CSER 96-012, Facility Reclassification and Criticality Alarm System Shutoff for Deactivated PUREX

A. L. Hess
Westinghouse Hanford Company, Richland, WA 99352
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Abstract: This evaluation documents the justification for changing the PUREX criticality safety classification from "Fissionable Material Facility" to "Limited Control Facility", and to dismiss the requirement for a Criticality Alarm System for the facility's deactivated status. The basis for both changes is the recognition that the residual fissile material in the various plant cells, gloveboxes, vessels, piping, etc., is of a form and distribution for which criticality is not credible. Incumbent to the new owners of the deactivated PUREX is the responsibility that any plans for intrusions into the Pu contaminated cells, or for other disturbances of the residues, be reviewed for criticality safety implications.

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CSER 96-012: FACILITY RE-CLASSIFICATION AND CRITICALITY ALARM SYSTEM SHUTOFF FOR DE-ACTIVATED PUREX

WESTINGHOUSE HANFORD COMPANY

June 1996

For the U. S. Department of Energy

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TABLE OF CONTENTS

APPENDICES

CRITICALITY SAFETY ANALYSIS REPORT 96-012

Title: FACILITY RE-CLASSIFICATION AND CRITICALITY ALARM SYSTEM SHUTOFF FOR DE-ACTIVATED PUREX

Prepared by: [signature] Date: June 13, 1996
Engineer, Criticality and Shielding

Reviewed by: [signature] Date: 1996 June 13
Engineer, Criticality and Shielding

Approved by: [signature] Date: 6/13/96
Manager, Criticality and Shielding

CRITICALITY SAFETY EVALUATION REPORT 96-012: FACILITY RE-CLASSIFICATION AND CRITICALITY ALARM SYSTEM SHUTOFF FOR DE-ACTIVATED PUREX

1.0 INTRODUCTION AND SUMMARY

As part of the PUREX transition project, the majority of the residual fissile material left at the end of the last processing campaign was removed from processing equipment and gloveboxes. There also has been a number of cleanup projects, including dismantling and removal of contaminated equipment, piping and cabling, plus scraping and wiping of surfaces, in order to greatly reduce the inventory of Pu-bearing deposits. The remaining material is generally dispersed in thin layers in glovebox floors and walls or in the L Cell on the floor. Based on the quantities, form and distribution of this material, criticality is not considered a credible accident during the remaining deactivation activities or during the surveillance and maintenance period.

This evaluation discusses the material, form and distribution as well as credible upsets or accidents involving this material for the remaining deactivation work and the surveillance and maintenance period. The material is addressed by facility location for this evaluation. It is concluded, because the form and distribution precludes the possibility of criticality, that PUREX may now be reclassified as a "Limited Control Facility" for criticality safety program purposes, and that a Criticality Alarm System (CAS) is no longer required.

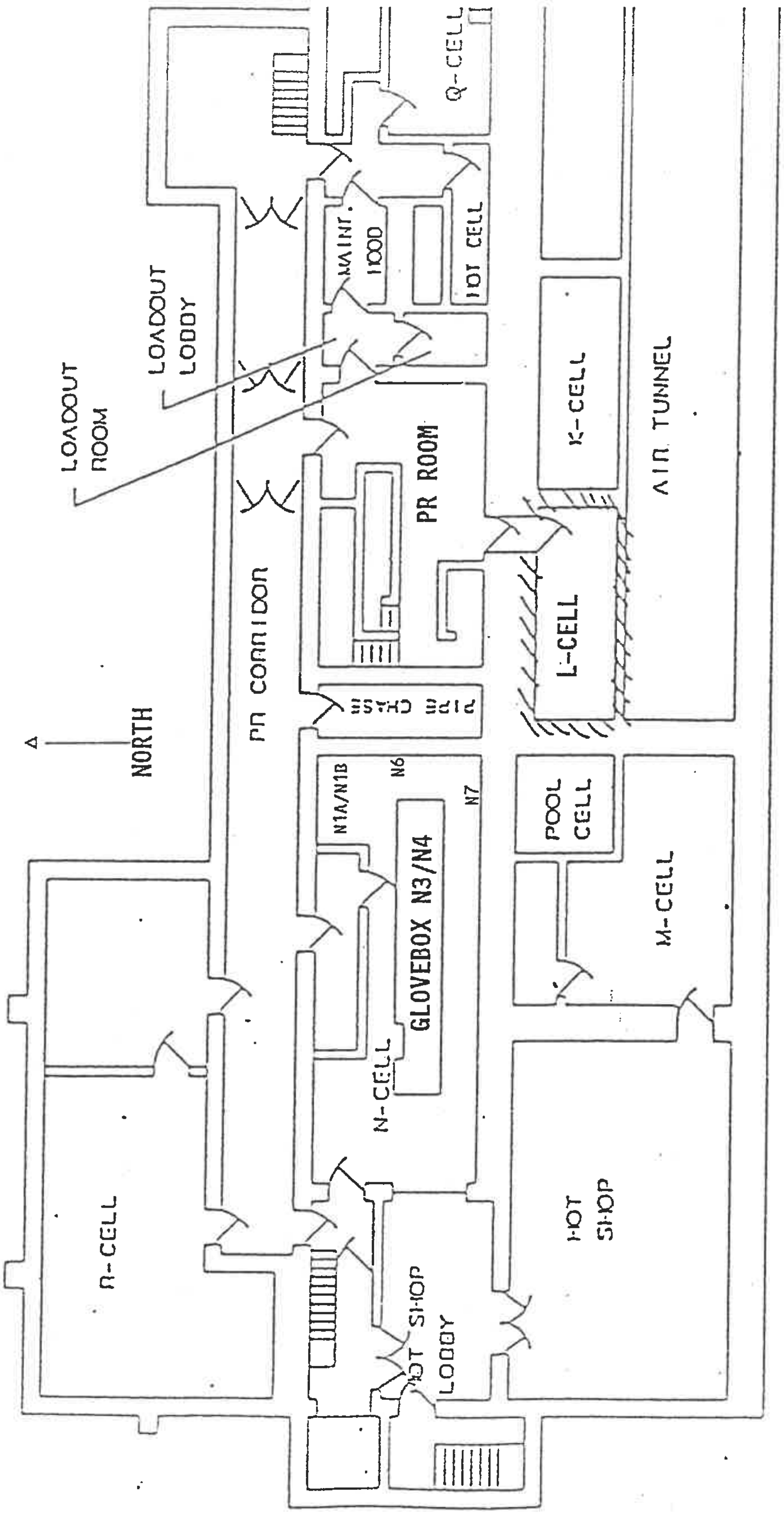
2.0 DESCRIPTION OF PU HOLDUP AREAS

The facility areas of concern to this evaluation are the personnel-accessible cells and gloveboxes which have been contaminated with plutonium from past handling of plutonium nitrate solution or of the various solid compounds involved in the PuO_2 production campaign. There may also be significant plutonium residues in other PUREX cells in which highly radioactive, irradiated-uranium bearing materials or solutions were handled remotely; except for the L-Cell and some E-Cell material, these deposits are not well characterized. However, such canyon areas are well shielded by thick concrete walls and were never covered by a criticality alarm system, nor was a detector system required.

Figure 1 illustrates the overall plan of the west end of the PUREX building, indicating the relative locations of the three major cells with plutonium residues; the N-Cell, the L-Cell, and the Product Removal (PR) Room. Within the N-Cell are the Wet Gloveboxes and the dry N3/N4 Glovebox complex used for calcining to plutonium oxide. The PR-Room holdup is mostly residues on the inside surfaces of the L-9 hood.

The appendices to this report discuss deactivation activities for these Pu contaminated areas and include summaries of the non-destructive assay (NDA) mappings for the distributions of the Pu bearing materials. Specific details and discussions by area are given in the following subsections.

FIGURE 1: FLOOR PLAN OF WEST END OF PUREX, BUILDING 202A



All of the gloveboxes in N-Cell, Q-Cell and the PR-Room have been deactivated such that all process lines to them have been blanked or otherwise isolated, including process water lines. Except for the limited-volume fire suppression water to the PR Room (5 gallons per glovebox), no other systems remain active for the remainder of deactivation activities within these gloveboxes. Ventilation is maintained in the gloveboxes and as part of deactivation will be cascaded to the canyon and main stack.

2.1 L-CELL FLOOR RESIDUAL PU CHARACTERIZATION

Appendix A provides memos concerning the residual Pu contamination on the floor of the L-Cell, including a discussion of the pre-deactivation options for the material disposition and the results of NDA measurements mapping the distribution of floor deposits. The selected option has been to leave the floor residues "as is", without attempts to further fix in place.

The scale-like substance on the L Cell floor was sampled and these samples were analyzed to determine the quantity of Pu in the material. Based on these analyses, the total quantity of Pu material remaining on the L Cell floor is approximately 3.9 kg. The residue is found to be as a hardened, immobile form which is insoluble and is very tightly adhered to the stainless steel floor. The maximum thickness of the L cell scale is approximately 0.5 inches and its maximum Pu concentration is approximately 230 grams per liter. Appendix A, Item A.2, provides further details on the process used to obtain the floor material characterization.

The floor Pu residues are in various locations near processing equipment within the cell. Four such areas are identified on the diagrams at the end of Item A.2 in Appendix A. The greatest depth of material is identified in location #1 in these figures, where the material is approximately ½ inch in depth over a 2-ft square area. Location #3 is identified as having a depth of ¼ inch of the residue over an area of about 2 x 3 ft. The remaining locations, #2 and #4, were found with material depths of approximately ⅛ inch spread over 4 to 6 ft^2 areas.

2.2 N-CELL RESIDUAL PU CHARACTERIZATION AND TREATMENTS

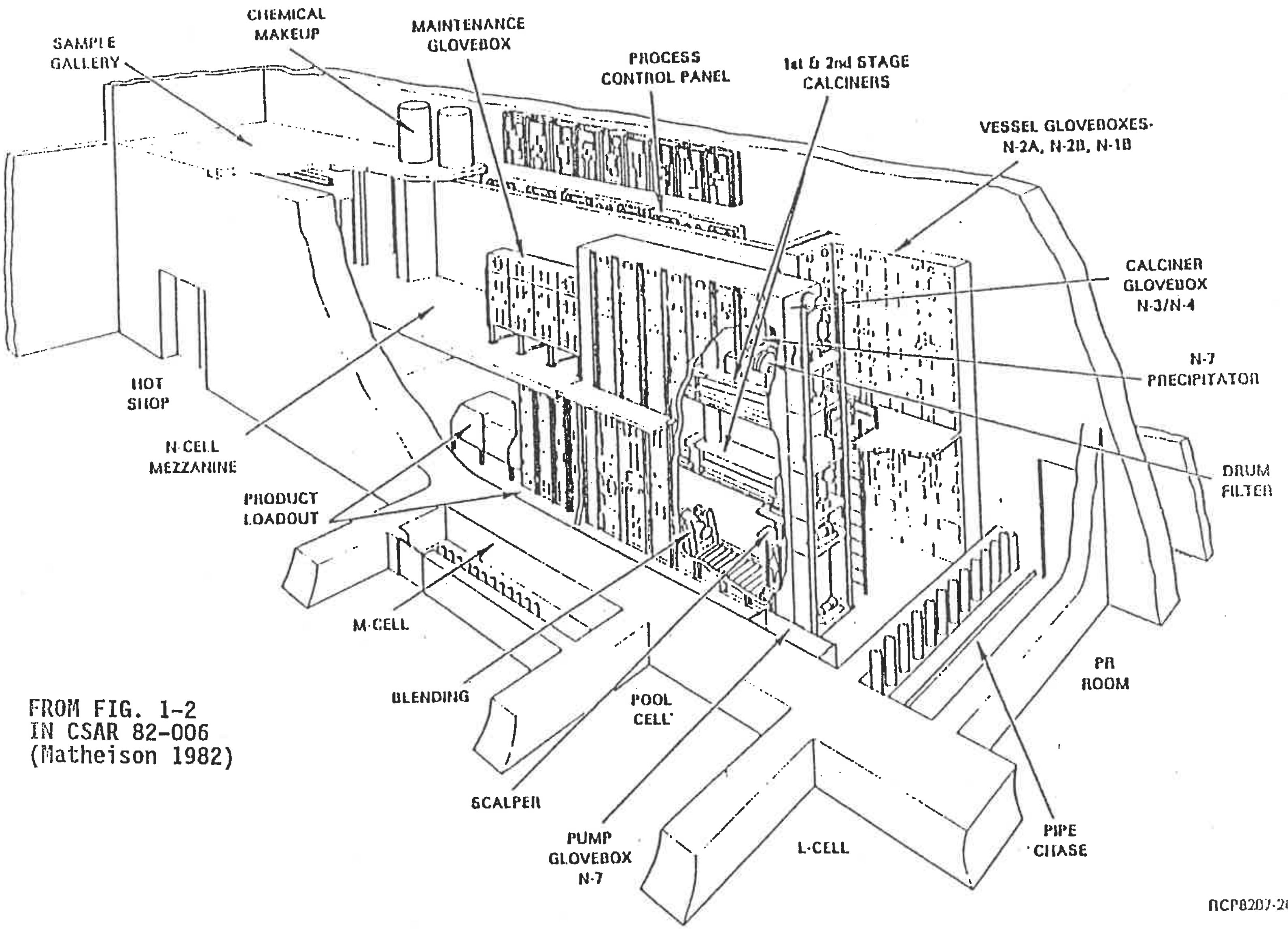
Appendix B provides memos on the NDA measurements to determine the distribution of Pu-bearing residues in the various gloveboxes of the N-Cell, and also letters discussing criticality safety aspects for the treatments to fix these contamination deposits. Figure 2 illustrates in closer detail the layout of the N-Cell, showing the positions of the wet gloveboxes N1A, N2A, N1B, N2B and N7 relative to the dry, calcining glovebox N3/N4 complex (wet boxes N6 and N2C are against the wall by the pipe chase). The location of the Maintenance Glovebox is also shown at the west end of N3/N4 on the upper level.

The plutonium distributed as residues throughout the N-Cell glovebox totals to not more than 2100 grams, using the "high value" NDA results.

2.2.1 Fixing of Pu Contamination in N-Cell N3/N4 Gloveboxes

Item B.1 in Appendix B is a letter presenting the results of the last NDA measurements for the Pu holdup in the dry gloveboxes in the N-Cell. The data indicate that there is about 1360 grams total of Pu material left as an oxide in the glovebox. The activity distribution mapping with the letter (page B-5) suggest that a good fraction of the residues are entrained with the remaining fixed equipment, the two stages of calciners, in addition to the surface contamination of the box walls and floor.

Figure 2: CUTAWAY VIEW OF PUREX N-CELL (PU-OXIDE CONVERSION FACILITY)



FROM FIG. 1-2
IN CSAR 82-006
(Matheison 1982)

Item B.2 in Appendix B is a letter from the Criticality and Shielding group discussing the application of Polymeric Barrier System (PBS) paint as a means to fix the residues. As seen in the Items B.1 and B.2 charts, the 1360 g total Pu in gloveboxes N3/N4 is spread over a wide area, with a maximum of about 110 grams behind any 3 ft x 2 ft face panel. The heaviest concentrations are in the vicinity of the calcining equipment.

2.2.2 Residual Pu Contamination in N-Cell Maintenance Glovebox

Item B.3 in Appendix B is a memo about NDA measurements for the residual Pu in the Maintenance Glovebox attached on the upper level to the N4 Glovebox. A total of 160 g Pu is indicated in the glovebox by this data.

