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Pre-Conceptual Update for the Expansion of Oxide Production at Los Alamos National Laboratory

(b)(6)

Revision 0: June 23, 2021

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Los Alamos NATIONAL LABORATORY

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Revision History

Revision	Date	Changes
0	June 30, 2020	Initial Submittal

Table of Contents

List of Acronyms and Abbreviations

ALDGS	Global Security (Associate Level Directorate)
ALDWP	Weapons Production (Associate Level Directorate)
AoA	Analysis of Alternatives
ARIES	Advanced Recovery Integrated Extraction System
CD	Critical Decision
CO	Contracting Officer
CSDR	Conceptual Safety Design Report
CTE	Critical Technology Elements
D&D	Decontamination and Decommissioning
DMO	Direct Metal Oxidation
DOE	Department of Energy
EDC	Electrolytic Decontamination
FY	Fiscal Year
GRS	Gamma Ray Isotopic Instrument
HEU	Highly Enriched Uranium
LANL	Los Alamos National Laboratory
LCCE	Life Cycle Cost Estimate
LIP	Line Item Project
MFFF	Mixed Oxide Fuel Fabrication
MIE	Major Items of Equipment
MMD	Major Modification Determination Worksheet
MOX	Mixed Oxide
MT	Metric Tons
NDA	Nondestructive Analysis
NMCA	Nuclear Materials Control and Accountability
NNSA	National Nuclear Security Administration
PDP	Pit Disassembly and Processing
PDSA	Preliminary Documented Safety Analysis
PF-4	Plutonium Facility Building 4
PPMI	Pit Production Mission Integration
PPY	Pits Per Year
PSDR	Preliminary Safety and Design Results
Pu	Plutonium
ROD	Record of Decision
SAVY	Compliant Nuclear Materials Storage Container

SDS	Safety in Design Strategy
SME	Subject Matter Expert
SPD	Surplus Plutonium Disposition
SRS	Savannah River Site
SQDP	Scope and Quantity Development Packages
TNC	Thermal Neutron Counter
TMP	Technology Maturation Plan
TRA	Technology Readiness Assessment
Triad	Triad National Security, LLC manages LANL
TRL	Technology Readiness Level
WBS	Work Breakdown Structure
WIPP	Waste Isolation Pilot Plant

Executive Summary

The purpose of this document is to update and mature the Pre-Conceptual Plan for expansion of SPD capability within Plutonium Facility Building 4 (PF-4) for optimizing production within the current rooms utilized by the Advanced Recovery Integrated Extraction System (ARIES) within PF-4 in compliance with the Contracting Officer (CO) Direction Letter regarding support of an Analysis of Alternatives (AoA) for increasing Pit Disassembly and Processing oxidation capacity (PDP) for disposition of surplus plutonium (original dated October 19, 2020 and updated version April 13, 2021).

The update and maturation of the Pre-Conceptual Plan scope will consist of defining the baseline set of equipment requirements, flow diagrams, and floor plans to support 1.5 Metric Tons (MT)/yr. oxide production capacity. Costs for the identified equipment suite will be escalated and adjusted accordingly (from FY17 to FY21 dollars). If new equipment scope that was not included in the Life Cycle Cost Estimate (LCCE) is identified and agreed upon by the National Nuclear Security Administration (NNSA), cost estimates from past projects will be used for the basis of the estimate. Assumptions will also be reviewed for applicability.

I. Introduction

The NNSA is sponsoring a federal Analysis of Alternatives (AoA) for increasing Pit Disassembly and Processing/oxidation capacity for disposition of surplus plutonium. NNSA anticipates the federal AoA will be initiated in July 2021. NNSA has requested that LANL provide an update on the preconception plans for expansion of its oxide production capability from 700 Kg to 1,500 Kgs per year.

LANL has also been requested to:

1) Update and mature the Pre-Conceptual Plan for expansion of SPD capability within PF-4 for optimizing production within the current rooms utilized by ARIES within PF-4. Identify potential areas of impacts to other program missions. Present opportunities for expansion into additional room locations where available.

The purpose of this document is to respond to that request.

