U.S. Nuclear Regulatory Commission (NRC) in the Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities (ISFR) program. This program enhances regulatory efficiency and effectiveness as the agency responds to an evolving national policy on the management and disposal of spent nuclear fuel (SNF) and other high-level radioactive waste. Program activities are conducted as CNWRA charter contract Task Order 9 (Job Code J5662)—titled Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste. The objective of this task order is for CNWRA to provide NRC with technical assistance on the identification and analysis of key regulatory and technical issues associated with a variety of alternatives for managing the back end of the fuel cycle, including ultimate disposal. These activities are needed independent of the direction of national policy, and were designed to support the Agency's mission under a range of policy outcomes—all of which are likely to require geologic disposal as a key component.

During the first half of fiscal year 2015, the NRC/CNWRA team's independent technical investigations focused on selected key technical issues associated with ultimate disposal; development and application of a system-level model of the back end of the fuel cycle (Subtask 6) was placed on hold. These activities were conducted as five subtasks, each focused on analyses of a particular technical topic and each conducted by a team of CNWRA and NRC staff members. Work on these topics builds on previous years' activities regarding risk-significant features and processes and efforts at familiarization with alternative geologic repository host rocks and designs, with a focus on those topics most generally applicable and potentially useful in terms of maintaining and enriching the NRC and CNWRA staffs' skills, knowledge, and technical contributions supporting NRC's regulatory responsibilities.

This mid-year report, organized by subtask, briefly summarizes activities conducted from October 2014 through March 2015. CNWRA activities conducted under the precursor projects in fiscal year 2012 and in the first 2 months of fiscal year 2013 were documented in Pensado (2012) and Pickett (2012), fiscal year 2013 Task Order 9 activities were summarized in Pickett, et al. (2013a), and fiscal year 2014 work was summarized in Pickett, et al. (2014a,b).

This report includes, as an appendix, a listing of CNWRA deliverables prepared under this task order and its precursor projects during fiscal years 2012, 2013, and 2014.

2 TECHNICAL ACTIVITIES

This section provides activity summaries and describes deliverables for the five active subtasks. Starting with the fifth period of this fiscal year, the Program Manager's Periodic Report reported spending for each subtask. Spending rates were highest in Subtasks 1 and 5, but progress was made in all areas. The title and technical focus of Subtask 5 was changed during this reporting period (see Section 2.5). As in previous years, the number of planned deliverables was low in the first half of the year because technical reports documenting subtask results were scheduled for late in the year. This reporting period was marked by the preparation of a number of conference papers and presentations, as well as revision of some fiscal year 2014 reports.

2.1 Continued Participation in DECOVALEX

CNWRA continued supporting NRC participation in the international **DE**velopment of **CO**upled Models and Their **VAL**idation Against **EX**periments (DECOVALEX) program by further

developing in-house modeling tools and expertise. The major CNWRA modeling task involved coupling the thermohydrological code xFlo with the geomechanical code FLAC® to produce the tool to be used in the NRC/CNWRA DECOVALEX task (Task B1). This coupled code will continue to be an important tool for DECOVALEX task activities in future years. CNWRA participated along with NRC staff in the 6th Workshop held in London in November 2014 (Stothoff and Fedors, 2014).

DECOVALEX Task B1 is designed to improve understanding of coupled thermal-hydrological-mechanical (THM) processes in a bentonite buffer and argillaceous host rock at the Mont Terri underground research laboratory in Switzerland. The task is based on three tests: (i) the HE-D heating test at Mont Terri (host rock only), (ii) a laboratory column test on granular bentonite (used as a buffer for the HE-E test), and (iii) the HE-E heating experiment at Mont Terri (integrating buffer materials and host rock). Activities during the first half of the fiscal year mainly focused on (i) completing revisions to the numerical model representing the column test and (ii) developing a numerical model to represent the THM behavior of granular bentonite in the HE-E test. In addition, the team was involved in code development of xFlo and contributed to the NRC/CNWRA Workshop on Buffer Conceptualization for Performance Assessment (a joint activity with Subtask 5; see Section 2.5). Finally, revisions were made in response to NRC comments on earlier reports on HE-D test modeling (Ofoegbu, et al., 2013) and column test modeling (Stothoff, et al., 2014a).