2.2.3 Fixing of Pu Contamination in N-Cell Wet Gloveboxes

In addition to the L-shaped glovebox-complex N1A, N2A, N1B, and N2B indicated in Figure 2, the N-Cell wet gloveboxes include N2C, N6, and N7, at locations noted in Figure 1 (N2C is overhead N6). A report on the NDA surveys conducted for all these gloveboxes is included as Items B.4, B.5 and B.6 in Appendix B. An NDA high-value of 555 g Pu was derived as the total for all seven of these gloveboxes. The best values, which are used for inventory purposes, came to a total of only 123 g Pu for the seven wet gloveboxes. The various solution tanks and vessels remaining in these gloveboxes were flushed and drained as part of the shutdown program and hold insignificant residual Pu.

Two of the three criticality drains from the N Cell wet gloveboxes to the canyon have been plugged with expansion plugs, but the secondary criticality drains connecting the gloveboxes were left open, so there is still a criticality drain route from each glovebox to the canyon.

Essentially all of the wet glovebox Pu residues are in the form of a dried plutonium nitrate fixed to the walls and floors. The inside surfaces of these old vessel gloveboxes have also been painted with PBS in the same manner as described in Item B.2 for the dry gloveboxes N3/N4.

2.3 PR ROOM GLOVEBOX RESIDUAL PU DETERMINATION, FIXING TREATMENT

Appendix C, Items C.1, C.2 and C.3 are copies of the reports on the NDA results for three contaminated gloveboxes in the PR Room, nos. L9, L11 and L14. The highest amount of Pu remaining within any PR-Room glovebox is about 1015 grams for Glovebox L-9, taken as the 1140 g NDA total (cited in the table on page C-6), less an estimated 126 g removed subsequent to the NDA measurements. The residual Pu bearing material in these four PR-Room gloveboxes is also predominately dried Pu nitrate that has been fixed to the glovebox interior with a Polymeric Barrier System (PBS).

The criticality drains from the PR Room gloveboxes to the canyon were also left open.

3.0 CRITICALITY SAFETY EVALUATION

3.1 PREVIOUS CRITICALITY SAFETY ANALYSES FOR PUREX

The more relevant previous CSERs pertaining to the plutonium oxide conversion facility in PUREX are CSER 82-006 (Matheison 1982), and its addenda, which determined the criticality safety specifications for the operation of the conversion process. This report included extensive details of the facility gloveboxes and equipment, and also discussed the criticality potential of Pu bearing solutions pooling at the bottom of the various gloveboxes.

Since the cessation of the Pu reprocessing operations there have been two CSERs pertaining to criticality safety for PUREX in a shutdown mode, CSER 91-003 (Matheison 1991) and CSER 86-011 Addendum 1 (Friar 1995). CSER 91-003, concerning PUREX in Standby Status, presented arguments for the beginning of phaseout for the Criticality Alarm System (CAS) throughout the facility as the fissile materials were removed and the residual inventory is diminished. The 1995 CSER addendum provided criticality safety rules for glovebox cleanout operations.

3.2 METHOD OF ANALYSIS

Because of the complexity and variety of situations for the residue plutonium and the uncertainty of their configurations, detailed calculations, using a Monte-Carlo or other neutronics code, are inappropriate. Instead, the criticality safety is basically argued by reference to standard handbook data for critical thicknesses of Pu-bearing media as infinite slabs, as the residues are predominately as thin fixed coatings on flat surfaces. Two of the most relevant charts for slab critical parameters are presented in Figures 3 and 4, from ARH-600 (Carter 1968).

For the purpose of this criticality evaluation, all residue material is modeled as a Pu-H_2O infinite slab with 0% Pu 240 by weight. This modeling is conservative since other materials clearly are contained in this matrix and one likely candidate material is iron, for which the neutron absorption properties can considerably raise the Pu mass needed for criticality. It is further conservative since the PUREX residual Pu in most of the concerned cells is approximately 12 weight percent Pu 240, and for the rest is 5% as a minimum.

3.3 ANALYSIS FOR L-CELL FLOOR

Based on the analysis of the data provided in appendix A, the maximum concentration of Pu in the L-cell floor material is 230 grams/liter. From Figure 3, the minimum thickness for criticality to occur at this concentration with full water reflection is approximately 2.3 inches. Similarly, the minimum critical thickness for this model with 10 inches of concrete as a reflector on both sides (see Figure 4) is approximately 1.5 inches. And in the most realistic case of 10 inches of concrete on one side and 1 inch of water on the other, the minimum critical thickness is 2.7 inches.

As a result, the material on the L Cell floor at its maximum thickness and concentration is 0.333 of the required thickness for the most conservative model

Figure 3: GRAPH OF CRITICAL SLAB THICKNESS VS PU DENSITY, PU-WATER MIX

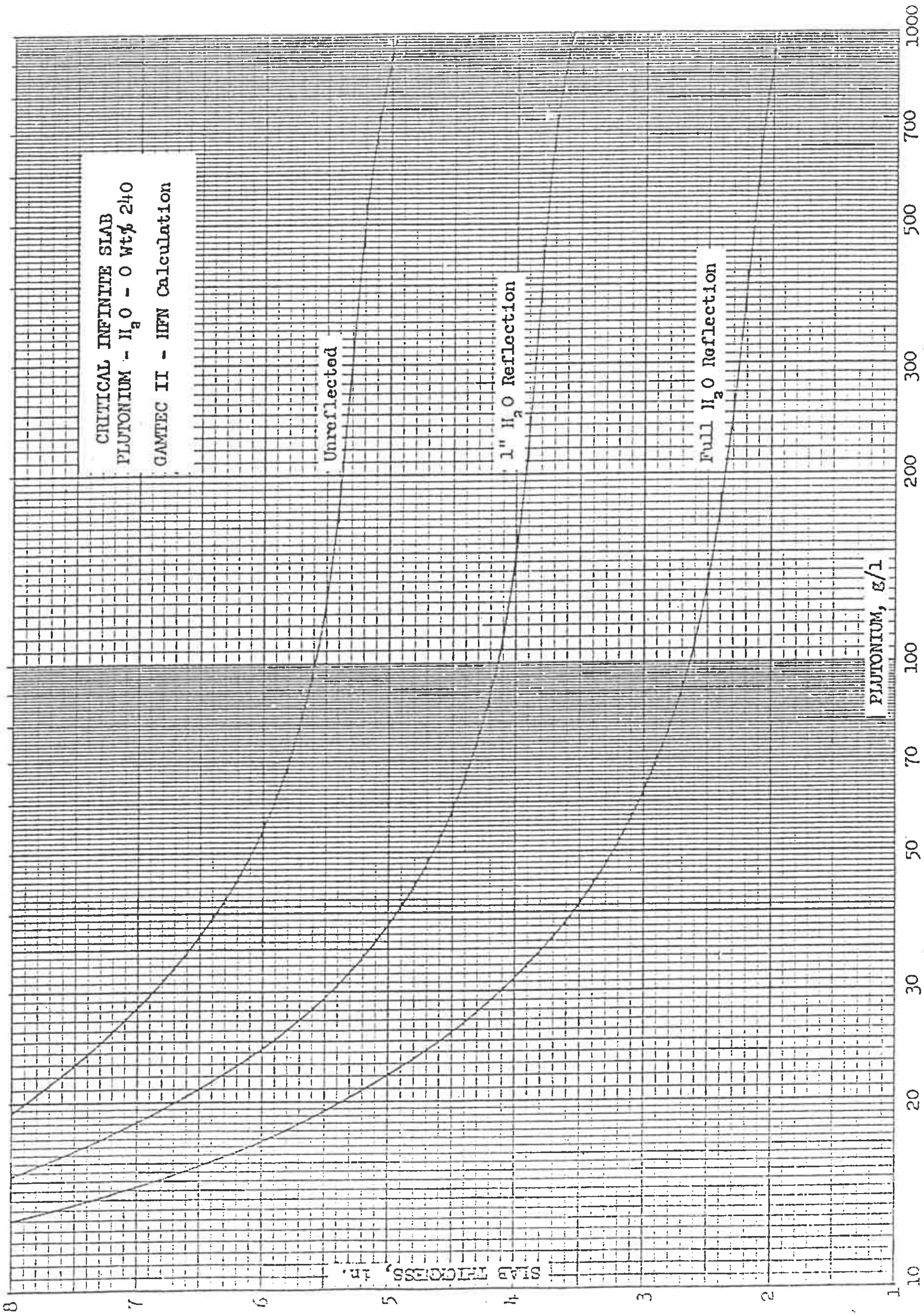
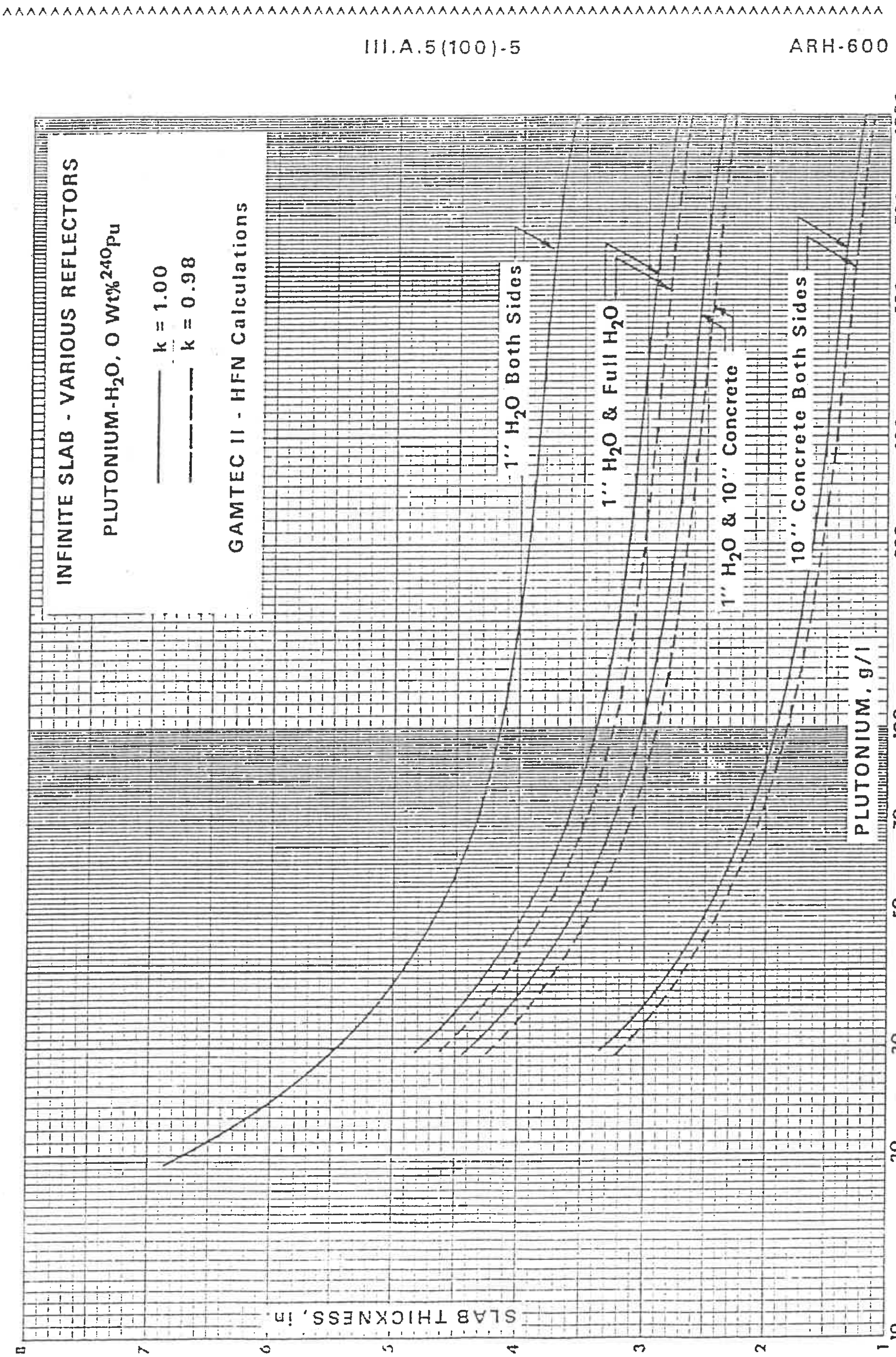


Figure 4: VARIATIONS OF CRITICAL SLAB THICKNESS BY REFLECTOR TYPE, PU-WATER MIXES



ling. For the other cases the ratio to the minimum critical thickness varies from 0.217 to 0.185 of the required depth. The conclusion is that this material is subcritical for all possible scenarios based on the form and distribution of the material.

The floor of the L-Cell is a rectangle of approximately 33 ft length and 14 ft width , giving an area of ~462 ft^2. Were flooding of the cell even remotely possible, and also if much of the residual Pu there was actually soluble, criticality would still not be possible with any solution depth. The Pu assay total of 3.9 kg yields an average areal density of 3900/462 = 8.4 g Pu/ft^2, which is an order of magnitude lower than the minimum critical areal density.

Since all of the gloveboxes are sealed and all gloves have been removed, and since L cell is a high radiation/high contamination area with no routine entry (the access door has been sealed and locked), it would require a willful violation of procedures for personnel to change the form and distribution of this material. As a result, the only credible scenarios impacting this material would be flooding of the L-cell floor, and perhaps flooding the N-Cell or PR-Room gloveboxes (which drain to the L-Cell). These scenarios are not considered credible based on the conditions and activities in the plant during the remaining deactivation and the surveillance and maintenance period. However, should such an event occur, the material still would be subcritical by a large margin.

3.4 ANALYSIS FOR N3/N4 AND MAINTENANCE GLOVEBOXES IN THE N-CELL

The total remaining fissile material in the N3, N4 and maintenance gloveboxes was determined by NDA to be approximately 1600 grams Pu, maximum, which is widely distributed throughout these gloveboxes. Though the material in these gloveboxes is Pu oxide it can be conservatively modeled the same as the other glovebox materials were above. For additional conservatism the Pu is considered to be 0 weight percent Pu 240. All water and process lines in the N cell dry gloveboxes have been blanked, and there is no water for fire fighting.

For the N3/N4 glovebox combination there is a total of about 1360 g Pu, which is distributed as illustrated in the diagrams of Item B.2 in Appendix B. The combined N3/N4 gloveboxes have a 3 ft wide by 24 ft long base, so that each of the assay panels indicated on the Item B.1 diagram is about 3 ft wide. The column of assay panels with the most residual Pu is at the east end, with 394 g Pu total in the eight sections vertically. Discounting the possible diversive effects of the mezzanine floor, if all of the 394 g Pu were washed or slumped to the bottom of the glove box and spread out on the floor within the panel width, the areal density would be only 394/(3 x 3) = 44 g Pu/ft^2, which is about 1/6 of the minimum for criticality in slab geometry. For the other seven assay panels to the right in the Item B.2 chart, the vertical tallies are less, and for all of the glovebox Pu to be washed into a floor pool would provide an areal average of not more than ~1800/(24 x 3) = 25 g Pu/ft^2 - - - an order of magnitude less than the minimum for criticality assuming full reflection both above and below the slab pool.

The 160 grams residual plutonium in the Maintenance Glovebox amounts to less than a third of the absolute minimum critical mass for Pu under the most optimum geometry plus water moderation and reflection conditions, so a critical reconfiguration of this material is impossible.