II. Background

A. Overview

The Material Disposition subprogram, referred to as the Dispose subprogram, is responsible for disposing of excess nuclear material in the United States and managing the provision of nuclear material for peaceful uses. The Dispose subprogram includes activities that are necessary to support the overall program to dispose of 34 MT of surplus weapons-grade plutonium including: surveillance, monitoring, packaging of surplus pits at Pantex, and surplus nuclear weapon pit disassembly and conversion of resultant metal to oxide, which is being conducted in ARIES at LANL.

The Dispose subprogram initially planned to convert the Pu oxide into mixed oxide fuel pellets for use in nuclear reactors, but delays and escalating construction costs to the Mixed Oxide Fuel Fabrication Facility (MFFF) caused the program to evaluate alternative disposal methods. Beginning in 2016, the program initiated development of the *Surplus Plutonium Disposition Program Dilute and Dispose LANL- Lifecycle Cost Estimate,* IPM 17-070 (LCCE). The scope of this assessment assumed that pits would be disassembled, converted from Pu metal to oxide, characterized and packaged for shipment to the Savannah River Site (SRS) by LANL. SRS would be responsible for the dilution of the oxide, packaging, and shipment of material for disposal at the Waste Isolation Pilot Project (WIPP) site in New Mexico.

The Dispose subprogram will continue ongoing plutonium oxide production operations at LANL in preparation for downblending, as well as procurement and installation of several Major Items of Equipment (MIE) at LANL to improve material movement efficiency, reduce worker dose, and address risk of single point failures in ARIES. Furthermore, the Dispose subprogram will continue activities to improve PF-4 vault storage including the disposition of legacy Mixed Oxide (MOX) Fuel materials that have been in storage in PF-4 at LANL in order to make that space available for higher priority materials. These activities are considered to be the base program and will be pursued with annual expense authorizations. NNSA plans to ramp up production using this base equipment to 700 Kgs/year. A new Line Item Project (LIP) is proposed that will increase the oxidation capacity to 1500 Kg/year in the 2030s. This document provides the preconceptual plans for that new Line Item Project.

B. Mission Need Reaffirmation and Analysis of Alternatives

NNSA currently anticipates that the mission need will be reaffirmed by July 2021. The reaffirmation is a key step in initiating the activities in this strategy and is required to move forward in project space, as well as being required prior to initiating the federal AoA. This strategy assumes that mission need will be reaffirmed by July 1, 2021, and the AoA will begin in the summer of 2021.

III. Update to the Pre-Conceptual Plan

The 2017 LCCE included the expected cost to construct, operate, and maintain the facilities at LANL necessary to complete the planned plutonium oxide production operations in support of the Dilute and Dispose Program. As a result, it included an estimate for expansion of capability up to 1.5MT of oxide annually, operational costs for the program life cycle, an estimate for maintenance and replacement of aging equipment, and an estimate of the Decontamination and Decommissioning (D&D) costs at the end of the program life.

A. Scope

The updated Pre-Conceptual Plan will be limited to the equipment required to expand disassembly and conversion capabilities in PF-4, the D&D to provide space within the facility, and the construction required to place this new equipment into operation. The plan will also include a warehouse to provide staging for product cans, new shipping containers, and other production supplies. The updated plan will not include additional infrastructure at LANL, the program life cycle costs, maintenance and replacement of equipment, nor the End of Life D&D costs. Specifically it will be limited to the equipment scope required to bridge the capability gap from the current capacity of ~700 Kg to the required capacity of 1.5 MT per year. The need to update the Pre-Conceptual Plan is based upon changes to several underlying assumptions that have changed the number of pieces of equipment and their processing functions.

B. Pre-Conceptual Planning and Design

1. Pre-conceptual equipment requirements

The required equipment and infrastructure included in the original LCCE used conservative assumptions of what capabilities would be required to establish the identified throughputs. Specifically, the analysis identified 15 sets of equipment, in addition to certain facility improvements, which would be required to achieve the identified throughput levels. (b)(7)(E), (b)(7)(F) Beginning in January 2021 NNSA and LANL examined the impact upon oxide production rates of several different equipment suites to determine the best balance of disassembly, oxidation, blending, interim storage, and Non Destructive Assay (NDA) equipment. This analysis was accomplished using a series of workshops and meetings in which various alternatives were discussed and evaluated by NNSA and LANL. The unit production capability of the equipment was evaluated using a model developed LANL's Engineering Division. It is shown here as Figure 1. In addition, operating requirements which had not been fully recognized in the preparation of the LCCE were also integrated into our analysis. In particular, Nuclear Material Control and Accountability (NMCA) requires that all material which has undergone a form change such as in the oxidation process must be measured using a calorimeter and gamma ray isotopic system before the Lot is closed out. This requirement is not a significant impediment when you are operating at lower production rates; however, at higher production rates it becomes a significant impediment as you

are currently required to bagout the material from containment, have it measured at NDA, and then reintroduce it back into the containment. This process takes several work days due to the coordination requirements and disrupts the material flow.

