INL/MIS-18-32556-Revision-1

Preliminary Project Execution Plan for the TREAT LEU Fuel Conversion Project

Colleen V Shelton-Davis

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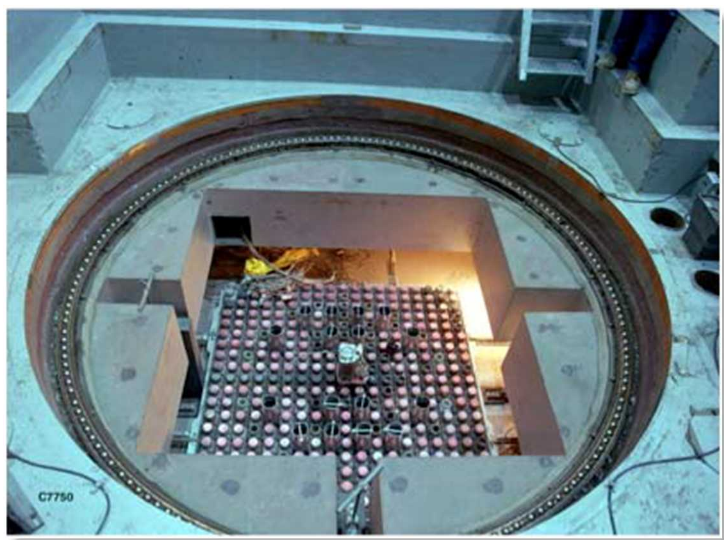
Prepared for the
U.S. Department of Energy
National Nuclear Security Administration
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Document ID: PLN-4726
Revision ID: 2
Effective Date: TBD
INL/MIS-18-32556

Project Execution Plan

Project Number: 31772

Project Execution Plan for TREAT LEU Conversion Program



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Project Execution Plan for TREAT LEU Conversion Program

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Project Number: 31772

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
0	Sep 2015	All	Initial draft release of document (Not entered into EDMS)
1	Mar 2016	iii 1 10 3, 5, 15, 23, 35 30 40	Added Signature Page Added two paragraphs to Section 1.1 Added sentence to Section 1.3.6, Item 3 Updated Figures 3, 4, 7, 8, 9, and 10 Added paragraph to Section 4.7 Updated Sections 5.11 and 5.13
2	DRAFT	All	Update all of document to reflect current program management and appropriate Project Execution Plan template.

CONTENTS

FIGURES

TABLES

ACRONYMS

ACWP	Actual Cost of Work Performed
ANL	Argonne National Laboratory
BCP	Baseline Change Proposal
BCR	Baseline Change Request
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
CNS	Consolidated Nuclear Services (or Y-12)
CSDR	Conceptual Safety Design Report
DDE	Design Demonstration Element
DNN	Defense Nuclear Nonproliferation
DOE	U.S. Department of Energy
DOE-ID	DOE Idaho Operations Office
DOE-NE	DOE Office of Nuclear Energy
DSA	Documented Safety Analysis
EA	Enterprise Architecture
eCR	Electronic Change Request
EDMS	Electronic Document Management System
FOR	Functional and Operational Requirements (document type)
FY	Fiscal Year
HEU	High-Enriched Uranium
HQ	DOE Headquarters
INL	Idaho National Laboratory
IWAD	INL Work Authorization Document
KPP	Key Performance Parameter
LANL	Los Alamos National Laboratory
LEU	Low-Enriched Uranium
LRS	Laboratory Review System
LTA	Lead Test Assemblies
LWP	Laboratory-Wide Procedure (document type)
MCP	Management Control Procedure (document type)
MMD	Major Modification Determination (document type)

N&HS	National and Homeland Security
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
PIE	Post Irradiation Examination
PNNL	Pacific Northwest National Laboratory
PSDR	Preliminary Safety Design Report
QA	Quality Assurance
QAP	Quality Assurance Program
QAPD	Quality Assurance Program Document
QAPP	Quality Assurance Program Plan
SAR	Safety Analysis Report
SOW	Statement of Work
STIMS	Scientific and Technical Information Management System
TEV	Technical Evaluation (document type)
TIE	TREAT Irradiation Experiment
TREAT	Transient Reactor Test (facility)
TWP	Task Work Plan
WBS	Work Breakdown Structure
wt%	weight percent

1. PROJECT SCOPE, SCHEDULE, AND COST

The Department of Energy (DOE) is re-establishing the capability to conduct transient testing of nuclear fuels [Lyons, 2010] at the Transient Reactor Test (TREAT) facility at Idaho National Laboratory (INL). The TREAT reactor first achieved criticality in 1959 and successfully performed many transient tests on nuclear fuel until 1994, when its operations were suspended. Resumption of operations at the TREAT facility was approved in February 2014 for meeting the DOE Office of Nuclear Energy (NE) objectives in transient testing of nuclear fuels.

The National Nuclear Security Administration's (NNSA) Office of Defense Nuclear Nonproliferation (DNN) has evaluated the efforts needed to convert TREAT from its existing high-enriched uranium (HEU) core to a new core containing low-enriched uranium (LEU) (i.e., with ^{235}U content less than 20% by weight). TREAT LEU Conversion Program objectives are to perform the design work necessary to generate LEU replacement fuel assemblies, to restore the capability to fabricate the assemblies, to qualify the fuel assembly design and fabrication process, to fabricate replacement LEU fuel assemblies, to implement the physical and operational changes required to convert the TREAT reactor to use LEU fuel element assemblies, and to replace the current HEU core with the new LEU core.

1.1 Mission Need

The DNN office in NNSA has a subprogram (Convert) that supports the mission to reduce the nuclear proliferation risk worldwide. Convert's goal is to reduce the need for HEU. This is accomplished in part by converting existing nuclear reactors that rely on HEU fuel to a LEU fuel that is comparable in performance. Converting research reactors from HEU to LEU originally began in 1978 as the Reduced Enrichment for Research and Test Reactors Program under the DOE Office of Science.

The mission of the TREAT LEU Conversion Program is to convert the DOE-regulated TREAT reactor from HEU to LEU fuel.

1.2 Program Description

The existing TREAT fuel elements were designed in two primary campaigns (hereafter referred to as the "original" and "upgrade" designs). The original and upgrade cores were designed to support two distinct mission types within TREAT. They were both designed effectively as "lifetime" cores because TREAT fuel elements undergo irradiation for short durations of time and achieve very low burn-up. TREAT conversion fuel element design inputs and requirements were gathered from original core (1950s) design efforts, along with other archival documents recovered and reviewed as part of the initial TREAT conversion efforts.

Fabrication of the original TREAT core was completed in 1959 and included 312 regular fuel elements, 266 un-fueled graphite reflector dummy assemblies, and 97 various "special" fuel elements, giving a grand total of 675 assemblies. The fuel section of each fuel element was composed of six blocks (about 4 in. square by 8 in. long) of U_3O_8 dispersed in graphite. These were stacked to form a fuel section 4 ft. in length, which was enveloped in an evacuated zircaloy-3 can. Aluminum-canned graphite reflectors and end fittings were also located above and below the fuel section to form a fuel element ~ 9 ft. long and weighing ~ 100 lb. (see Figure 1). Special-purpose fuel assemblies were similar to regular assemblies, except they included cavities for control/transient rods, gaps for hodoscope "access" viewing holes, and/or integral thermocouple instrumentation. Element assemblies are depicted in Figure 2.