Model refinements for the column test included modifying the constitutive relationship of thermal conductivity and saturation and accounting for temperature effects on the coefficient of thermal expansion. These changes resulted in improved matches with laboratory measurements in the column test.

HE-E test model development involved several steps, including compiling relevant input parameters mainly from information provided by the DECOVALEX program, and relying on previous work and other literature sources (especially for geomechanical properties). The conceptual model for the HE-E test was based on insights gained from the column test such as the role of metallic engineered barrier system components, the importance of vapor movement, and the evolution of air pressure. Initial simulations indicated that the grid refinement was particularly important at the bentonite blocks-granular bentonite and granular bentonite-host rock interfaces.

xFlo code development focused on improving its flexibility in representing constitutive relationships and developing a version compatible with Microsoft® Windows® 7. The current version of the code has numerous hard-coded parameters and constitutive relationships, and it is difficult to extend the models. Efforts focused on improving the input files and program access to constitutive relationship routines. A version of xFlo (originally developed in a Linux® environment) for the Windows operating system was transmitted to NRC as an intermediate milestone (documented in Pickett, 2014). The milestone also contained (i) documentation for installing xFlo in Windows, (ii) descriptions of installation-verification test cases, and (iii) a compressed file containing the source code and input and output files for the installation-verification test cases. Efforts to couple FLAC with xFlo were initiated, using MATLAB® to handle data transfer and simulation sequencing.

Model results will be presented at the 7th DECOVALEX Workshop, April 13–16, 2015, in the Czech Republic. In addition, two papers and corresponding presentations on the DECOVALEX modeling work were prepared in advance of the 2015 International High-Level Radioactive Waste Management Conference (Manepally, et al., 2014, 2015; Stothoff, et al., 2014b, 2015).

At the Workshop on Buffer Conceptualization for Performance Assessment, Subtask 1 team members presented topics related to (i) coupled processes in buffer, (ii) insights gained from recent DECOVALEX modeling efforts, and (iii) recent studies related to performance of buffer in a high temperature regime (~200 °C).

2.2 Analysis of Waste Form

The objective of Task 2 corrosion studies is to determine SIMFUEL dissolution rates under conditions representative of a predominantly reducing environment in a deep underground repository. Experimental studies continued during this fiscal year, involving pure UO_2 as well as two SIMFUEL types (BU35 and BU60) representing two burnup levels. The following experimental conditions are being studied: (i) saturated oxygen, (ii) saturated oxygen and hydrogen, (iii) unsaturated oxygen and hydrogen, and (iv) reduced oxygen and saturated hydrogen. Electrochemical impedance spectroscopy is used to estimate dissolution rates.

During the previous fiscal year, the experimental work suggested that SNF dissolution rates are dependent on both the dissolved oxidizing species concentration and the hydrogen concentration. However, some variability was observed in the data. For example, dissolution rates under the saturated oxygen and hydrogen condition were lower than dissolution rates for the unsaturated oxygen and hydrogen case for BU35. Further, for BU35 and BU60, the measured dissolved oxygen concentration in the test solution did not correlate with the flowrate of the gases being passed through the test solution. This fiscal year, additional tests have been conducted to address the variability observed in the dissolution rate and in the dissolved oxygen concentrations in the test solutions.

Microstructure analyses of the SIMFUEL samples have also been conducted in order to verify the chemical composition and microstructure of the samples that were procured from the Korean Atomic Energy Research Institute (KAERI). The analyses were performed using Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Scanning Electron Microscopy (SEM), and Energy Dispersive X-Ray Spectroscopy (EDX). The data obtained from the ICP-AES analysis showed that the chemical composition of the SIMFUEL samples is consistent with the equivalent burnup spent nuclear fuel. Further, the SEM and EDX data showed that grain and porosity structures are also consistent. In addition, SEM and EDX analyses results showed the presence of ε-particles in the BU35 and BU60 samples. The ε-particles are metal agglomerations that form during the fission process. The microstructure analysis also showed a higher density of ε-particles in the BU60 sample than in the BU35 sample, consistent with the higher concentration of simulated fission products in BU60.

