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1	1	Design Authority L. DAYLEY	L. Dayley	5-2-00	T4-20	1	1	Ops. Manager B.D. Skeels		5/10/00	T5-09
1		Design Agent				1	1	Radcon J.E. Pieper	T. Merkel for	5/10/00	T5-57
1	1	Cog. Eng. L. Dayley	L. Dayley	5-2-00	T4-20						
1	1	Cog. Mgr. R.A. Burk	R.A. Burk	5/1/00	T4-20						
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ALARA Design Review for the Resumption of the Plutonium Finishing Plant Cementation Process Project Activities

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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Richland, Washington

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Project Enhancement Corporation

Date Published
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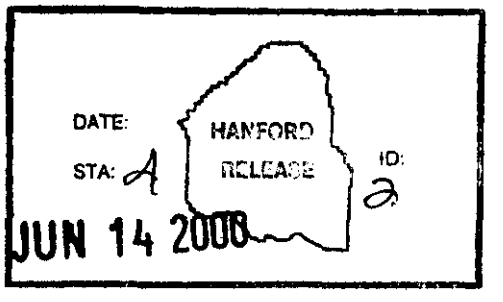

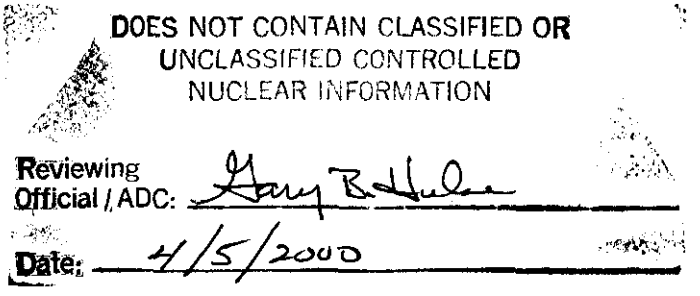

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55 TOTAL PAGES

ALARA Design Review for Resumption of PFP Cementation Process Project Activities

The Review

Attachment A

Attachment B

Attachment C

ALARA Design Review for Resumption of PFP Cementation Process Project Activities

Purpose:

The requirements for the performance of radiological design reviews are codified in 10CFR835, *Occupational Radiation Protection.* The basic requirements for the performance of ALARA design reviews are presented in the Hanford Site Radiological Control Manual (HSRCM). The HSRCM has established trigger levels requiring radiological reviews of non-routine or complex work activities. These requirements are implemented in site procedures HNF-PRO-1622 and 1623. HNF-PRO-1622 *Radiological Design Review Process* requires that "radiological design reviews [be performed] of new facilities and equipment and modifications of existing facilities and equipment". In addition, HNF-PRO-1623 *Radiological Work Planning Process* requires a formal ALARA Review for planned activities that are estimated to exceed 1 person-rem total Dose Equivalent (DE).

The purpose of this review is to validate that the original design for the PFP Cementation Process ensures that the principles of ALARA (**A**s **L**ow **A**s **R**easonably **A**chievable) were included in the original project design. That is, that the design and operation of existing Cementation Process equipment and processes allows for the minimization of personnel exposure in its operation, maintenance and decommissioning and that the generation of radioactive waste is kept to a minimum.

Scope:

The scope of this review is to re-validate and document ALARA design considerations for the successful resumption of the previously suspended PFP Cementation Process Project.

The PFP Cementation Process Project was originally started in the Fall of 1996. It was subsequently put on hold due to a self-imposed stand-down of operations by BWHC to correct observed plant performance deficiencies. The PFP Stabilization and Deactivation Project successfully restarted plutonium stabilization and packaging in January 1999.

The PFP Cementation Process was designed to immobilize Pu bearing Sand, Slag, and Crucible (SS&C) and other residues (SNM of less than 30 wt-percent Pu) stored in the PFP vaults in cement. Stabilizing this material will facilitate disposal of the material as either TRU/M or TRU waste and reduce worker exposure. This project is one of several modifications being undertaken by PFP Solutions/Residues Stabilization Project to stabilize Plutonium solutions and solids in support of the PFP Integrated Project Management Plan (IPMP). Plutonium currently stored at PFP must be stabilized for long-term storage and eventual shipment to the Savannah River Site for final disposition (>30% Pu) or packaged for long term storage and eventual shipment. Solid waste

generated by these processes will be sent to WIPP (TRU/M or TRU) or to Low Level Waste by the onsite management interface.

The material to be cemented (i.e. SS&C) will be removed from the vaults, assayed via Non-Destructive Analysis (NDA) and transported to an existing Glove Box, HA-20MB, for cementation. Cemented material, after curing, will be sealed out of the Glove Box or it's associated conveyor. The cemented cans will be put into waste drums containing a Pipe Overpack Container (POC). The TRU waste drums will be stored for later shipment to the Waste Isolation Pilot Project (WIPP).

This ALARA design review is limited to those operational and maintenance activities conducted during the removal of the SS&C material from the vaults, transport to and from NDA, transport to the Glove Box, cementation activities in the Glove Box, and final packaging and transport to the onsite storage location. Other residues, Ash and Oxides will be covered under a separate review once further information is available.

ALARA Review Methodology

The radiological design review process at Hanford and PFP are conducted at two levels:

(1) Minor modifications of existing facilities, and
(2) Major modifications of existing facilities or new facilities.

Minor modifications are those changes that are not expected to result in significant personnel dose during installation, operation and maintenance. The review of such activities is normally conducted as part of the routine radiological work planning process per HNF-PRO-1623 (Reference 2).

Major modifications to existing facilities are defined as "A physical change to a structure, set of structures or system(s) that could result in either a change in collective radiation exposure due to installation, maintenance and operations of 1 person-rem TEDE [Total Effective Dose Equivalent] or greater or a change in collective extremity dose of 10 person-rem or greater over the life of the project." The review of such changes requires a structured radiological design review process per HNF-PRO-1621, 1622 and 1623 (References 2,3 and 4)

Furthermore, a major modification is required to have a radiological engineer as a member of the design team if the modification meets any of the following criteria:

- The whole body collective dose for installation, maintenance and operation of the modification might reasonably be expected to exceed 5 person-rem over the life of the project.
- The collective extremity dose for installation might reasonably be expected to exceed 50 rem over the life of the modification.

- The modification meets the criteria for a radiological design review, and the radiological control manager feels that the modification is sufficiently complex or risky to warrant having a radiological engineer on the design team.

Based on current program requirements, the PFP Cementation Process Project would have been classified as a major modification that required a radiological engineer on its design team based on both its potential exposure to PFP personnel and the significance and uniqueness of the process to PFP. At the time of the original project implementation, B&W Hanford Company assigned a member of the PFP Radiological Engineering staff to this project. Once it was determined that a project restart was planned and the project designated as a former major modification, thus establishing the need for a radiological design review, a new PFP Radiological Engineer was assigned to the project. A contract radiological engineer was later assigned to support this individual.

Review of current site and PFP ALARA Design Requirements requires that a choice must be made for which ALARA Decision-Making Methods will be used. As described in HNF-PRO-1621, *ALARA Decision-Making Methods,* there are currently three methods approved for use at Hanford:

(1) Standard Decision Making Method
(2) Decision-Making Using Cost-Benefit Analysis
(3) Decision-Making Using an ALARA Decision Team

Of the three available methods, method three (3) was chosen as the most appropriate method utilized during the original project design. Furthermore, based on the review of past data, it appears to be equally applicable today, and has thus been utilized as part of the restart project.

"This method is appropriate at the stage of design or work planning where many small decisions about the design or task would likely make a significant affect on the exposure due to installation, maintenance and operations, but where the use of other decision making techniques would be prohibitively difficult because of the number of relatively small decisions to be made."

Although it would not be accurate to characterize the decision making process for the cementation project as being "prohibitively difficult" to analyze due to the large number of "relatively small decisions to be made", it is entirely appropriate to characterize this project as one whose "whole is greater than the sum of its parts". That is, the design effort is focused on making the glovebox and cementation process work together to ensure a more radiologically acceptable product. Such an effort is not best characterized/evaluated by cost-benefit analysis alone (although small decisions may be driven by ALARA cost-benefit considerations).

Since the DNFSB 94-1 Implementation Plan had identified cementation as the process of choice for SS&C, and because of the nature of this project (i.e., ensuring that the

glovebox modifications and cementation process is ALARA, rather than determining which glovebox design and process is more ALARA), evaluation under the ALARA Decision Team process appears appropriate.

Decision-Making Using an ALARA Decision Team

HNF-PRO-1622, *Radiological Design Review Process,* outlines the 12 basic steps to be taken for the performance of a radiological design review (Figure 1). Backup documentation (such as meeting minutes, design drawings, memorandums, and such) is contained in the FHI cementation project file (which is maintained according to the FHI record retention process). This information shall stand as documentation for the performance of the individual steps required for the radiological design review process (or to show how the intent of each step was followed).

For the sake of brevity, and to eliminate redundancy, no copies of these documents have been attached to this radiological design review package (unless these documents are germane to the understanding of this ALARA design review package). However, a brief synopsis is provided herein to demonstrate how the intent of each step was met.

Initial Radiological Input to Early Project Conception

During the original phases of the Cementation Process Project, the PFP Radiological Control Manager worked with the FHI Design Decision Authority by assigning a member of his radiological engineering staff to work with the design team (comprised of engineers, designers, operators, and managers from B&W Hanford Company and FHI. The radiological engineer was an integral part of the design team and participated actively. A review of the documentation and discussions with design team members indicate that the radiological engineer was involved intimately in major decisions. In addition, the Design Authority ensured that the budget contained resources necessary to cover the expected costs of the radiological design review and any preliminary ALARA controls identified in the System Design Description (SDD) or in conceptual design meetings. These functions are currently being performed through the Project Cognizant Engineer and the assigned PFP Radiological Engineer.