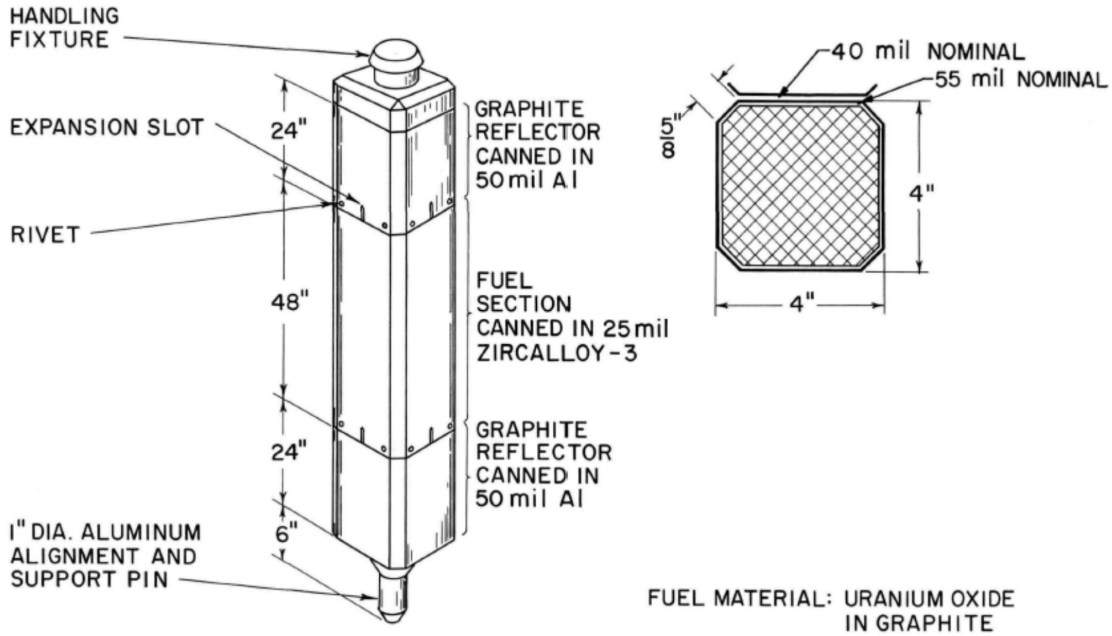

Figure 1. TREAT Original Core Fuel Element Regular Assembly.

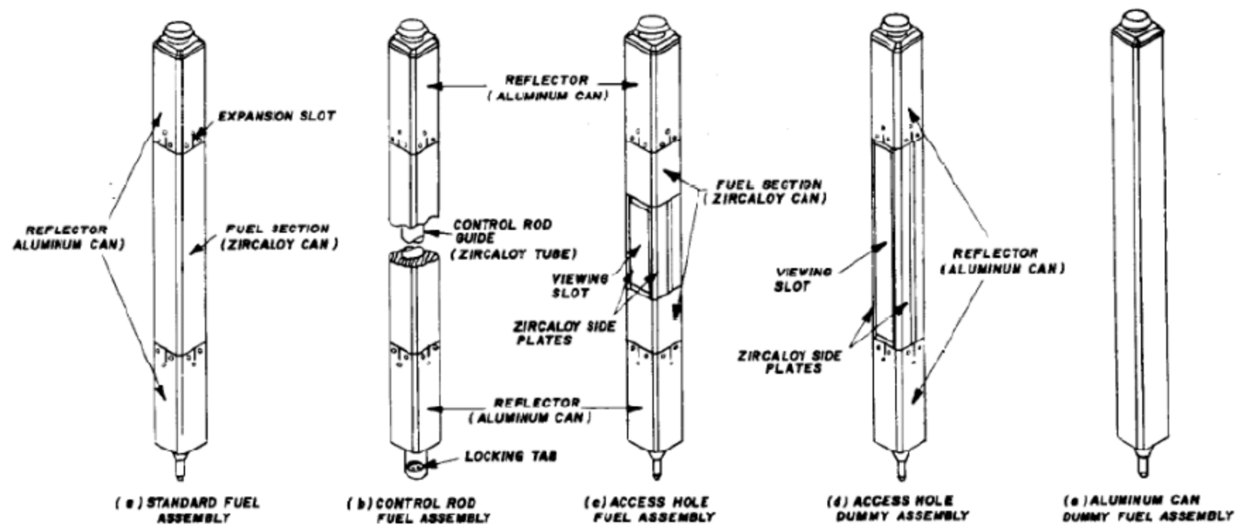

Figure 2. Types of TREAT Original Core Special Element Assemblies.

The original TREAT core first went critical in February 1959 and was used for more than 6,000 reactor startups, of which nearly 3,000 were transient irradiations. Operations were suspended in 1994, with the TREAT core having achieved approximately 0.7% burn-up. The fuel elements currently remain either in the TREAT core or in storage locations. There is sufficient fuel remaining in these elements to support an additional approximate 40-year facility lifetime [TEV-2033]. The core and key components of the reactor are shown in Figure 3.

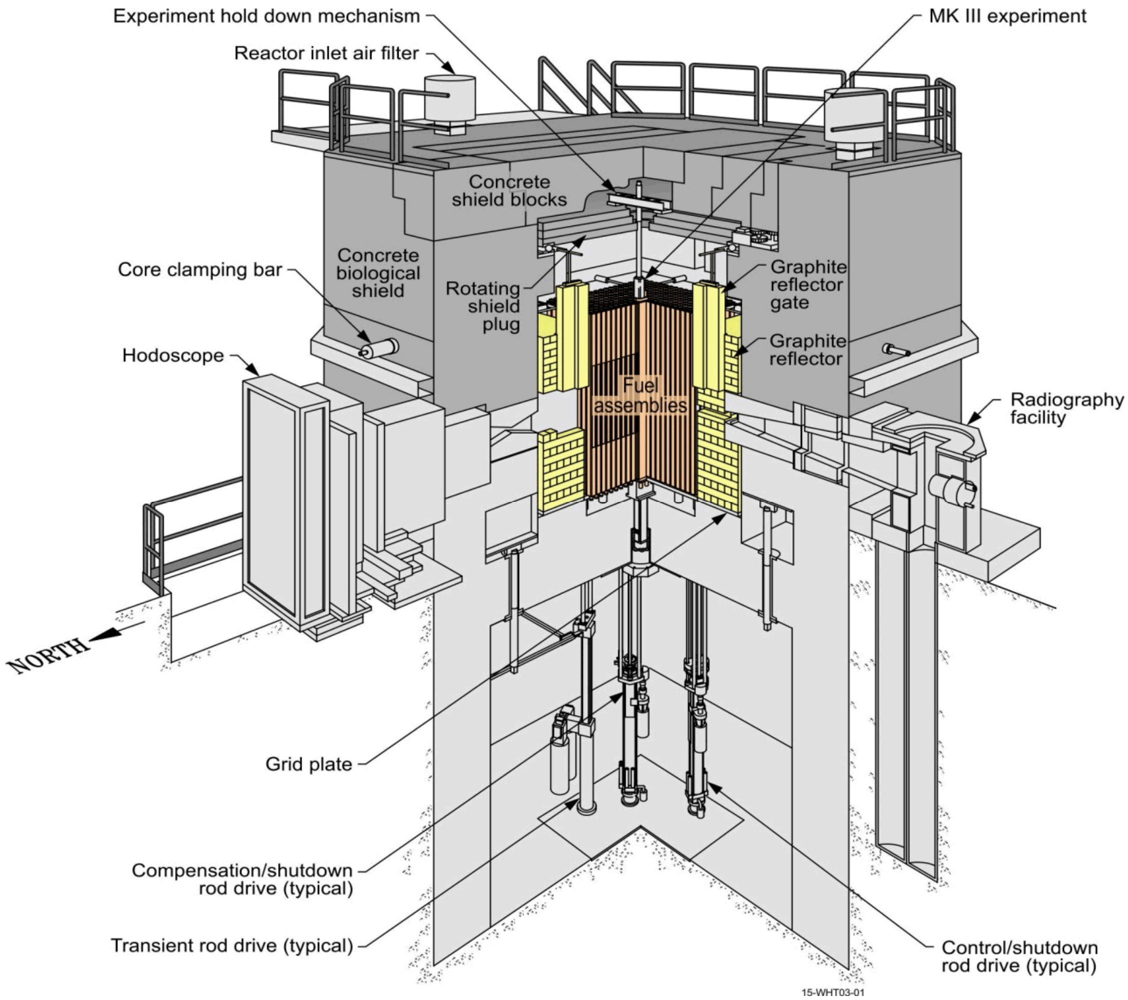

Figure 3. TREAT Reactor Cutaway.

