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Project Execution Plan - Environmental Management Spent Nuclear Fuel Technology Development

March 2021

Changing the World's Energy Future

Elmar Ferdinand Eidelpes, Josh J Jarrell

Idaho National Laboratory

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Project Execution Plan

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Environmental Management Spent Nuclear Fuel Technology Development

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Environmental Management Spent Nuclear Fuel Technology Development Project Execution Plan

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REVISION LOG

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ABBREVIATIONS

ASNF	Aluminum clad spent nuclear fuel
ATR	Advanced Test Reactor
CFD	Computation fluid dynamics
DOE	Department of Energy
DOE-EM	DOE Office of Environmental Management
DOE-NE	DOE Office of Nuclear Energy
EBR	Experimental Breeder Reactor
EDMS	Electronic Document Management System
eCR	Electronic change control
FASB	Fuels and Applied Science Building
FERMI	Enrico Fermi Power Plant Unit 1
FY	Fiscal year
GA	General Atomics
INL	Idaho National Laboratory
MEDE	Melt-drain evaporate
MPO	Memorandum Purchase Order
NEPA	National Environmental Policy Act
PEP	Project Execution Plan
QAP	Quality Assurance Program
R&D	Research and development
SGE	Selective gas extraction
SNF	Spent nuclear fuel
SNFWG	Spent Nuclear Fuel Working Group
SRNL	Savanna River National Laboratory
TD	Technology Development

1. PROJECT SCOPE, AND COST OVERVIEW

This Project Execution Plan (PEP) sets forth plans, organizations, and systems to be employed for managing the Environmental Management Spent Nuclear Fuel (SNF) Technology Development (TD) Project (project #33645). This project was created as an organizational structure to plan, manage, control, and coordinate individual activities funded by the National Spent Nuclear Fuel (NSNF) Program through the U.S. Department of Energy (DOE)-Office of Environmental Management (EM).

The format of this report is based on that of the PEP for the Aluminum Clad Spent Nuclear Fuel (ASNF) Long Term Dry Storage Technical Issues Project (project #32855) [1]. The activities of the ASNF project were incorporated as an individual task (Task 1). In total, the Environmental Management SNF TD Project currently includes the following nine tasks listed in Table 1, though not all are presently active:

Table 1. Project task list and status.

Task	Title	Status	Notes
Task 1	ASNF laboratory technical and engineering studies	Active	This task includes the activities of former project #32855
Task 2	Technical and engineering analyses to address spent fuel management	Merged	Due to overlapping scope, this task was merged with Task 6
Task 3	Spent fuel data management and analysis	Merged	Due to overlapping scope, this task was merged with Task 6
Task 4	ASNF validation/verification	Active	
Task 5	Disposition of sodium-bonded SNF – Technical risks and uncertainties	Active	
Task 6	Reducing SNF management technical risks and uncertainties	Active	Includes activities of Tasks 2 and 3
Task 7	Disposition options for fuel debris at Savanna River National Laboratory (SRNL)	Never initiated	
Task 8	Project controls and integration	Active	
Task 9	Evaluation of SNF packaging	Active	

The activities of these nine tasks have been gradually initiated since fiscal year (FY) 2017. Parts of these activities have been completed, and the scopes of some of the tasks were adapted due to the identification of additional research and development (R&D) needs, project management needs, or funding prioritizations. To be specific:

- Task 1 includes six subtasks (see Section 1.2.1), with Subtasks 1.1 and 1.4 having been completed successfully.
- The activities of the original standalone Tasks 2 and 3 were merged with the activities of Task 6. Thus, Tasks 2 and 3 will not be discussed in detail within this PEP.
- Task 7 has not been initiated and there are no plans for funding this task. Thus, this task will not be discussed in detail within this PEP.

At the time of writing this PEP, the DOE-EM funding for project #33645 was $19 million (FYs 2017–2020). Additional FY 2021 funding of $5 million was requested and approved.

The schedule for this project aims to have Tasks 1, 4, and 5 completed within FY 2021. Activities within the scope of the remaining tasks are expected to continue beyond FY 2021, should additional funding become available. The structure of this project will be adapted if new R&D needs are identified.

This PEP also establishes and documents the methods and controls for managing the project. It will be a controlled document, effective throughout the life of the project (i.e., after completion of all current and future activities), and reviewed and updated both annually and as-needed (i.e., whenever significant changes occur).

1.1 Mission Need

The Environmental Management SNF TD Project was tailored to address DOE-EM mission needs [2, 3], and its activities are funded through the annual U.S. congressional budget (e.g., in FY 2021) [4, 5]: "Within Technology Development and Deployment, $5,000,000 is provided for the National Spent Nuclear Fuel Program to address issues related to storing, transporting, processing, and disposing of Department-owned and managed spent nuclear fuel. Within these amounts, the Department shall use funding to address the need for additional assessments into material degradation that may occur as a result of multiple decades of EM spent nuclear fuel storage facilities, nuclear material measuring and monitoring in the Department's storage systems, and other activities recommended by the U.S. Nuclear Waste Technical Review Board in its 2017 report on the Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel."

1.2 Project Description

In the following sections, activities within the scope of each individual task of the Environmental Management SNF TD Project are described in detail.

1.2.1 Task 1 – ASNF fuel laboratory technical and engineering studies

This task was created to help develop an improved understanding of ASNF behavior during extended dry storage, as well as a technical basis for the continued storage of this type of DOE SNF, using laboratory experimental work on surrogate materials and simulations. This task is critical for ensuring safe, extended dry storage in both current and future ASNF configurations, and for providing information for the future transportation, conditioning, and disposal of ASNF.

1.2.1.1 Task 1 – Activities

The DOE Spent Nuclear Fuel Working Group (SNFWG)'s report on technical considerations and challenges for extended dry storage of ASNF (DOE/ID RPT-1575) [6] identified five knowledge gaps and technical data needs. The report also made several recommendations, including the development of an action plan (INL/EXT-17-93408) [7] to identify needed technical and engineering activities/analyses for addressing these gaps/needs. The activities in Task 1 represent the R&D work toward the development of a technical basis for extended dry storage of ASNF (see Figure 1).

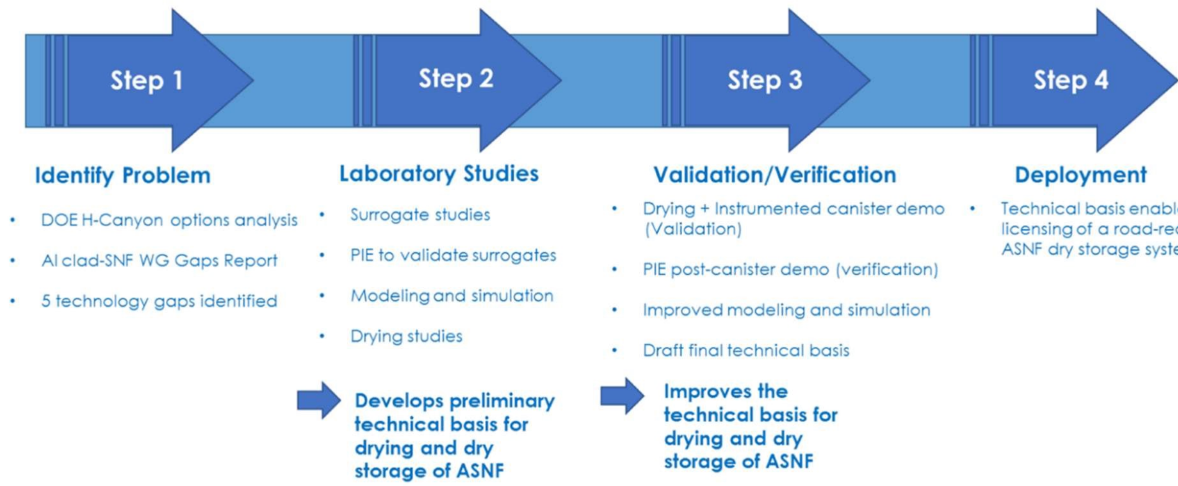

Figure 1. Necessary steps for developing the technical basis for extended dry storage of ASNF [1].