Design Review Process and Schedule

The former FHI Design Authority and the current Cognizant Engineer maintains a project schedule, which delineates the key steps in the ALARA design review process. Although this schedule is not driven primarily by the design review process, the schedule none-the-less accounts for major design review steps (for example, activity timelines and engineering controls evaluation). As required by HNF-PRO-1622, a "Basic Design Review Checklist" was completed for the Cementation Process and is provided as Attachment 1 to this document.

Functions and requirements

A System Design Description (SDD) for the Cementation Process Project was issued by PFP Process Engineering (Ref. 5). The purpose of this document is to address the specific scope and location of the project, provide its justification, delineate the integration of the project, describe the equipment and the processes involved, provide equipment performance characteristics and criteria, and outline the design criteria to be used for components and systems. This document either provides the criteria itself or directs the reader with specific references.

The SDD received a formal review by the PFP Radiological Engineering staff as part of the formal document review and approval process. The Cognizant Engineer is currently revising this project document. No significant radiological issues were outstanding at the time of its finalization.

Process Flow Document or Other Description of Process

In addition to the information contained in the SDD, other documents exist that pertain to process descriptions. Two such documents include the *Process Flow Document (PFD) for the Cementation Process* and the *Operating Specification Document (OSD) for the Cementation process.* Based on these two documents, the SDD and discussions with representatives of PFP Projects, PFP Solution/Residues Stabilization Operations and PFP Engineering, the radiological engineer developed a process timeline, Attachment 2, Cementation Project Dose Summary, Timeline and Assumptions. This timeline was then used to determine the radiological exposure and dose expected from the operation of the Cementation glove box, Attachment 3, *ALARA Design Review Dose Estimate Table.*

Expected activities, concentrations, dose rates and other assumptions were derived from various documents (See references 6-9) and discussions with project personnel.

Design Specifications (or Criteria)
Conceptual/Preliminary Design

Design drawings to be used in the modification of the original glove box and process equipment were reviewed by the original Radiological Engineer. Several recommendations were made by the radiological engineer on the glovebox design and process operation. Design considerations were incorporated into the modification specification for the glovebox. These recommendations were made by formal documentation between the radiological engineer and the design engineers as part of the ALARA Assessment for the Cementation Process Project (Ref. 6).

Final Design

Final design specifications were incorporated into the SDD (Ref 5).

Preparation of Dose Estimates

A design criterion of 1,000 mrem/yr (TEDE) was utilized when evaluating engineering controls for work at/in the glovebox. This is consistent with 10CFR 835 and HSRCM requirements.

Dose estimates were performed using the information derived from the process timeline, available survey documentation, discussions with experienced operations and radiological controls personnel and source dose rate calculations provided by References 6, 7 and 8. A Microsoft Excel spreadsheet was developed to easily evaluate the impact on worker dose from changes in Pu concentration, source dose rates, number of batches processed, and process times (Attachment 3).

Based on using the most likely scenario of processing 2 batches per shift of containers having 50-60 g of Pu material, assuming a shift complement of five operators per shift for two shifts, and a work off rate of two batches per shift, an operator would be likely to receive approximately 570 **mrem/year** above ambient background levels. Taking ambient background levels into consideration for process areas, an operator would be likely to receive approximately 850 **mrem/yr**.

> NOTE: The 850 **mrem/year** is based solely on the operator's incremental exposure received while assigned to the Cementation project. Any additional exposure the operator receives while assigned to other projects during the year has not been included here.

Re-Start Testing

The Project Cognizant Engineer is developing a procedure to outline the functional testing required of the glovebox and process equipment. This test will be reviewed by PFP radiological engineering prior to its implementation.

This procedure will include steps to ensure that assumptions made in the radiological design review process were accurate. Such radiological steps will include, but not be limited to:

(1) time - motion reviews
(2) gamma and neutron dose rate measurements
(3) effectiveness of engineering controls

Post Re-Start – Review of Effectiveness

HNF-PRO-1622 states that "after one year of operation of the equipment for which a design was done, the Radiological Control Manager shall ensure that the effectiveness of the design radiological measures are reviewed". However, since this project is likely to have less than a 4-year life, waiting one year for post construction review of effectiveness is not acceptable.

At the end of 6 months of full time operations (after the initial "break-in period"), the PFP Radiological Engineering staff will provide a review of the effectiveness of ALARA design parameters for equipment and process operations. This review should entail the following parameters:

(1) A review of radiological conditions, including:

- a- Confirmatory surveys of actual dose rates, contamination levels and airborne contamination levels. This should include a review of routine survey data collected during operations.
- b- Comparison of actual to expected dose rates and contamination levels.
- c- Evaluation of individual and collective dose based on operational data.
- d- Explanation of significant differences.

(2) A discussion of any unexpected facility and/or equipment layout problems, or any unexpected construction, maintenance or operational problems **with radiological consequences.** This can be determined by

- a- Evaluating the effectiveness of glovebox and process equipment
- b- Reviewing process operations to determine if physical and/or procedural modifications can be made to improve worker efficiency and hence lower exposure

(3) Recommendations for future equipment design and operations

Note: Due to the nature of this process, it is not necessary to suspend operations while performing this review.

Individual and Area Monitoring

During routine operations, individual and area monitoring will be used to demonstrate that the basic radiation dose limits are not exceeded and that the exposure levels are ALARA. The existing operational ALARA program and radiation control program will be used to implement this process.

ALARA Design Considerations

During the design and operational preparations for the original cementation process run, ALARA considerations were recommended and instituted to decrease the expected dose. A summary of these actions are provided below:

Minimize Operator Time at Glove box in Gloves

- Feed with auger instead of hand feeding
- Equipment switches outside the glove box
- Valves outside glove box, where possible
- Remote temperature sensors
- Mixing by machine versus hand
- Sphincter port installed for product can and cement insertion
- Commercial can opener to open cans versus a hand opener

Optimize Operator Dose

- Equipment grouped on side of glove box with lowest background dose contribution
- Shielding provided on most used side of glove box
- Water shields provided to reduce background dose from HA-23S Glove box
- Cleanout of the HA-20MB Glove box and adjacent glove boxes to improve background levels

Process Controls

- Higher dose items sent to Los Alamos for reprocessing
- Blend Plan limits items for cementing to <60g Pu per item.
- Maximum batch sizes used, where possible
- Use of larger slip lid can to cement material and reduce total number of containers and associated dose

Current Recommendations

As a result of this ALARA review, the following ALARA recommendations are provided to further promote the ALARA philosophy and reduce personnel dose.

1) Consideration should be given to using additional engineering controls to minimize the spread of contamination and

generation of airborne radioactivity during seal outs from the conveyor and during the opening of the lard cans.

- Add a seal in port on the conveyer HA-28, east of Glovebox HA-20MB. Build a containment structure at this location to use for opening the lard cans and sealing in the individual containers. This containment can also be used to seal out cemented billets and load them into the pipe overpack containers.

2) Consideration should be given to further reducing background radiation levels around the Cementation Glove box. Background radiation accounts for more than a third of the dose being picked up by project personnel. Consideration should be given to eliminating or reducing background radiation levels through

- Adding additional shielding to reduce the impact from radiation scatter or shine from near by equipment,
- Flushing /decontamination of lines and ventilation ducts to reduce contribution to background levels, and
- Conducting seal ins and seal outs in lower background areas and not near the glove box.

3) Consideration should be given to further reducing task cycles by maximizing and consolidating materials during transport, elimination of multiple redundant activities (i.e. NDA) and pursuing improvements in work processes and special tooling to reduce time spent in radiation fields.

4) Consideration should be given to promoting the consistent application and use of lead aprons and gloves for all process tasks to help reduce chronic exposure from low energy x-rays.

5) Consideration should be given to improving the plants ability to track, trend and alert personnel of radiation fields and dose they are being exposed to during project work. The plant should investigate the use of improved electronic dosimetry to provide feed back to workers (i.e. chirping) and data to decision makers so they can make informed decisions on the best utilization of worker dose in accomplishing plant priorities on a real time basis.

6) Consideration should be given to finalizing the design and construction of new, shielded transfer wagons to further reduce personnel dose during material transport.

References:

1) 10CFR835, Occupational Radiation Protection
2) HNF-PRO-1623, Radiological Work Planning Process
3) HNF-PRO-1622, Radiological Design Review Process
4) HNF-PRO-1621, ALARA Decision Making Methods
5) System Design Description for the Cementation Process project, HNF-SD-CP-SDD-020
6) ALARA Assessment for HA-20MB Cementation Process, Internal Memo 15530-96-MWG-099, 9/96
7) PFP Stabilization Dose Equivalent Estimate, Mel Chew, 1995
8) Analysis of Immobilization Alternatives, EIS-0244-F
9) PFP Survey Data for Vaults and Cementation Glove Box Background, 2/00

Figures:

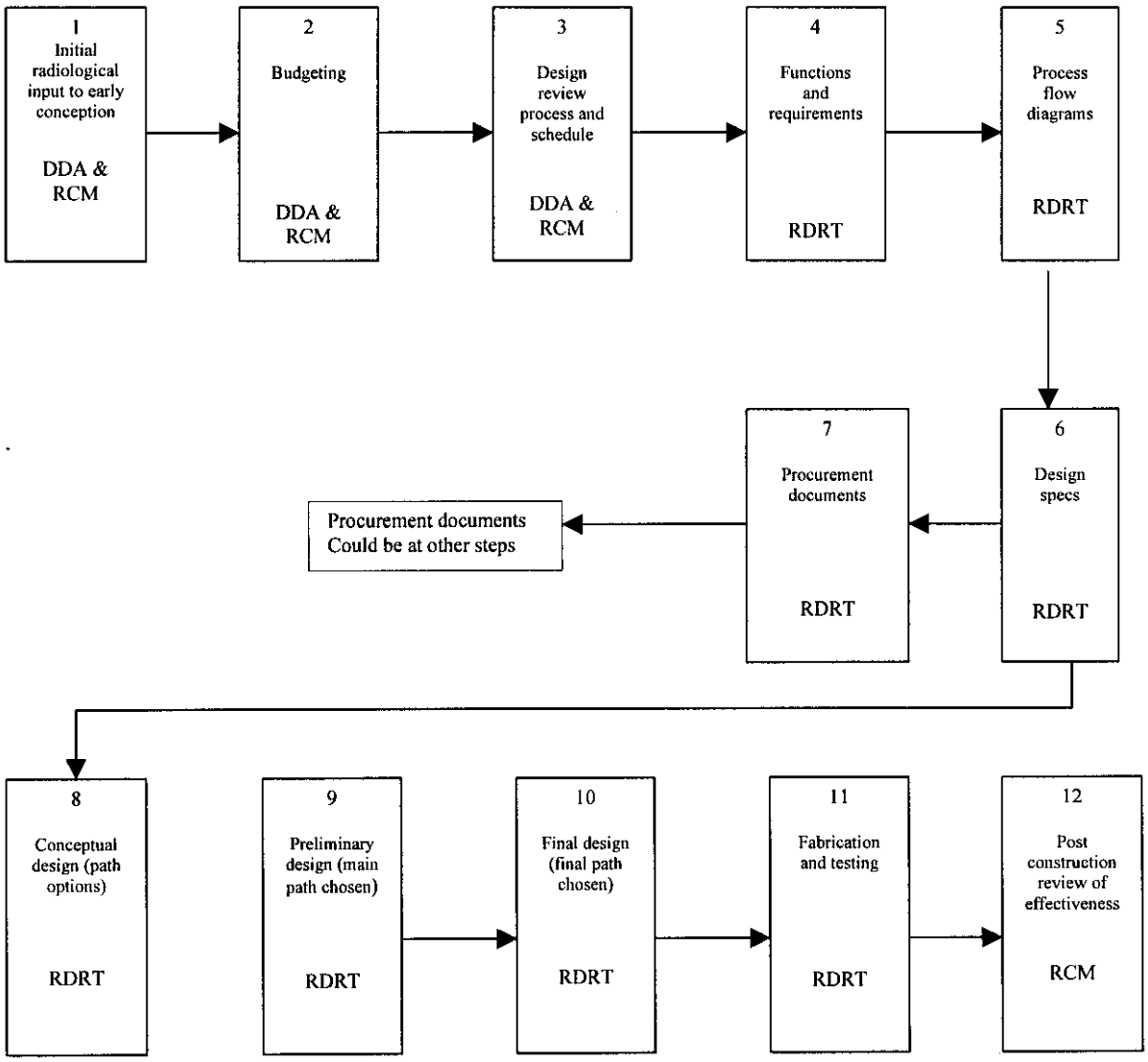
1) Schematic Representation of the Radiological Design Review Process

Attachments:

1) ALARA Design Review Checklist, Cementation Project
2) Cementation Project Dose Summary, Timeline and Assumptions
3) Cementation Project ALARA Design Review Dose Estimate Table

Figure 1

Schematic Representation of the Radiological Design Review Process for Major Modifications of Existing Facilities and New Facilities



DDA = Design Decision Authority
RCM = Radiological Control Manager
RDRT = Radiological Design Review Team
Note: For a given project, the exact steps and sequence of steps may vary, but the intent will be preserved

ALARA Design Review Checklist
Cementation Process Project

This checklist is not intended to be a checklist for any specific sub-contractor or facility. It is intended as a general list out of which site-specific checklists can be developed. Many of the items listed may not apply to specific facilities. On the other hand, particular facilities may needed to add items specific to their facility.

1.0 Design Process Regulatory Requirements (10 CFR 835)

1.1	What plan do the designers have or what actions have they already taken to ensure that doses will be ALARA through the combined use of facility and equipment design and administrative control? (835.1001(a)) [Recall documentation 835.704(b)]	Development of timelines, shielding of components, development of procedures, cleanup of material from glove boxes in the area, minimization of operator time in the glove box gloves and lessons learned from previous cementation runs.
1.2	How are designers implementing the requirement that physical design features be the primary methods used to maintain exposures ALARA (e.g., confinements, ventilation, remote handling, & shielding)? (835.1001(a)) [Recall documentation 835.704(b)]	All radiological work is performed in a glovebox. Shielding has been designed for use on the most utilized side of the glove box to ensure workers exposures are maintained ALARA. Processing operations will occur in the lowest radiation fields. Minimize time operator spends in glove box by providing a feed auger instead of hand feeding, equipment switches and valves outside the glove box, mixing cement by machine and not hand, and the use of a commercial can opener to open feed cans.
1.3	For cases where administrative controls are to be used, how were design features demonstrated to be impractical so that administrative controls are justified? (835.1001(b)) [Recall documentation 835.704(b)]	Not applicable to this project.

1.4	How are the designers ensuring that administrative controls can be practically implemented in cases where design features are demonstrated to be impractical? (835.1001(b)) [Recall documentation 835.704(b)]	Not applicable to this project.
1.5	For design of new facilities and modifications of old facilities, how do the designers plan to use or how are they using optimization methods (ALARA decision-making methods) to assure that occupational exposure is maintained ALARA in developing and justifying the facility design and physical controls? (835.1002(a)) [Recall documentation 835.704(b)]	The body of this ALARA Design Review discusses the project's choice in the ALARA decision-making process.
1.6	For design of new facilities and modifications of old facilities, how do the designers plan to meet or how are they meeting the design objective to maintain exposure levels ALARA *and* below an average of 0.5 mrem/h in continuously occupied areas (2000 hours/year)? (835.1002(b)) [Recall documentation 835.704(b)]	Not applicable to this project. See response to #1.7 below.
1.7	For design of new facilities and modifications of old facilities, how do the designers plan to meet or how are they meeting the design objective to maintain exposure levels ALARA *and* below 20% of the applicable standard in 835.202 in areas not continuously occupied (less than 2000 hours/year)? (835.1002(b)) [Recall documentation 835.704(b)]	Performed time-activity studies to evaluate the need for maintaining personnel to annual doses below 1,000 mrem for entire time spent in radiation field while assigned to this project. Time handling the material has been minimized. Shielding has been provided to the most utilized side of the glove box. Background dose is the most significant contributor to personnel dose. As such, sources of background radiation have been minimized through the use of water shields and cleanup of adjacent glove boxes.

1.8	For design of new facilities and modifications of old facilities, how do the designers plan to meet or how are they meeting the design objective to avoid, under normal conditions, releases of airborne radioactive material to the workplace atmosphere? (835.1002(c)) [Recall documentation 835.704(b)]	All radiological work involving un-canned material is performed within the confines of a glove box. Glove box is maintained under a negative pressure to minimize the spread of radioactive contamination.
1.9	For design of new facilities and modifications of old facilities, how do the designers plan to meet or how are they meeting the design objective to control, in any situation, the inhalation of radioactive material by workers to levels that are ALARA? (835.1002(c)) [Recall documentation 835.704(b)]	All radiological work involving un-canned material is performed within the confines of a glove box or greenhouse (for lard cans). Glove box is maintained under a negative pressure to minimize the inhalation of radioactive material. Glove box has been provided with 2 stages of HEPA filtration of air prior to discharge. Furthermore, pressure gradients and airflows provide flow away from areas of low potential for airborne to areas of higher potential.
1.10	How do the designers plan to meet or how are they meeting the objective that the design or modification of the facility and the selection of materials include features that facilitate operations? (835.1002(d)) [Recall documentation 835.704(b)]	The System Design Description (SDD) and the 1996 PFP Cementation Process ALARA Assessment outlines these features.
1.11	How do the designers plan to meet or how are they meeting the objective that the design or modification of the facility and the selection of materials include features that facilitate maintenance? (835.1002(d)) [Recall documentation 835.704(b)]	The System Design Description (SDD) and the 1996 PFP Cementation Process ALARA Assessment outlines these features.

1.12	How do the designers plan to meet or how are they meeting the objective that the design or modification of the facility and the selection of materials include features that facilitate decontamination? (835.1002(d)) [Recall documentation 835.704(b)]	The System Design Description (SDD) and the 1996 PFP Cementation Process ALARA Assessment outlines these features. Equipment and other items are located in a glove box and will not require decontamination.
1.13	How do the designers plan to meet or how are they meeting the objective that the design or modification of the facility and the selection of materials include features that facilitate decommissioning? (835.1002(d)) [Recall documentation 835.704(b)]	The System Design Description (SDD) outlines these features. All equipment is free standing and easily removed from the glove box for disposal.
1.14	What is the plan to use monitoring, during routine operations, to demonstrate that exposure levels are as low as reasonably achievable? (835.1003(b)) [Recall documentation 835.704(b)]	Such requirements will be captured in the functional re-start testing of the glovebox and the cementation process during a post re-start ALARA effectiveness review.

2.0 Facility Layout

2.1	Review the general configuration of the facility, considering traffic patterns, location of the radiation areas, location and size of the changing rooms, adequacy of personnel decontamination facilities, location of the fixed survey equipment, and adequacy of space for anticipated operations, maintenance, production, research, and decommissioning. Facility design and selection of materials shall include features that facilitate operation and maintenance, decontamination, and decommissioning (10 CFR 835.1002(d) and RCM 128.1).	This project does not involve the construction of new facilities. A location assessment was performed to determine the location that most closely meets the criteria defined herein. The Cementation process equipment was designed and installed into existing facilities at PFP identified in the location assessment.