The TREAT upgrade core was designed to accommodate a larger test section in an 8-in. diameter advanced test loop. The upgrade core was designed to retain the original TREAT fuel elements in the core's periphery, with the new upgrade elements in the center 11 × 11 ring of the reactor grid. Unlike the original elements, the standard upgrade elements contained a longer 5 ft. fuel section, composed of a 4 × 4 array of 1 in.-square HEU UO_2 in graphite fuel blocks, with graphite reflectors on the top and bottom, all canned in Inconel 625. These fuel elements also contained variable uranium loading, with those elements closest to the core center (and experiment loop) containing much greater uranium concentrations (about 0.45 to 3.2 weight percent [wt%] UO_2) than is seen in original TREAT elements (about 0.22 wt% UO_2).

The upgrade design also used axial grading to control power profiles [Wade 1982]. The TREAT upgrade fuel elements were successfully fabricated in the 1980s, but the program for which the upgrade fuel was required was suspended before the fuel was loaded into the core. These elements currently remain in storage at the TREAT facility. This fuel acquisition campaign was executed in the late 1970s through early 1980s.

1.3 Work Scope

The TREAT LEU Conversion Program will design and qualify a LEU fuel for the TREAT reactor and convert the reactor from HEU fuel to LEU fuel. A collaborative effort between INL, Argonne National Laboratory (ANL), Los Alamos National Laboratory (LANL), Consolidated Nuclear Services (CNS, or Y-12), Pacific Northwest National Laboratory (PNNL), universities, and private industry was initiated to accomplish the diverse aspects of the program. Three key performance parameters (KPPs) are used to confirm successful completion of the program, listed below. Detailed requirements derived from these KPPs are found in the Functional and Operational Requirements TREAT LEU Conversion Program [FOR-160].

1. Integrate newly designed and fabricated LEU fuel into TREAT, converting from HEU to LEU fuel with no change to core geometry.
2. Maintain adequate safety margins during normal operations (steady-state and transient) and key accident scenarios.
3. Provide key operational and functional core performance metrics to meet the scientific mission of the facility.

To support these parameters, the scope of the project includes all aspects necessary to convert the reactor and support subsequent operations. Initial activities included feasibility studies and impact assessments which have been completed and form the basis for the remainder of the program. Development of graphite fuel blocks containing LEU, including a fabrication process that will consistently produce blocks that meet the required specifications, is a significant phase in the program. In parallel to the block development, studies are being performed to select a cladding material. Design of the fuel elements, including structural, neutronic and thermal analyses, are also being performed. Once the block fabrication methodology has been defined and verified as viable for production, then efforts to setup a production line will begin. There are four processes in producing fuel elements: producing uranium oxide (as U_3O_8 or UO_2), fabricating fuel blocks, fabricating the cladding, and assembling the elements. Each product line will need to be qualified before the design demonstration elements (DDE) are made.

Qualification of the fuel will be completed through three irradiation experiments. The TREAT Irradiation Experiment (TIE) will provide information on material properties of graphite and cladding materials through end of life exposure. The data will be used as supporting information in the fuel qualification report. The DDE experiment will be used to demonstrate fuel performance characteristics in the reactor. Lastly, a lead test assembly (LTA) experiment will be completed to verify the performance demonstrated with the DDE. Results of the DDE and LTA will provide confidence that the LEU fuel meets core performance metrics necessary for the scientific mission of TREAT (KPP #3). If the results from the DDE experiment demonstrate the desired outcome for the performance and requirements for the LEU fuel, then the LTA experiment may be omitted if approved by DOE. Data from the experiments will be captured in the fuel qualification report and submitted (with the design package) to DOE for approval to qualify the fuel.

In parallel with development and qualification of the LEU fuel, analysis and documentation will be performed as part of the submittal package requesting approval to convert the reactor. Modeling of the existing core based on historical information and data from TREAT operations will serve as the benchmark for modeling the LEU core. The ANL-led team will work closely with the TREAT operations team to ensure a robust and representative model is produced. Analyses and modeling of the LEU fuel is dependent on material, component and irradiation testing which is captured in a TREAT Low Enriched Uranium Fuel Design Analysis Guide [INL/EXT-15-37074].

A major modification determination [MMD-111] was completed to evaluate the potential impact to the TREAT facility [DOE-STD-1189]. The conclusions determined that a major modification may be indicated based on a series of required assessments to evaluate increase mass, thermal resistance, changes in technical requirements, and reactor safety envelope. A safety design strategy will be prepared that presents the methodology proposed to address the potential issues if they occur. The Conceptual Design Report for the TREAT Low Enriched Uranium Conversion Program [CDR-150] (CSDR) was completed in 2016 (may be updated before submittal to DOE since the program has been delayed); a preliminary safety design report (PSDR) and associated hazard analyses will be prepared as the program matures. A final documented safety analysis (DSA) will be submitted to DOE for approval to convert TREAT (with the final design and fuel qualification documents). These safety analyses will demonstrate acceptable performance within a safe envelope during normal and accident scenarios (KPP #2). Once the final design, DSA, and fuel qualification package have been submitted, various operational readiness reviews will be performed (internally, by management, and by DOE representatives). When the reviews are approved, the HEU fuel elements will be removed, and the LEU elements will be installed. Low power physics testing will conclude the reactor conversion (KPP #1).

It is anticipated that minimal modifications will be required to TREAT facilities, supporting functions, processes and procedures to allow conversion from HEU to LEU. Should the assessments identified in MMD-111 and the subsequent safety design strategy indicate the work meets the requirements for capital asset, then a separate project will be added to this program to manage the activities according to DOE O 413.3B, "Program and Project Management for the Acquisition of Capital Assets." Fuel development and fabrication do not meet the requirements of a capital asset, but general project management principles are incorporated into the work activities.

TREAT operations began again in FY2018. With development of new reactor technologies, the scope of future TREAT operational needs is not certain; thus, the requirements for the new LEU core are not fully defined yet. A decision was made to slow the TREAT Conversion program and initiate a standby while requirements can be more fully developed. Three years of standby, followed by three years of startup, is assumed in the revised baseline presented in this program plan.

1.3.1 Program Assumptions

The work scope assumptions used to establish the program baseline are:

1. Few, if any, facility modifications other than LEU replacement of the HEU fuel will be needed for operation of the converted TREAT. This assumption is made with the expectation that the restart effort has addressed facility refurbishments through startup testing of the existing HEU fueled core (pending results of the assessments identified in MMD-111).
2. The total number of LEU and dummy fuel elements to be fabricated and installed in the TREAT reactor will be similar to the original HEU core, replacing the entire existing core. An additional set of elements will be fabricated to replace the capabilities of the upgrade core in order to meet all performance requirements.

3. Because of the potential physical degradation of the existing core, dummy fuel elements will also be replaced. They will be fabricated and installed with the LEU elements.
4. Because no complete full-scale graphite fuel manufacturing infrastructure currently exists, supplier fabrication equipment will need to be modified, procured, and/or installed to move from process evaluation to full-scale studies and fabrication.
5. Generic qualification of the TREAT LEU fuel through the Nuclear Regulatory Commission (NRC) will not be needed because TREAT is the only reactor for which this fuel would be used, and the TREAT facility is regulated by DOE.
6. An experiment with full-size elements representing various assembly configurations will be performed to demonstrate performance characteristics and compliance with requirements (DDE). A subsequent LTA will be completed to verify results from the DDE, if elected to do so.
7. It is acknowledged that the LEU fuel may generate temperatures higher than the HEU fuel. It is assumed that there will be no facility impacts due to the higher operating temperatures that will require facility modifications or replacement; analyses will be performed to confirm this assumption. Likewise, no additional cooling systems important to safety will be required to establish safety basis or operations. The cooling system may be used during operations to limit the amount of oxide growth (similar to the current SAR), but this will not be necessary for safety basis establishment or required as an operational control.
8. Existing safeguards and security plans and procedures will apply for the LEU conversion.

1.4 Schedule

In FY2018, the TREAT LEU Conversion Program baseline was revised to reflect changes in structure, development, organization, and process. It was subsequently changed to implement the program standby, assumed for three years. The program has one control account and work scope is divided into 13 discrete work packages. Project activities within each work package are defined in the resource loaded schedule. Previous completed activities have been removed from the FY2018 plan; some activities were combined, and a few were deleted based on the current status and program maturity. Below is the revised work breakdown structure (WBS) with a brief description, which is represented by the baseline schedule (the complete schedule is large and thus not included in this plan, but is available to all performers).