It has been reported in the literature that SNF dissolution may be completely suppressed when the dissolved hydrogen concentration exceeds a certain threshold. The primary source of the dissolved hydrogen is the solution contacting the waste package, but that hydrogen is likely to migrate away from the package under repository conditions. An approach has been developed to estimate dissolved hydrogen concentrations in a deep geological repository system when generated hydrogen migrates away from the fuel surface. The approach will be used to estimate the formation and concentration of dissolved hydrogen under various scenarios.

Other activities during this reporting period included preparation of a paper and accompanying presentation for the 2015 International High-Level Radioactive Waste Management Conference (Shukla and Ahn, 2014, 2015), and participation in the NRC/CNWRA Workshop on Buffer Conceptualization for Performance Assessment. In addition, revisions were underway on a

previous technical report (Shukla, et al., 2014) to respond to NRC comments and update laboratory results.

2.3 Analysis of Waste Package

During this reporting period, some tests continued and new tests were initiated after receiving NRC concurrence on test plans to address some challenging and controversial issues related to copper and carbon steel corrosion. Previous scratch tests of carbon steel in an alkaline environment indicated a strong repassivation tendency. To further understand this tendency under realistic conditions without polarization, tests were initiated at open circuit conditions using different methodologies. Quantifying hydrogen generated from the corrosion process has proven to be very challenging because of the low corrosion rate, limited test duration, complications from the metallic test cell, and incomplete oxygen depletion. To improve the reliability of test results, a control test was conducted in parallel with a copper corrosion confirmation test. Triplicate U-bend specimens were used for carbon steel hydrogen induced cracking tests. All the tests were conducted at elevated temperatures and deaerated conditions to simulate an anoxic environment. Temperatures and oxygen concentration levels were monitored closely to ensure the reliability of the test results. In addition to experimental testing, literature information on corrosion of waste package materials was reviewed to strengthen understanding and corroborate the testing results. Preliminary results obtained on carbon steel and copper were communicated to NRC and summarized in papers for the NACE 2015 conference (He and Ahn, 2015) and the International High-Level Radioactive Waste Management Conference (He, et al., 2014a, 2015). An informal trip report on the NACE conference was prepared for the NRC staff. In addition, during this reporting period a previous intermediate milestone was revised to respond to NRC staff comments and to incorporate more recent results (He, et al., 2014b).

2.4 Analysis of Alternative Geologic Media

Assessment of the thermomechanical behavior of salt host rock in a hypothetical underground nuclear waste repository continued from the previous year. Based on a literature survey of models for simulating the thermomechanical response of intact and crushed salt, the FZK-INE material model was selected to represent the creep behavior of intact salt at the Waste Isolation Pilot Plant (WIPP) Facility, Carlsbad, New Mexico. A process was developed for implementing and testing the stress-strain equations of the FZK-INE material constitutive model in the FLAC computer code for simulating the thermal-mechanical behavior of salt. FLAC was used to simulate triaxial compression and creep laboratory testing performed on WIPP salt host rock. The simulated results were compared with laboratory data obtained from a Sandia National Laboratories test data report. More simulations of laboratory tests will be conducted to establish ranges of values for the parameters defined in FZK-INE model. As a part of this investigation, rock convergence of the Rooms B and D in-situ experiments at WIPP will be modeled and the model results will be compared with actual measurements to improve understanding of parameter significance.