2.2	Verify that the design shall be able to maintain personnel entry control for each radiological area, commensurate with existing or potential radiological hazards within the area, by using one or more of the methods listed in 10 CFR 835.501.	This project does not involve the construction of new facilities. The Cementation process equipment was designed and installed into existing facilities at PFP.
2.3	Verify that the entrance of each access point to high and very high radiation areas shall have the control features required by 10 CFR 835.502	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No high radiation fields expected.
2.4	Equipment and controls are located for accessibility and to minimize radiological exposure to personnel during normal operations, shutdown, maintenance, anticipated operational transients, and postulated accident conditions.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: Cementation process operations have been designed to occur in a low dose rate area of the glove box. In addition shielding has been provided to the most utilized side of the glove box.
2.5	Develop facility layout and personnel traffic routes to minimize radiological exposures to personnel.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: This project does not involve the construction of new facilities. The Cementation process equipment was designed and installed into existing facilities at PFP.
2.6	Accessibility requirements for the maintenance, inspection, removal, or replacement of equipment consider potential radiological exposure to personnel.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
2.7	Doorways and labyrinths are wide enough to permit personnel, component and equipment passage.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: This project does not involve the construction of new facilities. The Cementation process equipment was designed and

		installed into existing facilities at PFP.
2.8	Evaluate and confirm the adequacy of specific control devices for reducing occupational exposures, including shielding, hoods, glove boxes, containments, interlocks, barricades, shielded cells, decontamination features, and remote operations.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: This was confirmed through discussions with experienced personnel who took part in the previous cementation runs.
2.9	Are areas of the facility which exhibit high occupancy, or are presently uncontrolled, adequately protected from new or increased radiation sources?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The impact of the Cementation process operations on the existing facility has been previously evaluated. There will no new or increased radiation source in high occupancy or uncontrolled areas.
2.10	Is maximum distance provided between serviceable components and any substantial radiation sources in the area?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
2.11	Does the design change protect the public and facility personnel from hazards associated with the use of radioactive and other hazardous materials as a result of normal operations, anticipated operational occurrences, and Design Basis Accidents (DBA) conditions, including the effects of natural phenomena pertinent to the site, and maintain these effects ALARA?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: Work will be done inside a glove box inside the RCA. A Safety Analysis was performed on the process that determined that the process is within the existing safety envelope for the facility.
2.12	Does the project protect government property and essential operations from the effects of potential accidents?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

3.0 Installation Considerations

3.1	Modular components or other design considerations are utilized to reduce the duration of construction or installation activities in the area.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: Installation of the Cementation process equipment was done previously during its initial start-up. All equipment is off the shelf and can be replaced, as needed.
3.2	Bolted rather than welded flanges are used for quick removal where appropriate.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1
3.3	Build-in rigging provided for ease of installation.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1
3.4	Is the equipment ready for service as received?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1
3.5	Does the equipment require modification prior to installation? If so, is the modification reflected in applicable documents, and can the modification be performed in a non- radiologically controlled area?	[x] Yes [ ] No [] Not applicable Explanation of deviation: See response to 3.1. Electrical equipment modifications were reflected in 96400 and mechanical modifications in H-2-99536. These modifications done prior to introducing the equipment into the glovebox.
3.6	Have the radiological conditions in areas not routinely accessed been adequately characterized? Are any assumptions made about them valid?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1

3.7	For tasks that have historical dose data, has this data been reviewed?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: Dose data is not readily available for review. Previous ALARA assessment and discussions with experienced personnel have been used to establish historical basis.

4.0 Maintenance and Operations

4.1	Permanent platforms, walkways, stairs, or ladders are provided to permit accessibility	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: Equipment design and selection included features that facilitate operation and maintenance.
4.2	Serviceable components are capable of being isolated and drained	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.3	Flange components are provided for quick removal of high maintenance components	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
4.4	Installation design provides for rapid removal	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.5	Surveillance can be performed from outside a high radiation area through the use of TV camera, viewing port, or remote readout	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No high radiation areas are expected.
4.6	Built-in rigging is provided to facilitate component handling	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.7	Components are designed to facilitate flushing and decontamination	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.8	Components are designed and selected with consideration for long service life, ease of removal, and frequency of maintenance	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1

4.9	Serviceable components are easily accessible with adequate work space, laydown areas, and lighting	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1. As far as practical for work within a glove box.
4.10	Design features prevent personnel from inadvertently entering high radiation areas	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No high radiation sources are contained within the glove box.
4.11	Special provisions are made for ease of maintenance and operation of equipment	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.12	Equipment cover plates are hinged or captive quick-opening fasteners are used to facilitate routine personnel access or maintenance access.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.13	Life expectancy and reliability of the chosen equipment for their selection and location are considered to minimize personnel access in the area.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 4.1
4.14	Electrical, mechanical, or hydraulic quick release mechanisms are used where possible for insulation, sample bombs, electrical connections, and even entire skids.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 4.1
4.15	Remote operators or robotics are considered for use in high radiation areas.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No high radiation fields are expected.

5.0 Shielding

5.1	Shielding analysis has been performed	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: Shielding analysis was performed during the previous ALARA Assessment. Shielding has been

		provided to the most utilized side of the glove box. Also, water shields have been placed between the process area and HA-23S glove box to reduce its background contribution.
5.2	Entrances to high radiation areas are adequately shielded (e.g., labyrinth)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No high radiation fields are expected.
5.3	Radioactive equipment is separated by shielding from non-radioactive equipment (to minimize exposure to personnel in adjacent areas)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
5.4	Shield penetrations are minimized in size and number	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
5.5	Shield penetrations are located high on the wall and in a corner to avoid line-of-sight streaming	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
5.6	If the answer to 5.5 is "No", are the penetrations adequately shielded or sealed (e.g., use of high-density sealant or equivalent)?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
5.7	Permanent shielding is employed, to the degree feasible, to avoid the need for temporary shielding	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: To the degree practical. Due to the nature of this operation and equipment, some non-routine maintenance activities may require temporary shielding to be employed. This will need to be determined on a case by case basis.
5.8	If permanent shielding is not feasible, provisions are made to allow temporary shielding during maintenance activities	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
5.9	Is shielding placed between serviceable components and any substantial radiation source in the area?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 5.1

5.10	Are shields employed to prevent streaming of radiation through doors, pipes, and duct penetrations (e.g., labyrinths or shadow shields)?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
5.11	Is an adequate safety margin applied to seismic load analysis to accommodate the additional load from temporary shielding?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: No temporary shielding is required.
5.12	Has shielding calculations and design been verified to meet ALARA requirements?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 5.1
5.13	Have the shielding calculations, including the basic assumptions, been reviewed by an independent, competent reviewer?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 5.1

6.0 Contamination Control

6.1	Corrosion-resistant material is used for piping and equipment	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1
6.2	Low-cobalt material is used for piping and equipment in contact with primary reactor coolant	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 3.1
6.3	Curbs are provided to control spread of liquid spills. Can containment be established to reduce the spread of contamination, i.e., cribs, catch pans, drip pans, or cofferdams?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: All radiological material is handled within a glovebox.

6.4	Radioactive floor drains are inside the curbs	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 6.3
6.5	Floors slope toward the drains	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 6.3
6.6	Easily decontaminable coatings have been specified	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 6.3
6.7	Ventilation is provided to control airborne radioactivity	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: 2 stage HEPA filtration provided. Pressure gradients and airflows provided for flow from areas of lower potential for airborne radioactivity to areas of higher potential.
6.8	Drain lines are sloped continuously and backflooding is prevented	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
6.9	Surfaces that could be contaminated are made non-porous or sealed for ease of decontamination. Are rough surface finishes such as crevices, hole, notches, recesses, socket-head cap screws, and knurled finishes avoided?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
6.10	Consider design measures to minimize potential releases of solids, liquids, or gases to reduce contamination when the design requires the breaching of a system which may contain radioactive material	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
6.11	Where material might become activated, materials with low activation potential and corrosion-resistant materials are used as much as possible.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
6.12	Where material might become activated, proper chemical and flow control is used to minimize erosion and corrosion.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
6.13	Preclude by design cross-connections of radioactive drains with non-radioactive drains.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

6.14	Does the design incorporate features that will reduce the likelihood of cross-contamination of clean systems and unmonitored release pathways?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

7.0 Liquid Systems -- Tanks, Pumps, and Sumps

7.1	Pumps are located apart from tanks they serve (so exposure rates from tanks don't increase maintenance exposures)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.2	Pumps are fitted with catch basins that are properly drained	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.3	Pump casings are provided with equipment drains	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.4	Pump seals are covered to prevent contaminated liquids from being projected from the pump	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.5	Vents are provided	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.6	Pumps requiring frequent maintenance are equipped with flanged connections for easy removal	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.7	Canned pumps or mechanical seals are employed instead of standard packing glands	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.8	Tanks and sumps are provided with a mechanism for flushing and decontamination	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.9	Vents and relief tail pipes are routed to drains	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
7.10	Components are designed to facilitate draining, flushing, and cleaning by chemical or mechanical means.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

7.11	Agitators or other devices are provided in tanks or other vessels to ensure adequate mixing and to minimize localized radioactivity buildup.	[x] Yes [ ] No [x] Not applicable Explanation of deviation:
7.12	Tanks and other vessels are designed with conical or dished bottoms with a central drain and spargers to remove radioactive sediment.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

8.0 Liquid Systems – Valves

8.1	Valves are located away from tanks, filters, demineralizers, etc., where practical	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
8.2	Process valves are remotely operated where needed	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
8.3	Valves are mounted with the stem facing up where practical	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.4	Platforms are provided for valve maintenance	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.5	There is sufficient space around the valve for efficient maintenance	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.6	Valve designs minimize cavities and crevices	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.7	The design eliminates the use of cobalt-containing materials for parts or components (e.g., valve trim, seats, pins, etc.) that could be in a flow path leading to a reactor core	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.6	The design maximizes the removal of cobalt particulates from systems that can interface with reactor coolant systems	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
8.9	Valves can be installed or removed without cutting or welding	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

8.10	Manual valve operators are used only for infrequently operated valves.	[ ] Yes [x] No [ ] Not applicable Explanation of deviation: Process operations require the manual manipulation of some valves by the operator as he works within the glovebox.