Major milestones are included in the life cycle schedule to define the conclusion of a specific body of work. Progress milestones are added to the working schedule each fiscal year. DNN has defined two levels of milestones: Level 0 for program accomplishment (TREAT converted) and Level 1 for the progress milestones. Level 1 is equivalent to the INL assigned external milestone E2, and Level 0 is equivalent to E1 (both defined by DOE). The major activities, milestones, and a timeline for the conversion of TREAT to LEU fuel are shown in Figure 4, TREAT Conversion Road Map.

C.D.10.01.17.01.30 Fuel Block Development

Development includes producing graphite-based LEU fuel blocks meeting the required uranium content and distribution, density, and structural integrity. Fabrication processes, chemistry, destructive and nondestructive testing are evaluated during development. Alternate fabrication methods are being investigated to optimize the process based on efficiency and product quality. Cladding material options are also being evaluated that will meet the technical requirements with minimal facility modifications for production.

C.D.10.01.17.01.31 Fuel Element Design

Design of the fuel blocks, cladding, end caps, and assembly will be completed and documented according to INL Engineering procedures. Analyses are performed iteratively with mechanical design to ensure performance and technical requirements are being met. Reviews of the design products will be periodically completed, using appropriate levels of rigor. A final design package with documented requirements, analyses, drawings, and verification and validation results will be delivered as part of the qualification package.

C.D.10.01.17.01.32 TREAT Irradiation Experiment (TIE)

The TIE will be performed to evaluate material properties through end of life. Samples will be prepared that represent the final composition and fabrication process as closely as possible. All tasks necessary to complete an irradiation experiment are included in this work package (design/fabrication of samples and test vessels, modeling and analyses, pre-irradiation characterization, irradiation, post irradiation examinations (PIE), cooling, and shipping).

C.D.10.01.17.01.33 Design Demonstration Element (DDE)

At least one element of each selected configuration will be irradiated in the TREAT reactor. Results of the DDE will demonstrate that the performance characteristics of the fuel meet the requirements. All tasks necessary to complete an irradiation experiment are included in this work package (design/fabrication of samples and test vessels, modeling and analyses, pre-irradiation characterization, irradiation, PIE, cooling, and shipping).

C.D.10.01.17.01.34 Lead Test Element (LTA)

Similar to the DDE, at least one element of each selected configuration will be irradiated in the TREAT reactor. Results of the LTA are a validation of the DDE results and serve as the last experiment. All tasks necessary to complete an irradiation experiment are included in this work package (design/fabrication of samples and test vessels, modeling and analyses, pre-irradiation characterization, irradiation, nondestructive PIE, cooling, and shipping).

C.D.10.01.17.01.35 Fuel Qualification

Approval to convert TREAT from HEU to LEU fuel will be based on a fuel qualification package, a final safety analysis report (C.D.10.01.17.01.38), and an operational readiness review (C.D.10.01.17.01.39). Activities needed to complete the fuel qualification package (a qualification report based on fuel design, material testing, and irradiation experiments; and supporting documents) are included in this work package. An independent review and comment resolution will be completed prior to submittal to DOE.

C.D.10.01.17.01.36 Fuel Element Production

Element production includes uranium oxide, graphite blocks (fueled and reflector), cladding, assembly, final inspection, and transportation. Selection of a facility and necessary modifications (if required), purchase and installation of equipment, and qualification of the process are included with each component. Once qualified, the production of the fuel elements will be performed. Purchase of materials is also included in this work package.

C.D.10.01.17.01.37 Modeling and Analysis

Modeling of the reactor and fuel (thermal, structural, neutronic, material properties) is iterative with the fuel design (C.D.10.01.17.01.31). Analyses are also used to determine performance over a wide range of conditions based on actual data from a smaller pool of test results. Modeling results will support the fuel qualification package (C.D.10.01.17.01.35) and the safety basis (C.D.10.01.17.01.38).

C.D.10.01.17.01.38 TREAT Safety Basis

A conceptual safety basis report has been completed. Preliminary safety analysis and report will be based on the DDE design and PIE results. It will be submitted to DOE for a preliminary approval prior to initiating the LTA. The final safety analyses and report will be provided to DOE with the fuel qualification package prior to the operational readiness review in preparation for approval to convert.

C.D.10.01.17.01.39 TREAT Conversion

Some modifications to the facility and the operating procedures may be required prior to conversion. Once any necessary modifications are completed, three consecutive assessments will be performed: a program internal review, a formal management assessment, and a final operational readiness review by DOE. Once the final review is complete and approved, the HEU core will be removed and the LEU core installed. A series of tests will be performed to ensure adequate operations, completing the conversion.

C.D.10.01.17.01.40 Project Management

Management of TREAT Conversion includes cost and schedule preparation, oversight of all tasks and personnel, resource management, quality assurance (QA), risk management, reporting, and interaction with the customer and other stake-holders.

C.D.10.01.17.01.41 HQ Management Support

Technical direction and response to DNN requests are included in this work package.

C.D.10.01.17.01.42 Closeout

This work package includes the activities needed to close the project: finalization of documents, records, drawings, procurement, reporting, and finances.

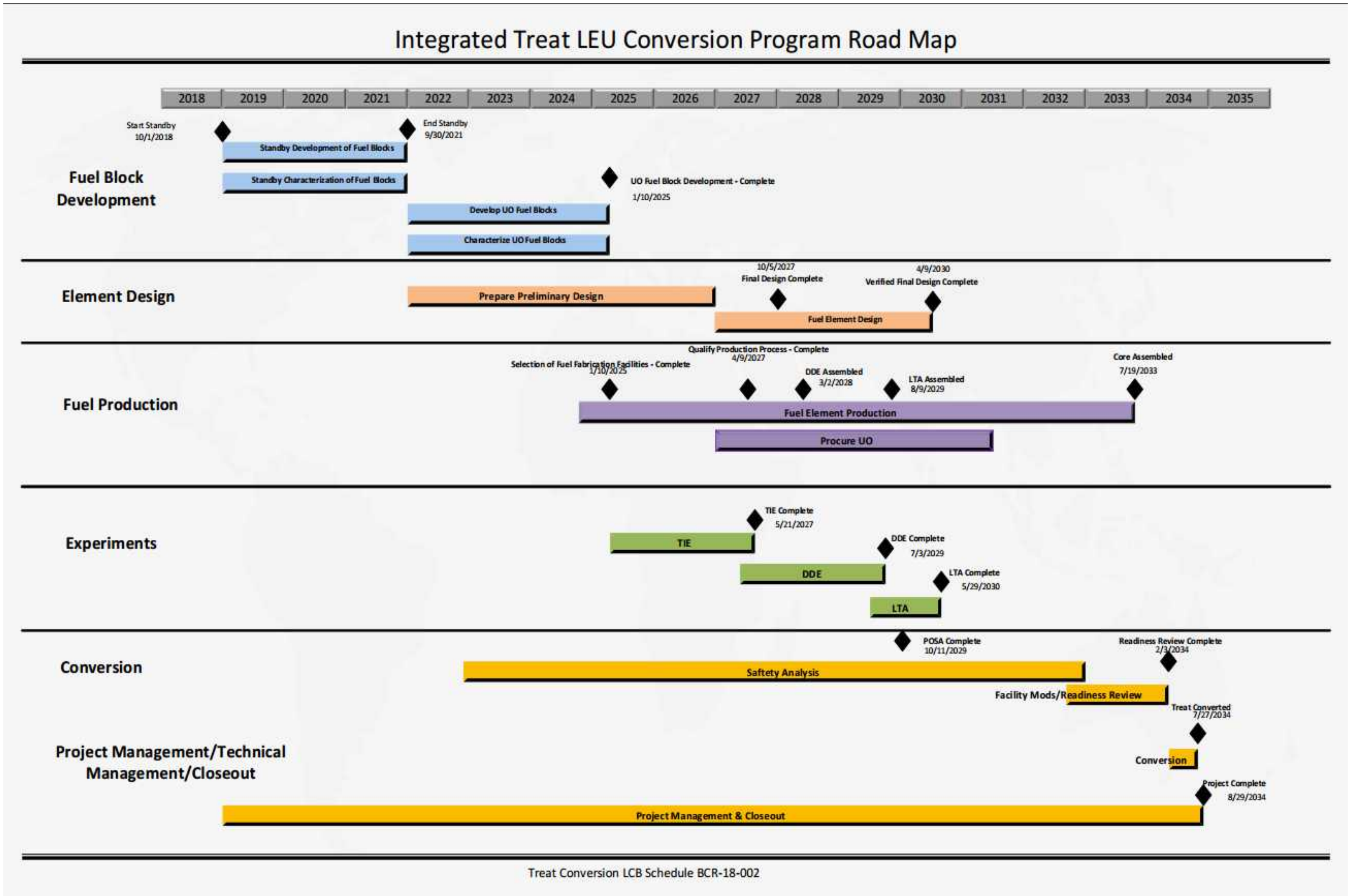

Figure 4. TREAT LEU Conversion Roadmap.