2.5 Buffer and Near Field Performance Assessment

The Scoping of Options and Analyzing Risk (SOAR) code implements a generic model to probabilistically evaluate performance of concepts for geological disposal of high-level waste. Subtask 5 involves buffer and near-field performance assessment using the SOAR code. This fiscal year, SOAR efforts have focused on identifying and addressing key knowledge gaps to

enhance the conceptualization and abstraction of processes associated with the engineered buffer and its interactions with the waste package and host rock.

On February 24, 2015, members of the NRC and CNWRA staffs participated in a technical workshop on buffer conceptualization for performance assessment held at NRC headquarters with a video link to CNWRA. (Completion of the workshop was documented in Pickett, 2015.) The workshop participants included subject matter experts in coupled processes, corrosion, geochemistry, and performance assessment modeling. The goals of the workshop were (i) to assess current understanding of buffer performance in the near field of a geologic disposal facility, and (ii) to develop scenarios and conceptualizations of buffer evolution that may be incorporated into the SOAR code, if considered relevant to repository performance. The workshop devoted more time and effort to facilitated discussions rather than topical presentations; this approach enabled participants to focus on knowledge integration directed at improving abstraction of buffer-related processes in the SOAR code.

The workshop agenda included four presentations and three sequential facilitated discussion sessions. The presentations summarized the current state of knowledge and technical gaps on buffer coupled processes, waste package corrosion, geochemical conditions, and performance assessment modeling. With the goal of defining a nominal or reference scenario to support development of a generic abstraction of buffer performance, the facilitated discussion sessions were framed around a set of preliminary topics developed from a series of prior workshop planning meetings between NRC and CNWRA staff members. These planning meetings resulted in consensus on three basic functions of the buffer: (i) containment of wastes, (ii) retardation of radionuclide releases, and (iii) mechanical stability of tunnels and deposition holes. These functions were reiterated in the presentations and facilitated discussions. During the discussion sessions, the workshop participants identified key buffer processes, defined the main elements of a nominal scenario for performance assessment incorporating an engineered buffer, and identified potential variations of the nominal scenario resulting from high temperatures, disruptive events, and climate change. The workshop concluded by enumerating action items for abstraction of a nominal or reference scenario into the SOAR code and agreement on information needs, residual uncertainties, and concepts that require further understanding.

Preparation began on a workshop report. All presentation slides are archived on the NRC-CNWRA Microsoft® SharePoint® site.

3 SUMMARY AND CONCLUSIONS

Task Order 9 activities during the first half of fiscal year 2015, conducted in close collaboration with NRC staff, continued CNWRA contributions to the understanding of risk-significant processes in geologic disposal of SNF and high-level radioactive waste. Technical work was topically organized around coupled process modeling for DECOVALEX, waste form, waste package, salt host rock, and buffer and near-field performance. The team is well-positioned to achieve project milestones during the remainder of the fiscal year.

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APPENDIX

CNWRA Deliverables, Fiscal Year 2012 Through 2014, Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste

CNWRA Deliverables, Fiscal Year 2012 Through 2014, Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste				
Fiscal Year 2012				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
AI14005.01.001.235	Integrated Modeling of Spent Fuel Management Stages	Pensado, O., S. Mohanty, K. Compton, E.L. Tipton, and R. Nes	2012	Conference abstract
AI14005.02.001.202	Redox Processes in the Safety Case for the Proposed U.S. Repository	Pickett, D., R. Pabalan, and B. Sagar	2012	Conference presentation
AI14005.02.001.203	Corrosion of Borated Stainless Steel in Water and Humid Air	He, X., T. Ahn, and T. Sippel	2012	Conference presentation
AI14005.02.001.204	Corrosion of Titanium Grades 7 and 29 Under Dripping of Seepage Water	He, X.	2012	Conference presentation
AI14005.02.001.203	Corrosion Study of SIMFUEL in Aerated Carbonate Solution Containing Calcium and Silicate	Jung, H., T. Ahn, R. Pabalan, and D. Pickett	2012	Conference abstract
AI14005.02.001.205	Corrosion of SIMFUEL in Carbonate Solution Containing Calcium and Silicon	Jung, H., T. Ahn, R. Pabalan, and D. Pickett	2012	Meeting presentation
AI14005.02.001.205	High Burnup of Spent Nuclear Fuel and Its Implications for Disposal Performance Assessments	Mohanty, S., R. Nes, L. Tipton, and D. Pickett	2012	Conference abstract
AI14005.02.001.207	Modeling Swelling and Swelling Pressure in Expansive Clays	Ofoegbu, G., B. Dasgupta, C. Manepally, H. Basagaoglu, and R. Fedors	2012	Conference abstract
IM14005.01.001.210	Scoping of Options and Analyzing Risk (SOAR) Model Verification Report	Janetzke, R., C. Markley, O. Pensado, K. Compton, G. Adams, R. Nes, and S. Mohanty	2012	Report
IM14005.01.001.215	System-Level Analysis Model	Pickett, D.	2012	Model file and letter documenting completion
IM14005.01.001.220	Workshop on Conceptual Models	Pickett, D.	2012	Letter documenting completion