The five data/knowledge gaps identified in the SNFWG report and needing to be filled in order to help decision-makers better understand the environmental, safety, and long-term programmatic risks associated with a management strategy for ASNF placed in extended (i.e., greater than 50 years) dry storage are:

1. Behavior/chemistry of oxyhydroxide layers for the broad range of ASNF fuel designs and dry storage configurations
2. Resolution of radiolytic gas generation data regarding ASNF oxyhydroxide layers
3. Combined effect of episodic breathing and the radiolytic generation of potentially corrosive gases in sealed and vented systems
4. Performance of research test reactor ASNF in existing dry storage systems
5. Effects of high-temperature (i.e., greater than 100°C) drying on the chemistry and behavior of oxyhydroxide layers.

Task 1 includes six subtasks. Figure 2 illustrates how Subtasks 1.1–1.6 interface with each other in order to fill the five data/knowledge gaps listed above.

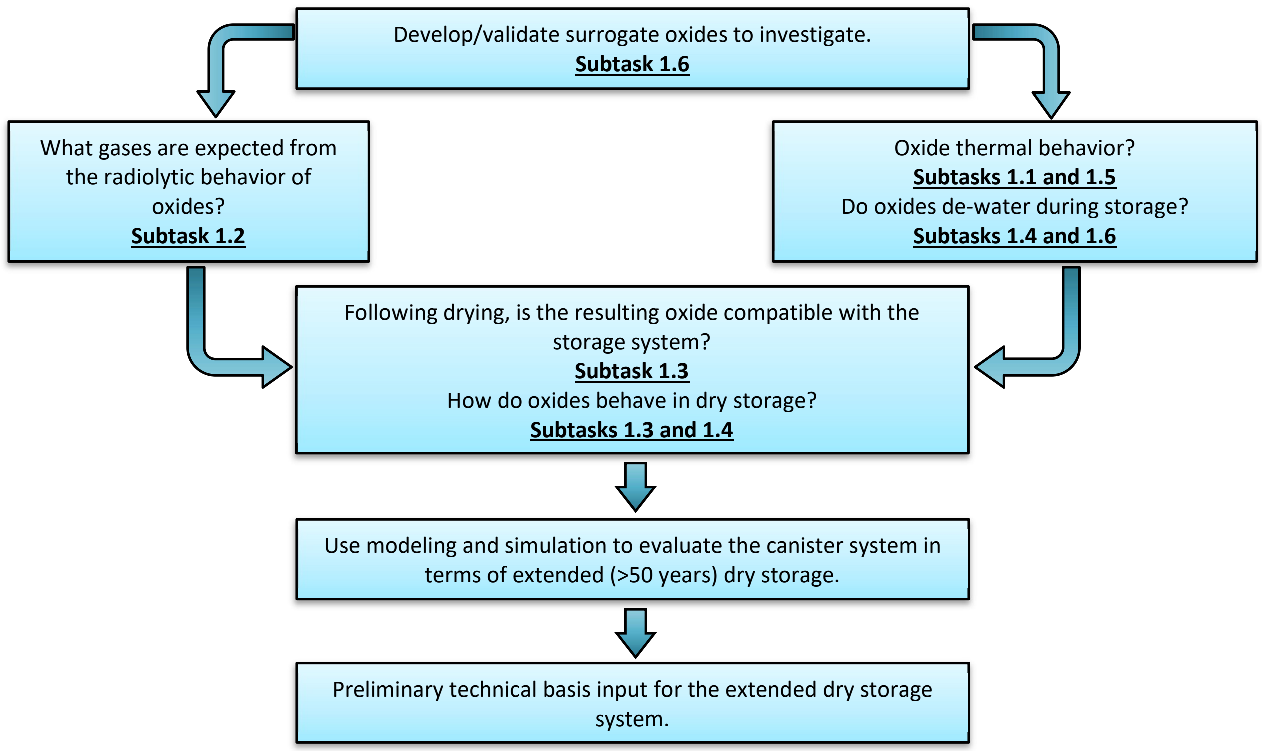

Figure 2. Illustration of the technical questions to be answered, and the interfaces between the activities of Task 1 (adapted from [1]).

The work included in Task 1 has been ongoing since FY 2017. Subtasks 1.1 and 1.4 are partly completed. Subtasks 1.2, 1.3, 1.5, and 1.6 are expected to be finished by the end of FY 2021. Details on the Task 1 activities are summarized in the following paragraphs. Additional details can be found in the Technical Task Plan [8].

Subtask 1.1 – Oxyhydroxide layer behavior and chemistry

The first step in building an understanding of how ASNF will perform over extended storage periods is to understand the behavior of oxide/oxyhydroxide films created during in-reactor operations and out-of-reactor storage, with a focus on how temperature affects those films.

Subtask 1.1 was completed. It answered several questions, such as whether mechanisms exist that could alter the aluminum oxide/oxyhydroxide layers during extended storage, whether (and under what conditions) these layers decompose, and whether this decomposition process could lead to SNF storage canister integrity issues. Within the scope of this subtask, oxide layer thicknesses and growth rates were evaluated based on fuel history. Both thermal effects and corrosion behavior in different oxide layers were characterized. Based on these experiments, no hydrogen is expected to be produced, due to corrosion of the oxyhydroxide layers under the range of temperatures used in testing—temperatures representative of those anticipated in dry storage. The results obtained via the work in Subtask 1.1 inform the current modeling activities regarding DOE SNF dry storage systems (Subtask 1.3) and drying (Subtask 1.5).

Subtask 1.2 – Oxide layer radiolytic gas generation

While the results of Subtask 1.1 provide information regarding the amount of gas generated due to thermal effects on, or corrosion of, the oxide/oxyhydroxide layer, the activities of Subtask 1.2 focus on radiolysis of the oxide/oxyhydroxide layer and the gaseous sources present within a storage canister.

This subtask was tailored to answer questions on the types of important gases (e.g., hydrogen, oxygen, and NO_x) that may be produced inside sealed and vented ASNF canisters, questions on radiolytic gas generation rates, questions on the radiolytic degradation mechanisms, and the question of whether in-canister conditions can be predicted based on these mechanisms. Fundamentally, this subtask supports the development of storage models (Subtask 1.3) by providing information on maximum gas generation rates.

Subtask 1.3 – Sealed and vented system episodic breathing and gas generation prediction

Subtask 1.3 will model the combined effects of episodic breathing (in the vented canisters stored within INL's CPP-603 facility) and radiolytic gas generation on the ASNF cladding, oxide layers, canister, and other system components. Additional activities include the comprehensive modeling of sealed and inert canister storage systems, using the DOE Standard Canister as an example.

Diffusional and convective exchanges of reactive gaseous species and heat inside the canister, with ambient air induced by episodic breathing in both the vented and unsealed storage systems, will shift the chemical equilibrium conditions and affect the level of radiolytic production of corrosive gases. The modeling activities within this subtask apply insights gained from Subtasks 1.1 and 1.2 in order to identify the primary gas-generation reactions and kinetics in both sealed and vented systems, and to implement the reactions in the canister-scale multiphysics computational fluid dynamics (CFD) models for predicting the long-term evolution of concentrations of corrosive gases and moisture contents inside/outside the canisters. The simulation results are continuously coordinated with the technical leads and research staff of Subtasks 1.1 and 1.2, and used to guide their experimental designs.

Subtask 1.4 – Performance of ASNF in dry storage

To predict the long-term integrity of stored ASNF, baseline information about the fuel's passive oxide/oxyhydroxide surface characteristics at various stages during its lifecycle is needed.

Corresponding activities were completed within the scope of Subtask 1.4. These activities included visual inspections of ASNF, with a priority focus on Advanced Test Reactor (ATR) ASNF stored at INL's CPP-603 facility, evaluations of ATR endboxes from the ATR canal, and evaluations of corrosion layers from actual ATR SNF in dry storage in the CPP-603 facility.

At the end of reactor service, the end boxes are removed from each ATR element before transferring the elements out of the ATR canal. These end boxes provided opportunities to obtain limited ASNF sample material post-irradiation and before the dry storage stage of the fuel's lifecycle. Inspection of ASNF in dry storage established a baseline understanding of how ASNF performs over its storage lifetime. The primary criteria in selecting ATR elements for inspection were a long storage duration and a high burnup for fuel of the selected vintage.

The utilized evaluation techniques were coordinated with Subtask 1.6 research activities of SRNL to allow for more consistent comparisons between SRNL and INL sample materials. Part of the reason for inspecting the ATR ASNF and end boxes was to address concerns about expected corrosion and radiolytic phenomena, and to ensure that storage conditions do not introduced new, unexpected fuel behaviors. The analyzed samples indicate that there is minimal change in the oxide and associated hydration of the surface of the aluminum ATR fuel elements that can be attributed to dry storage. Note that, within Subtask 1.4, an ATR fuel handling tool for handling individual elements was designed and procured.