1.5 Cost Baseline

Estimated funding required for the remaining program work scope was revised based on costs to date for completed and continuing activities, additional activities to produce upgrade fuel elements, and quotes from vendors where available. Table 1 presents the actual costs through FY2018 and projected costs through the end of the program by laboratory, with a total life cycle cost estimated at about $310M. The life cycle funding profile by year is presented in Figure 5.

Table 1. Life cycle costs by laboratory for each year.

Year	INL	LANL	ANL	PNNL	TOTAL
Historical	$1,360,407	$924,447	$1,796,362	$0	$4,081,216
FY2015	$7,843,855	$462,668	$1,768,598	$202,535	$10,277,656
FY2016	$6,662,849	$472,333	$1,194,620	$21,752	$8,351,554
FY2017	$7,269,544	$753,326	$795,191	$176,398	$8,994,459
FY2018	$10,348,702	$852,167	$941,083	$101,442	$12,243,394
FY2019	$600,000	$450,000	$250,000	$0	$1,300,000
FY2020	$600,000	$450,000	$250,000	$0	$1,300,000
FY2021	$600,000	$450,000	$250,000	$0	$1,300,000
FY2022	$2,673,596	$3,735,551	$1,100,390	$100,000	$7,609,537
FY2023	$2,384,945	$3,574,353	$1,099,610	$100,000	$7,158,908
FY2024	$2,498,547	$3,035,752	$950,000	$100,000	$6,584,299
FY2025	$20,262,048	$3,569,017	$430,652	$100,000	$24,361,717
FY2026	$32,789,272	$1,093,126	$522,559	$100,000	$34,504,957
FY2027	$23,007,245	$909,087	$913,612	$100,000	$24,929,944
FY2028	$23,978,191	$892,177	$473,567	$100,000	$25,443,935
FY2029	$14,981,160	$1,166,296	$2,254,610	$100,000	$18,502,066
FY2030	$29,498,407	$773,168	$1,050,067	$100,000	$31,421,642
FY2031	$28,689,748	$638,368	$875,984	$100,000	$30,304,100
FY2032	$28,022,545	$775,081	$258,949	$100,000	$29,156,575
FY2033	$18,301,488	$368,026	$0	$100,000	$18,769,514
FY2034	$2,780,024	$0	$0	$0	$2,780,024
TOTAL	*$265,152,573*	*$25,344,943*	*$17,175,127*	*$1,702,127*	*$309,375,497*

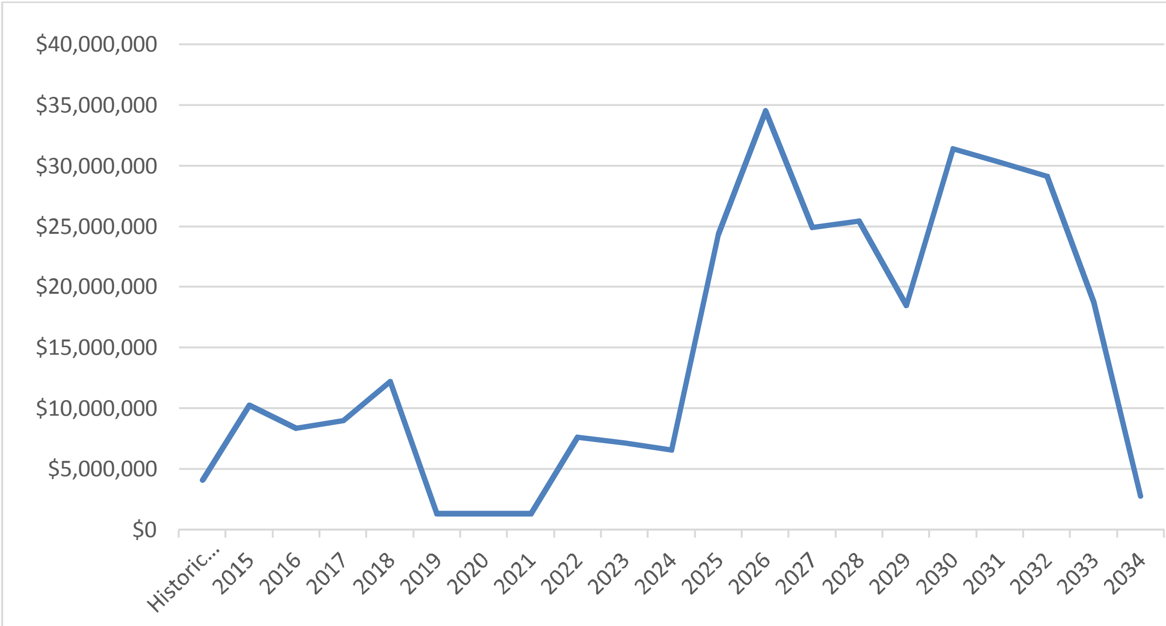

Figure 5. Life cycle funding by year.

2. PROGRAM ORGANIZATION AND INTERFACES

The TREAT LEU Conversion Program is funded by and reports to the DNN. A Federal Project Manager is assigned as the point of contact for DOE/DNN. INL is the primary contractor for the program and will perform or oversee the following activities: fuel development and design, characterization and out-of-pile analyses, irradiation testing, post irradiation examination, modeling, fuel element production, and interfaces with TREAT operations. Other national laboratories and private industry have significant roles in the development and production of a LEU core for TREAT. The interfaces and responsibilities are described below.

2.1 Program Interfaces: External and Internal

The primary customer for TREAT LEU Conversion Program is DNN within NNSA; a Federal Project Manager is assigned to the program as the customer point of contact. Figure 6 shows the relationship between the organizations and key positions.

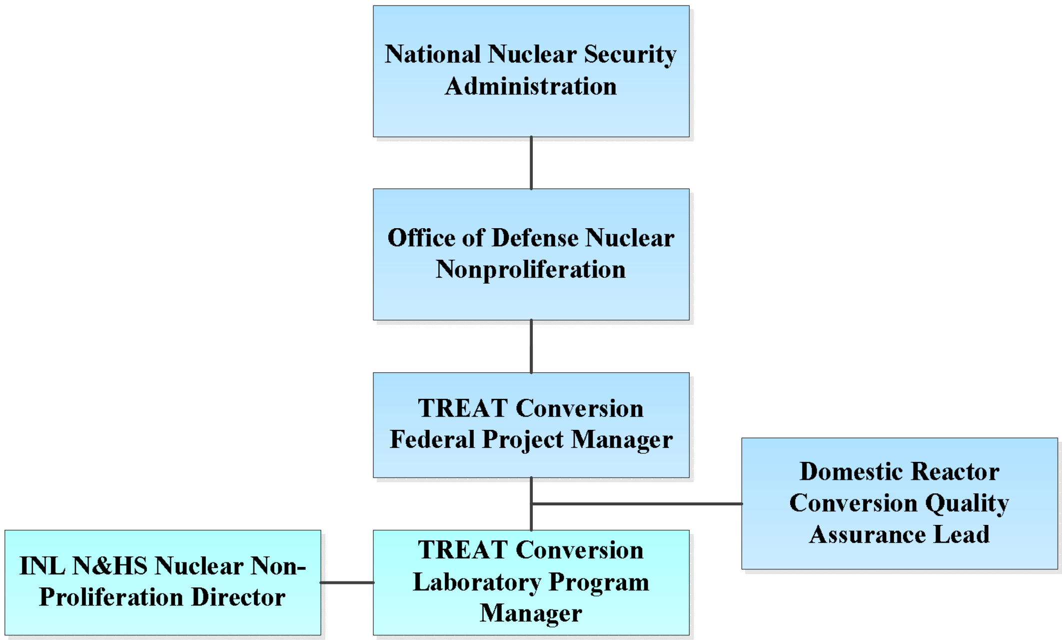

Figure 6. NNSA Organizational Relationship to TREAT LEU Conversion Program.