3.5 ANALYSIS FOR N-CELL WET GLOVEBOXES

The NDA measurement results reported in Appendix B, Item B.5 for the wet gloveboxes in N cell include three sets of assay values, low, best, and high. For the purpose of this safety evaluation the "High NDA" values are used, which total to 555 grams for the whole complex of seven N-Cell wet gloveboxes identified in Section 2.2.1. The most residual Pu in any one glovebox is 118 g by the high assay value. All process and water lines to these wet gloveboxes have been blanked and the residual Pu in all has been fixed to the glovebox surfaces with the PBS.

Given even an implausible scenario which would have the Pu in all the wet gloveboxes washed off into the bottom of one of them (drainage could occur across some of them), and a deep pool formed by water flooding, there is not enough Pu for criticality for the possible material form, geometry and reflection conditions. In reality, a deep enough pool could not be formed, as the cross draining would eventually reach a criticality drain leading to the floor of the PUREX canyon. For the past processing operations, with considerably more fissile contents, the wet gloveboxes were provided with the drains down to the canyon floor, where tens of kilograms of Pu in solution could be spread out without fear of a criticality.

3.6 ANALYSIS FOR PR-ROOM WET GLOVEBOXES

All surface of the wet gloveboxes in the PR room, including L-9, have been coated with PBS. The L-9 glovebox is the bounding case for these gloveboxes since it contains the most material. The determination of Pu material in the L-9 glovebox was made by NDA and the results are included in Appendix C. A total of 1.14 kg Pu identified by the final NDA was reduced by 126 g in a subsequent cleanup task to give a current residual of 1015 grams Pu. Since the PR Room was used to handle product plutonium nitrate solution, it can be assumed that all residues are $Pu(NO_3)_4$ as dried sludge, perhaps with some degree of hydration.

For evaluation, this material is assumed as an infinite slab and again conservatively evaluated as 0 weight percent ^{240}Pu. The material is dispersed throughout the glovebox and there were no significant concentrations of Pu-bearing material identified via the NDA measurements. Additionally all solution and water lines to the glovebox have been blanked. The only remaining source of water is the fire system designed for operations, which as water supply is volume limited. From chart III.A.5.100-1 in ARH-600 (Carter 1968) the minimum critical thickness for Pu as nitrate in solution as a slab configuration is approximately 2.5 inches, when the Pu concentration is in the range 300 to 500 grams/liter.

The floor dimensions of Glovebox L-9 are a length of 19 ft and width of 18 inches (from Matheison, 1991). Criticality with 300 grams Pu/liter in a 2.5 inch deep pool would thus require more than 50 kg of entrained plutonium. Besides, the internal fire water supply could not give the 44 gallons needed, and the criticality drain would not enable that deep of pool to form. Therefore, the Pu in the L-9 glovebox is subcritical by form and distribution for all scenarios.

3.7 ANALYSIS FOR OTHER PUREX PU-CONTAMINATION AREAS

3.7.1 Other Non-Canyon Cells and Vessels

The K-Cell was used for the final U cycle so there would be only traces of Pu in the vessels or floor of this cell.

The M cell vessels were flushed and the floor washed down. The M Cell vault vessels were flushed and drained to the N Cell gloveboxes. In addition, because the piping for the M Cell vault vessels was all butt welded, there never were any leaks to contaminate the M-Cell Vault floor.

3.7.2 Canyon Cells, Vessels and Floors

There is a metal waste collection tray (skip) in the F17 position that contains an estimated 400 g Pu with associated fuel uranium as E Cell floor debris, mostly canyon floor solids scraped from beneath Tk-E3. Because of the material makeup and the flat container geometry this waste cannot possibly pose a criticality hazard. Thus, continued storage of this "canyon skip" box is permitted. Disposal of this skip would require further evaluation per the considerations in Section 5.0, below.

The "Standby Status" CSER (Matheison 1991) discussed the plant fissile inventories existing at that stage (1991) of the shutdown/standby transition activities. In addition to inventories for the out-of-canyon cells analyzed above, this 1991 review discussed canyon cell areas where there was residual fuel and plutonium materials, as metal, compound, solution or dried nitrate. Specifically noted for the canyon cells were the following (in 1991);

a) Buckets of Al-clad irradiated natural or depleted uranium, with holdup of about 9 kg Pu, in the water-filled fuel storage basin.

b) A limited number of irradiated fuel elements remaining on the floor of the dissolver cells; these were allowed to remain by CSER 91-013.

c) A minimal amount of irradiated uranium, associated with zircalloy cladding hulls, remaining in the Head-end dissolver vessels A3, B3 and C3.

d) Approximately 6 metric tons of uranyl nitrate solution in Head End Tanks Tk-D5 and Tk-D6, which includes about 7 kg of Pu.

e) 50 kg of neptunium 237, with a minimal Pu content, present in the Np recovery cycle storage tank Tk-J2.

f) Minimal fissionable material in the remainder of the canyon vessels.

g) Solution in canyon sumps may be collected in Tk-F18.

Cleanout and deactivation activities since 1991 have removed the fuel elements/pieces cited in items (a) and (b) and the fuel solution in item (d). The item (e) neptunium solution has since been transferred to tank farms. For the hulls in the dissolvers, item (c), the residual irradiated uranium with Pu is not significant for criticality safety.

Pertaining to item (g), tank Tk-F18 has been deactivated and sources of liquid to the sumps have been blanked or isolated.

For whatever fissile-material bearing residues remain in the canyon cells, a critical reconfiguration is not credible because the fissile enrichments (percent ^{235}U plus ^{239}Pu in total U + Pu) are insufficient for criticality for the limited mass of such materials possibly available. Thus, the principal focus of this criticality safety assessment is the separated plutonium which exists in the out-of-canyon cells covered in the previous sections.

4.0 CRITICALITY ALARM SYSTEM REQUIREMENTS

The provisions of Chapter 11, "Criticality Alarm System" (CAS), in WHC-CM-4-29 (WHC 1992), the Westinghouse manual on criticality safety, are derived from the requirements of DOE order 5480.24 (DOE 1992), which in turn defers to the ANS/ANSI 8.3 standard for specifics about capabilities for criticality detection and methods for alarms and warning systems. Under Section 5.1 in WHC-CM-4-29 are the Coverage Requirements as stipulated in the DOE order (the same requirements are in the pending revised order 422). The provision for an exemption to the CAS requirement are given in item (3) under section 5.1 of Chapter 11, as follows;

(3) In those cases where the mass of fissionable material exceeds the limits established in paragraph 4.2.1 of ANS/ANSI-8.3, but a criticality accident is determined to be impossible due to the physical form of the fissionable material, or the probability of occurrence is determined to be less than 1 x 10^{-6} per year (as documented in a DOE-approved SAR), neither a CAS nor a criticality detection system is required. - - - - Also, neither a CAS nor a criticality detection system are required for fissionable material during shipment of fissionable material in approved shipping containers, or fissionable material packaged in approved shipping containers awaiting transport providing no other operations involving fissionable material not so packaged is permitted on the dock or in the shipment area.

In the past operational mode, the CAS coverage at PUREX has included all of the out-of-canyon-cell locations where fissionable materials were processed or stored, in accordance with the item (1) requirements in WHC-CM-4-29 section 5.1. For the heavily shielded canyon cells, a CAS was never utilized, but there were means to detect if a criticality occurred, as required by paragraph (2) of the Section 5.1
on Coverage.

The NDA data presented in the appendices have demonstrated that the residual separated plutonium in the PUREX facility is well distributed as thin layers or deposits on equipment and glovebox or cell surfaces. The evaluations presented in Section 3, above, provide the assurance the a criticality occurrence involving these deposits is not credible. For the canyon areas, the residual irradiated uranium, as pieces or sludge, also can not be made critical because of the low enrichment and limited inventory. On this basis, the DOE and WHC requirements for exemption from CAS system at PUREX have been satisfied.

5.0 DEACTIVATION PROCESSES ALLOWED

The only other activity anticipated during the remaining deactivation that will involve any Pu bearing material is the removal of contaminated equipment or flushing of non-canyon vessels. All Pu bearing vessels have been previously flushed and there are no out-of-canyon vessels containing greater that 15 grams of Pu identified in the facility. As a result, the continued flushing of these vessels is authorized by this CSER and criticality is not credible based on the form and distribution of this material.

The removal of Pu contaminated equipment and disposal in waste drums is also an authorized activity under this CSER. Storage of TRU bearing waste containers may continue as provided for in previous CSERs and CPSs. As stipulated in WHC-CM-4-29, and quoted above in section 4.0, a CAS coverage is not required for storage of shipping containers with approved payloads.

No activities involving greater than 15 g of non-fixed Pu material are authorized per this CSER. In the event that any activity should identify this quantity of material, the activity is to be stopped until a criticality evaluation is completed to identify the potential for criticality and the necessary controls to complete the activity. Work orders that pertain to or involve intrusions into the Pu contaminated cells or gloveboxes shall receive USQ screening for criticality safety implications, to ascertain if the activity would significantly change the fissile material distribution assumed as the basis for this evaluation.

6.0 CONCLUSIONS

In the current conditions and with the remaining activities for the conclusion of deactivation and the surveillance and maintenance period, criticality is not credible in the PUREX facility based on the form and distribution of the residual fissile material. Per the definitions of WHC-CM-4-29, *Nuclear Criticality Safety*, the PUREX facility may be reclassified a "Limited Control Facility", with the commensurate reduction of the criticality safety program requirements. Following the approval and release of this CSER, the current posting required for the fissionable material facility status will be removed and replaced with posting appropriate for a limited control facility.

The basis for the change in facility status also satisfies the requirements for elimination of the PUREX Criticality Alarm System (CAS). Per both DOE 5480.24 and the WHC-CM-4-29 manual, no criticality alarm system or detection system is required when criticality is not credible based on the form and distribution of the material. Since PUREX meets that criterion, upon approval and release of this CSER and the re-posting of the facility, the criticality alarm system will be deactivated.

7.0 TECHNICAL PEER REVIEW

This document was reviewed by J. Lee Geiger of WHC Criticality and Shielding. His comments follow.

The document adequately demonstrates that, since most of the fissile material has been removed from the PUREX Plant, criticality detection and alarm systems are superfluous in PUREX for the remainder of deactivation and the S&M phase. Specific activities that would require additional evaluation include:

- L Cell, contains more than a minimum critical mass on the floor. Any activity involving fissionable material in L Cell must include criticality alarm protection. Therefore, no entries into L Cell are permitted by this CSER. An additional criticality evaluation with determination of appropriate criticality alarm coverage is required prior to L Cell activities.

- Some of the gloveboxes in N Cell and the PR Room contain greater than a minimum critical mass. This CSER does not address any glovebox work. If any activities are planned involving work in either the N Cell or PR Room gloveboxes, a new CSER must be completed to evaluate the necessary controls and criticality alarm coverage. Among other considerations, the new CSER should address the possibility that removal of the PBS might lead to concentration of more than a minimum critical mass in a particularly reactive form.

- Although a CAS is not required for storing or handling properly loaded and sealed shipping containers, this exemption does not extend to the loading operation, or to the closed containers themselves until they have been shown to comply with the appropriate permit. Thus, a portable criticality alarm will be needed when loading TRU material into drums whenever the potential exists for exceeding the per-drum fissile limit, and until conformance to the limit is confirmed and documented. In particular, criticality alarm coverage will be needed whenever removing anything from the PR Room or N Cell gloveboxes.

- It is expected that insignificant quantities of material remain in the M Cell and Pipe Chase storage tanks. However, the expectation has not been confirmed by NDA measurements. Until NDA measurements confirm that each location contains less than a minimum critical mass, any operation or modifications in the Pipe Chase or the M Cell vault should be covered with a portable criticality alarm and a specific CSER.

Any of the above activities will need to be covered by a criticality safety evaluation. This document is not intended to serve as the required CSER for these activities.

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APPENDIX A:

MEMOS ON CHARACTERIZATION OF L-CELL RESIDUAL PU

ITEM #	DESCRIPTION	PAGE NOS.
A.1	**EXCERPTS FROM WHITE PAPER ON L-CELL** Draft White Paper, AGW Feb. 7, 1995, "L-Cell Deactivation Issues": Sections on -**BACKGROUND**, **L-CELL FLOOR CONTAMINATION**, Leave as Is subsection of **ALTERNATIVES**, and **CONCLUSIONS**.	A-2 through A-6
A.2	**MEMO ON L CELL FLOOR PLUTONIUM ESTIMATES** Letter by D. W. Nelson (System Deactivation) to R. W. Bailey, Oct. 19, 1994, "L Cell Plutonium Estimates"	A-7 through A-14

Item A.1: EXCERPTS FROM WHITE PAPER ON L-CELL

Draft White Paper
AGW 2/7/96

L CELL DEACTIVATION ISSUES

BACKGROUND

The PUREX plant is in the process of being deactivated in preparation for transfer from the Office of Facility Transfer and Management (EM-60) to the Office of Environmental Restoration (EM-40). The overall objective of deactivation is to achieve a safe, stable, and environmentally sound condition suitable for an extended period, as quickly and economically as possible. A logical system of end point criteria was developed to clarify the scope of work required for deactivation and to facilitate the transfer from EM-60 to EM-40. The end points are documented in WHC-SD-WM-TPP-053, PUREX DEACTIVATION END POINT CRITERIA, which was prepared by WHC and consultants with the concurrence of BHI, the DOE, and regulators. The end points for the L Cell part of the PUREX canyon are the subject of this discussion. The floor of L Cell has an estimated 3.9 kgs of Pu distributed between and under equipment in an immobile form.

The L Cell area of the PUREX plant is the farthest west processing cell in the canyon and contains part of the second Pu cycle and all of the third Pu cycle equipment. Unlike the other processing cells in the PUREX canyon, L Cell contains a doorway through the 6-ft thick canyon wall with an airlock which allows manned entries into the cell from the Product Removal (PR) Room. This door was used during plant construction in the 1950's, but has rarely been used since. The canyon cranes generally were used to maintain the L Cell equipment and replace components when necessary. Figure 1 shows L Cell in relation to other cells and support areas at the west end of the PUREX facility. ~~Figure 2 is an overhead photo of L Cell showing the process equipment and connecting jumpers~~.

The L Cell equipment consists of a feed tank, three solvent extraction columns, a stripper column, a product concentrator and a product receiver tank. The equipment is fabricated from either 304L stainless steel or titanium. The jumpers are mostly made of stainless steel but have some carbon steel parts on the remote connectors. The wall between L Cell and the adjacent occupied area on the north side is 6 ft thick concrete while the west and south walls which separate it from the pool cell, pipe trench, and air tunnel are 2.5-ft thick concrete. A 1-ft thick concrete dividing wall separates L Cell from K Cell to the east. The cell floor is 5'6" thick concrete with a stainless steel liner which extends up the wall for 1 ft.

Since nearly all of the fission products were removed from the product stream before it reached L Cell, the beta-gamma radiation is low enough to allow personnel entries without excessive radiation exposure. However, the cell is highly contaminated with Pu nitrate residues so personnel entries are a major undertaking which require supplied breathing air and three pairs of Anti-C clothing. Several entries were made into L Cell shortly before and after plant shutdown in 1988 to replace a corroded stripping column. Personnel who

1

Item A.1: continued

had been involved in those entries reported that part of the floor was covered by a layer of blackish material. This material was suspected to contain a significant amount of Pu.

Only a minimal amount of Pu is left inside the L Cell equipment. The equipment was flushed with nitric acid at the end of the stabilization run in 1990 and part of it has recently been flushed with water to remove hazardous constituents.