Subtask 1.5 – Oxide layer response to drying

Within the scope of Subtask 1.5, the effects of drying on the development and composition of oxide layers on ASNF are investigated. The underlying goal is to develop an understanding of how effectively different drying procedures (e.g., temperature, vacuum, and forced helium) remove the chemically bound water in parts of the oxide layers, as well as the impact of drying procedures on the formation/transformation of those layers. The selection of specific drying temperatures and types of oxide layers for analysis is heavily informed by the results of Subtask 1.1. Furthermore, Subtask 1.5 activities are conducted by INL in collaboration with its partners in academia (University of South Carolina) and industry (Holtec).

Subtask 1.6 – Surrogate sample preparation and validation

Investigations into knowledge gaps and technical data are supported by the evaluation of laboratory-grown oxide/oxyhydroxide layers on surrogate material. Subtask 1.6 is led by SRNL and is designed to validate the accurate representation of ASNF oxide/oxyhydroxide layer composition (e.g., gibbsite, bayerite, and boehmite) by surrogate materials. The activities of this subtask include characterization of the oxide/oxyhydroxide layers on actual Savanna River Site SNF materials, as well as preparation and characterization of representative surrogate materials for use in other activities.

1.2.2 Task 4 – ASNF validation/verification

The intent of Task 4 is to move the ASNF work of Task 1 from the laboratory scale to a verification/validation stage. The focus of this work is on the development and utilization of an instrumented lid, along with associated instrumentation to monitor the internal conditions of SNF canisters currently used to store DOE SNF at INL's CPP-603 facility. Data collected within the scope of Task 4 will help quantify and reduce the technical risks and uncertainties associated with DOE SNF packaging evaluation (Task 9).

1.2.2.1 Task 4 – Activities

The TD for the SNF canister internal-condition monitoring of Task 4 includes activities such as determining the phenomena to be monitored, down-selecting the appropriate monitoring and data collection technologies, and working through the logistical, operational, and regulatory concerns relating to the deployment of the developed canister lids. As part of the transition from the ASNF laboratory studies of Task 1 to larger demonstrations progresses, research staff and technical leads will closely coordinate to ensure that the latest data and physical behavior of ASNF is understood and appropriately incorporated into planning activities. Task 4 includes two subtasks described in the following paragraphs.

Subtask 4.1 – Development of a DOE Standard Canister lid

Subtask 4.1 is led by SRNL. Within the scope of this subtask, an instrumented lid for the DOE Standard Canister was developed to collect data on the internal conditions of the canister during extended dry storage of DOE SNF. The DOE Standard Canister is a leak-tight (i.e., not vented) system usable for continued dry storage of the various DOE SNF types, including the ASNF currently stored at INL's CPP-603 facility. Subtask 4.1 further includes the selection of parameters to be monitored within the DOE Standard Canister, based on the results of the experimental work in Task 1. The data collected using the developed canister lid are expected to help verify the experimental and predictive modeling work conducted within the scope of Task 1.

Experimental work on aluminum sample material, complementary to the activities of Task 1, is planned to be conducted during the prototype development process of this subtask in order to ensure full lid functionality. This includes using the developed instrumentation to measure hydrogen release rates (i.e., G-values) for unirradiated and irradiated aluminum coupons.

Subtask 4.2 – Development of a CPP-603 canister lid

Within the scope of Subtask 4.2, an instrumented lid for canisters in INL's CPP-603 facility is under development. A variety of DOE SNF types, including ASNF, have been stored in these vented (i.e., non-leak-tight) canisters for years—in some cases, even decades. The canisters are located within CPP-603's fuel storage area, a highly radioactive environment enclosed by thick concrete walls.

The technical challenges posed by the activities of Subtask 4.2 involve selecting the appropriate sampling parameters and the development of a reliable sampling system to support determining the condition of SNF stored within the CPP-603 canisters and verifying the experimental and predictive modeling work conducted in Task 1. Different canister lid instrumentation systems are under evaluation. Currently, two feasibility studies are being conducted by industry partners (i.e., Westinghouse) and partners in academia (Idaho State University, ISU) that include testing of the different systems in simulated conditions, including radioactive environments. Further, evaluations of available wireless data transfer technologies are needed, to ensure reliable transfer of sampling data from within the fuel storage area to the outside.

Furthermore, the activities within Subtask 4.2 include technical support provided by Fluor Idaho to INL. Fluor Idaho is the Battelle Energy Alliance's contractor currently operating INL's CPP-603 facility.

1.2.3 Task 5 – Disposition of sodium-bonded SNF – Technical risks and uncertainties

DOE high-level waste and SNF repository requirements specifically exclude hazardous materials as identified in the Resource Conservation and Recovery Act. Experimental Breeder Reactor (EBR)-II or Enrico Fermi Power Plant Unit 1 (FERMI) SNF utilized sodium to bond fuel pins to the cladding. Because this sodium has the potential to react violently with water, it must be removed or passivated prior to repository disposal.

DOE activities necessary for meeting the Idaho Settlement Agreement's 2035 deadline [10] include identification and evaluation of potential sodium-bonded SNF treatment technologies, followed by technology down-selection of a preferred option, completion of National Environmental Policy Act (NEPA) and Record of Decision requirements, and retrieval and treatment of 34 metric ton of heavy metal FERMI SNF over the next 17 years. Based on the disposition timeline and the long lead time for the required DOE-EM activities, is critical to execute these studies in a timely manner.

1.2.3.1 Task 5 – Activities

The DOE Office of Nuclear Energy (DOE-NE) has been processing EBR-II fuel at INL using electrometallurgical technology since the early 2000s, and aims for completing processing of both driver and blanket materials in 2035. This is a very costly and time-consuming process. EBR-II driver fuel is challenging to treat, since sodium diffused into the metal fuel core during fuel irradiation. However, EBR-II and FERMI blanket materials experience much less irradiation, and sodium does not migrate into the heavy metal core to nearly the same extent as in the driver fuel. This difference in SNF characteristics makes EBR-II and FERMI blanket materials amenable to heat treatment alternatives such as melt-drain evaporate (MEDE). Another alternative treatment option to be evaluated for sodium-bonded SNF is selective gas extraction (SGE).

Based on these evaluations, alternative treatment options for FERMI blanket materials will be recommended. Additional sodium-bonded SNF or blanket material treatment R&D work will be conducted as needs are identified and additional funding becomes available. Task 5 includes two subtasks described in the following paragraphs.

Subtask 5.1 – Evaluation of MEDE as a treatment alternative for sodium-bonded SNF

Within the scope of Subtask 5.1, review and analyses of results from preliminary studies on DOE-EM-funded FERMI and DOE-NE-funded EBR-II MEDE studies were performed, and new FERMI MEDE R&D work was initiated. This includes staging several unirradiated FERMI blanket elements and a single blanket assembly and subjecting them to MEDE processing. Figure 3 depicts the FERMI MEDE treatment development process using a high-level simplified flow chart.

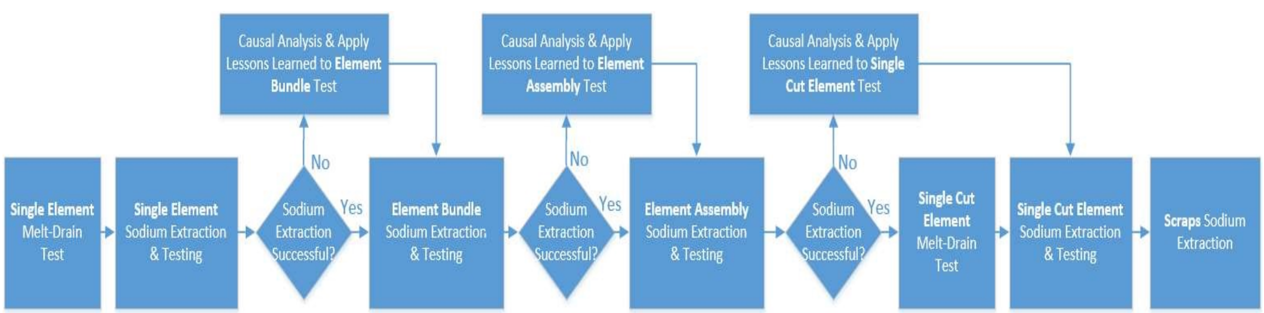

Figure 3. Simple flow chart of MEDE testing [11].