The TREAT Conversion Federal Project Manager is the primary interface with the TREAT Conversion Laboratory Program (INL) for DNN and oversees implementation of the program. Specific responsibilities are listed below.

- Provides guidance and resources to the Laboratory program management in order to execute the TREAT LEU Conversion Program.
- Serves as a point-of-contact for Laboratory program management in communicating with other DOE Headquarters (HQ) offices to support project execution.
- Reviews and approves project budget requests, ensures their integration within the NNSA budget submission reviews, and provides direction on proposed baseline change requests.
- Reviews and approves all program documents requiring NNSA approval.
- Ensures that technical, project control, management, and quality assurance aspects of the program are implemented appropriately.

Other external program interfaces include DOE Office of Nuclear Energy (DOE-NE), DOE Idaho Field Office (DOE-ID), LANL, ANL, CNS, PNNL (also members of the TREAT LEU Conversion Program team), fuel fabrication vendors, and universities. Interfaces external to the program but internal to INL include the TREAT operations staff and the various INL support staff. A description of the interfaces is presented in Table 2.

Table 2. TREAT LEU Conversion Program Interfaces.

Entity	Description and Relationship to Program
DOE/DNN	Sponsoring organization.
DOE-NE	DOE entity sponsoring TREAT operation.
DOE-ID	On-site DOE management of INL having responsibility for project management and execution.
ANL Modeling and Analysis	Modeling and analysis lead of TREAT LEU fuel element performance and safety basis.
LANL Fuel Development and Fabrication	Lead for developing fuel block composition and fabrication methods, out of pile testing and selection of fuel element materials, and process for final assembly and inspection of elements.
PNNL Risk Management	Prepares and maintains the risk management system, works with program management and technical staff for input to the risk database program.
CNS Uranium Oxide Production	Develops and establishes a production capability to provide the uranium oxide within the specified criteria for fuel block fabrication.
LEU Fuel Fabricators	Once selected, includes manufacturer of fuel blocks, fabricator of cladding, and final assembly and inspection of elements (will supply elements for qualification testing and new LEU core).
Universities	Primarily perform material testing (Boise State University, corrosion of cladding materials; Idaho State University, post irradiation examination support; Massachusetts Institute of Technology, irradiation experiment).
TREAT Operations	INL staff who operate and manage the TREAT reactor and will facilitate conversion to LEU fuel.

2.2 Integrated Program Team

The TREAT LEU Conversion Program is managed at the INL but is a multi-laboratory effort. Figure 6 shows the program team organizational structure through the product area leads. A summary of the responsibilities of each position is presented below in Figure 7.

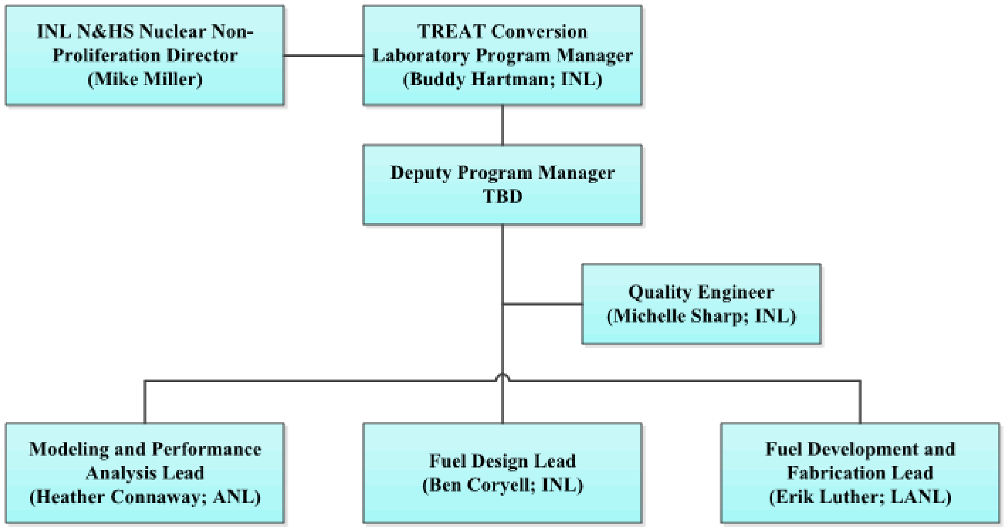

Figure 7. TREAT LEU Conversion Program Organization

- TREAT *Conversion Laboratory Program Manager* is the principal point-of-contact and has primary responsibility for developing and executing the program from the lead laboratory (INL). The Program Manager has the following responsibilities.
  - Reports internally to the INL National and Homeland Security (N&HS) Nuclear Nonproliferation Director.
  - Primary point of contact with NNSA and represents the TREAT LEU Conversion Program in interactions with DOE at all levels (ID, NE, NNSA/DNN, etc.).
  - Participates in regular meetings with management, DNN, DOE-ID, and TREAT Operations to communicate program status and issues.
  - Ensures environmental, safety, and health responsibilities and requirements are performed and integrated into the TREAT LEU Conversion Program.
  - Assures compliance with the Quality Assurance Program Plan (QAPP) for TREAT LEU Conversion Program (PLN-4728), including, but not limited to, development of quality products and records throughout the project life cycle.
  - Performs periodic management assessments of the program from an oversight and quality view point.
  - Identifies program-specific training requirements and assigns them to appropriate team members.
  - Identifies project risks with the program team, and elevates them to the TREAT Conversion Federal Project Manager when needed.
  - Assigns technical leads and recommends or approves supporting technical staff at INL as needed.
  - Provides guidance and approves research and development activities, design, analysis, major purchases, fabrication, installation, and facility modifications (if any).

- Responsible for final deliverable products developed at INL and supporting laboratories, universities, and vendors.
- Responsible for all aspects of fuel qualification (with support from technical leads and other staff): developing planning documents, performing qualification experiments, verifying documentation and data are adequate for qualification, and completing the fuel qualification report.
- Responsible for all aspects of reactor conversion (with support from technical leads, other staff, and TREAT Operations): modeling, safety analysis and subsequent reports, facility modifications (if required), readiness reviews, procedure modifications, training, fabrication of fuel elements, physical removal of HEU and insertion of LEU elements, and testing to verify operations meet requirements.
- Determines major decisions of record for the program at the laboratory level; provides relevant information and/or recommendations to DOE for their decisions of record.
- Requests internal and external reviews of program products.
- Interfaces with and directs support staff (financial controls specialist, scheduling specialist, document and records coordinator, and others as needed).
- Works with team leads to develop and approve the program annual and life cycle baselines including scope, schedule, cost estimates, milestones and deliverables.
- Manages program to ensure execution is within the approved scope, cost, and schedule; provides regular performance reports as required.
- Provides recommendations and internal approvals for change control proposals.

• *Deputy Program Manager* is the alternate point-of-contact and supports the Program Manager in developing and executing the program. Specific responsibilities are listed below.