9.0 Piping

9.1	Crud traps are minimized and stagnant legs avoided	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: This equipment was installed into existing facilities and as such equipment designs may incorporate these features as much as possible.
9.2	Socket welds are avoided	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 9.1
9.3	All sections of piping can be adequately drained	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 9.1
9.4	Vents are provided and piping can be flushed or hyrdolased	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
9.5	Piping run is in a shielded pipe case where needed	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
9.6	Piping run lengths and horizontal runs are minimized	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 9.1
9.7	Field joints are minimized	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 9.1
9.8	Piping that potentially contains radioactive contaminants is physically separated from non- radioactive piping	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

9.9	Use of field-run piping is avoided	[ ] Yes [x] No [ ] Not applicable Explanation of deviation: This equipment is being installed in existing facilities and as such piping runs are dictated by facility space. However, only one piping run exists outside of the glovebox.
9.10	System piping is designed to eliminate or minimize dead legs, standpipes, or low points.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 9.1
9.11	Drains are provided at unavoidable low points and dead legs to flush out radioactive residues.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
9.12	All piping or tubing connections for tritium processes are inside a ventilated hood or glove box and positive sealing connections are used.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

10.0 Slurry Systems

In addition to considerations for liquid systems, systems containing slurries should also meet the criteria below.

10.1	Sharp bends in pipes are avoided (5 x diameter or greater bends are acceptable)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
10.2	Check valves or strainers are provided at interfaces with liquid systems	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
10.3	Backflush connections and/or hydrolasing ports are provided	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
10.4	Spent resin or slurry piping is designed with full-ported valves and without screwed connections and orifices.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

10.5	Spent resin or slurry piping are sloped downward and designed to maintain turbulent flow and to minimize pipe connections and fittings.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
10.6	Piping tees in resin or slurry piping are designed to ensure that the normal flow is through the straight portion and the branch line is located above the run.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

11.0 Instrumentation

11.1	Instrument readouts are located in the lowest radiation area feasible	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: process instrumentation is located in low dose areas. Since the cementation process equipment was installed in existing facilities, this requirement was attempted to be met, but may not be practical.
11.2	Instrument taps on liquid systems are located above the piping midplane	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
11.3	Existing radiation monitors are appropriate in terms of types and locations. (If "No", indicate how existing radiation monitoring systems should be modified or new systems that will be required)	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
11.4	Instruments and controls are grouped functionally to minimize time spent in the area	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 11.1
11.5	Instruments are selected and specified for long service life and low maintenance requirements	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
11.6	Provisions are made for remote calibration	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
11.7	Instruments can be flushed to reduce crud accumulation	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

11.8	Assess the adequacy of planned radiation monitoring (10 CFR 835.403) and nuclear criticality safety instrumentation (10 CFR 835.1304(b)), including whether the proposed instrumentation is appropriate for the expected types and intensities of radiation, and whether it has sufficient redundancy and capability for operation under normal operating conditions and in emergencies (10 CFR 835.401(c)).	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
11.9	Readouts or control points for instruments and controllers are located outside of radiation areas.	[ ] Yes [x] No [ ] Not applicable Explanation of deviation: Process instrumentation is located in low dose areas. Since the cementation process equipment is being installed in existing facilities, this requirement will be attempted to be met, but may not be practical.
11.10	Radiation monitoring systems (RMS) channels have both local and remote readouts and alarms, with a readout in a central location if appropriate.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: THE CEMENTATION PROJECT WILL UTILIZE EXISTING FACILITIES AND EQUIPMENT. THE ADEQUACY OF EXISTING EQUIPMENT NEEDS TO BE EVALUATED.
11.11	RMS have circuitry indicating component failure and built with fail-safe capabilities.	[ ] Yes [ ] No [ ] Not applicable Explanation of deviation: THE CEMENTATION PROJECT WILL UTILIZE EXISTING FACILITIES AND EQUIPMENT. THE ADEQUACY OF EXISTING EQUIPMENT NEEDS TO BE EVALUATED.

11.12	Instruments using radioactive or contaminated working fluid contain a minimum quantity of working fluid.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
11.13	Effluent airborne, and off-line process monitor lines and sampler lines are as short as possible and heat-traced and insulated, as necessary, to minimize line loss, water condensation and radioactivity build-up.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

12.0 Ventilation

12.1	Provisions are made for ventilating the area	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The Cementation project will utilize existing facilities and services. The glove box is provided with 2 stage HEPA filtration.
12.2	The flow of air is from areas of lesser contamination to areas of greater contamination	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: All radiological work is conducted within a glove box and pressure gradients provide flow from low potential areas to higher potential areas.
12.3	Filter banks are readily accessible for maintenance	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
12.4	Filter banks are separated or shielded from each other to permit working on one with the other operating	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
12.5	The ventilation system (exclusive of filters) is designed to minimize radioactivity buildup	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

12.6	Ventilation ducts have cleanout ports for decontamination	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
12.7	Verify that the design of the confinement and ventilation systems provide the required level of protection from airborne contamination, giving particular attention to patterns of air flow and to the locations of air inlets, penetrations, and exhausts. Releases of radioactive material to the workplace atmosphere shall be avoided under normal operating conditions and inhalation of such materials by workers shall be controlled to the extent reasonably achievable (10 CFR 835.1002(c)).	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
12.8	Direction of ventilation flow is maintained from areas of lower potential airborne radioactivity to areas of higher potential airborne radioactivity.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: All radiological work is conducted within a glove box and pressure gradients provide flow from low potential areas to higher potential areas.
12.9	Ducts carrying clean air are located to eliminate, where possible, the passing through radiologically controlled areas and are at positive pressure where they pass through areas of potential airborne radioactivity.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and services.
12.10	All process fittings, valves, and equipment for tritium processes are inside a ventilated hood or glove box.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
12.11	Ducts containing potentially contaminated air are at negative pressure if they pass through clean areas.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and services.

12.12	The number of direction changes in ductwork containing potentially contaminated air are minimized.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and services.
12.13	Fans or blowers in ventilation systems containing potentially contaminated air are located downstream of filters.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
12.14	Air hoods or glove box openings have sufficient linear air velocity for their service conditions.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

13.0 Filters and Demineralizers

13.1	Vents and relief valve tail pipes are routed to drains	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and equipment.
13.2	Filters and demineralizers have been assessed as radiation sources	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The routine radcon surveillance program will provide for filter changeout at currently specified dose rates.
13.3	Multiple filters or demineralizers are housed in separate cubicles to permit maintenance with the system operating	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and equipment.

13.4	Filter cartridge sizes are common to other filters already in use at the plant	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The cementation process HEPA filter is of standard design.
13.5	Filters are designed to minimize servicing frequency	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
13.6	Filters are designed for efficient removal	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The cementation glove box HEPA filter is provided with an efficient and effective bag out system.
13.7	Filters are located in low occupancy and low traffic areas	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
13.8	Filters are provided for remote or shielded methods of filter removal	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
13.9	Submicron filters are employed as applicable	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
13.10	System filters are provided upstream of heat exchangers or demineralizers.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

14.0 Implementation Requirements

14.1	Temporary shielding	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.2	Additional or temporary ventilation	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

14.3	Temporary containments	[x] Yes [ ] No [] Not applicable Explanation of deviation: Opening of lard cans will require the use of a greenhouse.
14.4	Decontamination of systems, components, and/or work areas	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
14.5	System flushing	[] Yes [ ] No [x] Not applicable Explanation of deviation:
14.6	Tool list	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.7	Special installation	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.8	QA/QC inspection/hold points	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.9	Support work (scaffolding, etc.)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.10	Special training (mock-up, classroom)	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
14.11	Safety	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

15.0 Breathing Air & Cooling Systems

15.1	Are breathing air and cooling systems being planned if needed?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and equipment.

15.2	Are the system specifications adequate?	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: The cementation project will utilize existing facilities and equipment.

16.0 Waste Minimization

16.1	The volume of radioactive waste generated is minimized by operation of the system or equipment (e.g. minimize the quantity or volume of consumables, use high capacity filter elements, use mechanical seals rather than packings on rotating equipment).	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
16.2	Non-radioactive waste (e.g. oil, refrigerant) is segregated from potential contamination to preclude the generation of mixed waste.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

17.0 Post Construction Review of Effectiveness

17.1	Are there plans for a post-construction review of effectiveness of engineering features to reduce dose and the spread of radioactive materials to provide feedback to the design engineers and help refine the design process?	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: Due to relatively short life span of this operation, the post construction review is anticipated to occur within 6 months of full time operations, rather than after a year as prescribed in HNF-PRO-1622.