The MEDE research plan starts with extracting sodium at the individual element scale, expands to bundles (nine elements), and ultimately, to a full assembly (25 elements), analyzing lessons learned from each step before proceeding to the next step.

Prior to MEDE heat treatment, cut points along the blanket elements had to be identified. Cutting the elements allows liquid and gaseous sodium to escape the elements during heating. To identify these cut points, original, non-irradiated FERMI blanket assemblies provided by the Henry Ford Museum were analyzed using radiography. A fourth test of the MEDE process, identical to the single element test, is planned to evaluate a treatment after cutting open only one end of the element for venting.

Subtask 5.1 has seen significant progress, and the activities are expected to be completed by the end of FY 2021. For example, the equipment needed for MEDE evaluation was developed and procured. This includes a furnace to heat the FERMI blanket materials, a retort for condensation of the vaporized sodium released from the fuel, a programmable logic controller for the furnace, and handling tools. The furnace and retort were installed in the pyro-chemistry glovebox at INL's Fuels and Applied Science Building (FASB). Mockup FERMI blanket assemblies and elements were also designed.

In the MEDE demonstration process, the furnace heaters will be de-energized after each round of sodium extraction, and the system pressure will be equalized. The MEDE apparatus will then be positioned horizontally for disassembly and unloading. Separation of element slugs from its cladding will be assessed, and samples of the separated element, cladding, and bond-sodium will be taken for elemental and isotopic analyses at INL's Analytical Laboratory. The MEDE test apparatus will then be reloaded for subsequent operations. Results from each analysis will be applied as lessons learned to the subsequent test.

Two additional objectives of the MEDE treatment evaluations are (1) verification of the "melt and drain" portion of the MEDE process, and (2) removing sodium from scraps produced in the FASB glovebox during the cutting operations (Figure 3). Verification of "melt and drain" can be performed as part of the first single element test, and includes MEDE test runs using different temperature holding times, as well as heating under atmospheric pressure or under vacuum.

To test the sodium removal from contaminated scraps generated during FERMI blanket element cutting, these scraps will be loaded into the MEDE basket that will, in turn, be loaded into the retort. Subsequently, the furnace will be tested in regard to extracting the elemental sodium from the scraps.

Subtask 5.2 – Evaluation of SGE as a treatment alternative for sodium-bonded SNF

As part of the activities of Subtask 5.2, R&D work is scheduled for evaluating SGE as an alternative treatment option for sodium-bonded SNF. General Atomics (GA) will lead these efforts. GA has developed proprietary techniques for the chemical separation of materials that have the potential for being applied in the field of nuclear waste treatment, and was previously awarded a patent for related SGE technology (U.S. 9,076,561 B2) for Mo-99 recovery. GA's specific focus in SGE TD includes consultations on and design, construction, and testing of required preliminary equipment for EBR-II fuel separation, among other activities.

1.2.4 Task 6 – Reducing SNF management technical risks and uncertainties

The research work in Task 6 will support DOE-EM's mission by developing a better understanding of the diversity and unique characteristics of the various types of DOE SNF. The goal is to develop specific research that addresses a number of cross-cutting considerations in order to ensure safe, long-term management of the broad range of SNF types.

1.2.4.1 Task 6 – Activities

The activities in Task 6 will address unique needs by providing technical studies, evaluations, and option analyses, as identified and prioritized by DOE-EM strategic planning initiatives and the Spent Nuclear Fuel Working Group (SNFWG). Some of the identified technical risks involve complying with criticality safety requirements for highly enriched fuels, age-related SNF degradation, and design issues associated with packaging DOE SNF for storage, transportation, and eventual disposal. Further, the activities include providing data and analyses for SNF processing TD, and for feasibility studies and evaluations such as those performed by the DOE SNFWG, the Idaho Integrated Product Team, and other DOE and governmental oversight groups. Specifically, the central goals of Task 6 are to support R&D efforts for achieving a DOE SNF configuration that enables safe transportation and disposal after long-term dry storage (i.e., a road-ready condition). Furthermore, Task 6 will provide data and technical support to the DOE Standard Canister Packaging Demonstration Project (Task 9) and to the SNFWG on related strategic initiatives.

1.2.5 Task 8 – Project controls and integration

To meet DOE-EM mission needs within the scope of the Environmental Management SNF TD Project, oversight is necessary for steering any collaborative efforts toward the desired outcomes.

1.2.5.1 Task 8 – Activities

Task 8 includes management, control, coordination, and integration activities for this project, with the understanding that data and information obtained over the course of these activities may be used in future DOE R&D activities. The project control and integration activities will ensure successful implementation of the Environmental Management SNF TD Project. The goal of this task is to foster communication among the technical leads by holding regular meetings to align the various research activities conducted within the scope of the individual tasks and subtasks, track deliverable developments, control project costs, identify technical and financial risks, and coordinate additional funding. Additional activities within this task include reporting the project progress to DOE-EM, developing project control/management-related documents such as this PEP, and presenting results/findings to the scientific community.

1.2.6 Task 9 – Evaluate SNF packaging

Task 9 supports DOE-EM's mission to evolve road-ready SNF dry storage. It includes DOE SNF packaging TD.

1.2.6.1 Task 9 – Activities

Task 9 includes DOE Standard Canister packaging demonstration activities. The DOE Standard Canister [9] is a standardized canister system developed to store various types of DOE SNF. The packaging demonstration aims to successfully transfer DOE SNF stored in CPP-603 canisters into one or more DOE Standard Canister. Subsequently, the canister(s) will be loaded into the dry storage overpack(s).

An important FY 2021 Task-9 TD step is the completion of a DOE Standard Canister remote closure system design, including procurement of the required equipment. The current design state of the welding technology is an orbital tool platform with a rotating, modular head that carries a welding tool, eddycurrent and ultrasonic non-destructive examination equipment, tools for weld repair, and hammer peening equipment for weld stress relief. Besides design and equipment procurement, qualification testing of the closure system and safety analyses of the required SNF packaging procedures are also planned.

The understanding developed throughout the activities of Tasks 1, 4, and 9 will support the design of procedures and equipment for DOE SNF canister loading, conditioning, and sealing. Furthermore, canister transfer procedures and equipment could be developed, and a dry storge overpack model selected and procured. This additional R&D work would allow for moving a loaded and sealed DOE Standard Canister from within CPP-603's fuel handling cave to an external storage location for continued dry storage. Funding provided by DOE-EM in coordination with DOE-NE beyond FY 2021 levels is needed to initiate the development and procurement of the remaining system procedures and components.

1.3 Work Scope

INL, SRNL, and INL's industry and academia partners (e.g., Fluor Idaho, GA, Holtec, Westinghouse, Idaho State University, and University of South Carolina) will continue working together to ensure that the overall objectives of this work are met. INL will continue to lead the tasks and be supported by its partners, as appropriate. The technical leads for each task will continue developing and documenting the activities within their scope of work, including experimental configuration, testing matrices, results documentation approach, and quality assurance approach.

1.4 Schedule

This project was formed from R&D activities ongoing since FY 2017. It will be continued throughout FY 2021 and beyond. Since the initiation of these R&D activities, a significant number of milestones have been completed, and additional ones will be completed throughout FY 2021. Table 2 summarizes the project milestones as they exist at the time of writing this PEP, and provides the date of completion for some of the milestones.

Table 2. Schedule and milestones.

TASK 1 – ASNF Laboratory Technical and Engineering Studies[a, b]	Completion	Reports
Milestone 1.1[c]: Final report on ASNF technical evaluations		
Milestone 1.2[c]: Draft report on preliminary technical basis for extended dry storage for aluminum-clad SNF		

Table 2 (cont.). Schedule and milestones.