L CELL FLOOR CONTAMINATION

Characterization

The material on the L Cell floor was characterized and evaluated during the summer and fall of 1994. This task included a personnel entry into L Cell to videotape the floor and obtain 12 samples of the material on the floor. The material covering two areas of the floor could not be sampled due to obstructions. The material was hard enough that it had to be scraped from the floor with a spatula to obtain the samples. Following the cell entry, a map was made of the cell floor showing the areas covered by the material, the locations where the samples were taken, and estimates of the material thickness. The samples were analyzed and found to contain between 0.014 and 0.258 grams Pu per gram of solid material. Figure 3 is a map of L Cell * showing where the Pu material is located, the estimated area covered by the material and estimated thickness of each area. The total volume of the Pu material was estimated to be 27 liters. Figure 4 shows where the samples were * taken and gives the Pu concentration in each sample.

The samples had a grainy consistency with the color varying from black/brown to brown to dark rust to rust to mustard. The grainy consistency and the dark color can be seen in the videotape. The videotape also shows that there is only a thin layer of the material and that it contains miscellaneous cell debris. The beta-gamma dose rate of the samples at contact varied from 1-25 mr/hr. The source of the beta-gamma dose rate is Am-241 which builds up from the decay of Pu-241. The density of the samples varied from a light powder to a dense solid so an analytical solid matrix density provided little value. Laboratory Subject Matter Experts were consulted and provided a solid matrix density estimate of 1.5 gm/cc.

Based on sample results and observations made during the sampling operation, it was estimated that the material in the areas that were sampled contained 2.0 kg of Pu. The Pu in the areas that could not be sampled due to obstructions was estimated to be 1.9 kg assuming concentration gradients based on the results of nearby samples. Combining the two estimates gives a total estimate of 3.9 kgs of Pu. The internal letter in Attachment 1 describes in more detail how the Pu estimates were made. The wt% Pu in the samples indicates that 29-53% of the material is dried Pu nitrate. The other constituents are unknown, but are likely to consist of degraded organic solvent, titanium dioxide, paint chips, and rust along with miscellaneous floor debris. Some organic solvent (TBP/NPH) was spilled into L Cell in the 1980s and probably reacted with Pu nitrate. Several lines in L Cell plugged

* See last pages of Item A.2

Item A.1: continued

with titanium oxide solids during the 1980s and some of the solids were flushed onto the cell floor when the lines were cleared.

Implications

1) Safeguards and Security

The Pu is located in a canyon cell that is crowded with equipment and highly contaminated which makes it nearly inaccessible. The access door between L Cell and the PR Room, as well as the doors to the vault area that includes the PR Room, are kept locked. When deactivation is completed, the exterior doors to the building and the L Cell access door will be locked. The vault doors will be left unlocked. The Pu is distributed under and between processing equipment over a wide area of the L Cell floor. The Pu is in the form of dried Pu nitrate mixed with floor debris which is an unattractive form for diversion. Therefore, personnel from safeguards and security concluded that leaving it as it is until D&D activities begin at PUREX will not present an unacceptable safeguards or security risk. This decision is documented in the electronic mail message in Attachment 2.

b) Safety and Environmental Concerns

The Pu material on the cell floor is presently in a hardened, immobile form. The material was reported to be slippery underfoot during a previous cell entry in 1988. If the material is mostly dried Pu nitrate, it can be expected to slowly oxidize into a powder over a number of years which would make it more mobile. However, if the Pu nitrate has reacted with organic solvent as suspected, it is less likely that it will slowly oxidize to a powder.

The material on the L Cell floor is isolated from both personnel and the environment. Both the inner and outer doors in the airlock between L Cell and the PR Room are sealed with neoprene gaskets and toggle clamps to prevent contamination spread into the PR Room. The pressure gradients and airflows in the PUREX ventilation system are designed to control contamination. Contaminated areas are maintained at a negative pressure relative to cleaner areas with L Cell a minimum of 0.5 in WG more negative than the PR Room. The canyon cells are ventilated by a separate ventilation system from the gallery and office areas of PUREX and are maintained at a more negative pressure. Supply fans draw outside air into the crane way above the cells. This air is drawn into the canyon cells including L Cell through cracks between the cover blocks and is exhausted from the cells directly into the air tunnel through holes in the lower south wall of the cells. From the air tunnel, the air passes through the main building exhaust filters and is then released from the main stack. The HVAC consolidation that will be done as part of the deactivation project will result in similar pressure gradients and air paths, but at lower flow rates. The air from the canyon will continue to pass through two banks of filters in series before it is released to the stack. Figure 5 is an illustration of the ventilation flow through the PUREX canyon cells.

There are no liquid effluent routes from L Cell to the environment. Any liquid which drained into the cell sump during processing either was recycled

Item A.1: continued

or transferred to the waste tank farm. Steam and water lines will be isolated from the PUREX facility outside the perimeter fence and the headers inside will be drained as part of deactivation. This will prevent water leaks into L Cell which could potentially flood the floor and move contamination through the access doorway into the PR Room.

ALTERNATIVES

Three alternatives for handling the Pu solids on the L Cell floor were evaluated: 1) Leave as is, 2) Clean up during deactivation, and 3) Fix in place. The alternatives are discussed in the following section.

1) Leave As Is

Under this alternative, the Pu bearing material on the L Cell floor would be left as it is and the condition documented for turnover to BHI. This is the lowest cost alternative and would have no effect on the PUREX deactivation schedule since this alternative was assumed for the baseline schedule. Any cleanup would be done as part of future D&D activities. Since the scope of future D&D activities at PUREX are unknown, the impacts and risks of leaving the L Cell floor in its present condition on D&D activities are also unknown. If the PUREX facility is going to be entombed in concrete or the canyon filled with concrete, leaving L Cell in its present condition will have little effect on D&D. However, if the cells are going to stripped and cleaned up, leaving L Cell as it is will make D&D significantly more difficult than if it is cleaned up now. The risks to D&D workers if they clean up L Cell will probably not be appreciably greater than the risks to PUREX workers if the cell is cleaned up as part of deactivation (discussed under the following alternative). The risk will largely depend on the training and experience of the personnel involved and the equipment/methods available then. The D&D workers will not be as familiar with the PUREX facility as current operating personnel. They also may not be as well trained and as experienced in working with fissile materials and in high contamination areas.

The hazards of leaving L Cell in its present condition during the surveillance and maintenance period were evaluated in the Draft PUREX Deactivated End-State Hazards Analysis prepared by SAIC. In that analysis, the material was described as chemically stable with a wax-like consistency. The resuspension of material due to the failure of structural equipment was assigned the same likelihood class as 100-year flood. A criticality hazard analysis is underway on the Pu in L Cell along the Pu that will be left in N Cell gloveboxes and other areas of the plant. The conclusion of this analysis is expected to be that a criticality from the Pu on the L Cell floor is not credible due to its form and distribution.

Plutonium is present in the floor debris of other canyon cells besides L Cell. Since cells A - E, H, and J all handled Pu in concentrations of at least 1 g/l and have had process solution spilled to the floor, the floor debris in these cells probably contains significant quantities of Pu. The floor debris in E Cell was sampled in 1988 and found to contain significant Pu. The conditions in L Cell are similar enough to the other cells that common deactivation end points were developed for all the canyon cells as discussed later.

Item A.1: continued

All of the L Cell cover blocks will be in place at the end of deactivation to control ventilation flow through the cell and to separate it from the crane way. The access door will be left locked and sealed to isolate L Cell from the PR Room and other areas on the surveillance route. There should be no reason to enter L Cell during the surveillance and maintenance period and there are no plans to do so. The radiological conditions inside L Cell will be posted at the access door in the PR Room to ensure that anyone planning to enter the cell during the surveillance and maintenance period or during D&D will be aware of the conditions inside. The radiological conditions will also be included in documentation that is turned over to BHI as part of the end point closure process.

The long term stability of the material on the L Cell floor cannot be predicted. If the Pu material in L Cell dries out and crumbles into a powder, some of it may become suspended in the ventilation air and carried into the air tunnel. The deep bed fiberglass filters would prevent a release of the Pu into the environment. The HEPA filters downstream from the fiberglass filters provide another stage of filtration before the air is released from the stack. The differential pressure across the filters and the radiation dose rate on the HEPA filters will be monitored. The stack will be continuously sampled and the flow rate recorded to document radioactive emmissions. The sample filter will changed out and analyzed monthly unless an evaluation shows it can be done less frequently. The stack monitoring would show if there was a gross movement of Pu from L Cell into the air tunnel, but a small movement would not be detected due to the decontamination factor across the filters. Since the Pu material in L Cell will be isolated and inaccessable, it is assumed that periodic monitoring of the material on the floor is not required.

The Pu on the floor of L Cell is not considered a safety or environmental risk if left as it is during the surveillance and maintenance period. The Pu will remain inside the PUREX canyon where it is isolated from workers, the public and the environment.

CONCLUSIONS

PUREX management concluded that the material on the L Cell floor should be left as it is and documented in the project turnover package that will be given to Bechtel Hanford Inc. Cleanup of the L Cell floor during deactivation would not be consistent with the deactivation endpoint process. The reasons for reaching this conclusion are listed below:

- No value would be added since leaving L Cell in its present condition is not considered a risk to the public, environment or onsite workers.
- Removing the material from the L Cell floor would not reduce the risk to D&D workers appreciably.
- The ultimate D&D approach/cost for the PUREX plant has not been determined so any work done in L Cell during deactivation will not necessarily facilitate D&D.
- It is estimated that removing the material from the L Cell floor during deactivation would extend the deactivation project schedule by 6 months and increase the cost by $15 million (ROM).

Item A.2: MEMO ON L CELL FLOOR PLUTONIUM ESTIMATES

Westinghouse
Hanford Company

Internal
Memo

From: System Deactivation Engineering
Phone: 373-2841 S6-18
Date: October 19, 1994
Subject: L CELL FLOOR PLUTONIUM ESTIMATES

17710-94-020

To: R. W. Bailey S5-66

cc: T. L. Cox S5-66
D. G. Hamrick S6-15
D. G. Harlow S6-19
J. P. Hayfield S6-18
W. E. Matheison S6-19
C. H. Merry S5-65
L. F. Perkins S6-15
R. L. Walser S6-19
DWN File/LB

PUREX System Deactivation Engineering has completed an estimate of the amount of plutonium (Pu) on the canyon floor of L Cell. Pu estimates are based on twelve (12) samples taken on May 4, 1994 (See Table 1-A and Figure 4-A.)

The density of the samples obtained varied from a light powder to a dense solid. Due to these variations, an analytical solid matrix density provides little value. Laboratory Subject Matter Experts (SME's) were consulted to provide a solid matrix density estimate. A density value of 1.5 gm-matrix/cc was chosen.

Based on sample analyses from samples taken from distinct solid matrix accumulation areas; assuming a solid matrix density of 1.5 gm-matrix/cc and estimating the volume of solid matrix remaining on the L Cell floor, 1,993 grams of Pu remain in those sampled solid matrix accumulation areas on the floor (see Table 1-A).

Refer to Table 2-A and Table 2-B:

Two areas (under T-L2 and TK-L8) were not sampled due to obstructions. Both areas are in line with the flow of criticality drain test solutions (L-14 and L-11, respectively) to the L Cell sump, SLL. In both color and granularity, the solid matrix covering these two "suspect" areas is similar to the solid matrix samples obtained from the Northwest corner (L-11 criticality drainage) floor area. Sample analyses from the solid matrix samples near the L-11 criticality drain area (.177 gPu/gMatrix) and analyses from samples taken closer to SLL along the west wall (.0731 gPu/gMatrix) were applied to provide maximum and minimum Pu estimates for both "suspect" areas. These are summarized in Table 2-A and Table 2-B, respectively.

Item A.2: continued

R. W. Bailey
Page 2
October 19, 1994

17710-94-020

Refer to Table 3-A and Table 3-B:

A concentration gradient estimation method reveals a quantity of Pu approaching the minimum values listed in Table 2-B. The area under T-L2 was first divided into 10 sections of 1 lineal foot each. Using sample data from samples obtained at each end of the T-L2 area, a concentration gradient was applied across the area. Using this method, 1,743 grams of Pu are estimated to exist under T-L2. Dividing the area under TK-L8 into 5 sections of 1 lineal foot each yields a Pu estimate of 159 grams. Concentration gradient values are shown in Table 3-A and Table 3-B, respectively.

In conclusion, limited sampling activities of the L Cell floor have yielded a Pu estimate of 1,993 grams. Two solid matrix accumulations exist under T-L2 and Tk-L8. The maximum Pu estimate for the area under T-L2 and Tk-L8 is 4,175 grams. The minimum Pu estimate for the area under T-L2 and Tk-L8 is 1,725 grams. Adding the sample-based estimate of 1,993 grams Pu, the minimum Pu estimate for the PUREX L Cell floor is 3,718 grams. The maximum Pu estimate for the PUREX L Cell floor is 6,168 grams. The application of a concentration gradient estimation method yields a Pu estimate of 1,743 grams (under L2) and 159 grams (under L8). Adding the sample-based estimate of 1,993 grams Pu, the concentration gradient estimate for the PUREX L Cell floor is 3,896 grams of Pu.

D. W. Nelson

D. W. Nelson, Senior Engineer
System Deactivation Engineering

klw

Attachments 5

Item A.2: continued

Attachment 1
17710-94-020
Page 1 of 1

Table 1-A

L Cell Floor Plutonium Estimate For Sampled Areas

SAMPLE NO.	FT^3	MAX [ ]	TOTAL Pu
1F	.0208 ft^3	.177 gPu/gMatrix	157 gms
2F	.0625 ft^3	.2579 gPu/gMatrix	685 gms
3F	.0208 ft^3	.177 gPu/gMatrix	157 gms
4F	.0625 ft^3	.2579 gPu/gMatrix	685 gms
5F	.0315 ft^3	.0617 gPu/gMatrix	83 gms
6F	.0315 ft^3	.0731 gPu/gMatrix	98 gms
7S	.0625 ft^3	.0142 gPu/gMatrix	38 gms
8S	.0625 ft^3	.0142 gPu/gMatrix	38 gms
9S	.0039 ft^3	.1061 gPu/gMatrix	18 gms
10T	.0104 ft^3	.01895 gPu/gMatrix	8 gms
11T	.0104 ft^3	.0283 gPu/gMatrix	13 gms
12T	.0104 ft^3	.0283 gPu/gMatrix	13 gms
			1993 gms

ASSUMPTION
- Assumes a solid matrix density of 1.5 gm-matrix/cc.

TYPICAL CALCULATION
- For sample 1F:
  gPu = (.177 gPu/gMatrix)(.0208 ft^3)(1.5 gMatrix/cc)(28,317 cc/ft^3)
  gPu = 157 gPu

Item A.2: continued

Attachment 2
17710-94-020
Page 1 of 1

Table 2-A

L Cell Floor Plutonium Estimate (Maximum)
For L2 & L8 (Unsampled) Areas

AREA ID	FT^3	MAX [ ]	TOTAL Pu
L2	.5208 ft^3	.177 gPu/gMatrix	3915 gms
L8	.0347 ft^3	.177 gPu/gMatrix	260 gms
			4175 gms

ASSUMPTION
- Assumes a solid matrix density of 1.5 gm-matrix/cc.

TYPICAL CALCULATION
- For L2:
gPu = (.177 gPu/gMatrix)(.5208 ft^3)(1.5 gMatrix/cc)(28.317 cc/ft^3)
gPu = 3915 gPu

Table 2-B

L Cell Floor Plutonium Estimate (Minimum)
For L2 & L8 (Unsampled) Areas

AREA ID	FT^3	MIN [ ]	TOTAL Pu
L2	.5208 ft^3	.0731 gPu/gMatrix	1617 gms
L8	.0347 ft^3	.0731 gPu/gMatrix	108 gms
			1725 gms

ASSUMPTION

- Assumes a solid matrix density of 1.5 gm-matrix/cc.