18.0 Decommissioning Considerations

18.1	Use modular, separable confinements for radioactive materials to preclude contamination of fixed portions of the structure.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: The cementation process will utilize existing facilities and equipment. This consideration was attempted to be met, but may not be practical.
18.2	Long runs of buried contaminated piping will be avoided and provisions will be included in the design to ensure the integrity of joints in buried pipelines.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
18.3	Designs that ease cut-up, dismantlement, removal, and packaging of contaminated equipment from the facility (e.g., gloveboxes, filtration equipment, ductwork, etc.).	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 18.1
18.4	Use of modular shielding, in lieu of monolith shielding walls.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: See response to 18.1
18.5	Use of lifting lugs on equipment.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: See response to 18.1
18.6	Fully drainable piping systems that carry contaminated products.	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:

19.0 DOE Regulations, Orders & Notices

Verify that radiological design criteria are consistent with applicable federal/state regulations, recognized standards and guides, and with the following DOE directives relating to radiological safety in design :

19.1	10 CFR 835, Occupational Radiation Protection (DOE, 1993a);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.2	DOE Order 5400.1, General Environmental Protection (DOE, 1988c);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

19.3	DOE Order 5400.5, Radiation Protection of the Public and the Environment (DOE, 1990a);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.4	DOE Order 5480.6, Safety of Department of Energy-Owned Nuclear Reactors (DOE, 1986b);	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
19.5	DOE Notice N5480.8, Radiological Health and Safety Policy (DOE, 1993c);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.6	DOE Order 5480.22, Technical Safety Requirements (DOE, 1992f);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.7	DOE Order 5480.23, Nuclear Safety Analysis Reports (DOE, 1992g);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.8	DOE Order 5480.24, Nuclear Criticality Safety (DOE, 1992h);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.9	DOE Order 5480.25, Safety of Accelerator Facilities (DOE, 1992i);	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
19.10	DOE Order 5480.30, Nuclear Reactor Safety Design Criteria (DOE, 1993e);	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
19.11	DOE Order 6430.1A, General Design Criteria (DOE, 1989);	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.12	DOE Order 5820.2A, Radioactive Waste Management (DOE, 1988d), and	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
19.13	DOE Radiological Control Manual.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

20.0 State of Washington Environmental Requirements Affecting Design for Occupational ALARA

20.1	WAC 246-247, Section 060 requires permits for new construction and modifications of existing sources. These permits should be reviewed to ensure that there are no conflicts with occupational radiation protection.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

20.2	WAC 246-247, Section 040 contains standards; differing standards apply based on the potential release from the unit and whether it is a new construction or modification. All new construction must meet BARCT (Best Available Radionuclide Control Technology) standards. These standards should be reviewed to ensure that there are no conflicts with occupational radiation protection.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

21.0 Environmental Assessments

21.1	Review any associated environmental assessments to ensure that there are no conflicts with occupational radiological protection.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

22.0 Safety Analysis Reports

22.1	Review any associated safety analysis reports to ensure that there are no conflicts with occupational radiological protection.	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

23.0 Design Documentation

SEE BODY OF RADIOLOGICAL DESIGN REVIEW FOR DISCUSSION.

23.1	Statement of purpose of the design	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.2	Statement of scope of the design	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.3	Radiological input to the budget for the design	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

23.4	Copies of radiological surveys used as reference in the design	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.5	Process flow diagram or other record of the step-by-step approach	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.6	Records of all ALARA decision-making methods used (HNF-PRO-1621)	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.7	Radiological review and input into functions and requirements	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.8	Radiological review and input into procurement documents	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.9	Radiological review and input into design specifications	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.10	Descriptions of the design concepts considered including a description of the advantages and disadvantages of each	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: No document is available.
23.11	ALARA Review Meeting Minutes	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: No document is available
23.12	Dose estimates made at various stages	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.13	Failure analysis of critical components affecting ALARA and mitigating plans	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.14	Summary of the ALARA features of the design	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.15	Description of how the various regulations concerning radiological design are met	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:
23.16	ALARA initiatives to aid in decommissioning	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

23.17	Records of any shielding calculations done and the verification of the shielding calculations	[x] Yes [ ] No [ ] Not applicable Explanation of deviation: No document available.
23.18	Radiological reviews of mockups	[ ] Yes [ ] No [x] Not applicable Explanation of deviation: No mockups were used.
23.19	Radiological reviews of fabrication and testing	[ ] Yes [ ] No [x] Not applicable Explanation of deviation:
23.20	Records of the post-construction review of ALARA design effectiveness	[x] Yes [ ] No [ ] Not applicable Explanation of deviation:

Cementation Project Dose Summary, Timeline and Assumptions

I) Project Dose Summary

	Activity	Dose (Person-mrem) W.B.	Extremities
1	**Vault Access-** Remove and load containers (individual cans/lard cans) of plutonium materials (SS&C and Residues) stored in the PFP vaults for transport.	4.09 E +3	4.21 E +3
2	**Move Containers to 235-B Temporary Storage Area-** Transport, transfer custody, and unload containers to 235-B temporary storage area.	4.20 E +2	5.98 E +2
3	**Transport Lard Cans to HA 28/235 B Containment-** Load and transport lard cans to the HA 28/235-B containment for opening.	2.14 E +2	2.70 E +2
4	**Open Lard Cans-** Load lard cans into containment, open lard cans, and remove/survey individual cans.	5.70 E +3	7.25 E +3
5	**Move Containers to NDA-** Load, transport and unload containers from 235-B storage area or containment to NDA for assay.	4.44 E +3	5.95 E +3
6	**NDA Containers-** Perform Segmented Gamma Ray Scan assay of containers.	1.61 E +3	2.11 E +3
7	**Move Containers to Cementation Glove Box-** Load transport wagon and transport assayed containers to the Cementation Glove Box.	2.66 E +3	3.16 E +3
8	**Load In Containers-** Load individual cans into the Cementation Glove Box.	2.76 E +3	3.26 E +3
9	**Cementing Operations-** Immobilize plutonium materials in cement matrix.	1.44 E +4	3.27 E +4
10	**Seal Out of Cemented Containers-** Seal out grouted waste from the Glove Box.	2.64 E +3	7.53 E +3

11	**Load Cylinders into Pipe Overpack Containers**-Load cemented containers into Pipe Overpack Containers.	1.90 E +3	2.59 E +3
12	**Move Drums to Staging Area-** Transport drums to staging area for transport/shipment to storage facility.	1.88 E +2	1.88 E +2
	Total Dose – All personnel	4.10 E +4	6.98 E +4
	Annual Dose	1.09 E +4	1.85 E +4
	Annual Average Operator Dose	853	1588

II) Timeline/Assumptions

1. Vault Access

To estimate the total worker dose for this step, the following assumptions were made:

- 166 Lard cans require movement from vault.
- 12 Individual cans require movement from vault.
- The configuration of the lard can limits the maximum number of individual cans in each lard can to 12. It is assumed that there will be an average of 9 individual cans in each lard can.
- 178 Items of material to be removed from vault and loaded on to the transport wagons.
- Basic dose rates assume weapons grade plutonium with an average 270g of Pu per item/can for non-lard cans, and a range of 70 to 400 g Pu for each lard can, with 50 to 60 g Pu per individual can.
- Two vault operators, one vault technician, and one radcon technician would be involved in the removal of the 178 cans from the vault. Both operators would enter vault to remove cans while the vault technician and radcon technician would remain outside for support. On the average it would take 5 minutes to enter the vault, locate two lard cans or five individual cans and move them to the portal for removal. At the portal, it would then take another 5 minutes to survey the cans, fill in custody paperwork, and move them to transport wagon. Personnel would receive dose rates in the vault of 60 mrem/hr (50 to 70 mrem/hr range)

background, 20 mrem/hr (10 to 30 mrem/hr range) on contact, and 4 mrem/hr (2 to 6 mrem/hr range) at 30 cm. Background dose rates outside the vault are 0.5 mrem/hr.

- It would take two operators an average of 10 minutes to load the cans onto the transport wagons and place a shield blanket onto the wagon. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background.

2. Move Containers to 235-B Temporary Storage Area

To estimate the total worker dose for this step, the following assumptions were made:

- The configuration of the transport wagons limit the loads to two lard cans or five individual cans. This establishes the definition of a batch or cycle for transport. Therefore 86 trips will be required to remove all cans from the vault.
- It would take two vault operators an average of 5 minutes per trip to transport the material to the custody transfer point. A lead acrylic blanket would be used to provide shielding. The first operator would receive a reduced exposure at a rate of 10 mrem/hr contact, 2 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates. No contact exposure expected during transport. The bounding whole body dose rate has been reduced by a factor of 2 to account for the shielding of the lead blanket.
- It would take two vault operators an average of 10 minutes to open the wagon, identify each item and transfer custody to the Solutions/Residues Stabilization Project (S/RSP) operators. The S/RSP operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background during the transfer.
- It would take two S/RSP operators an average of 5 minutes per trip to transport the containers to the 235-B Temporary Storage Area. A lead acrylic blanket would be used to provide shielding. The first operator would receive a reduced exposure at rate of 10 mrem/hr contact, 2 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates. No contact exposure expected during transport. The bounding whole body dose rate has been reduced by a factor of 2 to account for the shielding of the lead blanket. It would take two S/RSP operators an average of 10 minutes to unload the cans at the temporary storage area. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background.

3. Transport Lard Cans to HA 28/235 B Containment

To estimate the total worker dose for this step, the following assumptions were made:

- The configuration of the transport wagons limit the loads to two lard cans. This establishes the definition of a batch or cycle for transport. Therefore 83 trips will be required to remove all lard cans from the 235-B Storage Area.
- It would take two S/RSP operators an average of 10 minutes to load the two lard cans onto a transport wagon at the temporary storage area. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background.
- It would take two operators an average of 5 minutes per trip to transport the lard cans to the containment for opening. A lead acrylic blanket would be used to provide shielding. The first operator would receive a reduced exposure rate of 10 mrem/hr contact, 2 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates. No contact exposure expected during transport. The bounding whole body dose rate has been reduced by a factor of 2 to account for the shielding of the lead blanket.

4. Open Lard Cans

To estimate the total worker dose for this step, the following assumptions were made:

- It would take two operators an average of 10 minutes to unload the two cans and put them into the containment. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 1 mrem/hr background.
- The configuration of the lard can limits the number of Individual cans in each Lard can to a maximum of 12. An average of 9 per lard can will be assumed for this calculation. Therefore a total of 1494 individual cans require removal from the greenhouse for NDA.
- It would take two operators and a radcon technician an average of 20 minutes to open the lard cans, remove the individual cans, survey, place cans in a ITC and remove the individual cans from the containment. The personnel would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 1 mrem/hr background.

5. Move Containers to NDA

To estimate the total worker dose for this step, the following assumptions were made:

- All items removed from the vault will require NDA.
- The configuration of the transport wagons limit the loads to five individual cans. This establishes the definition of a batch or cycle for transport. Therefore 302 trips will be required to move all 1506 individual cans from the 235-B Storage Area and HA 28/235 B Containment to NDA.
- It would take two S/RSP operators an average of 10 minutes to load five individual cans onto a transport wagon at the temporary storage area or greenhouse. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background.
- It would take two operators and a radcon technician an average of 10 minutes per trip to move the individual containers from the temporary storage area or the containment area to the NDA Lab. A lead acrylic blanket would be used to provide shielding. The personnel would receive a reduced exposure at rate of 10 mrem/hr contact, 2 mrem/hr at 30 cm and 0.5 mrem/hr background. No contact exposure expected during transport. The bounding whole body dose rate has been reduced by a factor of 2 to account for the shielding of the lead blanket.
- It would take two operators an average of 10 minutes to unload five individual cans at NDA. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 2 mrem/hr background (1 to 3 mrem/hr range).