SUBTASK 1.1 – Oxyhydroxide Layer Behavior and Chemistry	Completion	Reports
Milestone 1.1.1[d]: Aluminum oxidation experimental design and system assembly	6/28/2018	NA
Milestone 1.1.2: Model of aluminum/water reactions	12/1/2018	INL/EXT-18-51694
Milestone 1.1.3: Calculation of hydrogen generation from Al 1100	12/18/2018	INL/EXT-18-52249
Milestone 1.1.4: Calculation of hydrogen generation from other aluminum alloys	5/17/2019	INL/EXT-19-53964
Additional Report[e]: Vapor phase corrosion of pretreated aluminum alloys: Final Report	1/1/2020	INL/EXT-19-56497 Rev. 1
Milestone 1.1.6: Comprehensive analysis of hydrogen generation	8/30/2019	INL/EXT-19/55558

SUBTASK 1.2 – Oxide Layer Radiolytic Gas Generation Resolution	Completion	Reports/Notes
Milestone 1.2.1[d]: Experimental design	7/30/2018	NA
Milestone 1.2.2: Material characterization	2/1/2019	INL/EXT-19-52738
Milestone 1.2.3: Gamma irradiation	2/1/2019	INL/EXT-19-52738
Milestone 1.2.4: Demonstration of oxide layer radiolytic gas generation	2/1/2019	INL/EXT-19-52738
Milestone 1.2.5: Multi-dimensional irradiation test matrix	9/1/2019	INL/EXT-19-55202
Milestone 1.2.6[f]: Complete round-robin hydrogen gas analysis capability comparison	12/14/2020	INL/EXT-20-00810 Rev. 1
Milestone 1.2.7[b]: Evaluate molecular hydrogen gas measurement techniques	12/14/2020	INL/EXT-20-60008
Milestone 1.2.8[c, g]: Complete additional radiolytic gas generation analysis, including helium-backfilled samples		

SUBTASK 1.3 – Sealed and Vented System Episodic Breathing and Gas Generation Prediction	Completion	Reports/Notes
Milestone 1.3.1: Canister-scale conceptual models	4/3/2018	Not for external release!
Milestone 1.3.2: 3D canister-scale Multiphysics CFD models for sealed canisters	6/30/2018	INL/EXT-18-51683 Rev. 1
Milestone 1.3.3: 3D canister-scale Multiphysics CFD models for vented systems	9/30/2018	INL/EXT-18-51681
Milestone 1.3.4: Improve CFD models, including comprehensive sensitivity studies	1/31/2019	INL/EXT-19-52650
Milestone 1.3.5: Develop 3D facility-scale coupled Multiphysics CFD model	9/30/2019	INL/EXT-19-55185
Milestone 1.3.6[c]: Complete temperature and dose rate calculations for relevant SRNL fuel geometries	3/31/2020	INL-EXT-20-57893
Milestone 1.3.7[c]: Evaluate effect of helium G-values on radiolytic chemistry model		
Milestone 1.3.8[c]: Evaluate effect of neutron poison corrosion on DOE Standard Canister	10/15/2020	INL-EXT-20-59994

Table 2 (cont.). Schedule and milestones.

SUBTASK 1.4 – Performance of ASNF in Dry Storage	**Completion**	**Reports/Notes**
Milestone 1.4.1: Characterize aluminum from the ATR canal	10/11/2018	INL/EXT-18-51230
Milestone 1.4.2: Develop individual ATR element handling capability for use in CPP-603	9/20/2019	CCN 245627
Milestone 1.4.3: ATR element visual inspection	9/20/2019	CCN 245627
Milestone 1.4.4: Surface oxide sampling technique	9/20/2019	CCN 245627
Milestone 1.4.5: Canister monitoring evaluation	9/30/2019	INL/EXT-19-55950

SUBTASK 1.5 – Additional Drying Studies[h]	**Completion**	**Reports/Notes**
Milestone 1.5.1: Issue ASNF Subtask 5 experiment test plan	8/1/2019	INL/EXT-19-54019
Milestone 1.5.2: Issue engineering scale experiment design document	8/31/2019	INL/EXT-19-56017
Milestone 1.5.3: Successful completions of system operability testing	8/11/2020	INL/MIS-58841 Rev1
Milestone 1.5.4: Issue final report on ASNF drying		

SUBTASK 1.6 – Surrogate Sample Preparation and Validation	**Completion**	**Reports/Notes**
Milestone 1.6.1: Growth/characterization of oxides on 1100 alloy	8/1/2018	SRNL-STI-2018-00427
Milestone 1.6.2: Characterization of oxides on dry Uruguay fuel plate	8/1/2018	SRNL-STI-2018-00449
Milestone 1.6.3: Growth/characterization of oxides on 6061 alloy	10/1/2018	SRNL-STI-2018-00428
Milestone 1.6.4: Growth/characterization of oxides on 5052 alloy	11/20/2018	SRNL-STI-2018-00646
Milestone 1.6.5: Characterization of oxides on wet Uruguay fuel plate or L-basin aluminum materials	3/14/2019	SRNL-STI-2019-00058
Milestone 1.6.6[c]: Complete test plan for radiolysis testing of ASNF L-basin materials	3/20/2020	SRNL-RP-2020-00187
Milestone 1.6.7[c]: Complete irradiation of as-is L-basin samples		
Milestone 1.6.8[c]: Complete irradiation of dried L-basin samples		
Milestone 1.6.9[c]: Document results of gas generation on as-is and dried ASNF L-basin materials		

TASK 2 – Technical and Engineering Analyses to Address Spent Fuel Management	**Completion**	**Reports/Notes**
No milestones planned	NA	NA

TASK 3 - Spent Fuel Data Management and Analysis	**Completion**	**Reports/Notes**
No milestones planned	NA	NA

Table 2 (cont.). Schedule and milestones.

TASK 4 – ASNF Fuel Validation/Verification		
SUBTASK 4.1 – Development of a DOE Standard Canister Lid[i]	**Completion**	**Reports/Notes**
Milestone 4.1.1: Finalize instrumented canister test plan	3/31/2019	SRNL-RP-2019-00225
Milestone 4.1.2: Complete system detailed design	5/31/2019	SRNL-L2240-2019-00002
Milestone 4.1.3: Complete lid detailed design	6/30/2019	SRNL-L2240-2019-00003
Milestone 4.1.4: Obtain/fabricate basket and canister	12/9/2019	SRNL-L2240-2019-00006
Milestone 4.1.5: Assemble lid components	8/1/2019	SRNL-L2240-2019-00024
Milestone 4.1.6: Complete initial full system qualification testing	9/1/2019	SRNL-L2240-2019-00004
Milestone 4.1.7: Perform full system testing	10/30/2019	SRNL-L2240-2019-00005
Milestone 4.1.8: Issue final report	2/21/2020	SRNL-L2240-2019-00007 Rev. 1
Milestone 4.1.9: Complete test plan for real-time measurement of hydrated oxide specimens under irradiation	4/6/2020	SRNL-RP-2020-00219
Milestone 4.1.10: Fabricate hydrated oxide specimens for testing	8/5/2020	SRNL-L6000-2020-00034
Milestone 4.1.11: Initiate irradiation and measurement of as-is hydrated oxide specimens (large coupons)	9/1/2020	SRNL-L6000-2020-00038
Milestone 4.1.12: Initiate irradiation and measurement of dried hydrated oxide specimens (large coupons)	9/18/2020	SRNL-L6000-2020-0046
Milestone 4.1.13: Draft document of results of irradiated hydrated oxide specimens		
Milestone 4.1.14: Complete irradiation of as-received large coupons		
Milestone 4.1.15: Initiate irradiation of large coupon assembly and update drying recipe		
Milestone 4.1.16: File report of irradiated as-received and dried large coupon testing		

SUBTASK 4.2 – Development of a CPP-603 Canister Lid[j]	**Completion**	**Reports/Notes**
Milestone 4.2.1: Select and fabricate candidate's sensors	5/1/2020	INL/EXT-20-58149
Milestone 4.2.2: Feasibility study for wireless/spatial data system and point data system		
Milestone 4.2.3: Separate testing of radiation sensor and data acquisition and transmission		
Milestone 4.2.4: Draft report on selected CPP-603 instrumentation for canister monitoring technology		

Table 2 (cont.). Schedule and milestones.