TYPICAL CALCULATION

-For L2:
gPu = (.0731 gPu/gMatrix)(.5208 ft^3)(1.5 gMatrix/cc)(28.317 cc/ft^3)
gPu = 1617 gPu

Table 3-A

L Cell Floor Plutonium Estimate (Concentration Gradient)
For L2 & L8 (Unsampled) Areas

AREA ID	FT^3	ASSUMED [ ]	TOTAL Pu
L2	.05208 ft^3	.15394 gPu/gMatrix	353 gms
L2	.05208 ft^3	.13088 gPu/gMatrix	290 gms
L2	.05208 ft^3	.10782 gPu/gMatrix	239 gms
L2	.05208 ft^3	.08476 gPu/gMatrix	188 gms
L2	.05208 ft^3	.06170 gPu/gMatrix	137 gms
L2	.05208 ft^3	.06170 gPu/gMatrix	137 gms
L2	.05208 ft^3	.06170 gPu/gMatrix	137 gms
L2	.05208 ft^3	.05057 gPu/gMatrix	112 gms
L2	.05208 ft^3	.03943 gPu/gMatrix	87 gms
L2	.05208 ft^3	.02830 gPu/gMatrix	63 gms
			1743 gms

ASSUMPTION

- Assumes a solid matrix density of 1.5 gm-matrix/cc.

TYPICAL CALCULATION

-For L2 Suspect Area:

$$gPu = (.15394\ gPu/gMatrix)(.05208\ ft^3)(1.5\ gMatrix/cc)(28,317\ cc/ft^3)$$

$$gPu = 353\ gPu$$

Item A.2: continued

Attachment 4
17710-94-020
Page 1 of 1

Table 3-B

L Cell Floor Plutonium Estimate (Concentration Gradient)
For L2 & L8 (Unsampled) Areas

AREA ID	FT^3	ASSUMED [ ]	TOTAL Pu
L8	.00694 ft^3	.15394 gPu/gMatrix	45 gms
L8	.00694 ft^3	.13088 gPu/gMatrix	39 gms
L8	.00694 ft^3	.10782 gPu/gMatrix	32 gms
L8	.00694 ft^3	.08476 gPu/gMatrix	25 gms
L8	.00694 ft^3	.06170 gPu/gMatrix	18 gms
			159 gms

ASSUMPTION

- Assumes a solid matrix density of 1.5 gm-matrix/cc.

TYPICAL CALCULATION

-For L8 Suspect Area:
gPu = (.15394 gPu/gMatrix)(.00694 ft^3)(1.5 gMatrix/cc)(28.317 cc/ft^3)
gPu = 45 gPu

Item A.2: continued

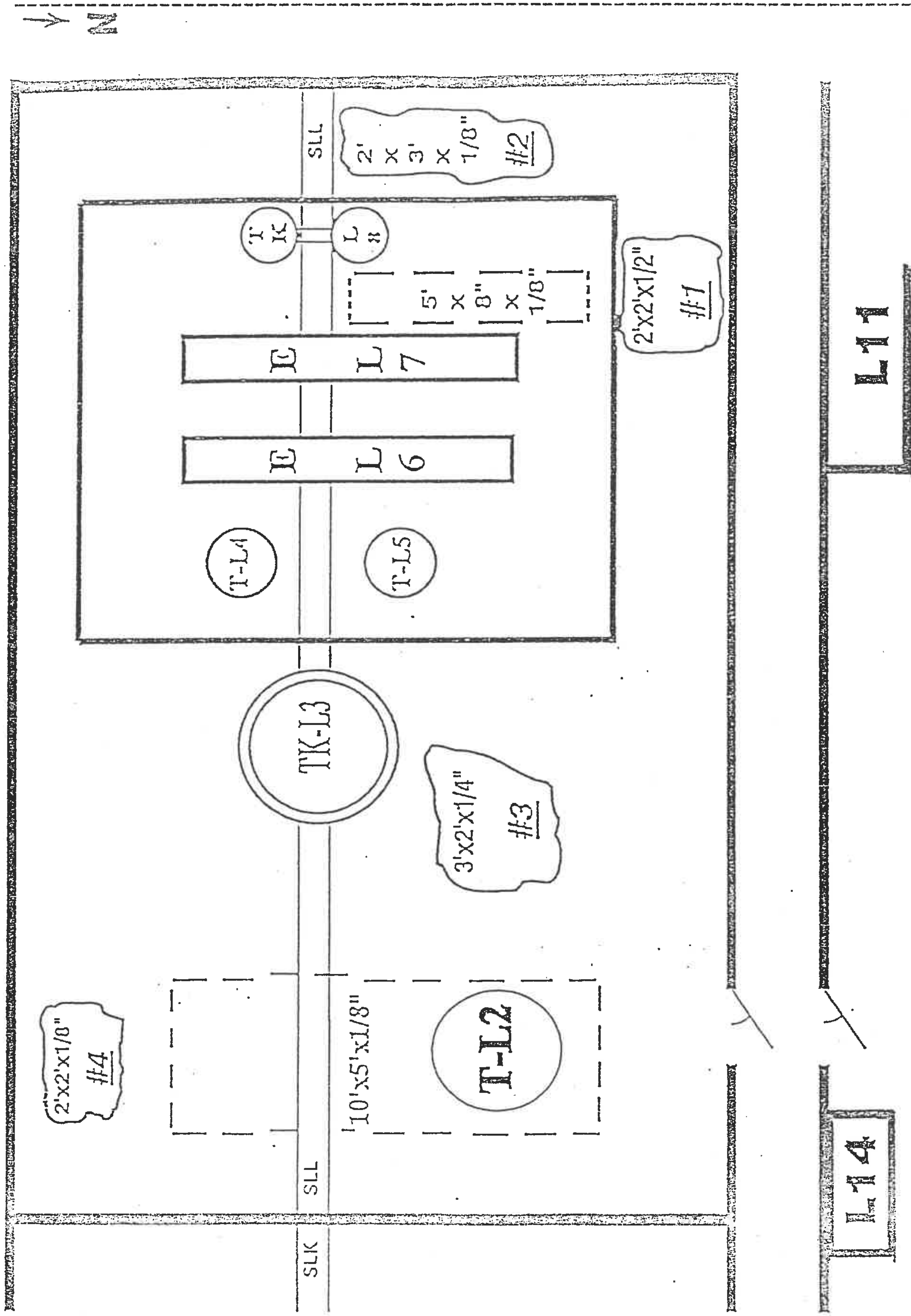

Figure 3. L Cell Floor Pu Area and Thickness Estimates

Item A.2: continued

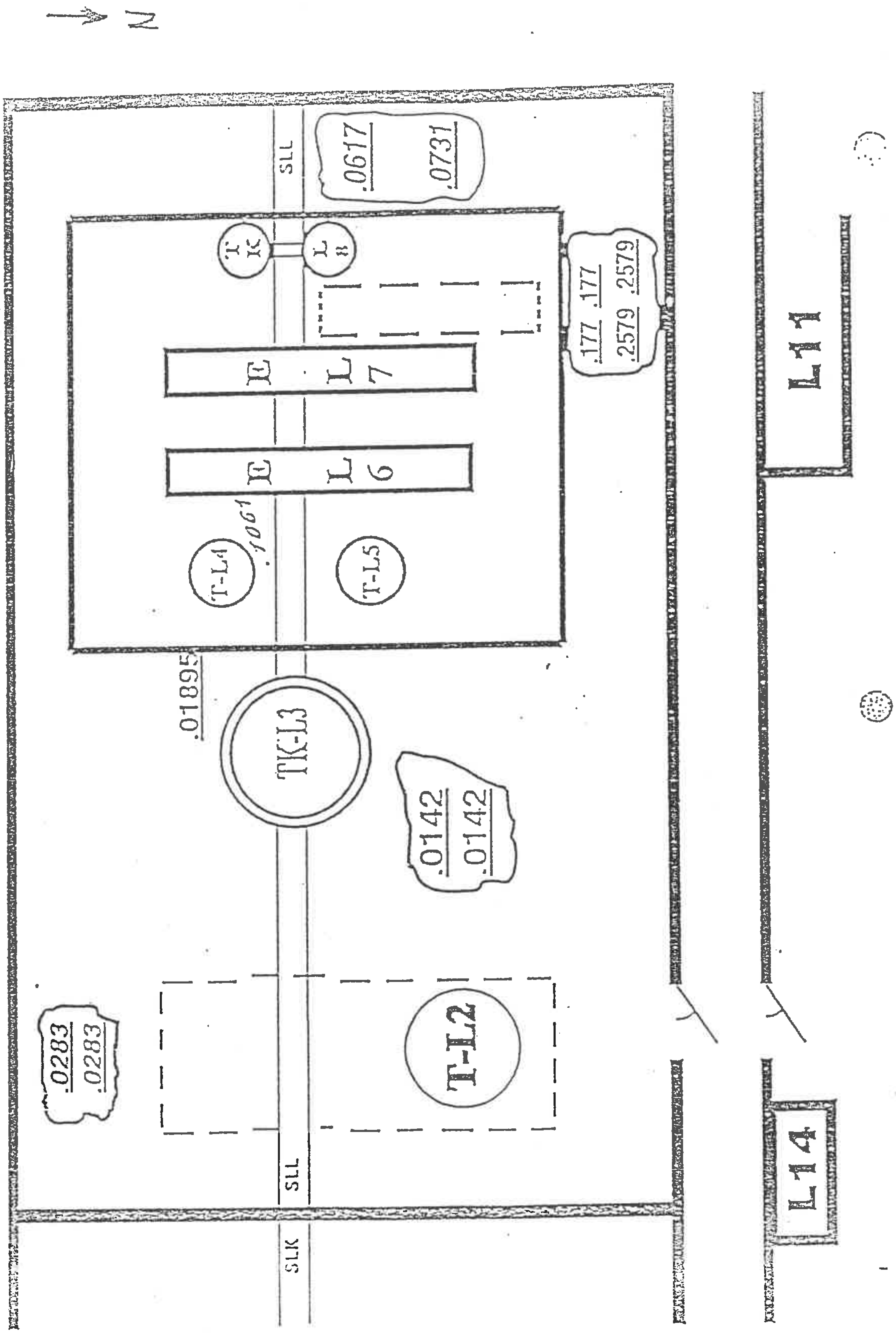

Figure 4. L Cell Floor Pu Sample Results

APPENDIX B:

MEMOS ON CHARACTERIZATION OF N-CELL RESIDUAL PU

ITEM #	DESCRIPTION	PAGE NOS.
B.1	**PNNL Results for Pu in N3/N4 Gloveboxes** Letter by R. J. Arthur (PNL) to A. G. Westra (WHC), May 20, 1996, "PNNL Non-Destructive Assay Results: N-Cell Glove Boxes"	B-2 through B-6
B.2	**Memo on Painting Inside of N-Cell Gloveboxes N3/N4** Letter by A. L. Hess and T. Chiao to File, Criticality and Shielding (ORG 8M730) at WHC, May 21 1996, "Applicability of CSER 86-001, Addendum 1, to Painting Inside of N3/N4 Gloveboxes in PUREX to Fix Residual Plutonium"	B-7 through B-10
B.3	**PNNL NDA Results for N-Cell Maintenance Glovebox** Letter by R. J. Arthur (PNNL) ot A. G. Westra (WHC), June 12, 1996, "PNNL Non-destructive Assay Results: N-Cell Maintenance Glove Box".	B-11
B.4	**PFP NDA Results for N-Cell Wet Gloveboxes N1A, N1B and N6** Letter by E. W. Curfman, (PFP Analytical Lab) to G. R. Henne (PUREX), January 3, 1995, "PUREX N-Cell Inventory"	B-12
B.5	**PFP NDA Results for N-Cell Wet Gloveboxes N2A, N2B and N2C** Letter by E. W. Curfman, (PFP Analytical Lab) to R. J. Robinson (PUREX), April 10, 1995, "Portable NDA of PUREX N-Cells N-2A, N-2B and N-2C"	B-13
B.6	**Summary Tabulation of NDA Results for N-Cell Wet Gloveboxes**	B-14

Battelle

Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-0405

May 20, 1996

Andrew G. Westra
Westinghouse Hanford Company
P. O. Box 1970
Mail Stop S6-21
Richland, WA 99352

Dear Mr. Westra:

PNNL NON-DESTRUCTIVE ASSAY RESULTS: "N-CELL" GLOVE BOXES

This report summarizes data collected between January 30, 1996, and May 10, 1996, using the PNNL NDA Systems on the N-3 and N-4 glove boxes in "N Cell of the PUREX Building, 200 East Area. The PNNL NDA Systems employ high-resolution (HPGe) gamma-ray spectrometers and/or total-neutron slab detectors to characterize radioactive emissions using non-destructive assay (NDA) techniques.

The counts were performed to assess the quantity and distribution of high-burnup plutonium expected within the N-3 and N-4 glove boxes. Initial measurement of the ratios of gamma rays arising from the decay of ^{239}Pu and ^{241}Pu confirmed the presence of high-burnup (12% ^{240}Pu) plutonium. We were informed that, toward the end of the assaying effort, the glove box had been thoroughly cleaned of any concentrated buildup of plutonium. Use of a collimated gamma-ray spectrometer ultimately confirmed this statement. We were also told to assume that the majority of the remaining plutonium would be uniformly spread on the walls or pieces of equipment. Again, data collected using a collimated gamma-ray detector confirmed this assumption.

Physical Layout of the N-3 and N-4 Glove Boxes

The N-3 and N-4 glove boxes of "N Cell" present themselves to the outside viewer as an integral unit. The glove boxes stand 25' tall and are serviced on the upper level by a mezzanine positioned roughly 12½' above the floor. The upper-level glove box extends 21' to a shield door that leads to an attached maintenance glove box. The lower-level glove box extends 25' to a shield door that leads through a power-loadout glove box to a can-fill station. The positioning of external support members divided the assay units into 3'-wide sections. Distance between glove-box wall and room wall limited the distance that the NDA equipment could be moved back from the glove boxes. Assays were obtained at a stand-off distance of at most 14" and as little as 4" in some instances. Various arrangements were devised to assay higher portions of the

Item B.1: continued

A. G. Westra
Page 2
May 20, 1996

glove boxes when overhead support structures and equipment did not interfere in the assay setup.

Activity Measured via Gamma-Ray Spectrometry

Several sets of data were acquired using high-purity germanium (HPGe) gamma-ray spectrometers and various combinations of collimators. Initially, a large aperture system was used to obtain gamma-ray data for photons detected passing through 3'x6' areas along the face of the upper and lower floors adjacent to the glove box.

Later, a collimator was designed to fit an ORTEC hand-held gamma-ray spectrometer system. The collimator system consisted of a 1-cm-thick sleeve of lead that fit over the snout of the detector and shielded the germanium crystal from low-energy gamma rays entering from oblique angles. Pairs of lead inserts with square holes were used to provide various aspect ratios. The spectrometer with this collimator system was calibrated using a 100-gram weapons-grade PuO_2 standard (α-particle activity traceable to NBS/NIST standards) that simulated a point source. A second plutonium standard obtained from Purex workers confirmed the PNNL calibrations; the Purex standard, 198-3, contains 198-g ^{239}Pu as the nitrate on filter media that is centered in a 208-L drum.