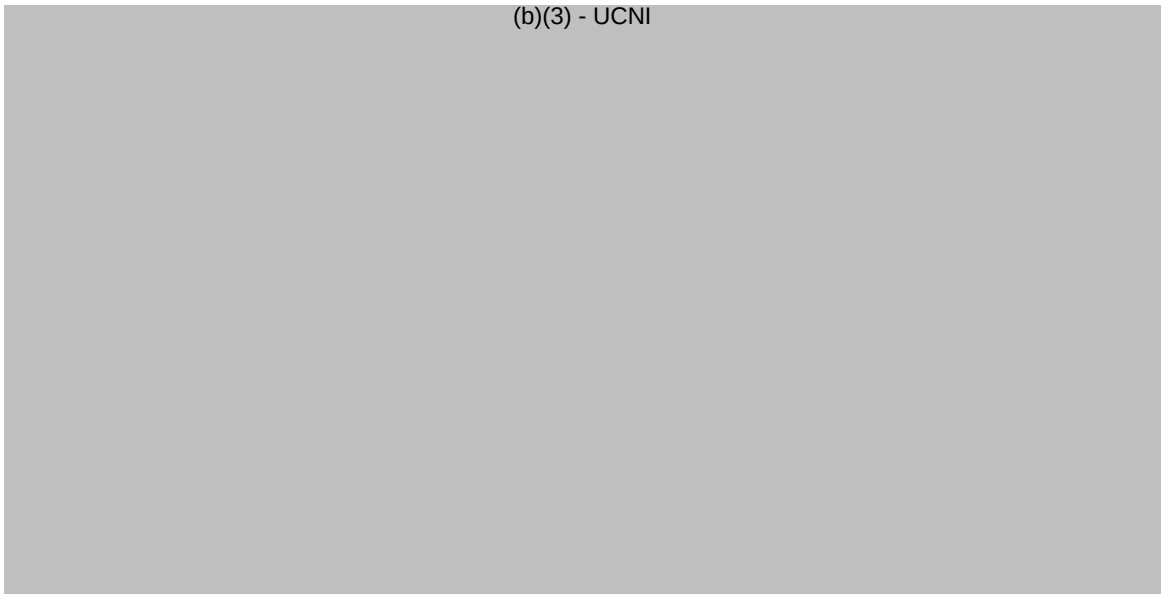


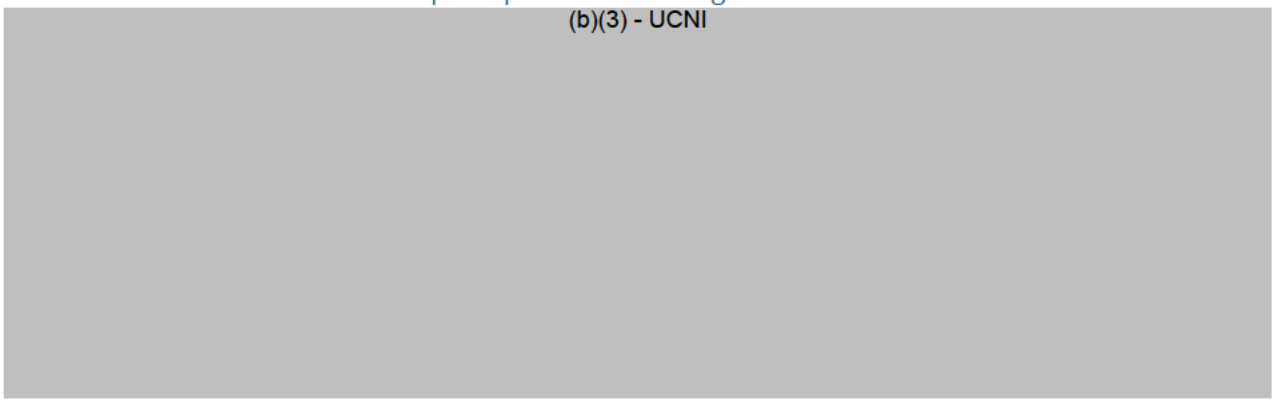
Figure 1 Capacity Bar Chart

It was determined that due to the need to perform NDA measurements on in process materials for NMCA that additional NDA equipment should be installed in the process line. This allowed the in process material to be analyzed without needing to remove it from containment and then re-introduce it back into the process line. A total of two additional calorimeters, a gamma ray isotopic instrument (GRS), and a thermal neutron counter (TNC) were added to the equipment suite. In addition, it was determined that additional blending capability should be added to reduce the cost and impact on the production schedule of moving all of the oxide produced to a single blending station. Three