TASK 5 – Disposition of Sodium-Bonded SNF - Technical Risks and Uncertainty		
SUBTASK 5.1 – Evaluation of MEDE as a treatment alternative for sodium-bonded SNF[k]	**Completion**	**Reports/Notes**
Milestone 5.1.1: Finalize FERMI MEDE test plan and analytical chemistry plan	7/29/2019	INL/EXT-19-54148
Milestone 5.1.2: Complete MEDE furnace design	12/9/2019	
Milestone 5.1.3: Fabricate or procure equipment used to extract sodium	4/30/2020	
Milestone 5.1.4: Determine element cut points using radiography	5/14/2020	
Milestone 5.1.5: Complete Phase I: MEDE furnace construction	5/21/2020	
Milestone 5.1.6: Complete Phase I: MEDE furnace qualification testing	6/22/2020	
Milestone 5.1.7: Complete MEDE furnace construction in FASB glovebox	8/27/2020	
Milestone 5.1.8: Operational readiness completion	11/3/2020	
Milestone 5.1.9: Complete blanket elements testing		
Milestone 5.1.10: Complete blanket assembly testing		
Milestone 5.1.11: Issue final report		
Milestone 5.1.12: MEDE project completion		
Milestone 5.1.13: End-of-year summary report on MEDE results and proposed Na-bonded blanket material path forward		

SUBTASK 5.2 – Evaluation of SGE as a treatment alternative for sodium-bonded SNF[l]	**Completion**	**Reports/Notes**
Milestone 5.2.1: Cladding Hull Waste – Data needs and test rigs designs		
Milestone 5.2.2: Cladding Hull Waste – Experimental test rig construction		
Milestone 5.2.3: Cladding Hull Waste – Final report on advancement of DOE nuclear waste separation technologies – GA support		

TASK 6 – Reducing SNF management technical risks and uncertainties	**Completion**	**Reports/Notes**
No milestones planned	NA	NA

TASK 7 – Disposition of Sodium-Bonded SNF - Technical Risks and Uncertainties	**Completion**	**Reports/Notes**
No milestones planned	NA	NA

TASK 8 – Project Controls and Integration	**Completion**	**Reports/Notes**
Milestone 8.1: Environmental Management TD ASNF dry storage final report		

Table 2 (cont.). Schedule and milestones.

TASK 9 – Evaluate SNF packaging	Completion	Reports/Notes
Milestone 9.1: Delivery of circumferential welding device for DOE Packaging Demonstration to INL.		

a: Milestone numbering changed from X.X to 1.X.X to reflect the incorporation of the ASNF Long Term Dry Storage Technical Issues under Task 1. Internal milestone number remains unchanged.
b: It was determined that Milestones 1.5, 1.7, and 2.6 did not add value to the project. Thus, they were dismissed or replaced.
c: New milestone.
d: Not for external release!
e: Intermediate, draft deliverable.
f: Replaces original milestone.
g: Includes intermediate milestones.
h: Milestone numbering for DOE dissemination only. Internal milestone numbering deviates and includes intermediate deliverables.
i: Milestone numbering changed from to reflect the incorporation under Subtask 4.1. Internal milestone number remains unchanged.
j: Milestone numbering changed from to reflect the incorporation under Subtask 4.2. Internal milestone number remains unchanged.
k: Milestone numbering changed from to reflect the incorporation under Subtask 5.1. Internal milestone number remains unchanged.
l: Milestone numbering changed from to reflect the incorporation under Subtask 5.2. Internal milestone number remains unchanged.

1.5 Cost Baseline

The current cost baseline for this project is $24M: $19M in FY 2017–2020 funds and $5M in FY 2021 funds, as illustrated in Table 3.

Table 3. Project budget

Task	Description	FY 2017 to 2020 ($K)	$FY 2021* ($K)
1	Aluminum clad spent nuclear fuel laboratory technical and engineering studies	8,165	725
2	Technical and engineering analyses to address spent fuel management	600	0
3	Spent fuel data management and analysis	800	0
4	Aluminum clad spent nuclear fuel validation/verification	2,425	875
5	Disposition of sodium bonded SNF – technical risks and uncertainty	3,332	200
6	Reducing SNF management technical risks and uncertainties	2,318	1,200
7	Disposition options for fuel debris at SRNL	0	0
8	Project controls and integration	360	500
9	Evaluate SNF packaging	1,000	1,500
	Totals ($K)	**19,000**	**5,000**
	Carryover from FY 2020 ($K)		**4,085**
	Total available for expenditure in FY 2021, including carryover ($K)		**9,085**
	Estimated expenditures in FY 2021 ($K)		**8,760**
	Estimated carryover from FY 2021 into FY 2022* ($K)		**325**

*NOTE: Some FY 2021 tasks are new starts or tasks for which the sub-contracts are still being placed. Therefore, the timelines and expenditures for those tasks are subject to change, depending on funding availability and negotiations with sub-contractors.

2. PROJECT ORGANIZATION AND INTERFACES

The project manager has approval authority over any action that will impact the project schedule, cost, scope, milestones, or commitments. The integration lead will coordinate with the technical leads and project manager to ensure that all project planning, execution, and oversight are appropriately conducted to meet the project objectives. Each technical lead is responsible for the development and execution of a task-specific test plan.

2.1 Roles and Responsibilities

The key project personnel are identified in the following list. The project manager is responsible for maintaining a current list of key project personnel in the event of any changes made prior to a revision of this PEP.

- **Project Manager:** Josh Jarrell (INL)
- **Integration Lead:** Elmar Eidelpes (INL)
- **Technical Leads – Task 1:**
  - Subtask 1.1: None (Closed)
  - Subtask 1.2: Greg Horne (INL)
  - Subtask 1.3: Alex Abboud (INL)
  - Subtask 1.4: None (Closed)
  - Subtask 1.5: Rebecca Smith (INL)
  - Subtask 1.6: Robert Sindelar (SRNL)
- **Technical Leads – Task 4:**
  - Subtask 4.1: David Herman (SRNL)
  - Subtask 4.2: Evans Kitcher (INL)
- **Technical Leads – Task 5:**
  - Subtask 5.1: Brian Preussner (INL)
  - Subtask 5.2: Robert Buckingham (GA)
- **Technical Lead – Task 6:** Brett Carlsen (INL)
- **Technical Lead – Task 8:** Josh Jarrell (INL)
- **Technical Lead – Task 9:** Dan Thomas (INL)
- **CPP-603 Technical Support Staff:** Russ Cottam (Fluor Idaho)
- **DOE-EM Project Manager:** Hitesh Nigam (EM-4.23)

Battelle Energy Alliance support organizations such as Environment, Safety, and Health and Quality Assurance will be employed as well.

3. PROJECT CONTROL AND REPORTING

3.1 Project Authorization

Funding of this project is requested by INL through Work Authorization and Task Change Requests. In accordance with LWP-7390, initial work authorization was given by DOE-EM on September 6, 2017, and the approved Work Authorization and Task Change Requests are included as Appendix A of this PEP. The initial fund authorization form from October 31, 2017, is included as Appendix B of this PEP.

3.2 Activity Work Authorization

All work authorizations will be conducted in accordance with LWP-7390. The project manager will, as needed throughout the project lifecycle, continue authorizing work activities in accordance with the work breakdown structure. Task Baseline Agreements, Memorandum Purchase Orders (MPOs), and Work Orders will be issued, as needed, and approved by the project manager prior to starting work.

3.3 Performance Baseline Measurement

Project earned value will be measured by assessing the milestones completed for designated project activities. The milestone completion will be evaluated in agreement between the project manager and principal investigator. Spending plans on the activity level will be developed, and spending-based progress tracking will be employed to control the project's financial performance. Performance measurement begins when the formal baselines (scope, schedule, and cost) in this PEP have been approved, and as work is authorized.

3.4 Reporting

INL's Planning and Financial Controls prepares monthly status reports using P6, Cobra, Discoverer and BDSIS.

The project manager will report frequently (no less than bi-monthly) the activities and status of the project to Hitesh Nigam, DOE-EM 4.23.

3.5 Baseline Change Control and Management

The project will use an internal trend program to record any change history. Baseline change control will be applied to the approved performance measurement baseline in accordance with INL procedures. The project manager of INL will make the final decision on changes within the project work package.

4. SAFEGUARDS AND SECURITY

Activities performed for this project will be in accordance with LRD-11500. Environmental Management SNF TD Project personnel are responsible to comply with INL safeguards and security requirements and are responsible for the quality of the end products and results. Specifically, the use of export control and classification control will be required.