6. NDA Containers

To estimate the total worker dose for this step, the following assumptions were made:

- All 1506 cans brought to NDA will undergo segmented gamma ray scan assay. Estimated time for performing the scan is 30 minutes.
- NDA personnel performing the assay will be in contact with material for approximately 1 minute and receive exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 2 mrem/hr background.

7. Move Containers to Cementation Glove Box

To estimate the total worker dose for this step, the following assumptions were made:

- It would take two operators an average of 10 minutes to load five cans onto the wagon and place a shield blanket onto the wagon. The operators would receive an exposure at rates of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 0.5 mrem/hr background.
- The configuration of the transport wagons limit the loads to five individual cans. This establishes the definition of a batch or cycle for transport. Therefore 302 trips will be required to move all individual cans from NDA to the Cementation glove box area.
- It would take two operators an average of 10 minutes per trip. A lead acrylic blanket would be used to provide shielding. The first operator would receive a reduced exposure at rate of 10 mrem/hr contact, 2 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates. No contact exposure expected during transport. The bounding whole body dose rate has been reduced by a factor of 2 to account for the shielding of the lead blanket.

8. Load In Containers

To estimate the total worker dose for this step, the following assumptions were made:

- It would take two operators and a radcon technician an average of 10 minutes to load each of the 302 batch/cycle of cans into the glove box. The first operator would receive an exposure at rate of 20 mrem/hr contact, 4 mrem/hr at 30 cm and 1 mrem/hr background. The second operator and radcon technician would receive exposure at a background rate. (Note: Background rate assumed here does not include the contribution from the operation of the three new muffle furnaces.)
- These times assume that all insertion will be via the sphincter port, since all lard cans will have been opened prior to NDA.
- The configuration of the transport wagon limits the load to five individual cans per trip. Therefore load in will occur in groups of five. A total of 1506 cans will be loaded into the glove box.

9. Cementing Operations

To estimate the total worker dose for this step, the following assumptions were made:

- The processing rate is expected to be 1 slip lid can per hour or approximately 8 to 10 slip lid cans of cemented material per day. Each cemented container would contain up to 60g of Pu. Tasks and associated times per cycle/batch are:

- Weigh and open feed items	20 mins.
- Sieve and Grind	30 mins.
-Transfer and weigh reaction charge	20 mins.
-Load auger, prepare mixer and start auger	35 mins.
-Monitor reaction and control foam	100 mins
-Weigh slip lid can and add material	40 mins
-Weigh, add cement and mix	45 mins.
-Pour cement and let set	15 mins.
Total	305 mins.

- It would take three operators an average of 305 minutes to process each batch/cycle of cans into the glove box. This time is broken up into the following batches: 302 @ 105 mins. (based on batches/cycles) and 1506 @ 200 mins (based on one for one cementation for each individual can). The first two operators would receive an exposure at rate of 8 mrem/hr contact, 1.6 mrem/hr at 30 cm and 1 mrem/hr background. The bounding contact and whole body dose rate has been reduced by a factor of 2.5 to account for the shielding of the Glove Box and gloves. The third operator would receive exposure at a background rate. (Note: The background rate assumed here does not include the contribution from the operation of the three new muffle furnaces.)

10. Seal Out of Cemented Containers

To estimate the total worker dose for this step, the following assumptions were made:

- Based on information contained above, 1506 cemented slip lid cans will be required to be sealed out and unloaded from the glove box.
- Sealing out a cemented container from the glove box would involve two operators and a radcon technician. Both operators would handle the container for approximately 10 and 5 minutes respectively. Both would receive dose at an exposure rate of 13 mrem/hr contact, 2.5 mrem/hr at 30 cm and 1 mrem/hr background. The bounding contact and whole body dose rate has been reduced by a factor of 1.5 to account for the self-shielding in the cement matrix. The radcon technician would receive dose at both handling and background levels for a period of 10 minutes.
- Operators would place the sealed out container directly into the Pipe Overpack Container assembly.

11. Load Cylinders into Pipe Overpack Containers

To estimate the total worker dose for this step, the following assumptions were made:

- Due to WIPP/WAC requirements the maximum allowed Pu in the Pipe Overpack Container is 200g (+/- measurement error). At present it is estimated that only three, cemented slip lid containers, each containing approximately 60 g Pu, will be loaded into a Pipe Overpack Container. This number may revised based on container content and NDA WIPP/WAC requirements.
- It would take an operator an average of 20 minutes to load 3 slip lid containers and bolt the lid onto the Pipe container. The first operator would receive an exposure at rate of 13 mrem/hr contact, 2.5 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates.
- Due to the configuration of the overpack drums, only one cylinder will fit into each drum. Therefore 502 drums will be loaded with cylinders.
- It would take an operator an average of 10 minutes to seal the drum. The first operator would receive an exposure at rate of 4 mrem/hr contact, 0 .75 mrem/hr at 30 cm and 0.5 mrem/hr background. The second would receive a dose at background rates.

12. Move Drums to Staging Areas

To estimate the total worker dose for this step, the following assumptions were made:

- It would take two operators an average of 10 minutes per trip to move a drum dolly to the facility shipment staging/storage area. The first operator would receive a reduced exposure at rate of 4 mrem/hr contact, 0.75 mrem/hr at 30 cm and 0.5 mrem/hr background. No contact exposure is expected during this transport. The second would receive a dose at background rates.
- A total of 502 drums will be moved to the facility shipment staging/storage area.

Annual and Average Operator Dose

To estimate the total worker and average operator dose, the following assumptions were made:

- Personnel will work 50 weeks per year, 2 shifts per day, 5 days per week and complete cementation of 2 batches per shift. This assumes an average work off of 400 batches per year.
- Based on the assumption that 1506 cans/items will be cemented one for one into cemented containers, it will take 3.8 years to complete task.
- Crew sizes to accomplish this task per shift 5 S/RSP Operators, 3 Vault personnel, 1 NDA personnel and 1 Radiation Control technician.
- Most limiting dose group would be the S/RSP Operators. Based on an annual average dose of 853 mrem per year per FTE. Other group annual average dose per year per FTE would be 180 for Vault personnel, 213 for NDA personnel, and 432 for Radiation Control personnel. Therefore, all groups are under the design criteria of 1000 mrem/yr TEDE.

References:

1. PFP Stabilization Dose Equivalent Estimate, Mel Chew and Assoc., 1995
2. ALARA Assessment for HA-20MB Cementation Process, Internal Memo 15530-96-MWG-099, 1996
3. Analysis of Immobilization Alternatives, EIS-0244-F
4. PFP Survey Data for Vaults and Cementation Glove Box Areas, 2/00
5. Notes of Telecons with Cognizant Engineer and Experienced Operations Personnel.

Attachment C
Cementation Project ALARA Design Review
Dose Estimate Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2																			
3	Activity #	Task #	Description of Activity/Task (not necessarily in exact order of performance)	# of cycles	Total time spent on task (minutes)	# personnel involved in task simul-taneously	Total person-time spent in highest WB rad field (minutes)	Total person-time spent in highest extremity rad field (minutes)	Total person time spent in work bkgd rad field (minutes)	Average Bkgd Dose rate for task (mrem/hr)	Average Whole Body Dose rate for task (mrem/hr)	Average Extremity Dose rate for task (mrad/hr)	Estimated Whole Body Dose (mrem) including Bkgd	Estimated Extremity Dose (mrem) including Bkgd	Estimated Whole Body Dose (mrem) without Bkgd	Estimated Extremity Dose (mrem) without Bkgd	Activity Whole Body Dose (mrem)	Activity Extremity Dose (mrem)	Task #
4	1		**Vault Access**														4.09E+03	4.21E+03	0
5		1	Remove containers of Pu bearing mat'l from vault (Vault Ops)	178	10	1	10	1	10	60	4	20	1.90E+03	1.96E+03	1.19E+02	1.78E+02			1
6		2	Support removal of Pu bearing mat'l from vault (VaultOps)	178	10	1	10		10	60	4	20	1.90E+03	1.90E+03	1.19E+02	1.19E+02			2
7		3	Support removal of Pu bearing mat'l from vault (RadCon)	178	5	1	5		5	0.5	4		6.68E+01	6.68E+01	5.93E+01	5.93E+01			3
8		4	Support removal of Pu bearing mat'l from vault (Vault Tech.)	178	10	1			10	0.5			1.48E+01	1.48E+01	0.00E+00	0.00E+00			4
9		5	Load containers onto wagon (Vault Ops)	178	10	1	10	1	10	0.5	4	20	1.34E+02	1.93E+02	1.19E+02	1.78E+02			5
10		6	Support loading of containers onto wagon (Vault Ops)	178	10	1	5		10	0.5	4	20	7.42E+01	7.42E+01	5.93E+01	5.93E+01			6
11	2		**Move Containers to 235-B Temporary Storage Area**														4.20E+02	5.98E+02	0
12		7	Transport containers to transfer location (Vault Ops)	86	5	1	5		5	0.5	2	10	1.79E+01	1.79E+01	1.43E+01	1.43E+01			7
13		8	Support transport of containers to transfer location (Vault Ops)	86	5	1			5	0.5	2	10	3.58E+00	3.58E+00	0.00E+00	0.00E+00			8
14		9	Support the transfer of custody to Transition Ops. (Vault Ops)	86	10	2	5		10	0.5	4	20	3.58E+01	3.58E+01	2.87E+01	2.87E+01			9
15		10	Verify and transfer custody of mat'l to Transition Ops. (Ops)	178	10	2	10	1	10	0.5	4	20	1.34E+02	1.93E+02	1.19E+02	1.78E+02			10
16		11	Transport containers to 235-B Temp Storage (Ops)	86	5	1	5		5	0.5	2	10	1.79E+01	1.79E+01	1.43E+01	1.43E+01			11
17		12	Support transport of containers to 235-B Temp Storage (Ops)	86	5	1			5	0.5	2	10	3.58E+00	3.58E+00	0.00E+00	0.00E+00			12
18		13	Unload containers at 235-B Temp Storage (Ops)	178	10	1	10	1	10	0.5	4	20	1.34E+02	1.93E+02	1.19E+02	1.78E+02			13
19		14	Support unloading of containers at 235-B Temp Storage (Ops)	178	10	1	5	1	10	0.5	4	20	7.42E+01	1.34E+02	5.93E+01	1.19E+02			14
20	3		**Transport Lard Cans to HA 28/235 B Containment**														2.14E+02	2.70E+02	0
21		15	Load containers onto wagon (Ops)	166	10	1	10	1	10	0.5	4	20	1.25E+02	1.80E+02	1.11E+02	1.66E+02			15
22		16	Support the loading of containers onto wagon (Ops)	166	10	1	5		10	0.5	4	20	6.92E+01	6.92E+01	5.53E+01	5.53E+01			16
23		17	Move lard cans to containment (Ops)	83	5	1	5		5	0.5	2	10	1.73E+01	1.73E+01	1.38E+01	1.38E+01			17
24		18	Support movement of lard cans to containment (Ops)	83	5	1			5	0.5	2	10	3.46E+00	3.46E+00	0.00E+00	0.00E+00			18