new Blending stations were added to the oxide processing rooms. An additional SAVY packaging station was also added to the equipment suite. The equipment suite was also optimized to decrease maintenance costs and increase the time available for operations. (b)(5)

The final listing of subprojects are shown below with both equivalent LCCE Work Breakdown Structure (WBS) and the new PDP LIP WBS. As can be seen some of the LCCE subprojects are no longer in our listing and we also have some new subprojects as discussed above.

Figure 2 Pre-Conceptual Required Equipment Listing

2. Pre-conceptual process flow diagrams



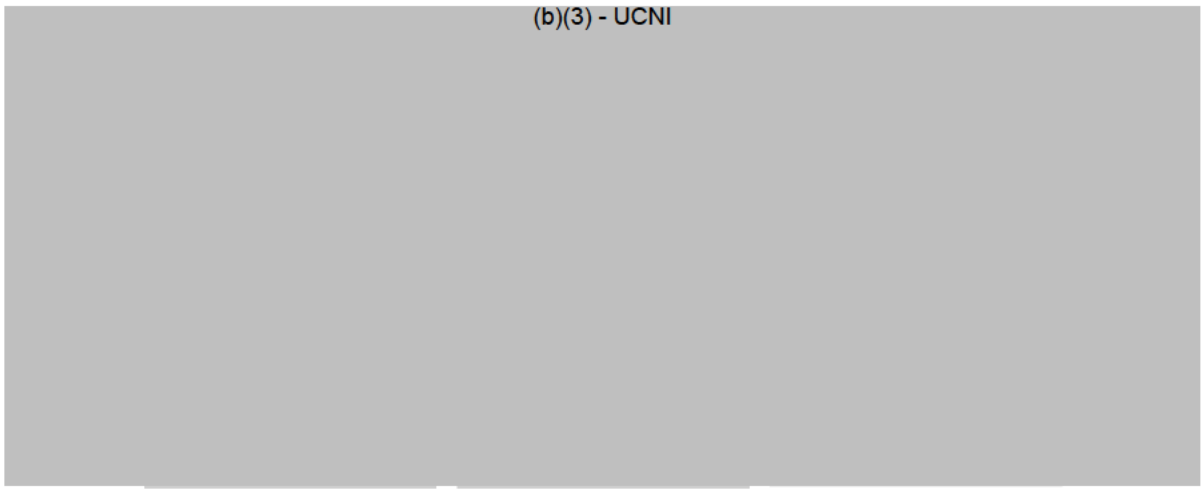


Figure 3. Proposed ARIES configuration highlighting usually expected plutonium movements (from thicker to thinner arrows).