5. QUALITY ASSURANCE

The Environmental Management SNF TD Project work performed at INL shall be in accordance with QAP requirements as defined in PDD-13000 and implementing procedures. This DOE Idaho-Operations-Office approved QAP invokes and implements the requirements of:

- DOE Order 414.1D, "Quality Assurance"
- Title 10 Code of Federal Regulations, Part 830, Subpart A, "Quality Assurance Requirements" (10 CFR 830, Subpart A)
- American Society of Mechanical Engineers, Nuclear Quality Assurance Standard (NQA-1-2008/1a-2009 Edition),
- NQA-1-2008/1a-2009, Subpart 2.7, "Quality Assurance Requirements for Computer Software for Nuclear Facility Applications"
- NQA-1-2008/1a-2009, Subpart 2.14, "Quality Assurance Requirements for Commercial Grade Items and Services."

Non-INL participants must comply with INL QAP requirements as they are specified in contracts, MPOs, Memorandums of Understanding, Memorandums of Agreement, or other interface agreements.

The project manager will ensure that work performed at INL is regularly evaluated to determine compliance with applicable INL QAP requirements. Each participant (e.g., INL, SRNL)'s scope of work shall be reviewed by a program/project quality engineer or procurement quality engineer to identify the appropriate NQA-1 requirements applicable thereto. Applicable acceptance criteria for participant work products shall also be specified in contracts, MPOs, Memorandums of Understanding, Memorandums of Agreement, or other interface agreements. Applicable INL requirements such as peer review and data qualification, shall be flowed down to the interface agreements.

6. HEALTH AND SAFETY

The NEPA is our basic national charter for protection of the environment. It establishes policy, sets goals, and provides a means for carrying out the policy. INL used an environmental checklist to determine the level of NEPA documentation required for the project, and to determine any required environmental evaluations, permits, or permit modification. The environmental checklist, INL-18-048, documented that the actions of the project would not individually or cumulatively have a significant effect on the human environment, and that no environmental assessment or environmental impact statement would be required.

The Environmental Management SNF TD Project is committed to doing work safely and will conduct all work in accordance with the Integrated Safety Management [12]. All employees have the obligation to stop work any time an unsafe work condition is identified. The project manager will be notified immediately if a "stop work" is initiated. Efforts will be directed to immediately fix the unsafe condition.

7. RECORDS AND CONFIGURATION MANAGEMENT

All documents and records (e.g., controlled documents, drawings, and photographs) needing to be captured, stored, and managed to support the Environmental Management SNF TD Project will be controlled in accordance with LWP-1202,"Records Management," and LWP-1201,"Document Management. The Electronic Document Management System (EDMS) is INL's approved file location for Environmental Management SNF TD Project records. Each record is given a unique identifier and retention period according to INL's Record Types List (Appendix C).

Once a record is complete, the participant will provide the record and associated documentation to Environmental Management SNF TD Project Records Coordinator within 60 days to be retained in accordance with INL's records management procedures.

The EDMS is used by the Environmental Management SNF TD Project for storage of controlled documents. The electronic change control (eCR) process in EDMS is used for release of all controlled documents and can be used for documentation of review comments and resolution. The eCR process automatically generates compliant records of all controlled documents and document changes.

Configuration management is maintained by implementing PDD-10502, "Configuration Management Program," and LWP-10500, "Configuration Information Management," as they apply to structures, systems, components, and all facility modifications. Experiment/equipment design configuration is managed through EDMS and eCR. Each individual who makes a change to a design or document is responsible for recording that change via the formal eCR process.

In addition, markings will be applied to project controlled documents and INL-generated reports, except in the case of documents intended for public release (e.g., external reports, publications, presentations, and posters), as determined by the INL Derivative Classifier Review and/or project management. Controlled information markings are applied in accordance with LWP-11202, "Controlled Unclassified Information Program."

8. PROJECT CLOSURE

The project manager will ensure an orderly and timely closeout of the project, including any transfer of documents. Project closeout activities will be conducted in accordance with LWP- 7001, "Management of Projects."

The project acceptance and closeout phase will begin once the project deliverable(s) have been accepted and transferred to the customer.

The project manager will write the project closeout report (including a lessons-learned section) and develop a final cost report.

9. REFERENCES

1. *Aluminum Clad Spent Nuclear Fuel Long Term Dry Storage Technical Issues Project Execution Plan*, PLN-5596, May 2018.

2. *Mission & Functions Statement for the Office of Environmental Management,* U.S. DOE-EM, https://www.energy.gov/em/downloads/mission-functions-statement-office-environmental-management, current as of January 20, 2021.

3. *Mission,* U.S. DOE-EM, https://www.energy.gov/em/mission, current as of January 20, 2021.

4. *Energy and Water Development and Related Agencies Appropriations Bill, 2021,* Full Committee Print, House of Representatives, 116th Congress 2d Session, 2020.

5. *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel,* U.S. NWTRB, December 2017.

6. *Aluminum-Clad Spent Nuclear Fuel: Technical Consideration and Challenges for Extended (>50 Years) Dry Storage*, DOE/ID RPT-1575, June 2017.

7. *Aluminum Clad Spent Nuclear Fuel Long Term Dry Storage Technical Issues Action Plan – Technical and Engineering Activities*, INL/EXT-17-93408, November 2017.

8. *Aluminum Clad Spent Nuclear Fuel Long Term Dry Storage Technical Task Plan*, INL, February 2018.

9. *Preliminary Design Specification for Department of Energy Standardized Spent Nuclear Fuel Canisters*, DOE/SNF/REP-011 Rev. 3, August 1999.

10. *1995 Settlement Agreement: Overview & FAQs*, Idaho Department of Environmental Quality, https://www.deq.idaho.gov/inl-oversight/oversight-agreements/1995-settlement-agreement/ as of December 21, 2020.

11. *Test and Chemistry Plan for MEDE Treatment of Fermi-1 Blanket Materials*, INL/EXT-19-54148, July 2019.

12. *Integrated Safety Management (ISM),* U.S. DOE EHSS, https://www.energy.gov/ehss/integrated-safety-management-ism, current as of February 19, 2021.

APPENDIX A

OFFICE OF ENVIRONMENTAL MANAGEMENT – TECHNOLOGY DEVELOPMENT OFFICE (TDO) WORK AUTHORIZATION/TASK CHANGE REQUEST (TCR)

Project Number:	ID101501	Date:	Sept. 2017	AFP Change Month:	Sept. 2017
Task Title:	**Spent Nuclear Fuel Technology Development**				
Site/Contractor:	INL/BEA	TDO Program Plan Focus Area:	SNF/SNM	Attachment One contains description of Tasks 1 to 3	Technical Task Plans are due by Sept. 30, 2017

Contract Number if other than National Laboratory or DOE site contractor:
Name of Principal Investigator: INL: Mike Connolly
SRNL: Bob Sindelar

Name of Budget Analyst at the site where the contract is held:
DOE-ID, Ron Ramsey
DOE-ID, Lance LaCroix

FY17 Technology Development (TD) activities include technical and engineering studies to address knowledge gaps and identify cost efficiencies in support of continued safe management of spent fuel at Idaho and Savannah River sites. These studies will require collaboration with other National Labs and universities, leveraging EM base funded spent fuel activities, and leveraging past and present EM/NE investments in research and development capabilities. The objective of these technical and engineering studies is to ensure viability/safety of extended dry storage of DOE spent fuel, help ensure viable spent fuel management options for DOE's research test reactors, and maintaining spent nuclear fuel data and conducting related analyses. Note that the indicated funding levels are approximate and may be reallocated within the available funding depending on pending programmatic decisions and development of detailed technical evaluation plans.

Specific FY17 TD Tasks

Task#	Description	Funding
1.	Technical & engineering studies to address knowledge gaps regarding dry storage of Al-Clad fuel	$ 2,600K
2.	Technical & engineering evaluation and analysis to address spent fuel management options and challenges	$ 600K
3.	SNF data management and analysis	$ 800K

The Technical Task Plans for each FY-17 TD Task are due by 30 September, 2017. NOTE: Until the details for Technical Task Plans for each task are completed, no more than 25% of the proposed funding for any of the 4 Tasks noted above can be spent.

The minimum information to be included in the Technical Task Plans is:

a. Brief description of the problem being addressed
b. How the research addresses the need and technical approach
c. ID of Lead laboratory and/or Principal Investigator
d. Duration of total effort (if a multi-year effort)
e. Total funding needed for FY-17 (and carryover into FY-18)
f. Funding apportionment
g. Timeline
h. Deliverables along that timeline

The Office of Nuclear Materials Management (EM-4.23) commits to supplying necessary information to the Office of Technology Development (EM-3.2) to help them prepare the TD-related reports noted in the FY-17 Omnibus Budget language and Senate report 114-236.