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Fiscal Year 2012				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
IM14005.01.001.230	Summary of Fiscal Year 2012 Activities: Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—System Analysis of Disposition Options for Spent Nuclear Fuel	Pensado, O.	2012	Report
IM14005.01.001.235	Use of SOAR Code to Develop Insights on Options for Geologic Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste	Osidele, O., O. Pensado, S. Mohanty, C. Markley, and C. Manepally	2012	Report
IM14005.02.001.120	Geologic Disposal of High-Level Radioactive Waste in Salt Formations	Winterle, J., G. Ofoegbu, R. Pabalan, C. Manepally, T. Mintz, E. Pearcy, K. Smart, J. McMurry, R. Pauline, and R. Fedors	2012	Report; extensive revision
IM14005.02.001.201	Numerical Simulations and Analysis of Lava Flow Cooling	Basu, D., K. Das, and S. Self	2012	Report
IM14005.02.001.215	Key Issues Project Plan	Pickett, D.	2011	Planning table; multiple contributors
IM14005.02.001.225	A Review of Sorption Research in Support of Performance Assessment for International High-Level Waste Programs	Bertetti, P., J. Prikryl, J. Myers, and L. Sabido	2012	Report
IM14005.02.001.235	Effect of Bentonite Buffer on Waste Package Corrosion	Pabalan, R., P. Shukla, and K.T. Chiang	2012	Report
IM14005.02.001.240	Evaluation of Salt as a Host Repository Rock Medium Under Thermomechanical Loading—Progress Report	Ghosh, A. and S.M. Hsiung	2012	Report
IM14005.02.001.245	Development of a Coupled Thermohydrological-Mechanical Model	Manepally, C., G. Ofoegbu, H. Basagaoglu, B. Dasgupta, and R. Fedors	2012	Report

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Fiscal Year 2012				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
IM14005.02.001.260	Experiments Investigating Plutonium Sorption onto Steel Corrosion Products: Status Report	Prikryl, J., D. Waiting, and P. Bertetti	2012	Report
IM14005.02.001.265	Summary of Fiscal Year 2012 Activities: Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Key Regulatory and Technical Issues	Pickett, D	2012	Report
IM14005.02.001.270	Waste Form Workshop Report	Jung, H., T. Ahn, J. Myers, E.L. Tipton, S. Mohanty, R. Nes, D. Pickett, O. Pensado, C. Markley, and J. Bradbury	2012	Report
IM14002.02.001.275	Uncertainty and Variability in Modeling Radionuclide Transport: Workshop Summary Report	McMurry, J., J.W. Bradbury, S. Mohanty, and S.A. Stothoff	2012	Report
IM14005.02.001.280	Update on Laboratory Corrosion Experiments—Key Regulatory and Technical Issues Task	He, X. and R. Pabalan	2012	Report
IM14005.02.001.285	Container Corrosion and Chemical Environment Workshop Report	Myers, J., T. Ahn, R. Pabalan, P. Shukla, G. Adams, O. Pensado, X. He, and K. Chiang	2012	
IM14005.02.001.290	Numerical Analysis of Lava Flow Cooling with Different Geometric Configurations	Basu, D., K. Das, and S. Self	2012	Report
IM14005.02.001.299	Buffer Workshop Report	Manepally, C., R. Fedors, G. Ofoegbu, B. Dasgupta, R. Pabalan, J. Bradbury, K. Chiang, and O. Osidele	2012	Report
None	Corrosion of Titanium Grades 7 and 29 under Dripping of Seepage Water	He, X.	2012	Conference paper