- Reports to the Program Manager.
- Represents TREAT LEU Conversion Program when the Program Manager is unavailable.
- Participates with the Program Manager in regular meetings management, DNN, DOE-ID, and TREAT Operations, and assists in communicating program status and issues.
- Ensures environmental, safety, and health responsibilities are understood and followed by program team members as directed by the Program Manager.
- Works with the quality engineer to develop the QAPP and associated training; ensures team members comply with quality requirements.
- Verifies team members have current training (general and program-specific).
- Participates in identifying risks and interfaces with the risk management team.
- Supports Program Manager in all aspects of fuel qualification.
- Supports Program Manager in all aspects of reactor conversion.
- Provides support in planning and execution (when needed) of research and development activities, design, analysis, purchasing, fabrication, installation, and facility modifications (if any).
- Interfaces with support staff (financial controls specialist, scheduling specialist, document and records coordinator, and others as needed).
- Participates in developing the program annual and life cycle baselines including scope, schedule, cost estimates, milestones and deliverables.

- Assists in managing the program within the approved baseline and provides regular performance reports.
- Assists in preparing change control proposals.

- *Technical Leads* are assigned to specific areas based on their expertise. Each reports to the Program Manager. General responsibilities of all team leads are below. Specific responsibilities for each technical lead are presented in the subsequent sections.
  - Ensures environmental, safety, and health responsibilities are understood and followed by their team members.
  - Works with the quality engineer to ensure research processes and team members comply with quality requirements.
  - Participates in identifying risks, developing mitigation strategies, and interfaces with the risk management team.
  - Responsible for selecting team members, ensuring appropriate training is completed, and directing work activities.
  - Responsible for work performed and resulting products (data, reports, drawings, etc.) in their area of expertise.
  - Responsible for ensuring products meet technical requirements to support approval of converting TREAT to LEU fuel.
  - Supports Program Manager in all aspects of fuel qualification.
  - Supports Program Manager in all aspects of reactor conversion.
  - With input from team members, ensures necessary activities are identified and integrated into the baseline.
  - Participates in baseline planning, budget estimates, and scheduling for their area of the program.
- *Fuel Design Technical Lead:*
  - Responsible for designing LEU fuel elements that meet TREAT conversion programmatic and technical requirements.
  - Integrates various technical functions and disciplines and provides oversight to engineering work scope.
  - Ensures engineering design control processes and documentation are followed per requirements.
  - Technical point-of-contact for project engineering actions, issues, and requests.
  - Responsible for management of design requirements, specifications, drawings, and configuration management.
  - Interfaces with the TREAT facility design authority and supports planning, coordination, and performance of actual conversion.
- *Core Performance and Safety Analysis Technical Lead:*
  - Responsible for modeling and analyzing LEU fuel element designs that meet TREAT conversion programmatic and technical requirements.
  - Provides modeling and analysis to support development of fabrication capabilities for manufacturing LEU fuel elements.

- Supports analyses necessary for performing irradiation experiments for material property studies and fuel qualification.
- Responsible for modeling and analyzing LEU fuel as applied to the TREAT facilities to support reactor conversion activities.
- In cooperation with TREAT reactor analysts, performs safety analyses necessary to ensure approval by the regulator (DOE) to convert the reactor to LEU.

• *Fuel Development and Fabrication Technical Lead:*

- Responsible for developing composition and fabrication parameters for LEU fuel blocks.
- Oversees material property analysis of test blocks and potential cladding materials and responsible for ensuring materials meet specified requirements.
- Determines the fuel block composition, cladding material, and fabrication process parameters.
- Responsible for developing fabrication capabilities for manufacturing LEU fuel elements (fuel blocks, cladding, assembly, and element inspection) and participating in qualification of the production lines.
- Participates in determining the optimum location for fabricating and assembling elements.

• *Quality Engineer* reports directly to the Quality Manager as line management but is assigned to the TREAT LEU Conversion Program. Their primary role is to ensure quality is implemented appropriately and requirements are met throughout the program. Specific responsibilities are listed below.

- Reports organizationally to the QA line management and to the Program Manager for project-specific quality activities.
- Informs the Program Manager and Deputy Program Manager of quality implementation and potential deficiencies.
- Provides assistance to DNN Quality Assurance staff as needed (including participating in audits/surveillances at supporting national laboratories).
- Responsible for developing and ensuring implementation of the project QAPP.
- Provides oversight and assistance to program team concerning quality-affecting activities.
- Reviews and approves test plans and technical documents from a quality assurance perspective.
- Reviews procurement documents for appropriate application of QA requirements; approves Statements of Work (SOW) for subcontracts.
- Assists or leads regular quality assurance surveillances and audits of the program. Ensures independent internal audits are periodically performed.
- Completes an annual review of the status, effectiveness, and suitability of implementation of QA requirements within the TREAT LEU Conversion Program, and documents the results.

Other team members essential to the successful performance and management of the program include staff from several support organizations. Table 3 lists the positions with a brief description and relationship to the program.

Table 3. TREAT LEU Conversion Program Team Members.

Position	Description and Relationship to Program
Planning and Financial Controls Specialist	Supports development of program baseline, budget, funding, status, and change requests; prepares financial sections of monthly reports.
Scheduling Specialist	Supports development of program baseline and changes to the schedule; prepares interim schedule status as needed.
Records Coordinator	Assists authors as needed in preparation and issue of record documents; processes or supports document reviews via electronic change requests (eCR), Laboratory Review System (LRS) [formerly Scientific and Technical Information Management System (STIMS)], storage in Electronic Document Management System (EDMS), and transmittal forms (when used).
Training Coordinator	Assigns program-specific job codes to designated personnel as needed, supports verification of completed training and notification of delinquent training.
Requirements Management	Responsible for documenting requirements in a database, tracking to completion, and verifying the final design meets requirements.
Risk Representative	Collects information on program risks and provides to the Risk Manager (DNN assigned, PNNL), reviews assessment results, updates data as program progresses.
Design Authority	TREAT Operations person with authority to accept or reject a fuel design or product. Provides advice and support to conversion design, development and fabrication staff. May include other experts as a 'design authority team,' but retains final authority on acceptance.

3. PROJECT CONTROL AND REPORTING

3.1 Project Authorization

TREAT LEU Conversion life cycle baseline work scope, cost, and schedule has been approved by the TREAT Conversion Federal Project Manager and DNN. However, a yearly plan is developed based on current DOE budgets and expected program needs. Detailed annual work plans (including scope, cost, schedule, milestones, and deliverables) are developed by INL with input from supporting laboratories and documented in the DNN Work Packages. Work Authorization Forms (based on the approved work scope, funding, and schedule) are prepared at DNN and provided to DOE-ID (for INL funding). If a laboratory is funded directly (not via an INL subcontract), then the Work Authorization Forms are provided to the associated DOE field office. The forms are then forwarded to the laboratory for an acceptance signature. Once signed, approval to initiate work is complete. Documentation of the direct-funded work is maintained by the program through Task Work Plans (TWP). They include the work scope, cost, schedule, milestones, deliverables, and quality requirements; the plans are approved by both INL and the direct-funded laboratory.

3.2 Activity Work Authorization

The DNN Work Packages are submitted each year to request funding for the following year. Once the Work Authorization Forms are received at INL and signed, then work can be initiated. Note any unspent funding carried into the next fiscal year has been approved and is available to continue work prior to receiving new Work Authorization Forms. At INL, the approved scope, budget (including carryover funds), schedule, milestones and deliverables are then documented in the annual INL Work Authorization Document (IWAD). Each laboratory receiving direct funding is responsible for initiating work at their site based on signed Work Authorization Forms. The Program Manager is responsible for preparing the DNN Work Packages and IWADs with assistance from the Deputy Program Manager and the technical leads.

3.3 Performance Baseline Measurement

The project baseline (from the IWADs) establishes the core elements and activities required to measure performance and control the project. Throughout the fiscal year, the baseline for scope, budget, and schedule is controlled and monitored through a system of performance metrics to ensure that the approved scope is completed on time and within budget using an earned value system. Each month, all scheduled activities are statused to identify the percentage of completion for each activity. This information is entered into the INL financial system, and the budgeted cost of work performed (BCWP) is calculated. The BCWP value is compared to the budgeted cost of work scheduled (BCWS) to determine schedule variance. Further, the actual cost of work performed (ACWP) is compared to the BCWP to determine the cost variance. During each monthly reporting period, the Program Manager, Deputy Program Manager and technical leads are responsible for evaluating cost and schedule status for in-process work in terms of physical percentage complete against the baseline. The cumulative variances for cost and schedule (individually) may not vary more than plus or minus 10% from the baseline without a detailed explanation and corrective action plan.