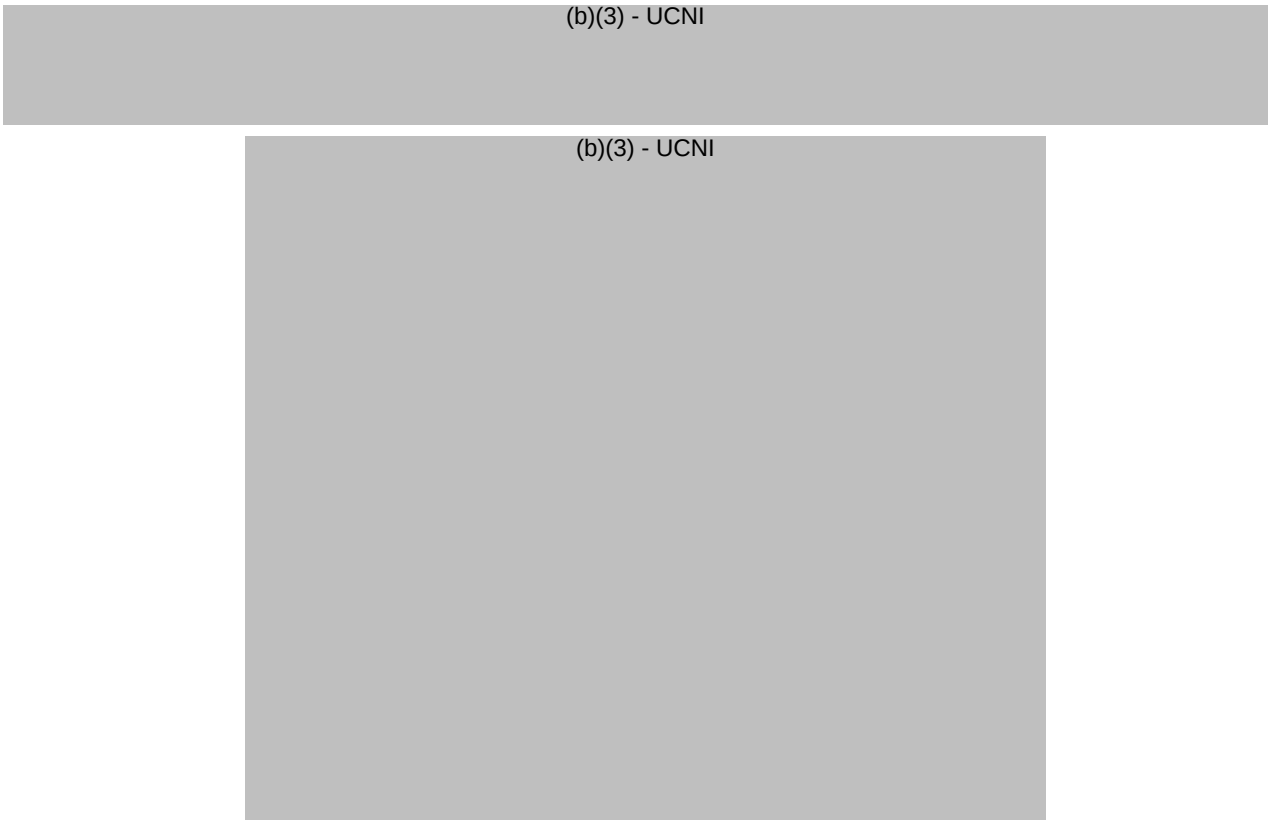
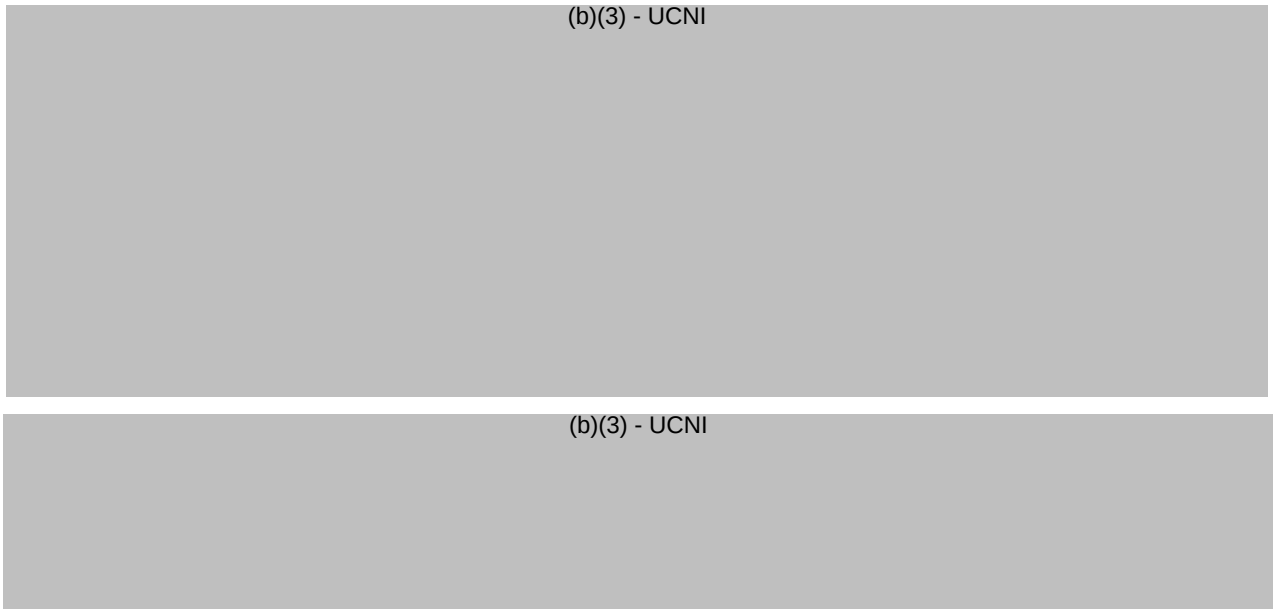