Attachment C
Cementation Project ALARA Design Review
Dose Estimate Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
25	4		**Open Lard Cans**														5.70E+03	7.25E+03	0
26		19	Unload lard cans at greenhouse (Ops)	166	10	1	10	1	10	1	4	20	1.38E+02	1.94E+02	1.11E+02	1.66E+02			19
27		20	Support unloading of lard cans at greenhouse (Ops)	166	10	1	5		10	1	4	20	8.30E+01	8.30E+01	5.53E+01	5.53E+01			20
28		21	Open Lard Cans and remove individual cans (Ops)	1494	20	1	20	2	20	1	4	20	2.49E+03	3.49E+03	1.99E+03	2.99E+03			21
29		22	Support removal of individual cans (Ops)	1494	20	1	10		20	1	4	20	1.49E+03	1.49E+03	9.96E+02	9.96E+02			22
30		23	Support removal of individual cans (RadCon)	1494	20	1	10	1	20	1	4	20	1.49E+03	1.99E+03	9.96E+02	1.49E+03			23
31	5		**Move containers to NDA**														4.44E+03	5.95E+03	0
32		24	Load containers onto wagon (Ops)	1506	10	1	10	1	10	0.5	4	20	1.13E+03	1.63E+03	1.00E+03	1.51E+03			24
33		25	Support the loading of containers onto wagon (Ops)	1506	10	1	5		10	0.5	4	20	6.28E+02	6.28E+02	5.02E+02	5.02E+02			25
34		26	Move containers to NDA Lab (Ops)	302	10	1	10		10	0.5	2	10	1.26E+02	1.26E+02	1.01E+02	1.01E+02			26
35		27	Support movement to NDA Lab (Ops)	302	10	1			10	0.5	2	10	2.52E+01	2.52E+01	0.00E+00	0.00E+00			27
36		28	Support movement to NDA Lab (RadCon)	302	10	1			10	0.5	2	10	2.52E+01	2.52E+01	0.00E+00	0.00E+00			28
37		29	Unload containers at NDA Lab (Ops)	1506	10	1	10	2	10	2	4	20	1.51E+03	2.51E+03	1.00E+03	2.01E+03			29
38		30	Support unloading of containers at NDA Lab (Ops)	1506	10	1	5		10	2	4	20	1.00E+03	1.00E+03	5.02E+02	5.02E+02			30
39	6		**NDA containers**														1.61E+03	2.11E+03	0
40		31	NDA - Segmented Gamma Ray Scan	1506	30	1	1	1	30	2	4	20	1.61E+03	2.11E+03	1.00E+02	6.02E+02			31
41	7		**Move containers to Cementation Glove Box**														2.66E+03	3.16E+03	0
42		32	Load containers onto wagon (Ops)	1506	10	1	10	1	10	2	4	20	1.51E+03	2.01E+03	1.00E+03	1.51E+03			32
43		33	Support loading of containers onto wagon (Ops)	1506	10	1	5		10	2	4	20	1.00E+03	1.00E+03	5.02E+02	5.02E+02			33
44		34	Move loaded wagon to Cementation Glove Box (Ops)	302	10	1	10		10	0.5	2	10	1.26E+02	1.26E+02	1.01E+02	1.01E+02			34
45		35	Support movement of loaded wagon to Cement Glove Box (Ops)	302	10	1			10	0.5	2	10	2.52E+01	2.52E+01	0.00E+00	0.00E+00			35
46	8		**Load in containers**														2.76E+03	3.26E+03	0
47		36	Load/Seal in containers (Ops)	1506	10	1	10	1	10	1	4	20	1.26E+03	1.76E+03	1.00E+03	1.51E+03			36
48		37	Support load/seal in of containers (Ops)	1506	10	1	5		10	1	4	20	7.53E+02	7.53E+02	5.02E+02	5.02E+02			37
49		38	Support load/seal in of containers (Rad Con)	1506	10	1	5		10	1	4	20	7.53E+02	7.53E+02	5.02E+02	5.02E+02			38

Attachment C
Cementation Project ALARA Design Review
Dose Estimate Table

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
50	9		**Cementing Operations**														1.44E+04	3.27E+04	0
51		39	Weigh and open feed item	302	20	2	20	20	20	1	1.6	8	2.62E+02	1.07E+03	1.61E+02	9.66E+02			39
52		40	Sieve and grind materials	302	30	2	30	30	30	1	1.6	8	3.93E+02	1.60E+03	2.42E+02	1.45E+03			40
53		41	Transfer and weigh rxn charge	302	20	2	20	20	20	1	1.6	8	2.62E+02	1.07E+03	1.61E+02	9.66E+02			41
54		42	Load auger, prepare mixer and start auger	302	35	2	35	35	35	1	1.6	8	4.58E+02	1.87E+03	2.82E+02	1.69E+03			42
55		43	Monitor rxn and control foaming	1506	100	1	100		100	1	1.6	8	6.53E+03	6.53E+03	4.02E+03	4.02E+03			43
56		44	Weigh empty slip lid and add material	1506	40	2	40	20	40	1	1.6	8	2.61E+03	6.63E+03	1.61E+03	5.62E+03			44
57		45	Weigh, add cement and mix	1506	45	2	45	45	45	1	1.6	8	2.94E+03	1.20E+04	1.81E+03	1.08E+04			45
58		46	Pour cement and set up cement	1506	15	2	15	5	15	1	1.6	8	9.79E+02	1.98E+03	6.02E+02	1.61E+03			46
59	10		**Seal out of cemented containers**														2.64E+03	7.53E+03	0
60		47	Unload containers of cemented material (Ops)	1506	10	1	10	10	10	1	2.5	13	8.79E+02	4.14E+03	6.28E+02	3.89E+03			47
61		48	Support unloading of cemented material containers (Ops)	1506	10	1	10	5	10	1	2.5	13	8.79E+02	2.51E+03	6.28E+02	2.28E+03			48
62		49	Support unloading of cemented material containers (RadCon)	1506	10	1	10		10	1	2.5	13	8.79E+02	8.79E+02	6.28E+02	6.28E+02			49
63	11		**Load Containers into Cylinders and Overpack Containers**														1.90E+03	2.59E+03	0
64		50	Load containers into cylinders (Ops)	1506	20	1	20	2	20	0.5	2.5	13	1.51E+03	2.16E+03	1.26E+03	1.91E+03			50
65		51	Support loading of containers into cylinders (Ops)	1506	20	1			20	0.5	2.5	13	2.51E+02	2.51E+02	0.00E+00	0.00E+00			51
66		52	Package cylinders into drums and seal (Ops)	502	10	1	10	1	10	0.5	0.75	4	1.05E+02	1.38E+02	6.28E+01	9.62E+01			52
67		53	Support package and sealing of drums (Ops)	502	10	1			10	0.5	0.75	4	4.18E+01	4.18E+01	0.00E+00	0.00E+00			53
68	12		**Move Drums to Staging Area**														1.88E+02	1.88E+02	0
69		54	Move drums to staging area (Ops)	502	10	1	10		10	0.5	0.75	4	1.05E+02	1.05E+02	6.28E+01	6.28E+01			54
70		55	Support movement of drums to staging area (Ops)	502	10	1			10	0.5	0.75	4	4.18E+01	4.18E+01	0.00E+00	0.00E+00			55
71		56	Support movement of drums to staging area (RadCon)	502	10	1			10	0.5	0.75	4	4.18E+01	4.18E+01	0.00E+00	0.00E+00			56
72																			0
73						Total dose - all personnel							4.10E+04	6.98E+04	2.41E+04	5.29E+04	4.10E+04	6.98E+04	
74																			
75						Total dose - Vault Operators only							4.08E+03	4.20E+03	4.58E+02	5.77E+02			
76						Total dose - S/RSP Operators only							3.21E+04	5.98E+04	2.14E+04	4.90E+04			
77						Total dose - RadCon Personnel only							3.28E+03	3.76E+03	2.18E+03	2.68E+03			
78						Total dose - NDA Personnel only							1.61E+03	2.11E+03	1.00E+02	6.02E+02			
79						Total dose - all personnel							4.10E+04	6.98E+04	2.41E+04	5.29E+04			
80																			