3.4 Reporting

Two reports are provided to DNN each month. A schedule status report includes percent complete for each activity planned in the current fiscal year with a variance explanation, cumulative cost graph by laboratory, budget-cost comparison, status of all program milestones, two to four technical highlights, and a risk status summary. This same information is used for internal reporting on program status against the baseline, though DNN follows a standard calendar whereas INL uses a fiscal calendar. Status is prepared based on a standard calendar (meeting DNN requirements); thus, the INL report data are typically lagging.

A second monthly report is prepared that includes a brief discussion on results of each activity that has significant progress from the last report. This information is combined with input from other areas of the Reactor Conversion program, resulting in one final report provided to DNN (integration not performed by the TREAT LEU Conversion Program, assigned to ANL). Data for both reports and the internal baseline performance status are developed by the Technical Leads, Program Manager, Deputy Program Manager, and Financial Controls Specialist.

3.5 Baseline Change Control and Management

The program performance baseline is captured externally in the DNN work packages and internally in the IWADs. Changes in the technical work scope, cost or schedule are documented and approved through a formal process. Proposed modifications are accepted by the Program Manager prior to initiating documentation. A Baseline Change Request (BCR) form is prepared with appropriate backup information and submitted to DNN via the program SharePoint site for external review. Once approved by the

TREAT Conversion Federal Project Manager, the information is used to prepare a Baseline Change Proposal (BCP) with the associated revised IWADs, approved by the same positions as the baseline IWAD. Approval of the BCR and BCP serve as authorization to perform work according to the changed baseline.

4. RISK

Successful execution of TREAT LEU Conversion requires an understanding of risk factors and a strategy to mitigate these risks. DNN established a program-wide risk management system to identify and document risks with associated mitigation strategies, currently managed at PNNL. One individual at INL is assigned as a liaison to ensure information is captured in the risk management program correctly. Risks may be identified and characterized by all team members, but are compiled and submitted by the INL representative. The Program Manager approves all risks prior to submittal. TREAT LEU Conversion provides information to PNNL on each identified risk: cost/schedule impacts, mitigation strategies, impacts, etc. The PNNL risk team performs the evaluations, requests additional data when needed, and reports results to all applicable organizations. No actions will be taken with respect to risk management during the standby years; the existing plan (risks and mitigations) will remain as it currently stands until program re-startup. A review of the plan and associated schedule will occur at that time.

5. SAFEQUARDS AND SECURITY

Safeguards requirements are imposed to maintain accountability of fissile material. Control will be managed according to the procedures and requirements at the facilities where work is being performed. For example, characterization, testing, and conversion of TREAT at INL will be managed by INL procedures. But control during production of uranium oxide at CNS will be managed according to their requirements. The program is responsible to ensure the controls identified are sufficient and are being implemented correctly.

Release of documents to the public requires a review for classified matter, proprietary information, and export control material. This is typically performed at INL using the LRS process. Sharing of draft information between national laboratory staff working on the program is acceptable prior to the review. Currently, a LRS review is required for all final material that is to be shared outside the TREAT LEU Conversion program. Information and data obtained by collaboration efforts with TREAT operations can only be shared amongst the program with US citizens. All final and formal data and reports to be shared outside the program must go through the LRS system.

6. QUALITY ASSURANCE

All quality-affecting work defined by this plan will be performed in accordance with the "Quality Assurance Program Document (QAPD) for the Transient Reactor Test Facility (TREAT)," TREAT-QAPD-200 (to be issued), which invokes NQA-1-2008/1a-2009. Quality assurance for work specific to INL is implemented by the INL Quality Assurance Program Description [PDD-13000, QAP], which also invokes NQA-1 2008/2009 and is compliant with the QAPD. The TREAT LEU Conversion Program Manager is responsible for establishing and executing a QAP under NQA-1 (i.e., the INL QAP). Any or all of the work may be delegated to others, but the Program Manager will retain the responsibility.

A detailed matrix has been completed to map the NQA-1 requirements to INL implementing documents as defined by the QAPD and was accepted by DNN. All data used for fuel qualification and reactor conversion will be generated under the requirements of NQA-1 Part I, and applicable portions of Part II and III. Research activities may be conducted under NQA-1 Part IV, Subpart 4.2. The Quality Assurance Program Plan for the TREAT LEU Conversion Program [QAPP, PLN-4728] was developed to describe project-specific descriptions of QA-implementing processes. Implementation and applicability of all 18 NQA-1 elements are discussed in the QAPP.

Software quality requirements, suspect/counterfeit component control, and flow down of QA requirements to other participants are also addressed in the QAPP. Software approved for use on the program is listed in the INL Enterprise Architecture (EA) system. Individual software configuration items will be grouped under an EA "Application Detail Report" for work scopes that may be logically grouped together. Items listed in an "Application Detail Report" may utilize a common safety software determination and/or Quality Level Determination. Software items changed or added to the list of approved software shall follow the requirements of LWP-13620, "Managing Information Technology Assets."

Other national laboratories (primarily ANL and LANL) have similar programs that implement the QAPD and NQA-1 specific to their facilities. Quality requirements are applied to non-INL collaborators through experiment control plans, requirements documents (Functional and Operational Requirements, Technical and Functional Requirements, etc.), specifications, fabrication-control plans, contractual documents (subcontracts, work for others, Cooperative Research and Development Agreement), TWPs, and/or interface agreements. The QAPP provides additional guidance on the flow down of QA requirements.

Data quality requirements are determined based on final use of the data collected. A rigorous data control process is in place for collection, use, and archiving of data that will be used for fuel qualification or reactor safety basis. Background data, however, are treated as scoping research results. Use of background data for fuel qualification or reactor safety basis must be qualified following NQA-1 requirements for qualifying existing data. This information and process are included in MCP-2691, "Data Qualification."

7. HEALTH AND SAFETY

All research, operations, and maintenance work will be performed according to the approved company policies and procedures for radiation protection, industrial hygiene, and industrial safety. Specific hazards associated with an activity are addressed in the work control document (laboratory instruction, test plan, etc.). Every team member (including subcontract personnel) performing work on the project has stop-work authority. Each has the responsibility and authority to initiate a time out or stop work for any environmental, safety, or quality issue, as described in company procedures and employee training.

8. RECORDS AND CONFIGURATION MANAGEMENT

Project records include controlled documents, drawings, photographs, etc., that need to be captured, stored, and managed to support fuel qualification and reactor conversion. Document control, records management, and configuration control are managed according to standard INL procedures. EDMS is the INL electronic, controlled, record storage and retrieval system used by the TREAT Conversion Program for storage and revision management of controlled documents. The eCR process in EDMS is used for release of all controlled documents and can be used for documentation of review comments and resolution, and for submittal to EDMS. Data will be maintained on the program server, a quality-approved satellite file location.

9. PROGRAM CLOSURE

Program closeout will include turnover of the TREAT facility for operations once conversion of the reactor is complete. All project activities, including work orders, experiments and evaluations, procurement, reports, documentation, etc., must be finalized, issued, and closed (not just completed) before project closeout can be declared. The project team will prepare a checklist of closeout activities that need to be performed. Specific items will be determined at closeout, but the following tasks must be included:

1. Any project records not issued into EDMS or other approved storage site will be issued as part of project closeout at the completion of the project.
2. Project records will include at a minimum as-built drawings of hardware (fuel components), experiment and analyses reports, and technology development documentation.
3. Purchases and subcontracts must be closed, all materials and services received, and all payments cleared. All equipment and property must be appropriately distributed.
4. Any area cleanup and disposal activities will be completed.
5. A separate project Final Cost Report and Project Completion Report that combine and summarize the costs and completion reports from TREAT Conversion will be prepared. These reports will briefly describe significant accomplishments and lessons learned.
6. A document showing the distribution of project files will also be prepared.

10. REFERENCES

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