New BA ($K) Requested	Prior Funding ($K) in this FY	Total Uncosted ($K) as of Beginning of this FY	Total Available Funding ($K) including this request (add first three columns)

4000	0	0	4000

Spend Plan for Total Available Funding (use actual costed funds for previous quarters)

1st Quarter of FY	2nd Qtr of FY	3rd Quarter of FY	4th Quarter of FY	Projected uncosted at the end of this FY
0	0	0	500	3500

Funding Codes (To be Completed by Budget Office)

Site's	Fund	Year	Allottee	Reporting Entity	SGL	Object Class	Program	Project	Amount
INL	01250	2017	02	500003	61000000	25400	1110676	00046331	$3,000,000.00

This action obligates the remaining fiscal year 2017 funding of $3,000,000.00 for the national spent fuel program. Refer to the attached TCR that obligates the initial $1,000,000.00. All other approvals are provided on the attached.

Submitted by:	Genia Mckinley, TDO Program Manager John R. Shultz, Ph.D., EM-4.23 (N/A)	Date: 9/5/17
	Headquarters Project/Task Manager (Print & Sign)	
Field:	DOE-ID: Ron Ramsey (N/A)	Date:
	Field DOE Representative (Print & Sign)	
Concurred by:	Hitesh Nigam, EM-4.23 (N/A) Steven P. Schneider, EM-4.2 (N/A)	Date:
	TDO Program Manager (Print & Sign)	
Approved by:	Rodrigo V. Rimando, Jr.	Date: 9/6/2017
	TDO Director, EM-3.2	
Submitted to:	Fatima Pashaei	Date: 9/6/2017
	EM-HQ Budget Analyst for TDD to complete AFP change	

Page 2 of 2

APPENDIX B

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                    BATTELLE ENERGY ALLIANCE             31-Oct-2017
                    FUNDS AUTHORIZATION FORM

Period Name :    OCT-FY18
Original:           Revision_number:
___________________________________________________________________________

AFP Num: 0000000018              | Non AFP Num:
Work for Others:                 | WFO Control Num:
Local Use: 0502377               | WFO Proj Num:
Stars Project: 0004633           | Agreement Num:
Program : 1110676                |               :
Fund Code: 01250                 |               :
Object Class: 25400              |               :
                                 |               :
Oracle Project Number: 102973
Project Name: National Spent Nuclear Fuel 18
WFO Customer:
___________________________________________________________________________
Comments: This notifies the project team that carryover funds remain
          uncosted from prior years.

___________________________________________________________________________

Period of Performance:  Begin: 18-AUG-17 End: 30-SEP-18
________________________________________
FUNDING                  BA            |
                                       |
Prior Year Funding:       $3,905,282.82|
_______________________________________|
PREVIOUS                            $.00|
                                       |
OCT-FY18 CHANGE                     $.00|
_______________________________________|
TOTAL AMT                 $3,905,282.82|
_______________________________________|

Funds Assigned To
Funds Manager :  WRIGHT, CHRISTOPHER
Program Control Engineer :  LINDSAY, MARCIA
Project Manager:  CARLSEN, BRETT
Funding  Admin Signature :  JNY
FOR NON-ACCEPTANCE YOU MUST REPLY TO :  JNY

***************************************************************************
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APPENDIX C

;; Security/Privacy

INL INTRANET

IHOME ;;WWW ;;Phone;;;

Records Type List
Aluminum Spent Nuclear Fuel Program

Return to Records Schedule Matrix Home

- **Plan Number:** PLN-4653
- **Point of Contact:** Mount, Judy L.
- **DRSC:** EROB 3EO104
- **Comments:** Michael Connolly U003. Record retained on EDMS and \\fserob1\projects\ASNF

UFC	Record Description	Category (ies)	Disposition Authority	Destruct Moratorium (s)	Retention (Period)	Retention (Requirement/Citation)	Quality Assurance	Media Form (s)
0000	**MANAGEMENT/ADMINISTRATION**							
0250	**Controlled Documents** The master, or record copy, and the controlled document case file.							
0250	Controlled documents pertaining to operations, programmatic, safety significance, requirements roll down, or environmental aspects including Spent Nuclear Fuels (N1-434-01-3-1). This includes one record copy of each controlled document created with related instructions and documentation showing inception, scope, and purpose of the document (i.e., case file) *Comments:* *All controlled document to be processed through DRSC and retained in EDMS*		ENV1-b-4-a		Cut off when superseded, obsolete or canceled. Destroy 75 years after cut off.	ICP only: Retain nonpermanent WIPP QA records for ten years from the date of record generation, and then disposition according to the approved DOE schedule. New Mexico Environmental Department (NMED) Waste Isolation Pilot Plant (WIPP) Hazardous Waste Facility Permit	Sitewide / QA Lifetime	
1000	**MANAGEMENT SYSTEMS**							
1150	**Procurement**							
1151	**Request for Proposal (RFP)**							
1151	Contract, requisition, purchase order, lease, and bond and surety records, including correspondence and related papers pertaining to award, administration, receipt, inspection and payment. Procurement or purchase organization copy, and related papers. Transactions at or below the simplified acquisition threshold and all construction contracts at or below $2,000.		A3-3-a-1-b		Destroy 3 years after final payment.	For ICP records only: Legal Moratorium applies Cut off after DCAA audit. Destroy 4 years after cutoff, or 3 years after final payment, whichever is longer.		
7000	**OPERATIONS AND PROGRAMS**							
7650	**Nuclear Materials Handing** Includes (but not limited to) documentation pertaining to the receipt, storage, and handling of nuclear materials; documents retained for evidential information during the fuels lifecycle until the fuel is transferred to an off-site facility. Information may also include Criticality Control Areas (CCS) documentation such as inventories, criticality safety evaluations (CSE), criticality safety assessments, and other appropriate safety analysis documentation showing normal and abnormal conditions that may affect the nuclear material.							

7652	**Spent Nuclear Fuel** These records preserve documentary evidence for the protection provided to employees, the public, property, and the environment during activities associated with storing and handing the fuel.							
7652	Off-Site Storage Facility or Final Repository Documents - The SNF project case files include records required by DOE, DOT, EPA, and/or NRC. Spent nuclear fuel records may include, but are not limited to, the following related records: a. Documents that contain unique serial numbers for each fuel handling unit, dates received, types and conditions of fuel stored characteristics of fuel storage media, (e.g., pH, Cl-), the receipt and transfer of SNF within and between onsite or offsite facilities, fuel storage locations, and storage positions. b. Records that contain fuel information questionnaires completed by the shipper documenting fuel composition, cladding, physical description of fuel, fuel packaging, fuel-handling fixtures, and shipping containers. c. Documents that provide details sufficient to determine the requirements for and record the analytical results associated with radiation shielding, thermal performance, and basis of criticality safety for the fissile material contained in spent nuclear fuels and process systems (e.g., Criticality Safety Evaluation Reports, Origen computer code data containing radionuclide mass inventory, decay heat, and dose rate information). d. Correspondence, including management review and approval letters pertinent to receipt and shipment of spent nuclear fuel. e. Drawings, specifications, photographs, non-destructive examinations (NDE) reports or review records, contract or work agreements, statements of work, audits, event documentation, permits, personnel training and qualifications documents of individuals executing program requirements, organization charts, property lists, closure plans, final reports, and procedures. f. Documentation that describes how SNF records that require long-term retention periods are being stored, including documents and programs needed to retrieve information (i.e. indices, computer programs). g. Documents that provide evidence of the quality or describe processes associated with the characterization, conditioning, and acceptance of DOE spent nuclear fuel. *Alternate Description:* *Handling and Disposition Instructions:* *All ASNF records that have reached or exceeded the retention periods will be dispositioned as follows:* *Nonpermanent QA records shall be retained for a minimum of 3 years or as specified by procurement documents, whichever is longer.*		N1-434-01-3-1	LGL (Legal)	Destroy when 75 years old or 6 years after the demise of the repository/storage facility whichever is later.		Sitewide / QA Lifetime	

	Nonpermanent QA records shall NOT be disposed of until the following conditions are met: *1. Regulatory requirements are satisfied.* *2. Operational status permits.* *3. Purchasers requirements are satisfied.* *Program/Project Records:* *Training Records* *Development Artifacts* *Comments:* *EDMS* *TRAIN* *FSEROS1*							