Results

A summary of the results for the PNNL plutonium assay of the N-3 and N-4 glove boxes of the Purex "N Cell" are provided in Fig. 1. The glove boxes have been schematically divided into upper and lower levels, separated by a mezzanine floor. The location of the floor of N-3 is also indicated on the upper level. The glove boxes are divided into 3'-wide sections. The upper level is divided into 2'-high segments and the lower level is divided into 4'-high segments; most of the glove box is nominally 3' thick (distance between the walls.)

The numbers within the rectangles represent the apparent weight of high-burnup plutonium located within the corresponding glove box volume. The data analysis that generated Fig. 1 was performed by extracting the peak area of the 414-keV gamma ray, which is directly associated with the quantity of ^{239}Pu within the detector field-of-view. The initial estimate of plutonium was then corrected for cross-talk that occurs when gamma-rays in an adjacent section are seen by the limited collimation associated with any given assay of a section. The resulting data were then corrected for cross-talk that arises within a given section from plutonium located above and/or below the position being assayed.

Item B.1: continued

A. G. Westra
Page 4
May 20, 1996

The data of Fig. 1 therefore provide an assay of plutonium content that would explain the gamma-ray data collected if the plutonium were spread uniformly along the center plane of the glove boxes. It is known that the majority of the plutonium is distributed on the interior walls of the glove box and on the surfaces of the gloves. The data provided in Fig. 1 therefore represent a conservative estimate of plutonium content and are expected to slightly overestimate the actual quantity present. The individual data confirm that the plutonium, in general, is equally divided between the two opposing faces of a given section and height. Neutron counts obtained using a total-neutron slab detector also confirm this observation. In addition, the collimated hand-held system allowed the gamma-ray system to view potential "hot spots" with greater detail; in several instances, the higher resolution data confirmed that there was no aggregate of plutonium within the glove box that exceeded 46 grams.

Results and Conclusions

The PNNL plutonium assay of the N-3 and N-4 glove boxes of the Purex "N Cell" indicates the presence of approximately 1.360 kg high-burnup plutonium. A schematic of the glove box is provided that indicates the distribution of the plutonium throughout the cell. Potential "hot spots" were examined in greater detail with a more tightly collimated gamma-ray spectrometer; higher-resolution data observed no aggregate of plutonium within the glove box that exceeded 46 grams. The quantity of plutonium in the upper level is roughly twice the quantity found in the lower level. In general, higher plutonium contents correspond to positions where equipment is located.

Item B.1: continued

A. G. Westra
Page 6
May 20, 1996

Date: 5/16/96 6:10 PM

File: NCELL_SN.XLS

PNNL Plutonium Assay of N-3 and N-4 of "N Cell"

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8
9'+	52	119	12	17	16	12.5	23	
7'-9'	99	2	31	15	12.5	8	8	
5'-7'	11	57	7.5	13	5	7	22	
3'-5'	105	60	9	15	10	13	7	
1'-3'	55	0	31	19	20	13	28	
Mezzanine Floor								
8'-12'	15	23	63	20	14	18	37.5	0
4'-8'	23	16	26	13	0	2	1.5	2
0'-4'	35	6	9	9	40	28	0	22

Units are grams of Plutonium

Upper: 934.5 g
Lower: 423.0 g
Total: 1357.5 g

Floor of Glovebox

Figure 1 PNNL Plutonium Assay of N-3 and N-4 Glove Boxes of the Purex "N Cell."

Item B.1: continued

A. G. Westra
Page 5
May 20, 1996

Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-0405.

Sincerely,

Dr. Richard J. Arthur
Sr. Research Scientist

TRU Results Review and Concurrence:

Dr. Ronald L. Brodzinski
Staff Scientist

Enclosures
Attachments

cc w/attachments:
DE Robertson, P8-01
MD Winterrose, P8-01
File /LB

Date: May 21, 1996 8M730-ALH/TC-96-001

To: File

From: A. L. Hess and Tang Chiao,
Criticality and Shielding, Org.8M730

Subject: Applicability of CSER 86-001, Addendum 1, to Painting Inside of N3/N4 Gloveboxes in PUREX to Fix Residual Plutonium.

Reference: WHC-SD-SQA-CSA-20401, *Addendum 1 to CSER 86-011, Glovebox Cleanup in PUREX*, D.E. Friar, Westinghouse Hanford Company, October 6, 1995.

Confirmation of the subject question was requested by E. Dodd III, as Criticality Safety Representative for PUREX, before implementation of work-plans for final decommissioning activities on the N3/N4 complex of gloveboxes in the N-Cell of PUREX. Attachment 1 to this letter summarizes the status of the N3/N4 gloveboxes at the present. Attachment 2 provides a summary of the NDA mapping by PNNL for the residual Pu holdup in this part of the N-Cell facility. Attachment 3, a drawing showing a vertical section through the gloveboxes in question, is included for reference against the Attachment-2 mapping to show why some areas/equipment bear higher residual Pu deposits.

The residual Pu holdup of ~1360 grams total quoted on the attachment-2 NDA survey is on the order of 1400 grams lower than assay sums reviewed in early March of this year, taken before the last cleanup campaign was initiated in preparation for the PNNL work. These comparisons indicate that further decontamination would not be practical, and the residual Pu holdup now would involve extraordinary happenings to get it to anywhere near a criticality hazard. The Attachment 1 review establishes that adequate measures are in place to preclude additions of large amounts of water. The intended coatings of the glovebox walls and floor will provide further protection against mixing of the residues with inadvertent-entry water over the years ahead.

The proposed operation is similar to that which was carried out for the PR Room Glovebox at PUREX. The interior walls, floor and remaining equipment inside of N3/N4 will be painted with a water-based, non-strippable paint, using a spray nozzle instead of brushes. It is reasonable to expect that there would not be more than a gallon of paint still liquid on the interiors surfaces at any time, so that the formation of a critical thickness floor pool by slumping and carry down of plutonium would not be credible.

As for the previous painting inside of the PR Room glovebox, conduct of operations at PUREX will provide assurance the operators will remove any containers, rags and other debris involved in the painting effort when the process is finished.

It is concluded that, despite a total glovebox Pu holdup of over double the minimum critical mass (with very ideal conditions), the CSER 86-011 addendum encompasses the proposed work scope, and that the painting further reduces the probability for formation of a critical configuration with this residue.

Item B.2: MEMO ON PAINTING INSIDE OF N-CELL GLOVEBOXES N3/N4

Item B.2: continued

Status of N3/N4 Gloveboxes

The N3/N4 gloveboxes contained equipment to convert Pu nitrate into Pu oxide by oxalate precipitation followed by calcination. The Pu oxide powder was then blended and loaded into product cans. The N3/N4 gloveboxes were built as a unit that is 22' high x 25' long x 3' wide with a dividing wall that separated it into two processing areas. The smaller N3 glovebox contained the precipitator tank, vacuum drum filter, and first stage calciner. The N4 glovebox contained the second stage calciner, the scalper for screening Pu oxide, two blenders, a blender dolly, and a product can conveyor.

Prior to the start of N Cell deactivation, all liquid sources to the gloveboxes were isolated. Then equipment in the N3/N4 gloveboxes was disassembled and the Pu holdup removed. Smaller pieces of equipment were bagged out of the gloveboxes and packaged into TRU waste drums. The glovebox walls and remaining equipment have been wiped down with wet rags to remove contamination. The Halon fire protection system will remain in service until the remaining contamination is fixed and the gloves are all replace with stubby bags and port covers. The glovebox ventilation system will remain in service until the gloveboxes are vented to the air tunnel

5/21/96 Letter, AL Hess to File

ATTACHMENT 1: Note on N3/N4 Status

Item B.2: continued

Date: 5/16/96 6:10 PM

File: NCELL_SM.XLS

PNNL Plutonium Assay of N-3 and N-4 of "N Cell"

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8
9'+	52	119	12	17	16	12.5	23	
7'-9'	99	2	31	15	12.5	8	8	
5'-7'	11	57	7.5	13	5	7	22	
3'-5'	105	60	9	15	10	13	7	
1'-3'	55	0	31	19	20	13	28	Floor of Glovebox
Mezzanine Floor								
8'-12'	15	23	63	20	14	18	37.5	0
4'-8'	23	16	26	13	0	2	1.5	2
0'-4'	35	6	9	9	40	28	0	22

Units are grams of Plutonium

Upper:	934.5 g
Lower:	423.0 g
Total:	1357.5 g

5/21/96 Letter, AL Hess to File ATTACHMENT 2: N-CELL NDA MAPPING

Item B.2: continued

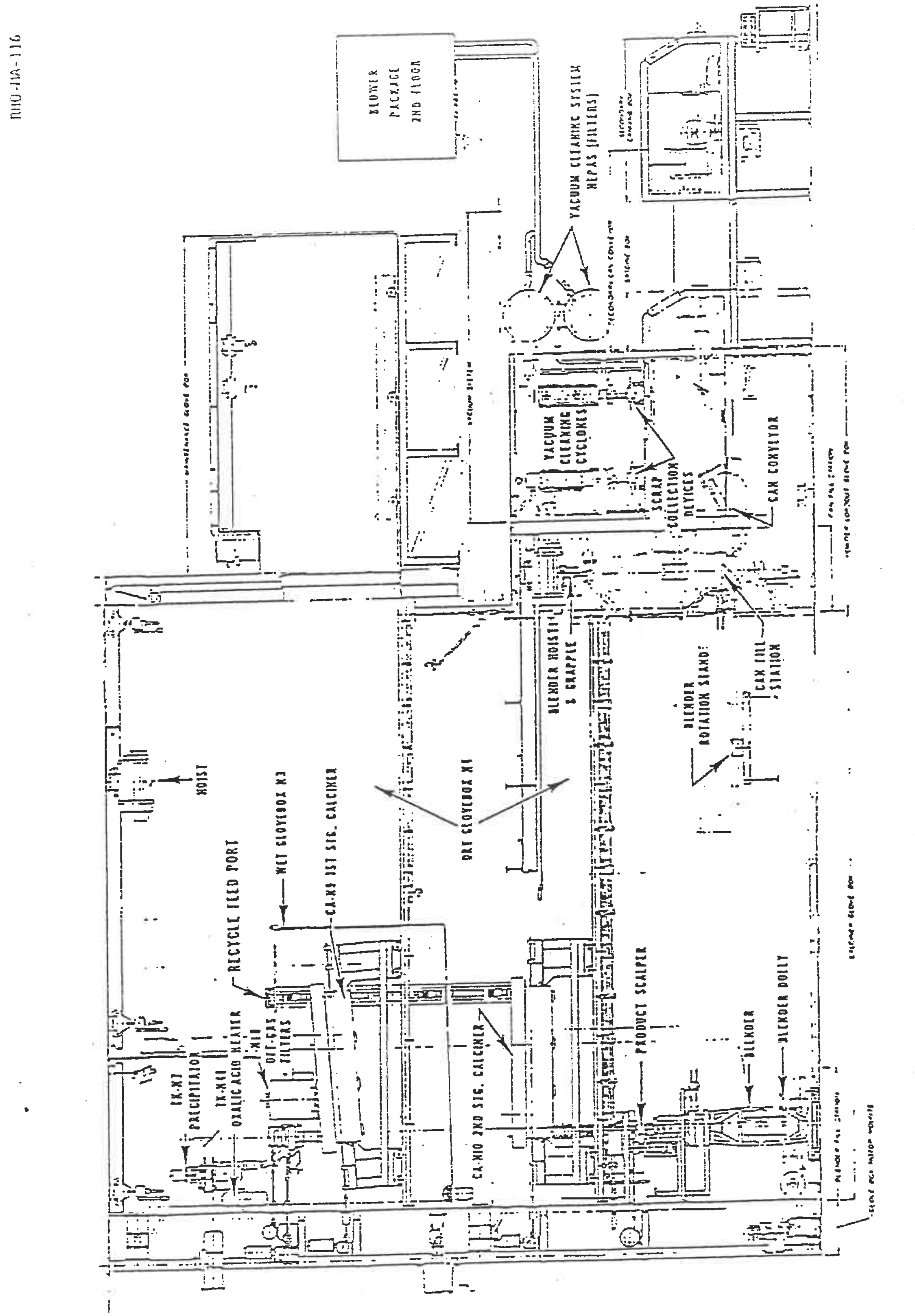

FIGURE 1.1-8. Gloveboxes N3 and N4 Equipment Arrangements (H-2-65400).

1-17/(1-18 blank)

5/21/96 Letter. AL Hess to File ATTACHMENT 3: GLOVEBOX N3/N4 ELEVATION VIEW

Item B.3: PNNL NDA RESULTS FOR N-CELL MAINTENANCE GLOVEBOX

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-0405

June 12, 1996

Andrew G. Westra
Westinghouse Hanford Company
P. O. Box 1970
Mail Stop S6-21
Richland, WA 99352

Dear Mr. Westra:

PNNL NON-DESTRUCTIVE ASSAY RESULTS: "N-CELL" MAINTENANCE GLOVE BOX

Subsequent to our report of May 20, 1996, that summarizes data collected between January 30, 1996, and May 10, 1996, using the PNNL NDA Systems on the N-3 and N-4 glove boxes in "N Cell of the PUREX Building, 200 East Area, I was asked by you to provide information regarding NDA results of the Maintenance Glove Box located on the upper mezzanine.

The log of data collected and discussions with my technician, Mr. Martin Winterrose verify that data were not collected on the contents of the Maintenance Glove Box other than data collected February 23, 1996. These data were presented at a meeting held March 11, 1996. Our estimates were divided among 3 sections that were 3 feet wide. The estimated weight of plutonium in the Maintenance Glove Box was (27 g + 16 g + 117 g) = 160 g. These estimates have been corrected for cross-talk between the 3'-wide sections as counted. This quantity of plutonium would be in addition to the 1.360 kg previously reported. The 117 g has been associated with pieces of equipment in that reside in the corresponding 3'-wide section of the Maintenance Glove Box. Our experience in the N-3 and N-4 glove boxes would indicate that this plutonium is present as smaller quantities; the most probable scenario is that some plutonium is present uniformly coating walls and surfaces of gloves and that the remainder is split between the 2 pieces of equipment.

Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-0405.

Sincerely,

Dr. Richard J. Arthur

cc:
DE Robertson, P8-01
RL Brodzinski, P8-07
MD Winterrose, P8-01
File /LB

Item B.4: PFP NDA RESULTS FOR N-CELL WET GLOVEBOXES N1A, N1B AND N6

Westinghouse
Hanford Company

Internal
Memo

15400-95-002

From: PFP Analytical Laboratory
Phone: 373-4654 T5-05
Date: January 3, 1995
Subject: PUREX N-Cell Inventory

To: G. R. Henne S5-58

cc: T. W. Ellis T4-40
A. L. Fishback S5-51
M. B. Nelson T4-40
R. J. Robinson S5-65
T. L. Welsh T6-07
C. R. Stallbaum T5-05
NDA File
EWC:LB File

On December 18, 1994, three Purex N-Cell Gloveboxes were assayed for residual plutonium content. This assay was performed with a high purity germanium detector and multichannel analyzer. The assay was completed by S. L. Holden, and D. L. Sorenson. The plutonium values are listed in Table 1 by hood number and item name.

Table I: PUREX N-Cell Residual Plutonium Content

Item Identification	Best Pu Result (grams)	Least Pu Result (grams)	Most Pu-Result (grams)
Hood N-1A	28	4	114
Hood N-1B	38	9	118
Hood N-6	22	2	107

The plutonium values listed in Table 1 are reported as the Best, Least and Most Results. The Best Result assumes the plutonium is located as a point source at the center of the item assayed. The Least Result assumes the plutonium is located as a point source at the surface nearest the detector, and the Most Result assumes the plutonium is located as a point source at the surface furthest from the detector. The counting uncertainity at two sigma is also included in Least and Most Results. The Least and Most Results are uncertainties in the measurement and should be treated as such.