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Fiscal Year 2012				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
None	Corrosion of Borated Stainless Steel in Water and Humid Air	He, X., T. Ahn, and T. Sippel	2012	Conference paper
None	Trip Report, DECOVALEX 2015 Kick Off Workshop, Lawrence Berkeley National Laboratory, Berkeley, California, April 17–19, 2012	Manepally, C.	2012	Trip report

CNWRA Deliverables, Fiscal Year 2012 Through 2014, Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste				
Fiscal Year 2013				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
AI14005.02.001.301 AI14005.02.001.303	Corrosion Study of SIMFUEL in Aerated Carbonate Solution Containing Calcium and Silicate	Jung, H., T. Ahn, R. Pabalan, and D. Pickett	2012	Conference presentation and paper
AI14005.02.001.302	High Burnup of Spent Nuclear Fuel and Its Implications for Disposal Performance Assessments	Mohanty, S., R. Nes, L. Tipton, and D. Pickett	2012	Conference presentation
AI14005.02.001.305 AI17860.09.001.302	Modeling Swelling and Swelling Pressure in Expansive Clays	Ofoegbu, G., B. Dasgupta, C. Manepally, H. Basagaoglu, and R. Fedors	2013	Conference paper and presentation
AI17860.09.001.303 AI17860.09.001.301	Integrated Modeling of Spent Nuclear Fuel Management Stages	Pensado, O., S. Mohanty, K. Compton, E.L. Tipton, R. Nes, and P. LaPlante	2013	Conference presentation and paper
AI17860.09.001.304	Trip Report: 3rd DECOVALEX-2015 Workshop, Seogwipo, Jeju Island, Korea	Fedors, R. and G. Ofoegbu	2013	Trip report

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Fiscal Year 2013				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
AI17860.09.001.310	Technical Activities Supporting the U.S. Nuclear Regulatory Commission's Geologic Disposal Program	Pickett, D., C. Manepally, P. Shukla, X. He, A. Ghosh, S. Stothoff, and O. Pensado	2013	Conference abstract
AI17860.09.001.320	Trip Report: 2nd DECOVALEX-2015 Workshop, Leipzig, Germany, November 6–9, 2012	Manepally, C. and R. Fedors	2012	Trip report
IM14005.02.001.240	Progress Report—Evaluation of Salt Under Thermomechanical Loading as a Host Repository Medium	Ghosh, A. and S. Hsiung	2013	Report; extensive revision
IM17860.09.001.305	Summary of Fiscal Year 2013 Activities: Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste	Pickett, D., C. Manepally, O. Pensado, O. Osidele, A. Ghosh, P. Shukla, and X. He	2013	Report
IM17860.09.001.315	Thermal-Hydrological-Mechanical Modeling of a Saturated Clay Shale—Report on HE-D Test Modeling	Ofoegbu, G., B. Dasgupta, C. Manepally, and R. Fedors	2013	Report; revised April 2015
IM17860.09.001.365	Incorporation of Decay Chain Transport in SOAR	Osidele, O. and O. Pensado	2013	Report
IM17860.09.001.370	System-Level Performance Assessment Model Update	Pensado, O., S. Mohanty, L. Tipton, and O. Osidele	2013	Report
IM17860.09.001.380	Numerical Analysis of Lava Cooling with Different Geometric Configurations—Final Report	Basu, D., K. Das, and S. Self	2013	Report