Figure 4. Current PF-4 laboratory floor layout by program and capability highlighting the ARIES-relevant trolley segments (red lines).



3. Pre-Conceptual floor plan

A number of different floor plans were evaluated by the joint NNSA and LANL team. The floor plan shown below was determined to be the best approach. It balanced the need to remain within the existing ARIES processing rooms, the need to increase raw production, the need to increase the speed of material movement, and the need minimize maintenance outage times.

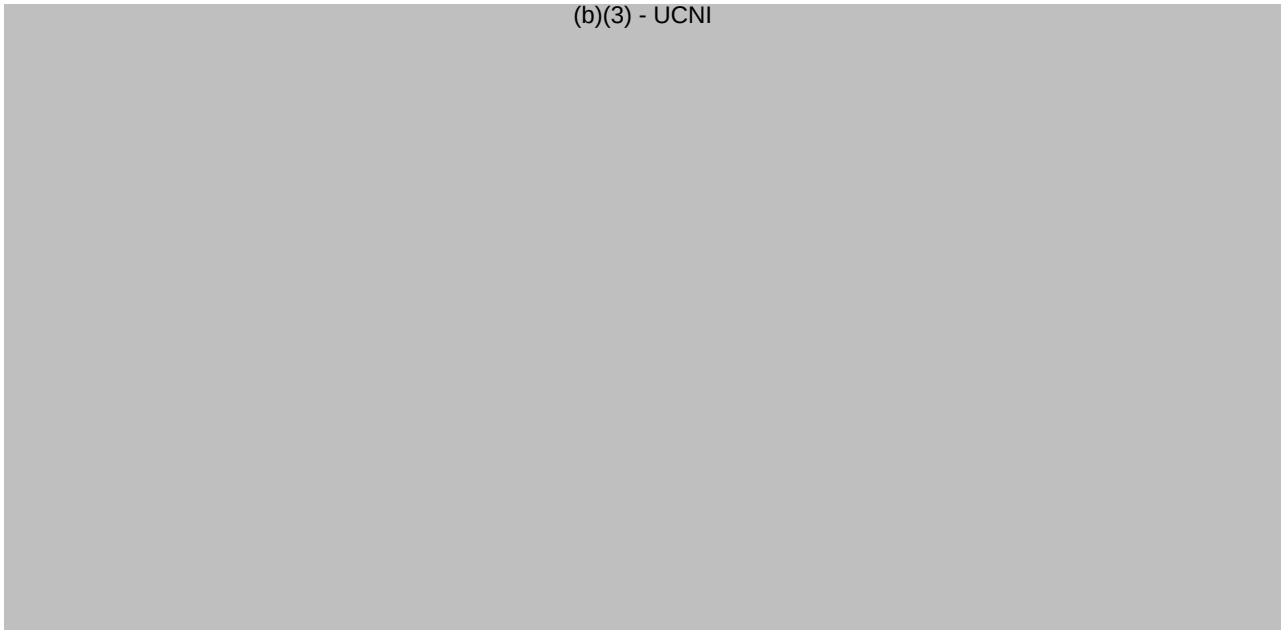


Figure 5 PDP Floor Plan

4. Identify special procurements

The majority of the equipment indicated in the required equipment listing maybe purchased using standard purchasing practices. This includes the muffle furnaces which are off the shelf commercial pieces of equipment. The lathes are also now available through commercial sources. The only exception are the calorimeters which are used as part of the NDA systems. These instruments will likely need to be constructed at the Laboratory due to the material they are measuring and the required precision of the measurements.