Should you have any questions regarding this assay, please contact Cheryl Stallbaum on 373-2562 or myself.

E. W. Curfman
E. W. Curfman
Manager

crs

Item B.5: PFP NDA RESULTS FOR N-CELL WET GLOVEBOXES N2A, N2B AND N2C

Westinghouse
Hanford Company

Internal
Memo

From: PFP Analytical Laboratory — 15400-95-028
Phone: 373-4654 T5-05
Date: April 10, 1995
Subject: PORTABLE NDA OF PUREX N-CELLS N-2A, N-2B, AND N-2C

To: R. J. Robinson S5-65

cc: C. R. Stallbaum T5-05
NDA File
EWC:LB File

On March 30, 1995 the PUREX N-Cells N-2B and N-2C were assayed for residual plutonium content. The assays were completed by S. L. Holden and D. L. Sorenson using the HPGe Detector Serial #5841111.

N-Cell N-2A was not assayed because the tank, which was the item being assayed in the hood, had been removed. The residual plutonium content in N-2B is 10 grams with a range of 0 to 87 grams. The residual plutonium content in N-2C is 14 grams with a range of 2 to 72 grams.

Should you have any questions regarding this assay, please contact Cheryl Stallbaum on 373-2562 or myself.

E W Curfman

E. W. Curfman
Manager

crs

Item B.6:

SUMMARY TABULATION OF NDA RESULTS FOR N-CELL WET GLOVEBOXES

N CELL NDA RESULTS AFTER COMPLETION OF WET GLOVEBOX CLEANOUT- 3/27/95

GLOVEBOX	NDA BEST VALUE	NDA LEAST VALUE	NDA MOST VALUE	DATA SOURCE
N7	7	0	39	MEMO 11/3/94
N6	22	2	107	MEMO 15400-95-002
N1A	28	4	114	MEMO 15400-95-002
N1B	38	9	118	MEMO 15400-95-002
N2A	4	0	18	MEMO 15400-95-028
N2B	10	0	87	MEMO 15400-95-028
N2C	14	2	72	MEMO 15400-95-028
TOTAL (N1A+N1B+N2A+N2B+N2C)	94	15	409	
TOTAL FOR ALL WET GBs	123	17	555	

APPENDIX C:

MEMOS ON CHARACTERIZATION OF PR-ROOM RESIDUAL PU

ITEM #	DESCRIPTION	PAGE NOS.
C.1	**Memo on NDA Results for L9 Glovebox in the PR Room:** Letter by R. J. Arthur (PNNL) to A. G. Westra (WHC), April 18, 1996, "PNNL Non-destructive Assay Results"	C-2 through C-7
C.2	**Memo on NDA Results for L11 Glovebox in the PR Room:** Letter by R. J. Arthur (PNL) to A. G. Westra (WHC), March 28, 1996, "PNNL Non-destructive Assay Results"	C-8 through C-12
C.3	**Memo on NDA Results for L14 Glovebox in the PR Room:** Letter by R. J. Arthur (PNL) to A. G. Westra (WHC), April 1, 1996, "PNNL Non-destructive Assay Results"	C-13 through C-16

Item C.1: Memo on NDA Results for L9 Glovebox in the PR Room:

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-0405

April 18, 1996

Andrew G. Westra
Westinghouse Hanford Company
P. O. Box 1970
Mail Stop S6-21
Richland, WA 99352

Dear Mr. Westra:

PNNL NON-DESTRUCTIVE ASSAY RESULTS

This report summarizes data collected March 30, 1996, April 3, 1996, and April 11-17, 1996, using the PNNL NDA Systems on the L9 Glovebox in the Product Removal (PR) Room of the PUREX Building, 200 East Area. The PNNL NDA Systems employ high-resolution (HPGe) gamma-ray spectrometers and/or total-neutron slab detectors to characterize radioactive emissions using non-destructive assay (NDA) techniques.

The counts were performed to assess the upper-limit quantity of plutonium expected within the L9 Glovebox and to assess its relative distribution. We were informed that the glovebox had never processed fluorides. Our gamma-ray data confirmed this information. We were also told to assume that the majority of the plutonium would be on or near the floor of the glovebox. Again, data collected using a collimated gamma-ray detector confirmed this assumption.

Alpha-Particle Activity Measured via Passive Neutron Counting

The passive thermal-neutron counter is a slab-type detector that employs 10 $^{10}BF_3$ tubes surrounded by 2.54-cm-thick high-density polyethylene. The 5-cm-diameter $^{10}BF_3$ tubes have an active length of roughly 180 cm and a fill pressure of 12 kPa. The boron is enriched to 95% ^{10}B.

Alpha-particle activity in the glovebox results in neutron emissions via (α,n) reactions, predominantly with oxygen and other light elements of the matrix. Neutron emissions are also generated by spontaneous fission, typically of even-numbered transuranic isotopes, such as ^{240}Pu. We were told to assume weapons-grade (6% ^{240}Pu) plutonium nitrate in the PR Room L9 Glovebox.

The neutron counts were taken at the face of the glovebox and again at a distance of approximately 27 cm at 4 separate positions along the 20-foot length of the glovebox; background counts were taken on a platform just inside the door to the

Item C.1, continued

A. G. Westra
Page 2
April 18, 1996

PR Room. Figure 1 shows the layout of the PR Room with the counting positions marked as "Section 1", "Section 2", "Section 3", and "Section 4." Sections 1 and 2 were visibly more contaminated than Sections 3 and 4, with Section 4 visibly being the least affected by previous campaigns.

The narrow false-floor adjacent to the face of the L9 Glovebox made positioning of the detectors difficult and limited the distance that the detectors could be moved back from the glovebox face. The narrow construction and the concrete walls resulted in a "neutron cave" in which emitted neutrons bounce between walls until thermalized and absorbed: a given neutron typically has several chances to be counted by a detector, which increases the apparent efficiency of the neutron detector; a point source does not appear to strictly follow the $1/R^2$-law but some smaller fraction of 2; a line source does not appear to strictly follow the 1/R-law but some smaller fraction of 1. These anomalies complicate the interpretation of observed data.

Table 1 summarizes count rates obtained along the L9 Glovebox on 3 separate occassions. The count on 03/28/96 established a baseline for the L9 Glovebox neutron count. A total of 425 g of plutonium were removed prior to the count on 04/03/96. A total of 228 g of plutonium were removed prior to the count on 04/11/96.

Table 1. Summary of Counts Taken Along the L9 Glovebox in the PR Room of PUREX.

Location	Distance to Face (cm)	Count Rate [03/28/96] (c/60s)	Count Rate [04/03/96] (c/60s)	Count Rate [04/11/96] (c/60s)
Outer Area	--	3749 ± 87	--	--
L9: Section 1	0	253910 ± 151	168130 ± 346	110616 ± 462
L9: Section 1	27	220903 ± 222	150402 ± 571	100955 ± 170
L9: Section 2	0	146020 ± 504	126598 ± 333	113487 ± 56
L9: Section 2	27	137034 ± 100	117744 ± 121	105251 ± 345
L9: Section 3	0	59333 ± 261	51214 ± 127	58203 ± 21
L9: Section 3	27	56064 ± 54	53126 ± 205	57738 ± 94
L9: Section 4	0	27225 ± 229	22570 ± 285	23625 ± 109
L9: Section 4	27	28449 ± 95	24018 ± 499	24349 ± 174

Item C.1, continued

A. G. Westra
Page 3
April 18, 1996

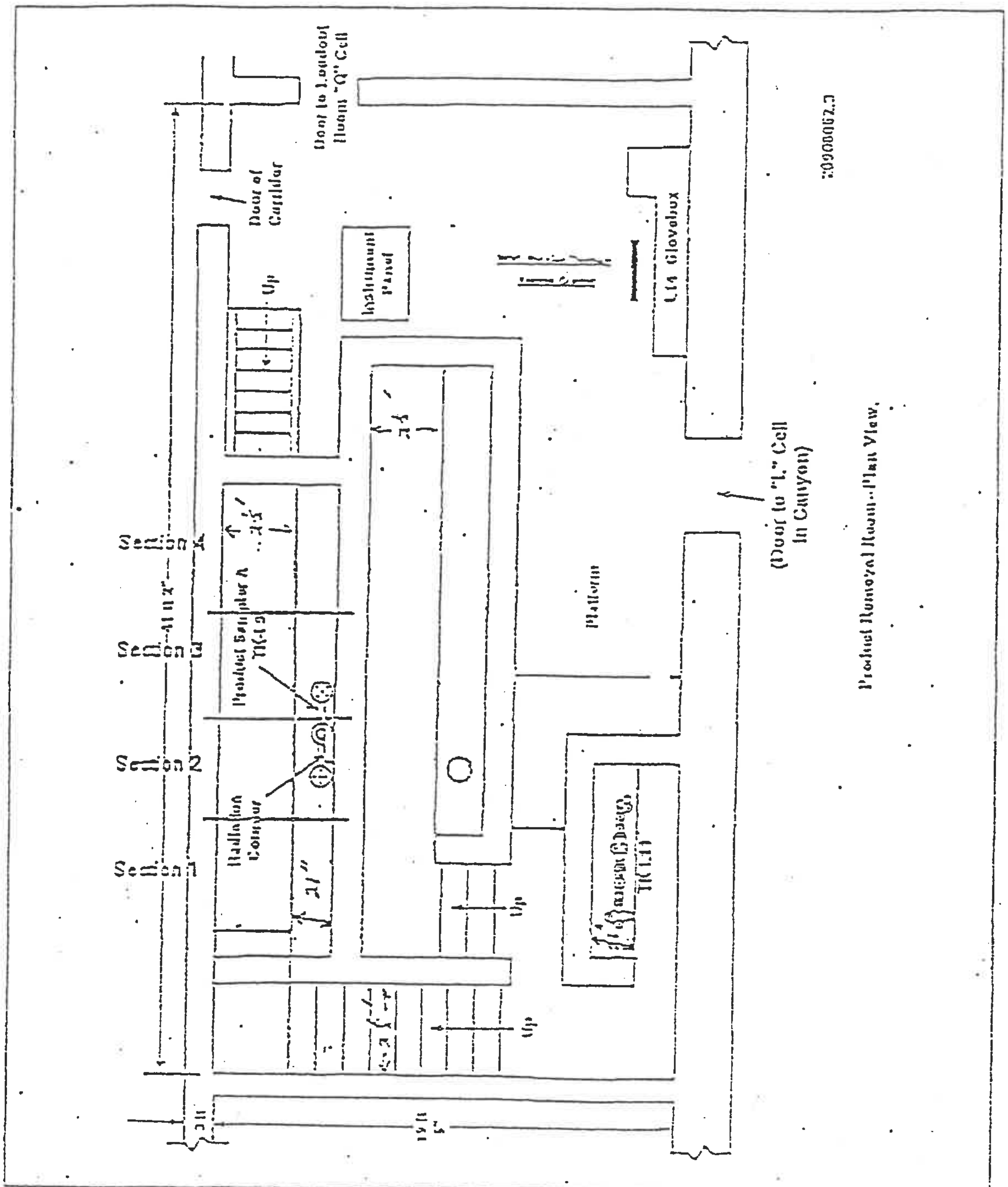

Figure 1 Product Recovery (PR) Room Layout.

Activity Measured via Gamma-Ray Spectrometry

Several sets of data were acquired using a high-purity germanium (HPGe) gamma-ray spectrometer. A collimator was designed to fit an ORTEC hand-held system. The collimator system consisted of a 1-cm-thick sleeve of lead that fit over the snout of the detector and shielded the germanium crystal from low-energy gamma rays entering from oblique angles. Lead inserts with square holes were used to provide various aspect ratios. The spectrometer with this collimator system was calibrated with a 100-gram weapons grade PuO_2 standard that simulated a point source.

Gamma-ray results were used to identify radiological activity within the L9 Glovebox, to locate hot spots, and to establish concentration levels. The gamma-ray system confirmed that fluorine was not present in the L9 Glovebox at a level that would detrimentally inflate the neutron count rate via the $^{19}F(\alpha,n)^{22}Na$ reaction; the presence of fluorine is manifest in the gamma-ray spectrum as 511-keV and 1275-keV gamma rays that are not as well resolved as adjacent peaks due to prompt capture/decay effects. The gamma-ray spectrometer also indicated the presence of ^{137}Cs in the L9 Glovebox with a higher ratio at Section 4 (relative to the plutonium) than in the other sections. The presence of ^{228}Th was also observed, presumably arising from ^{232}U (since no activity from ^{228}Ac was observed that would indicate ^{232}Th as the parent of the ^{228}Th).

Results and Conclusions

The neutron data were heavily used to estimate the quantity of plutonium present in the L9 Glovebox. The known response of the neutron counter to neutron sources at different positions allows corrections to be made for the cross-talk expected when counting adjacent sections. The gamma-ray data were used to aid the model used to correlate expected readings with actual measurements. Some allowance was made for the "neutron cave" effect and the apparent increased efficiency of the neutron counter.

The source term was apportioned in each section to a planar, a linear, and a point source. The planar source is allowed to be on both walls and does not vary with distance from the detector. The planar and linear sources are assumed to be close to the far wall of the glovebox.

The results of using this model and a similar, independent model are provided in Table 2. The Planar source is assumed to be a thin layer coating the face and back wall of the glovebox. The Linear source is assumed to be concentrations on the floor, along corners, and along any tubing. The Point source is assumed to be any pockets or hot spots.

The change in count rate for each section after known quantities of plutonium were removed proved invaluable in estimating the quantity remaining. The

Item C.1, continued

A. G. Westra
Page 5
April 18, 1996

approximate location of the removed quantities also contributed to estimating total amounts.

The total estimated quantity of plutonium is assumed to be spread throughout the glovebox, with larger quantities on or near the floor as may well be expected. The numbers in the table include the 125 g of plutonium removed on 4/17-18/96; therefore, the estimated plutonium remaining in the box currently is ≈1 kg. Additional data taken with the neutron counter after the 125 g quantity had been bagged up, but before it was removed from the hood, completely support the table data. Additionally, data taken with the gamma-ray spectrometer, especially looking at the floor through a hole in the side of the lead sleeve, further confirms these estimated quantities, further confirms that the preponderance of the remaining plutonium in is the lower reaches of the glove box, stongly supports the column of point source values, and indicates no particular heavy buildup of material that might constitute a criticality concern.

Table 2. Estimated Quantity of Plutonium: L9 Glovebox of the PR Room in PUREX.

Location	Estimated Quantity of Plutonium [Planar] (g)	Estimated Quantity of Plutonium [Linear] (g)	Estimated Quantity of Plutonium [Point] (g)	Total Estimated Quantity of Plutonium (g)
L9: Section 1	100	240	80	420
L9: Section 2	100	250	140	490
L9: Section 3	40	50	80	170
L9: Section 4	10	50	0	60
Total	250	590	300	1140

12

Item C.1.g. continued

Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-3405.

Sincerely,

Dr. Richard J. Arthur
Sr. Research Scientist

TRU Results Review and Concurrence:

Dr. Ronald L. Brodzinski
Staff Scientist

Enclosures
Attachments

cc w/attachments:
DE Robertson, P8-01
MD Winterrose, P8-01
File /LB

Item C.2, continued

A. G. Westra
Page 2
March 28, 1996

The counts were taken at a distance of approximately 27 cm at 3 separate positions along the glovebox, which is located within a contamination zone; background counts were taken on a platform just inside the door to the "L" Cell. Table 1 summarizes count rates obtained along the L11 Glovebox, as well as some counts taken in "N" Cell for comparison. Figure 1 shows the layout of the "L" Cell with the counting positions marked as "Section 1", "Section 2", and "Section 3."