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None	Trip Report: 3rd U.S./German Workshop on Salt Repository Research, Design and Operations, October 9–11, 2012, Sandia National Laboratories. Albuquerque, New Mexico	Ghosh, A. and S. Self	2013	Trip report
None	Trip Report: 2013 International High Level Radioactive Waste Management Conference, Albuquerque, New Mexico, April 28–May 2, 2013	Pickett, D., O. Pensado, G. Ofoegbu, O. Osidele, and T. Ahn	2013	Trip report

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Fiscal Year 2014				
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AI17860.09.001.401 AI17860.09.001.411	Carbon Steel Corrosion in Anoxic Alkaline Water	He, X. and T. Ahn	2014	Conference abstract and paper
AI17860.09.001.401	Technical Activities Supporting the U.S. Nuclear Regulatory Commission's Geologic Disposal Program	Pickett, D., C. Manepally, P. Shukla, X. He, A. Ghosh, S. Stothoff, and O. Pensado	2013	Conference presentation
AI17860.09.001.403	Trip Report: 4th DECOVALEX-2015 Workshop, November 11–15, 2013	Manepally, C. and R. Fedors	2014	Trip report

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Fiscal Year 2014				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
AI17860.09.001.404	Modeling Thermohydrological-Mechanical Behavior of Granular Bentonite	Manepally, C., S. Stothoff, G. Ofoegbu, B. Dasgupta, and R. Fedors	2014	Conference abstract
AI17860.09.001.404	Trip Report: 5th DECOVALEX-2015 Workshop, April 7-11, 2014	Ofoegbu, G. and R. Fedors	2014	Trip report
AI17860.09.001.406	Constitutive Model Development for Thermohydrologic Processes in Swelling Porous Media	Stothoff, S., C. Manepally, R. Fedors, G. Ofoegbu, and B. Dasgupta	2014	Conference abstract
AI17860.09.001.407	Effects of Dissolved Hydrogen on Dissolution Rates of SIMFUEL in Reducing Repositories	Shukla, P. and T. Ahn	2014	Conference abstract
AI17860.09.001.408	Corrosion of Carbon Steel and Copper Waste Containers in Reducing Environment	He, X., J. McMurry, and T. Ahn	2014	Conference abstract
IM17860.09.001.400	Fiscal Year 2014 Mid-Year Summary Report: Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste	Pickett, D., C. Manepally, O. Pensado, P. Shukla, O. Osidele, X. He, and A. Ghosh	2014	Report
IM17860.09.001.405	Summary of Fiscal Year 2014 Activities: Disposal-Related Integrated Spent Nuclear Fuel Regulatory Activities—Identification and Analysis of Key Regulatory and Technical Issues for Disposal of Spent Nuclear Fuel and High-Level Waste	Pickett, D., C. Manepally, O. Pensado, P. Shukla, O. Osidele, X. He, and A. Ghosh	2014	Report

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Fiscal Year 2014				
Deliverable Number	**Title**	**Authors**	**Year**	**Type**
IM17860.09.001.410	Modeling Thermohydrological-Mechanical Behavior of Granular Bentonite in a Laboratory Column Test	Stothoff, S., C. Manepally, G. Ofoegbu, B. Dasgupta, and R. Fedors	2014	Report; revised January 2015
IM17860.09.001.430	Hydrogen Effects on Dissolution of Spent Nuclear Fuel in Reducing Repository Conditions—Literature Review and Laboratory Experiments	Shukla, P., T. Ahn, J. McMurry, M. Rubal, D. Daruwalla, and Y. Pan	2014	Report
IM17860.09.001.440	Literature Review and Experiments on Waste Package Corrosion—Copper and Carbon Steel	He. X., T. Ahn, and J. McMurry	2014	Report; revised March 2015
IM17860.09.001.460	SOAR User Guide Addendum: Radionuclide Transport Parameter Updates	Osidele, O. and J. McMurry	2014	Model file and table
IM17860.09.001.465	Model: System-Level Performance Assessment Model	Pickett, D.	2014	Model file and letter documenting completion