C. Update Technology Maturity and Development Technologies Issues List

A Technology Readiness Assessment (TRA) was conducted in August 2016 to assess the level of maturity of the technologies used in the ARIES process. The team identified Critical Technology Elements (CTE) and assigned a Technology Readiness Level (TRL) to each technology. The TRA Team identified and reviewed 59 technology elements required to complete the proposed Dilute and Dispose approach. Of the elements evaluated, 6 were identified as CTEs and deemed critical to the program. The criteria used in this evaluation examined whether the technology elements were an integral part of the program and whether the technology was new, novel, modified, or being used in a unique way. Technology Maturation Plans (TMPs) were developed for those CTEs with a TRL of 6 or lower, to formally identify development needs to support the program. All of these TMPs except the concurrent oxidation of highly enriched uranium (HEU) and Pu have been completed. This TMP is currently in process and is expected to be complete in FY22. It is currently believed that the 2016 TRA is still representative of the vast majority of the process

being proposed for the PDP Project as the equipment items have been previously identified and their TRL levels evaluated. The only exception is the new inline NDA systems which are being proposed. The NDA systems have not been previously implemented inside of a glovebox. The current ARIES NDA Table is very similar to the inline NDA systems being proposed. (b)(5)

D. Plan to Develop "Safety in Design" Expectations (DOE-STD-1189)

The requirements for safety basis support of projects are addressed in DOE-STD-1189, Integration of Safety into the Design Process, and DOE-O-413.3B, Program and Project Management for the Acquisition of Capital Assets, include several reviews and documents depending on the outcome of the major modification determination. The intent of safety basis support is to provide thorough integration of safety in the design process, and to ensure that all hazards to the public, the worker, and the environment are analyzed and managed with an appropriate control set. This project is unique from most capital projects in that the equipment installation and associated work will take place within the footprint of an existing, operational, Hazard Category 2 nuclear facility that has a DSA and TSR document. As such, a key focus of the safety basis effort will be integration of this design into the overarching safety envelope for the facility.

The end goal of the safety basis work is comprehensive hazard and accident analysis and control derivation for this project. Whether the project constitutes a major modification or not per 1189 has yet to be determined, but for the sake of reduced risk and project conservatism, the strategy assumes that the outcome will be positive. The requirements associated with a positive major modification determination are as follows:

- Major Modification Determination Worksheet (MMD)
- Safety in Design Strategy (SDS)
- Conceptual Safety Design Report (CSDR)
- Preliminary Safety and Design Results (PSDR)
- Preliminary Documented Safety Analysis (PDSA)

Many of these documents contain information that is duplicated in the existing DSA for the facility. For the sake of configuration management, only relevant new documentation will be produced. This will ensure that the remaining functions of the facility are not impacted by the project and will ensure smooth integration of the project documentation into the facility safety basis upon project completion. The following table outlines the strategy for meeting these requirements for the PDP project.

Table 1 Safety Basis Strategy

Requirement	Summary of Contents	Strategy
MMD	Worksheet from 1189 that addresses screening criteria and answers questions regarding whether or not the project	Standalone document

	should be classified as a major modification	
SDS	Requirements outlined in 1189- includes required topics and headings to meet the following requirement: "The SDS provides preliminary information on the scope of anticipated significant hazards and the general strategy for addressing those hazards. The SDS is updated throughout subsequent project phases and should contain enough detail to guide design on overarching design criteria, establish major safety structures, systems, and components, and identify significant project risks associated with the proposed facility relative to safety."	Standalone document
CSDR	CSDR requirements per 1189 include: •Hazard categorization (HC-1, 2, or 3) of the facility; •Preliminary identification and analysis of the facility hazards and DBAs; •An assessment, based on significant hazard scenarios and DBAs, of the need for safety class and safety significant hazards controls; •Consideration of inherently safer design concepts, and application of the hierarchy of controls; •Preliminary assessment of the applicable NPH design criteria; and •Approach to meeting the safety design criteria of DOE O 420.1C, Chg. 1, or approved exemptions and equivalencies.	The contents and requirements of the CSDR are largely documented in the existing facility DSA. A subsection of the SDS will address each bullet and describe where the information is contained with references to the DSA and whether it requires updating in the new project.
PSDR	1189 addresses the requirement for "DOE review and approval of Preliminary Safety and Design Results"	The safety basis submittal to meet this requirement will include a 90% draft addendum based on this design phase that