Table 1. Summary of Counts Taken Along L11 Glovebox Located in the Product Removal Room of PUREX.

Location	Count Rate (c/30s)	Background Rate (c/30s)	Net Count Rate (c/30s)
"N" Cell, Upper S-1	496802	159828	336974
Outer "L" Cell Area	--	3673 ± 115	--
L11: Section 1	21160 ± 38	3673	17487
L11: Section 2	16514 ± 70	3673	12841
L11: Section 3	12650 ± 62	3673	8977
L11: Section 1, Opposite Concrete Wall	3829	--	--
L11: Section 2, Opposite Concrete Wall	2333	--	--
L11: Section 3, Opposite Concrete Wall	1909	--	--

Results and Conclusions

The behavior of the counts along the L11 Glovebox is consistent with a quantity of neutron-emitting TRU concentrated in the low end of the glovebox. Counting in the hallway on the far side of the concrete wall confirmed this behavior. However, a more conservative assumption was used to analyze the data, and each section counted was assumed to have some plutonium present that provided minimal cross-talk to adjacent counting locations.

Item C.2, continued

A. G. Westra
Page 3
March 28, 1996

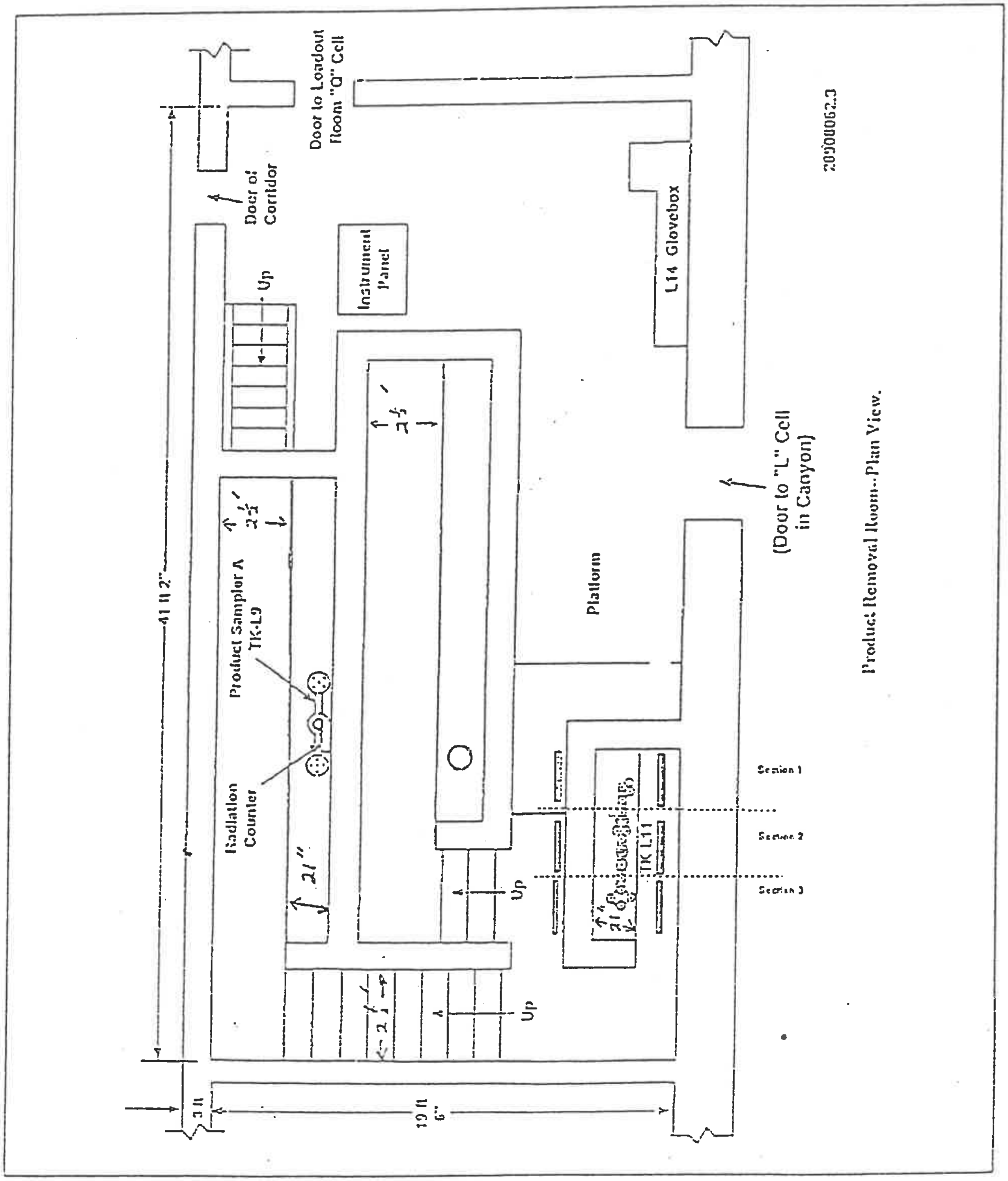

Figure 1

Item C.2, continued

A. G. Westra
Page 4
March 28, 1996

The amounts of plutonium estimated for the L11 Glovebox are based on the levels observed in the N-3 Glovebox of "N" Cell. The quantity of plutonium estimated to be at the Upper S-1 location of "N" Cell, based on gamma-ray spectrometry, was 655 g at the time of the neutron count. A ratio of the thermal-neutron count at the Upper S-1 location to the L11 counting locations provides an estimate of high-burnup plutonium that one would expect to find. The ratio of the specific neutron-emission rates for weapons-grade plutonium oxide versus fuels-grade yields the upper-limit quantity of plutonium listed in Table 2. The specific neutron-emission rate of weapons-grade PuO_2, neglecting any ^{241}Am that has decayed from ^{241}Pu, is roughly 107 n/s/g, whereas "N" cell material with 12.052% ^{240}Pu and 0.989% ^{241}Am (relative to plutonium) is calculated as 220 n/s/g. The assumption was made that the presence of nitrate does not enhance the neutron emission rate from (α,n) reactions on the oxygen. If significant quantities of fluorine are present, the estimated quantities of plutonium would be even lower.

Table 2. Estimated Quantity of Plutonium in L11 Glovebox of "L" Cell in PUREX.

Location	Estimated Maximum Quantity of Plutonium (g)
"N" Cell, Upper S-1 (12% Pu-240)	655
L11: Section 1	72
L11: Section 2	29
L11: Section 3	37
L11: Total (6% Pu-240)	138

Item C.2, continued

A. G. Westra
Page 5
March 28, 1996

Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-0405.

Sincerely,

Dr. Richard J. Arthur
Sr. Research Scientist

TRU Results Review and Concurrence:

Dr. Ronald L. Brodzinski
Staff Scientist

~~Enclosures~~
~~Attachments~~

cc ~~w/attachments~~:
DE Robertson, P8-01
MD Winterrose, P8-01
File /LB

Item C.3:
Memo on NDA Results for L14 Glovebox in the PR Room:

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-0405

April 1, 1996

Andrew G. Westra
Westinghouse Hanford Company
P. O. Box 1970
Mail Stop S6-21
Richland, WA 99352

Dear Mr. Westra:

PNNL NON-DESTRUCTIVE ASSAY RESULTS

This data summary is for work performed March 29, 1996, using the portions of the PNNL NDA Systems on the L14 Glovebox in the Product Removal Room of the "L" Cell at the PUREX Building, 200 East Area. The PNNL NDA Systems employ high-resolution (HPGe) gamma-ray spectrometers and/or total-neutron slab detectors to characterize radioactive emissions using non-destructive assay (NDA) techniques.

The counts were performed to assess the upper limit of plutonium expected within the L11 Glovebox, which is 7.62 m tall. We were informed that the glovebox had been acid washed and that the plutonium would therefore be in the form of nitrates. We were also told to assume that the majority of the plutonium would be in the lowest regions of the glovebox where the acid solutions would settle; such assumptions should be reasonable since, unlike the N-3 and N-4 Gloveboxes of "N" Cell, no oxide powders should be present that would be carried by convection to upper regions of the tall glovebox.

Alpha-Particle Activity Measured via Passive Neutron Counting

The passive thermal-neutron counter is a slab-type detector that employs 10 $^{10}BF_3$ tubes surrounded by 2.54-cm-thick high-density polyethylene. The 5-cm-diameter $^{10}BF_3$ tubes have an active length of roughly 180 cm and a fill pressure of 12 kPa. The boron is enriched to 95% ^{10}B.

Alpha-particle activity in the glovebox results in neutron emissions via (α,n) reactions, predominantly with oxygen and other light elements of the matrix. Neutron emissions are also generated by spontaneous fission, typically of even-numbered transuranic isotopes, such as ^{240}Pu. We were told to assume high-burnup (fuels grade with 12% ^{240}Pu) PuO_2 in counts taken of "N" Cell, but to assume weapons-grade (6% ^{240}Pu) plutonium nitrate in the "L" Cell L11 Glovebox.

A. G. Westra
Page 2
April 1, 1996

The counts were taken at a distance of approximately 27 cm at 3 separate positions along the glovebox, which is located within a contamination zone; background counts were taken on a platform just inside the door to the "L" Cell. Table 1 summarizes count rates obtained along the L11 Glovebox, as well as some counts taken in "N" Cell for comparison. Figure 1 shows the layout of the "L" Cell with the counting positions marked as "Section 1", "Section 2", and "Section 3."

Table 1. Summary of Counts Taken in Front of the L14 Glovebox Located in the Product Removal Room of PUREX.

Location	Count Rate (c/30s)	Background Rate (c/30s)	Net Count Rate (c/30s)
"N" Cell, Upper S-1	496802	159828	336974
L14 @ 24 cm	13493 ± 73	1773 ± 33	11720

Results and Conclusions

The amount of plutonium estimated for the L14 Glovebox is based on the levels observed in the N-3 Glovebox of "N" Cell. The quantity of plutonium estimated to be at the Upper S-1 location of "N" Cell, based on gamma-ray spectrometry, was 655 g at the time of the neutron count. A ratio of the thermal-neutron count at the Upper S-1 location to the L11 counting locations provides an estimate of high-burnup plutonium that one would expect to find. The ratio of the specific neutron-emission rates for weapons-grade plutonium oxide versus fuels-grade yields the upper-limit quantity of plutonium listed in Table 2. The specific neutron-emission rate of weapons-grade PuO_2, neglecting any ^{241}Am that has decayed from ^{241}Pu, is roughly 107 n/s/g, whereas "N" cell material with 12.052% ^{240}Pu and 0.989% ^{241}Am (relative to plutonium) is calculated as 220 n/s/g. The assumption was made that the presence of nitrate does not enhance the neutron emission rate from (α,n) reactions on the oxygen. If significant quantities of fluorine are present, the estimated quantities of plutonium would be even lower.

A. G. Westra
Page 3
April 1, 1996

Item C.3, continued

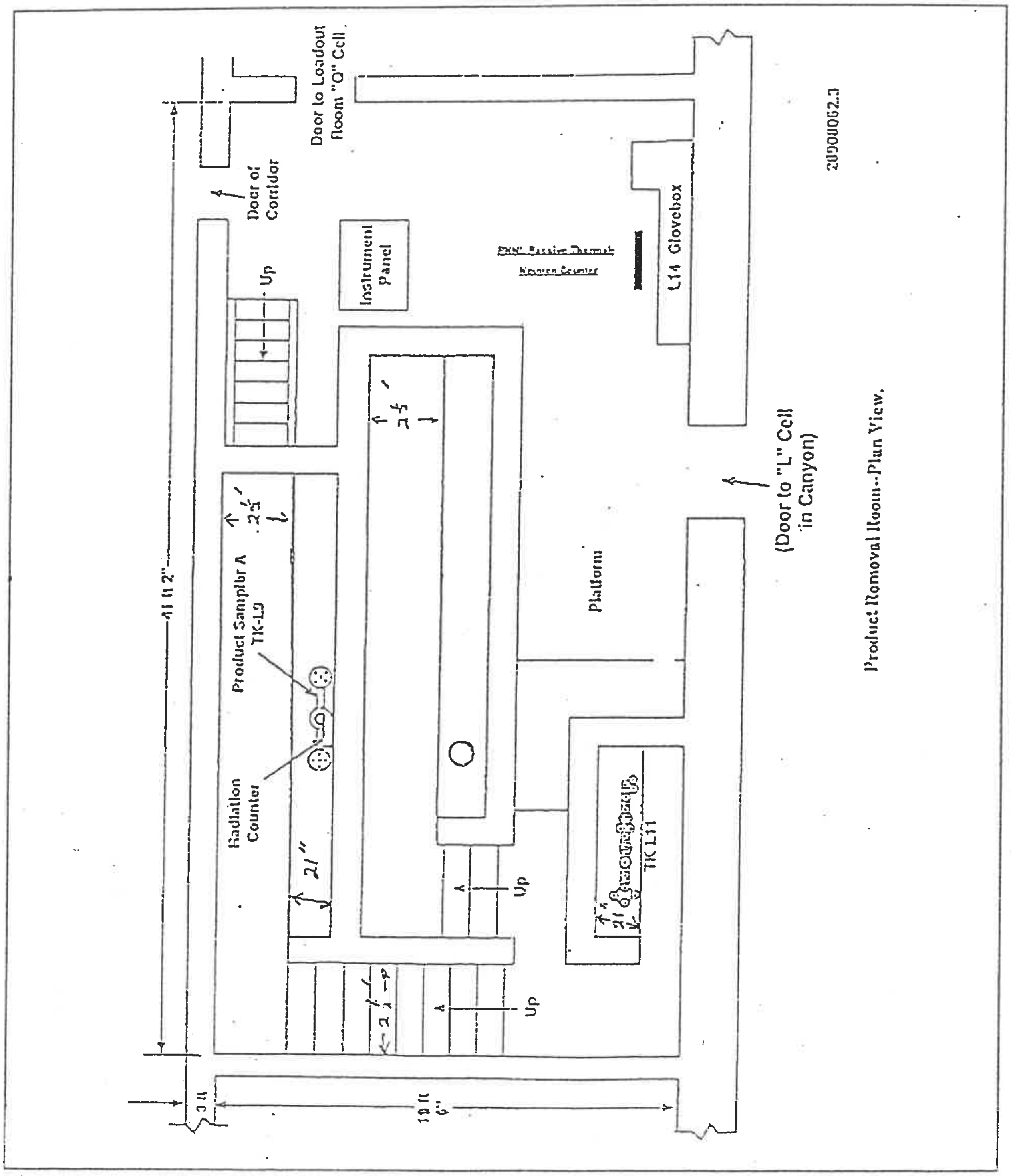

Figure 1

Item C.3, continued

A. G. Westra
Page 4
April 1, 1996

Table 2. Estimated Quantity of Plutonium in L11 Glovebox of "L" Cell in PUREX.

Location	Estimated Maximum Quantity of Plutonium (g)
"N" Cell, Upper S-1 (12% Pu-240)	655
L14: Total (6% Pu-240)	47

Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-0405.

Sincerely,

Dr. Richard J. Arthur
Sr. Research Scientist

TRU Results Review and Concurrence:

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cc:
DE Robertson, P8-01
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