	during the preliminary design phase of the project. Requirements for section headings are outlined in 1189 Section 4.4.5.	will constitute revisions to Chapters 2-5 as necessary of the DSA and any TSR revisions. The addendum will be written to DOE-STD-3009-2014 requirements.
PDSA	1189 Appendix D	The safety basis submittal to meet this requirement will include a complete draft addendum based on final design that constitutes revisions to Chapters 2-5 as necessary of the DSA and any TSR revisions. The addendum will be written to DOE-STD-3009-2014 requirements.

E. Pre-Conceptual Risk Assessment

Risk management is a continuous process that identifies, analyzes, mitigates, reports, and tracks risks that have the potential to affect program success. The risk management process spans the entire program, from its initiation to its successful completion and closeout, including both technical and programmatic (non-technical) risks. A brief examination of the existing risks identified in support of the Surplus Plutonium Disposition (SPD) Program has been conducted in cooperation with the SPD Program Risk Management team. The majority of these identified risks were unaffected by the modifications to the equipment suite being proposed for oxide production. However, we will need to perform a more detailed review during the Conceptual Design process.

F. Pre-Conceptual Equipment Fabrication and Installation Plan

We were unable to prepare a detailed equipment fabrication and installation plan as sufficient data is not yet available. However, the equipment suite selected is primarily available from commercial vendors and it is expected that standard procurement process will be followed.

G. Updated Pre-Conceptual Cost and Schedule Estimate

The estimate to install the equipment for the expansion of LANL's oxide production capability prepared in conjunction with the preparation of the Life Cycle Cost Estimate (LCCE) has been updated to reflect the suite of process equipment discussed in Section B.1, Pre-conceptual Equipment Requirements. The same basis was used in this revision where applicable. The revised estimate has been indexed and escalated to FY21 $ and then escalated at 4% per year to the expected year of expenditure. The estimate includes allowances for Management Reserve at 10%, Contingency at 15%, and an adjustment of 100% per DOE G 413.3, Program and Project Management for the Acquisition of Capital Assets to reflect the fact that it is a Class 5 estimate. (b)(5)
A summary of the estimate by FY is shown in Appendix A. The detailed Scope and Quantity Development Packages (SQDP) are included in Appendix B.

A summary schedule has been prepared for the Project and is shown below. The schedule is a high level milestone schedule based upon LANL's previous experience with large Ling Item Projects. The cost

estimate spread of expenditures is based upon this schedule. The schedule will be revised during the preparation of the CD-1 package.

#	Activity	Date	
		Start	Finish
1	Conceptual Design	(b)(5)	
2	Assemble CD-1 Package		
3	LANL Reviews		
4	NNSA Reviews and Approvals		
5	CD-1 Approval		
6	Final Design and CD-2/3 Approval		
7	Construction		
8	Startup/Commissioning and Turnover to Operations		

Figure 6 PDP Pre-Conceptual Project Schedule

H. References

1. SRNS-TR-00295, Rev. 0, *Surplus Plutonium Disposition Technology Readiness Assessment for the National Nuclear Security Administration Dilute and Dispose Approach*, November 2016.
2. SRNS-TR-2017-00008, Revision 0, *HEU / Pu Oxidation Technology Maturation Plan*, January 2017

Appendix A Preconceptual Cost Estimate

PDP PreConceptual Cost Estimate June 23, 2021

	Project Phase		CD-1	CD-1	CD-2/3	CD-2/3	CD-2/3	Const	Const	Const	Const	Const	SU/T	SU/T	Ops
WBS	Description	Totals	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	FY 2034
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1.01.04.24															
Project Subtotal															
Management Re															
Est. Uncertainity															
Escalation @4%/															
Project Total															

Appendix B PDP SQDPs